MODERATING EFFECTS OF THE SCHOOL SUPPORT SYSTEM ON THE RELATIONSHIP BETWEEN TEACHER-RELATED FACTORS AND ICT INTEGRATION IN GEOGRAPHY INSTRUCTION IN SELECTED PUBLIC SECONDARY SCHOOLS IN KENYA

BY

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DECLARATION

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DEDICATION

I dedicate this thesis to my beloved wife, Caroline Bett, whose unwavering support, love, and encouragement have been my pillar of strength throughout this journey. To my wonderful children, Ian Kimutai, Bravin Cheluget, Beryl Chebungei, and Caren Cherotich, you are my inspiration and the reason I strive to be a better person every day. I also dedicate this work to my dear father Gideon Bett and my Mother Constantine Bett, who have always believed in me and instilled in me the value of education and hard work.

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ABSTRACT

Despite the acknowledged benefits of ICT integration in Geography, actual levels of ICT integration by Geography teachers remain low in many countries including Kenya. Several studies have enumerated both barriers and influencers for successful ICT integration in teaching various subjects with limited focus in Geography subject. The purpose of this study was to investigate the moderating effect of school support system on the relationship between teacher-related factors and ICT integration in Geography instruction in selected Kenyan National and Extra- County secondary schools. The specific objectives are to Establish the availability and use of ICT resources for teaching Geography, to determine the influence of teachers' ICT self-efficacy on ICT integration in Geography Instruction, to examine the impact of teachers' attitudes towards technology on ICT integration in Geography instruction, to find out the effects of teachers' pedagogical strategies on ICT integration in Geography Instruction, and to determine the overall moderating effect of school support system on the relationship between teacher-related factors and ICT integration in Geography Instruction The study drew theoretical underpinnings from the Technology Acceptance Model, Unified Theory of Acceptance and Use of Technology (UTAUT) and Technological Pedagogical Content Knowledge (TPACK) framework. The choice of multiple theoretical framework was informed by the concept of theoretical integration approach which emphasizes on use of multiple theories to capture different dimensions of a research problem for comprehensive understanding of a complex phenomenon. The study employed a mixed method research design which encompasses both quantitative and qualitative techniques. The study was grounded in a pragmatic research philosophy because it emphasizes on practical solutions and real-world application, making the study more relevant and actionable. The target population comprises principals, heads of Geography departments, and Geography teachers in 106 National and Extra County secondary schools in the North Rift region, where most of the schools come from close proximity to the urban centres with several learning institution to provide access to ICT resources. The target population was 863 participants from which sample size of 274 respondents was selected using Taro Yamane's formula at a 5% margin of error. The study used proportionate, stratified and random sampling to select 34 principals 34 head of Geography departments and 206 teachers of Geography. Data collection instruments include a structured questionnaire and semi-structured interviews, and document analysis. Data analysis techniques include Correlation, multiple regression, moderated regression, and thematic analysis for qualitative data. Descriptive statistics showed that all the indicators that measured the constructs of the study demonstrated strong capability in integrating ICT into Geography Instruction with mean ranging from (4.85-3.47) this high mean indicate that all the teacher-related factors and school support system enhances ICT integration. Regression analysis revealed that teachers' ICT self-efficacy is the strongest predictor of successful technology integration followed by pedagogical. Interestingly, despite positive attitudes toward technology showing moderate correlation with integration, the regression analysis revealed a negative relationship, with school support systems showing significant direct effects but no moderating influence. The combined model explained 75.8% of variance. Thematic analysis also showed positive responses to all aspects of school support system. The findings of this study contributed to the knowledge base on ICT integration in geography Instruction and it provides insights for the educational policymakers, educators, and researchers to promote effective technology integration in teaching and learning. Based on these findings, researcher recommend prioritizing professional development that enhances teachers' ICT self-efficacy and student-centred pedagogical strategies. Professional development programs should focus on practical implementation skills to bridge the attitude-integration gap, schools should strengthen support systems (infrastructure, technical support, leadership), and develop comprehensive frameworks that address both teacher capabilities and institutional support simultaneously, while education policymakers should establish minimum standards for ICT infrastructure and technical support in schools.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABBREVIATIONS

BI	Behavioral Intention
CK	Content Knowledge
CLIL	Content and language integrated learning
CVI	Content Validity Index
GIS	Geographic Information Systems
GPS	Global Positioning System
ICT	Information and Communication Technology
I-CVI	Item-level Content Validity Index
IDT	Innovation Diffusion Theory
IREC	Institutional Research and Ethics Committee
KES	Kenyan Shillings
NACOSTI	National Commission for Science, Technology and Innovation
PCK	Pedagogical Content Knowledge
PEOU	Perceived Ease of Use
PEUE	Perceived Ease of Use and Efficacy
PK	Pedagogical Knowledge
PU	Perceived Usefulness
S-CVI	Scale-level Content Validity Index
SPSS	Statistical Package for the Social Sciences
TCK	Technological Content Knowledge
TK	Technological Knowledge
TPACK	Technological Pedagogical Content Knowledge
TPB	Theory of Planned Behavior
TPK	Technological Pedagogical Knowledge
TRA	Theory of Reasoned Action
UTAUT	Unified Theory of Acceptance and Use of Technology

CHAPTER ONE

INTRODUCTION TO THE STUDY

1.1 Introduction

The integration of ICT into Geography Instruction offers powerful tools for spatial analysis, data visualization, and authentic learning experiences. The presence of a curriculum that supports the use of ICT in Geography Instruction can contribute to more effective integration. This includes guidelines on how to incorporate digital tools in lesson plans (Eisenberg & Johnson, 2019). Studies such as the one conducted by Hew & Brush, (2020) have demonstrated that the integration of ICT in Geography Instruction can enhance student engagement and motivation, leading to better learning outcomes However, this requires thoughtful integration that aligns with students' learning preferences. Collaboration among teachers, sharing best practices and forming professional learning communities can foster an environment conducive to ICT integration (Davis et al., 2006). However, studies conducted by Storey (2021) on future trends in Geographic instruction indicated low integration of geospatial technologies like GIS and GPS in secondary schools, despite their potential benefits. Understanding the interplay of teacher-related factors and school support systems is crucial in promoting effective technology integration and to leverage ICT for enhancing Geography Instruction. This gave critical insights into the effectiveness of using ICT tools to enhance student learning outcome, encouraging critical thinking and preparing students for an increasingly competitive digital world.

This study employed convergent mixed method research design, utilizing both quantitative and qualitative strand to investigatethe moderating effect of school support system on the relationship between teacher-related factors and ICT integration in Geography instruction in selected Kenyan secondary schools, to enable the understanding of the conditions under which teacher factors interact with the school support system in maximizing technology use in Geography Instruction.

This chapter provides a comprehensive overview of the research study, introducing the background, problem statement, purpose, objectives and research questions. It also presents the hypotheses, justification, significance, assumptions, scope, and limitations of the study. The theoretical framework, which includes the Technological Pedagogical Content

Knowledge (TPACK) Framework, and Unified Theory of Acceptance and Use of Technology (UTAUT), is discussed, along with the conceptual framework and operational definitions of key terms. This chapter lays the foundation for the entire study, setting the stage for the subsequent chapters that delved deeper into the literature review, methodology, data analysis, and discussion of findings.

1.2 Background of the Study

The integration of ICT into education has become an important focus globally in the 21st century, as it enhances teaching and learning experiences, equips students with digital literacy skills needed for future careers, and improves educational outcomes (UNESCO, 2022; Kadhim, 2020). The field of Geography education stands to greatly benefit from the integration of ICT. Geospatial technologies such as GPS, GIS, remote sensing, virtual globes, and online mapping platforms offer powerful tools for spatial analysis, data visualization, fieldwork, and active learning, making geography more engaging and relevant for students (Kadhim, 2020; West, 2020; Storey, 2021). These technologies allow students to interact with authentic data, solve real-world problems, conduct investigations, collaborate with peers and experts, create multimedia artefacts, and participate in virtual field trips. Effective use of ICT in Geography classrooms can enhance spatial thinking skills, geographical knowledge, motivation, attitudes towards learning, self-directed and inquiry-based learning, and academic achievement (Cox & Abbott, 2017; Lee & Catling, 2019). Utilization of ICT resources in Geography prepares learners in achieving a National goal of education of developing Economic and career readiness though the use of Geographic data analysis, GIS, Cartography, and spatial problem-solving skills that are valuable in urban planning, environmental management, GIS industries and tourism

Despite the acknowledged benefits of ICT integration in Geography Instruction, the actual level of teachers' integration remain low in many countries as was found out by (Rani & Kant 2016:3329).This indicates that the availability of technology alone does not guarantee its effective integration in teaching and learning. Other barriers according to (Chisango & Marongwe, 2021). Include: inadequate access to ICT infrastructure and resources in schools, insufficient teacher training and technical support, inadequate of time to learn and integrate new technologies, curriculum constraints, and teacher-related factors like negative attitudes, low self-efficacy, and traditional pedagogical beliefs. According to the a study conducted in Zambia by Chirwa & Mubita, (2021) on preparedness of teachers and learners in the integration of ICT in teaching and learning Geography, the study showed that only 30% of

geography teachers had access to computers in their schools, and merely 20% had received ICT training. This finding highlights the need for increased investment in ICT infrastructure and professional development to support effective integration. Without addressing these barriers, the potential of ICT to transform Geography Instruction remains unrealized.

While countries like Singapore and Korea according to ((UNESCO Bangkok, 2020) have shown that the Countries have made significant strides with high student-computer ratios, other countries like Bangladesh still grapple with conventional lecture-based instruction and limited ICT experience among teachers In Indonesia, a study conducted by Ni'matussyahara et al.(2023) has demonstrated the potential of interactive digital media, such as the Our-Space website, to enhance media skills, accommodate different learning styles, and provide immersive and personalized learning experiences in geography However, realizing these benefits requires overcoming the variation in accessibility of ICT tools and capacity gaps that persist in many regions.

According to Balica et al., 2018; Sobaih et al.(2020), African continent lags behind in educational ICT integration due to inadequate infrastructure, poor connectivity, lack of technical support and maintenance, and insufficient teacher capacity .A study conducted in In Namibia by Nuumbosho et al. (2022) shows that ICT has the potential to enhance teaching and learning, but challenges such as lack of ICT infrastructure, inadequate teacher training, and limited technical support hinder its effective integration, in addition, the study by (Banda, 2023)also found that only 40% of geography teachers had access to computers, and a mere 25% had received ICT training. In Malawi another study conducted by Vagenas, et. al (2020)., has shown that despite positive attitudes towards ICT integration among teachers, barriers such as lack of facilities, inadequate skills, and limited training opportunities persist. Overcoming these challenges requires a multi-faceted approach, including investing in infrastructure, providing regular training, and incorporating ICT into curricula. Without addressing these systemic issues, the potential of ICT to transform Geography Instruction in these regions remains limited.

In Kenya, the government recognizes the importance of ICT in enhancing access, quality, and equity in education and has undertaken policy initiatives such as the National ICT Policy (2006), ICT Strategy for Education and Training (2006), establishment of computer labs in some schools, and integration of ICT into curricula and teacher training (Kenya MoE, 2019). However, implementation gaps persist, with a student-computer ratio of 250:1 in secondary

schools and most lacking internet connectivity (Kenya MoE, 2016). According to a study by Salamba & Yusuf, (2019) in Kenya, they found 39% of secondary teachers who felt confident using ICT in lessons but barriers cited by teachers include inadequate facilities, lack of training and support, insufficient time, heavy workloads, exam-oriented curricula, and negative attitudes. Studies such as the one conducted by Tarricone, (2021), highlighted the potential of approaches like Content and language integrated learning(CLIL) and multimedia resources can enhance engagement and learning outcomes in geography, realizing these benefits requires addressing the systemic barriers to effective ICT integration.

In the context of Kenyan secondary schools, the integration of geospatial technologies in geography Instruction remains low as shown by a study conducted by Akelo & Omondi, (2020) where only 5% of schools have access to GIS, with most teachers relying on conventional resources like globes and printed maps, challenges identified in their study include the lack of GIS-trained teachers, inadequate computer facilities, unsupportive instructional leadership on Geography teaching, and a curriculum that emphasize on factual knowledge over inquiry skills. The low penetration of educational ICTs in schools deprives students opportunities to engage with current geospatial data and technologies used in many careers such as cartography and survey (Kerski & Baker, 2019; Oganyo & Samkange, 2021). Addressing this gap requires a coordinated effort to build teacher capacity, improve infrastructure, and align curricula with the demands of a technology-driven world.

The COVID-19 pandemic has further exposed the digital divide, necessitating remote learning solutions like radio, TV, and online platforms. However, many students lacked access to digital devices and internet at home, with only 22% of households having computers and 43% internet access (Kenya National Bureau of Statistics, 2019). While teachers expressed positive attitudes towards ICT during the pandemic, they faced challenges such as lack of facilities, inadequate skills and limited training opportunities (Oyewumi, 2020). This crisis has amplified the urgent need for schools to invest in ICT infrastructure and teacher professional development to ensure continuity of learning during emergencies and prepare students for the digital world.

Even in schools with ICT infrastructure, effective integration depends on human factors like teachers' skills, attitudes, and pedagogical practices. Study such as the one conducted by (Kisirkoi, 2015; Namirembe et al., 2022) has consistently shown that these teacher-related factors are key determinants influencing integration and use of ICT. While teachers may have

positive attitudes towards ICT, they often face challenges such as lack of facilities, inadequate skills, and limited training opportunities (Ajagbe, 2023). Addressing these challenges requires a collaborative effort from policymakers, administrators, and teachers to prioritize ICT integration and provide necessary resources and support. Merely providing infrastructure is insufficient; effective integration requires addressing the human factor.

Teachers' pedagogical strategies, self-efficacy and teacher's attitudes towards technology play a crucial role in determining the effectiveness of ICT integration in Geography Instruction. Traditional lecture-based or teacher-directed approaches fail to realize the potential benefits of technology for promoting active, authentic, and engaging learning experiences (Noguera-Fructuoso & Valdivia-Vizarreta, 2023; Jayeoba et al., 2022). Effective integration requires student-centered, inquiry-based pedagogies that align with the affordances of ICT tools and resources. However, many teachers lack the specific competence to select and integrate appropriate technologies for teaching various geography content areas effectively, hindered by gaps in their technological pedagogical content knowledge (TPACK) according to (Mensah et al., 2022). Additionally, teachers' digital literacy skills and ability to incorporate technology into subject-specific pedagogical strategies are essential (Jayeoba et al., 2022). Addressing these gaps requires targeted professional development initiatives that build teachers' technical skills and equip them with pedagogical strategies for integrating ICT into geography instruction. Realizing the transformative potential of geospatial technologies in Geography Instruction requires a comprehensive approach that addresses teachers' TPACK, digital literacy, and subject-specific pedagogical strategies for integrating technology effectively. Therefore, the integration of ICT into Geography Instruction offers the potential to enhance teaching and learning experiences, equip students with digital literacy skills, and improve educational outcomes. However, despite these acknowledged benefits and measures put in place such as infrastructural development, ICT policy framework and Promotion of digital Literacy in Kenya, actual levels of ICT integration by geography teachers remain low due to various barriers, including inadequate infrastructure and resources, insufficient teacher training and support, lack of time, curriculum constraints, and teacher-related factors like negative attitudes, low self-efficacy, and traditional pedagogical beliefs. The COVID-19 pandemic has further exposed the digital divide and the urgent need to equip schools and teachers to deliver Instruction through ICT. Addressing these systemic challenges requires a coordinated effort from education policymakers, educators, and stakeholders to invest in infrastructure, provide

regular professional development, align curricula, and support teachers in developing the necessary skills, attitudes, and pedagogical strategies for effective technology integration. Only by addressing the complex interplay of individual, technological, and contextual factors can the transformative potential of ICT be realized in Geography Instruction. Therefore, this study investigated the moderating effects of school support system on the relationship between teacher-related factors and ICT integration in Geography Instruction.

1.3 Statement of the Problem

Geography is a subject that equips learners with knowledge and skills to understand complex spatial relationships in an increasing interconnected world(Cox and Abbott (2017), learning Geography encourages critical thinking on the ways in which humans interact with their environment hence fostering informed citizenship and sustainable practices. Geography instructional process requires incorporation of ICT into Geography teaching by use of ICT resources such a geospatial technologies like GPS, online mapping platforms, remote sensing, and GIS for spatial analysis, data visualization, fieldwork, and active learning which aligns with the main objective of teaching Geography in order to achieve ICT and data literacy skill in Secondary school. The integration of Information and Communication Technologies (ICT) in Geography Instruction has the potential to enhance teaching and learning outcomes by promoting spatial thinking skills, geographical knowledge, motivation, attitudes towards learning, self-directed, inquiry-based learning, and academic achievement. However, despite the increasing recognition of ICT's importance, its effective implementation remains limited in many contexts, including Kenya as studies suggest that the success of ICT integration into instruction is influenced by a range of factors related to teachers, such as their self-efficacy, teachers' attitude, and pedagogical integration strategies. Nonetheless, these teacher-related factors do not operate in isolation; they are often moderated by contextual school support systems, including the school support such as ICT resources ranging from computer labs, GIS softwares and digital maps, professional development opportunities, and technical support (Ngure, 2022).

In Kenya, despite substantial investments in ICT infrastructure and policy frameworks intended to promote ICT integration in schools, there remains a notable gap in the effective application of these technologies in Geography Instruction (MoE, 2020). The study findings by (Ngware et al., 2019).suggest that many teachers exhibit low levels of self-efficacy regarding their ability to integrate ICT into their lessons, potentially stemming from inadequate training and support. Additionally, teachers' attitudes towards technology integration can significantly influence their willingness to embrace these instructional

strategies (Hew & Brush, 2007). A positive attitude may foster innovation and engagement, whereas a negative perspective may lead to resistance and minimal use of available ICT resources (Mumtaz, 2000).Furthermore, the pedagogical strategies that teachers adopt when integrating ICT can play a crucial role in determining the educational outcomes of students in Geography (Olofson et al., 2015). Various studies conducted on ICT Integration in teaching have enumerated both barriers and influencers for successful ICT integration in teaching various subjects with limited focus in Geography subject. Based on the studies that have been conducted in ICT integration in Geography, there is limited empirical research that specifically investigated how the aspects of teacher-related factors such as teacher's self-efficacy, attitudes towards technology, and pedagogical integration strategies impact the effectiveness of ICT integration in Geography instruction within the Kenyan context. A study conducted in Kenya by (Wanyonyi et al., 2020) showed variability in the extent to which ICT is integrated into Geography Instruction. This variation is partly attributed to the differing levels of support provided by schools. Additionally, there is limited empirical research examining how teacher-related factors such as ICT self-efficacy, attitudes towards technology, and pedagogical strategies interact with the school support system in shaping ICT integration in geography Instruction in the Kenyan context (Kisirkoi, 2015; Namirembe et al., 2022. This study explored the interplay of teacher self-efficacy, attitudes towards ICT integration, and the pedagogical strategies employed and the moderating effects of school support system on the integration of ICT in Geography Instruction. Conducting a study on ICT integration in Geography align with increasing access which help to build data literacy and evidenced-based reasoning relevant to local issues like land use climate change and urban planning. Understanding these dynamics is vital in developing interventions and support mechanisms that can enhance the integration of ICT, ultimately improving educational outcomes in Geography and equipping students with the necessary skills for the 21st century.

1.4 Purpose of Study

The purpose of this study was to investigate the moderating effect of school support system on the relationship between teacher-related factors, and ICT Integration in Geography instruction in selected Kenyan public secondary schools.

1.5 Research Objectives

The specific objectives of this study are:

i. To establish the Availability and adequacy of ICT resources for teaching and learning of Geography in selected Kenyan National and Extra County schools.

ii. To determine the influence of teachers' ICT self-efficacy on ICT integration in Geography Instruction in selected Kenyan National and Extra -county secondary schools.

iii. To examine the impact of teachers' attitudes towards technology on ICT integration in Geography Instruction in selected Kenyan National and Extra County secondary schools.

iv. To find out the effects of the teachers' pedagogical strategies on ICT integration in Geography Instruction in selected Kenyan National and Extra County secondary schools.

v. To determine the moderating effect of the school support system on the relationship between teacher ICT self-efficacy, attitudes towards technology, pedagogical strategies, and ICT integration in Geography instruction in the selected Kenyan National and Extra- County secondary schools.

1.6 Research Questions

Are the ICT resources available and adequate for teaching and learning Geography?

i. To what extent does teachers' ICT self-efficacy influence their integration of ICT in Geography Instruction?

ii. How does the teachers' attitude influence integration of ICT in Geography Instruction?

iii. To what extent does teachers' pedagogical strategy influence integration of ICT in Geography Instruction?

iv. To what extend does school support system moderate the relationship between teacher-related factors and ICT integration in Geography Instruction?

1.7 Hypotheses

i. H_{01}: Teachers' ICT self-efficacy has no statistically significant influence on their integration of ICT in Geography Instruction.

ii. H_{02}: Teachers' attitudes towards technology have no statistically significant influence on their integration of ICT in Geography Instruction.

iii. H_{03}: Teachers' pedagogical strategies have no statistically significant influence on their integration of ICT in Geography Instruction.

iv. H_{04}: School support system has no statistically significant moderating effect on the relationship between teacher-related factors and ICT integration in Geography Instruction.

1.8 Justification of the Study

The importance of ICT integration in education cannot be overstated, and the Kenyan government has made efforts to promote it (National ICT Policy (2006). However, the actual integration of ICT in geography instruction remains low in public secondary schools (Ajagbe, 2023). Previous studies such as the one conducted by (Agbo & Ugwoke, 2021) have focused on general ICT use rather than subject-specific integration, and there is limited empirical research on how teacher-related factor influences ICT integration in the Kenyan context (Kisirkoi, 2015; Namirembe et al., 2022).

Despite the recognized benefits of ICT in teaching of Geography, its integration and effective use can be influenced by various teachers related factors such as attitudes, teachers self-efficacy and pedagogical strategies (Ertmer and Ottenbreit-Leftwich,2010). However the extent to which school support system moderates this relationship remains under-explored, and yet it is crucial because institutional support can significantly impact on teachers willingness and ability to integrate ICT into Geography Instruction (Sabri et al.,2020), therefore examining the moderating effects of school support system on the relationship between teachers related factors and ICT integration offered a comprehensive understanding of dynamic interplay influencing integration of ICT into Geography instruction. The findings contribute to the knowledge base on ICT integration in education and inform policy and practice decisions to enhance ICT use in Geography Instruction.

Given the increasing emphasis on Technology-driven education especially with the competence based education (CBE) in Kenya, Geography requires utilization of spatial resources such as GIS, GPS and virtual field trips, therefore this study explored how school system may amplify or reduce the influence of teachers related factors on ICT integration in geography Instruction hence contributing to the effective educational practice and policy formulation.

Several studies such as the one conducted by (Agbo & Ugwoke, 2021) on pedagogical integration strategies, teacher-self efficacy and attitudes towards ICT Integration lacked empirical research, specifically examining how Geography teachers' pedagogical strategies, teachers-self efficacy and attitudes towards technology influence their integration of ICT in Geography Instruction in Kenyan secondary schools. This study examined the effects of the teachers' related factors on ICT integration in Geography Instruction in selected Kenyan public secondary schools, by applying statistical analysis that checked the variance accounted

for by teachers-related factors on ICT integration which provided empirical evidence to the study. The findings provided insights into the specific pedagogical approaches and practices that facilitate or hinder effective ICT integration in Geography Instruction, and inform teacher professional development and curriculum design efforts to align pedagogy with technology use.

In overall, the findings provided a more comprehensive understanding of the complex interplay between individual and contextual factors shaping ICT integration, and inform the development of targeted interventions and support strategies to enhance ICT integration in Geography Instruction.

1.9 Significance of the Study

This study is significant for several stakeholders in the Kenyan education system. For educational policymakers, the findings provided evidence-based insights to guide the development and implementation of ICT policies and strategies that are responsive to the needs and realities of teachers and schools. By understanding the factors that influence teachers' integration of ICT in Geography Instruction, policymakers can design targeted interventions and allocate resources more effectively to support ICT integration .The study also highlighted areas where policy reforms may be needed to create an enabling environment for technology use in education, such as addressing infrastructure gaps, providing adequate funding, and aligning curricula with ICT goals. Ultimately, the findings also inform policymakers' decisions to promote the sustainable and equitable integration of ICT in Geography Instruction across the country.

For school administrator, the study underscored the importance of providing a supportive system for ICT integration, including infrastructure, technical support, professional development, and leadership. The findings provided school Principals with a better understanding of the specific factors that facilitate or hinder teachers' integration of ICT in Geography Instruction, enabling them to make informed decisions about resource allocation, staff training, and school policies. By identifying best practices and success stories from the selected schools, the study also offered practical examples and strategies that school administrators can adapt to their own contexts. Moreover, the study highlighted the crucial role of school leadership in creating a vision and culture that values and supports technology use in teaching and learning. As such, the findings empowered school administrators to become effective champions and enablers of ICT integration in their institutions.

For teacher educators, the finding informs the design of pre-service and in-service training programs that equip teachers with the necessary skills, knowledge, and attitudes to effectively integrate ICT in their teaching. The study provided insights into the specific competencies and pedagogical strategies that are most relevant and effective for using technology in Geography Instruction. By understanding teachers' self-efficacy beliefs, attitudes, and challenges related to ICT use, teacher educators can develop targeted training modules and support mechanisms that address these factors. The findings also guided the integration of ICT components into teacher education curricula, ensuring that future teachers are well-prepared to leverage technology for enhancing student learning. Additionally, the study contributed to the growing body of research on ICT in teacher education, providing a contextual perspective from Kenyan secondary schools that can enrich global discussions and collaborations in this field.

For Geography teachers, the study offered practical recommendations to enhance their ICT integration and realize the potential benefits for student learning. By identifying the factors that influence their integration of technology, such as self-efficacy, attitudes, and pedagogical strategies, the study provided teachers with a framework for self-reflection and professional growth. The findings also highlighted the importance of school support systems in enabling teachers to effectively use ICT in their instruction, empowering them to advocate for the necessary resources and training. Moreover, the study showcased examples of successful ICT integration practices from the selected schools, providing teachers with ideas and inspiration for their own classrooms. By participating in the study, Geography teachers got the opportunity to share their experiences, challenges, and successes, contributing to a community of practice that can support and learn from each other. Ultimately, the study validated the efforts of Geography teachers who are already using ICT in innovative ways and encourage others to embrace technology as a tool for transforming their teaching and enhancing student outcomes.

For students, the ultimate beneficiaries, the study provided quality and relevance of their geography education through the effective use of ICT. By investigating the factors that influence teachers' integration of ICT into Geography Instruction, the study indirectly supported the creation of learning environments that are more engaging, interactive, and authentic. When teachers effectively integrate ICT tools such as GIS, remote sensing, and digital maps into their teaching, students have the opportunity to develop critical skills in

spatial thinking, data analysis, problem-solving, and digital literacy. These skills are not only essential for future careers in fields such as urban planning, environmental management, and geospatial technologies but also for navigating an increasingly complex and interconnected world. Moreover, by exposing students to cutting-edge technologies and real-world applications of geography, the study contributed to increasing their interest, motivation, and achievement in the subject. As such, the findings of this study have ultimately benefited students by promoting the effective use of ICT to enhance their learning experiences and outcomes in Geography examinations.

For researchers, the study advanced the theoretical and methodological understanding of ICT integration in education and open up avenues for further inquiry. By applying established frameworks such as the Technological Pedagogical Content Knowledge (TPACK), and Unified Theory of Acceptance and Use of Technology (UTAUT) to the context of Geography Instruction in Kenyan secondary schools, the study tested the applicability and relevance of these theories in a new setting. The findings provided support for the existing constructs and relationships proposed by these frameworks or suggest modifications and extensions based on the unique characteristics of the study context. Moreover, by employing a mixed-methods approach that combines quantitative and qualitative data, the study demonstrated the value of integrating different types of evidence to gain a more comprehensive understanding of the research problem. The study also contributed to the growing body of empirical literature on ICT integration in secondary education, particularly in the African context, which is currently underrepresented in global research. As such, the study also provided a foundation for future researchers to build upon, replicate, and extend, contributing to the cumulative knowledge and theory development in this field.

1.10 Assumptions of the Study

This study assumes that:

i. The ICT resources for teaching and learning Geography are relevant and can enhance Geography Instruction.
ii. The participants provided honest responses to the items in the instruments of data collection.
iii. Teachers of Geography have equal opportunities for professional development and support related to ICT use.

1.11 Scope of the Study

This study was confined to the investigation of moderating effect of school support system on the relationship between teacher-related factors and ICT integration in Geography Instruction in National and Extra County School in the North Rift region of Kenya between January 2025 to July 2025. The study targeted the principals, Heads of Geography Departments and teachers of Geography. The variables of interest include school-level factors (ICT infrastructure, technical support, professional development opportunities, leadership support) and teacher-level factors (ICT self-efficacy, attitudes towards technology and pedagogical strategies in integrating ICT). The study did not examine other factors such as student characteristics, curriculum, or assessment practices. The study employed a cross-sectional research design with both quantitative and qualitative approach that utilized Convergent mixed methods. The study used a survey questionnaire, interview schedule and content analysis to collect data. Analysis was done by use of descriptive statistics inferential statistics and thematic analysis. The theoretical framework that guided the study was the Technology Acceptance Model (TAM), Unified Theory of Acceptance Use of Technology (UTAUT),and Technological Pedagogical Content Knowledge (TPACK) framework.

1.12 Limitations of the Study

The potential limitations of this study include:

i. The cross-sectional research design did not allow for the establishment of causal relationships or the assessment of changes in the variables over time, limiting the ability to infer temporal or directional effects.
ii. The self-report nature of the questionnaire may be subject to response biases such as social desirability or acquiescence hence the researcher provided clear instructions that emphasized on honest to reduce response biases
iii. There was difficulty in integrating qualitative and quantitative data from both strands especially when the results from the two methods were conflicting.

1.13 Theoretical Framework

This study utilized three theoretical frameworks: the Technology Acceptance Model (TAM), the Unified Theory of Acceptance and Use of Technology (UTAUT), and the Technological Pedagogical Content Knowledge (TPACK) framework to comprehend the elements impacting the incorporation of ICT by geography instructors. The researcher choice of multiple theoretical framework was informed by the concept of theoretical integration approach by (Flores and Clark,2014) which emphasizes on use of multiple theories to capture

different dimensions of a research problem for comprehensive understanding of a complex phenomenon.The sections below explain these frameworks.

1.13.1 Technology Acceptance Model (TAM)

The Technology Acceptance Model was originally proposed by Fred Davis in 1989 through his doctoral dissertation at the Massachusetts Institute of Technology, later refined in seminal publications in Management Information Systems Quarterly (Davis, 1989; Davis et al., 1989). The model emerged during the late 1980s when organizational computing was expanding rapidly, yet many technology implementations were failing due to user resistance and poor adoption rates. Davis developed TAM as a response to the need for understanding why individuals accept or reject information technologies, drawing heavily from Ajzen and Fishbein's Theory of Reasoned Action while focusing specifically on technology contexts. The model aimed to address the gap between technology availability and actual usage by identifying key psychological factors that determine user acceptance behaviors.

The Technology Acceptance Model comprises two fundamental constructs that predict technology adoption: perceived usefulness and perceived ease of use (Venkatesh & Davis, 2000). Perceived usefulness refers to the degree to which an individual believes that using a particular technology will enhance their job performance or effectiveness, while perceived ease of use represents the extent to which a person believes that using the technology will be free of effort and complexity. These constructs interact dynamically, with perceived ease of use directly influencing perceived usefulness, as technologies that are easier to use are more likely to be viewed as useful. Both constructs subsequently influence behavioral intention to use technology, which serves as the primary predictor of actual system usage. External variables such as system characteristics, training, and organizational support indirectly affect usage through their impact on perceived usefulness and ease of use.

Since its initial formulation, TAM has undergone significant development through contributions from numerous researchers who have extended and refined the original framework. Venkatesh and Davis (2000) introduced TAM2, which incorporated additional social influence processes and cognitive instrumental processes to better explain technology acceptance in organizational contexts. Later, Venkatesh and Bala (2008) developed TAM3, further expanding the model to include comprehensive determinants of perceived ease of use and their interactions over time. King and He (2006) conducted a meta-analysis revealing that

TAM has been one of the most widely cited models in information systems research, demonstrating its robustness across various technology contexts and cultural settings.

Despite its widespread adoption, TAM has faced several criticisms from the academic community. Bagozzi (2007) argued that the model oversimplifies complex technology adoption decisions by focusing primarily on utilitarian factors while neglecting hedonic motivations, social influences, and emotional responses. Benbasat and Barki (2007) criticized TAM for its narrow focus on individual-level factors, suggesting that organizational and contextual variables play equally important roles in technology acceptance. Additionally, researchers have questioned the model's assumption that behavioral intention directly translates to actual usage, particularly in mandatory use contexts common in educational settings. Limitations include the model's inability to fully explain post-adoption behaviors, its limited consideration of temporal factors, and its insufficient attention to the role of experience and expertise in shaping acceptance decisions.

The Technology Acceptance Model provides crucial insights for understanding the first and the second research objective regarding the status of ICT resources available for teaching Geography and teachers' ICT self-efficacy and its influence on ICT integration in Geography Instruction. When teachers perceive ICT tools as useful for enhancing geography instruction and easy to use within their pedagogical practice, they are more likely to develop positive attitudes toward technology integration. The perceived usefulness construct directly relates to teachers' beliefs about how ICT can improve student learning outcomes, facilitate curriculum delivery, and enhance their professional effectiveness in Geography Instruction. Perceived ease of use addresses teachers' confidence in their technical abilities and their assessment of the effort required to successfully integrate ICT tools into their Geography lessons, which directly connects to the concept of self-efficacy in technology use.

1.13.2 Unified Theory of Acceptance and Use of Technology (UTAUT)

The Unified Theory of Acceptance and Use of Technology (UTAUT) were developed by Viswanath Venkatesh, Michael G. Morris, Gordon B. Davis, and Fred D. Davis in 2003. The theory was introduced in their seminal article titled "User Acceptance of Information Technology: Toward a Unified View," which was published in the MIS Quarterly journal (Venkatesh, Morris, Davis, & Davis, 2003). UTAUT was formulated as a comprehensive synthesis and extension of eight prominent theories and models of technology acceptance, including the Technology Acceptance Model (TAM), the Theory of Reasoned Action (TRA),

the Theory of Planned Behavior (TPB), and the Innovation Diffusion Theory (IDT). The main objective of UTAUT was to provide a unified theoretical basis for explaining and predicting user acceptance and use of information technology across different contexts and populations (Venkatesh et al., 2003).

At the time of its development, there was a proliferation of competing theories and models of technology acceptance, each with its own set of constructs and relationships. Venkatesh et al. (2003) aimed to integrate the key elements of these theories into a single, parsimonious model that could be applied to a wide range of technologies and user groups. The UTAUT model consists of four key constructs: performance expectancy, effort expectancy, social influence, and facilitating conditions. Performance expectancy is defined as the degree to which an individual believes that using a particular technology will help them to attain gains in job performance, similar to the perceived usefulness construct in TAM (Venkatesh et al., 2003) this construct aligns with objective1 which sought to investigate availability of ICT resources for teaching and learning Geography and objective 2 which sought to investigate the influence of teachers' ICT self-efficacy on ICT integration in Geography Instruction. Studies have found that teachers with higher ICT self-efficacy are more likely to perceive technology as easy to use and thus have more positive attitudes toward using it (Joo, Park, & Lim, 2018; Scherer, Siddiq, & Tondeur, 2019).

Effort expectancy refers to the degree of ease associated with the use of a technology, akin to the perceived ease of use construct in TAM (Venkatesh et al., 2003). Objective 3 examines the impact of teachers' attitudes towards technology on ICT integration in Geography Instruction. Attitude is controlled by the performance expectancy and effort expectancy which shapes the intention to use technology.

Social influence is defined as the degree to which an individual perceives that important others believe they should use a particular technology, capturing the notion of subjective norms from TRA, TPB, and other theories (Venkatesh et al., 2003). Facilitating conditions (school support system) refers to the degree to which an organizational and technical infrastructure exists to support the use of a technology, encompassing aspects such as the availability of resources, knowledge, and support for using a technology (Venkatesh et al., 2003). These four constructs are hypothesized to influence behavioural intention, which is defined as an individual's intention to perform behaviour, such as using a particular technology (Venkatesh et al., 2003). Behavioural intention, in turn, is considered a direct

antecedent of actual use behaviour, which refers to the actual use of a technology by an individual (Venkatesh et al., 2003).

In addition to these key constructs, UTAUT also includes four moderating variables that are hypothesized to influence the relationships between the main constructs: gender, age, experience, and voluntaries of use. These moderators are intended to account for individual differences and contextual factors that may affect the strength and direction of the relationships between the constructs (Venkatesh et al., 2003). For example, the influence of performance expectancy on behavioral intention is hypothesized to be stronger for younger men, while the effect of effort expectancy on behavioral intention is expected to be more salient for older women and those with limited technology experience (Venkatesh et al., 2003).

Since its introduction, the UTAUT model has been widely applied and extended in various research contexts. Many scholars have used UTAUT to investigate technology acceptance and use in different domains, such as healthcare (Kijsanayotin, Pannarunothai, & Speedie, 2009), e-government (Gupta, Dasgupta, & Gupta, 2008), e-learning (Chiu & Wang, 2008), and mobile technologies (Wang, Wu, & Wang, 2009). These studies have generally provided empirical support for the key relationships proposed in the UTAUT model, while also identifying additional factors and boundary conditions that may influence technology acceptance and use in specific contexts (Dwivedi, Rana, Chen, & Williams, 2011).

In the context of this study, UTAUT is applicable to objective1,2 and 5, which focus on the effect of teachers' related factors and the moderating effect of school support system on ICT integration. Teachers' self-efficacy which ICT is closely related to the effort expectancy construct in UTAUT, as prior exposure to and familiarity with technology can reduce the perceived effort required to use it (Venkatesh et al., 2003). Studies such as the one conducted by (Inan & Lowther, 2010; Miranda & Russell, 2012).have found that teachers with high teachers' self-efficacy on ICT tend to have higher levels of technology acceptance and use in their teaching practices

The school support system, which includes factors such as ICT infrastructure, technical support, professional development opportunities, and leadership support, aligns with the facilitating conditions construct in UTAUT. Research conducted by (Agyei & Voogt, 2011; Petko, Prasse, & Cantieni, 2018), has shown that the presence of supportive facilitating

conditions, such as access to technology resources, training, and support from school leaders, can significantly influence teachers' integration of technology in their classrooms.

Examining the influence of teacher-related factors and the moderating role of school support system on ICT integration in geography instruction through the lens of UTAUT has contributed to the growing body of research on factors influencing technology acceptance and use in education. The findings also guided the development of interventions and support strategies that aim to enhance teachers' ICT experience and provide enabling conditions for technology integration in schools.

Therefore, the UTAUT model provided a comprehensive and robust framework for understanding the factors that influence user acceptance and use of technology across different contexts and populations. By integrating key elements from multiple technology acceptance theories, UTAUT offers a parsimonious and powerful explanation of the complex interplay of individual, technological, and contextual factors that shape technology integration and use behaviors. In the context of Geography Instruction, UTAUT is particularly relevant for examining how teachers' ICT experience and the school support system interact to influence their integration of geospatial technologies in their teaching practices. By applying UTAUT to investigate these relationships, this study contributed to the growing body of research on technology acceptance and use in education and provided valuable insights for educators, educational policymakers, and researchers seeking to promote the effective integration of technology in Geography Instruction.

1.13.3 Technological Pedagogical Content Knowledge (TPACK) Framework

The Technological Pedagogical Content Knowledge (TPACK) framework was introduced by Punya Mishra and Matthew Koehler in 2006 in a seminal article titled "Technological Pedagogical Content Knowledge: A Framework for Teacher Knowledge" published in the Teachers College Record journal (Mishra & Koehler, 2006). The framework was developed to describe the complex interplay of three primary forms of knowledge - technological, pedagogical, and content knowledge - that teachers need to effectively integrate technology into their teaching practices. The TPACK framework builds upon the earlier work of Lee Shulman (1986, 1987) on pedagogical content knowledge (PCK), which emphasized the importance of the intersection between teachers' pedagogical knowledge and their subject matter knowledge (Mishra & Koehler, 2006).

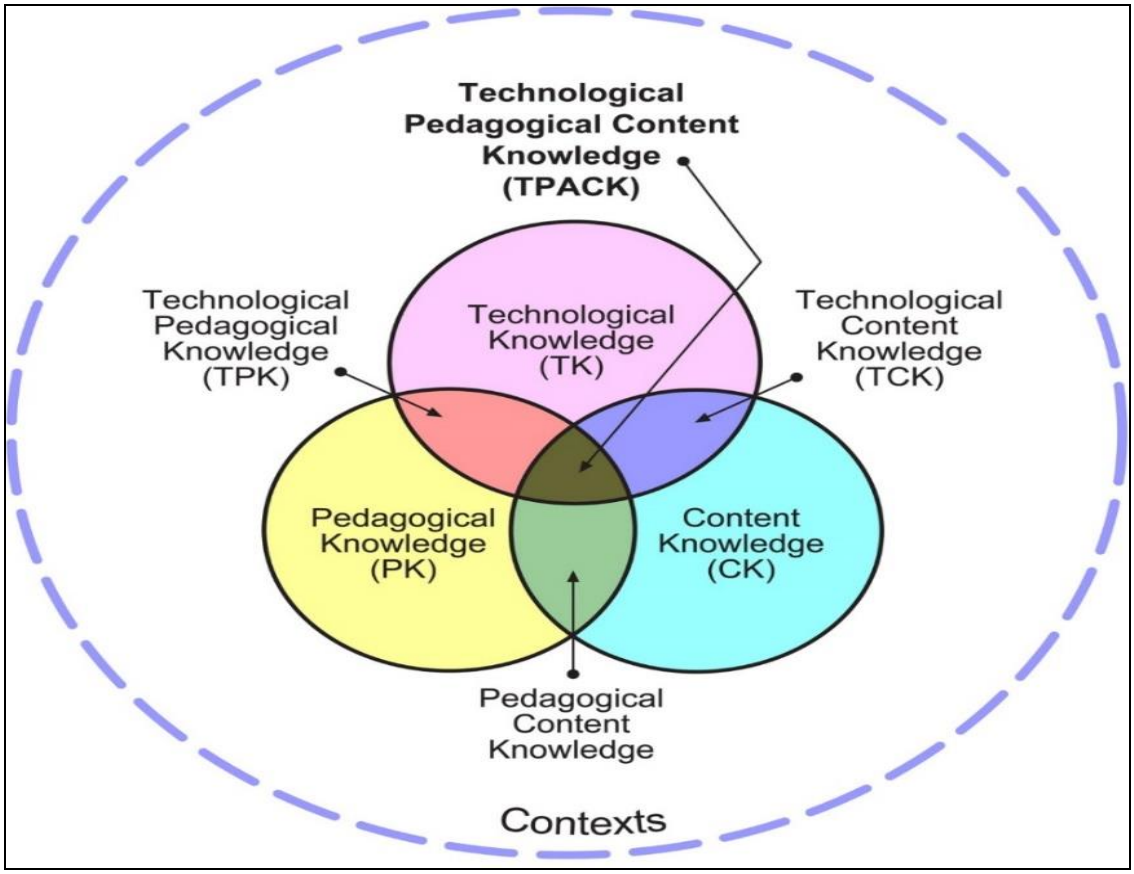

Figure 1: Technological Pedagogical Content Knowledge
Source: Tpack (2012)

Mishra and Koehler (2006) argued that with the increasing integration of technology in education, there was a need to extend the PCK framework to include technological knowledge as a third key component. The TPACK framework consists of seven components: content knowledge (CK), pedagogical knowledge (PK), technological knowledge (TK), pedagogical content knowledge (PCK), technological content knowledge (TCK), technological pedagogical knowledge (TPK), and technological pedagogical content knowledge (TPACK). Content knowledge (CK) refers to teachers' knowledge about the subject matter to be learned or taught, including concepts, theories, ideas, organizational frameworks, and established practices and approaches (Koehler & Mishra, 2009). Pedagogical knowledge (PK) encompasses teachers' deep knowledge about the processes and practices or methods of teaching and learning, including educational purposes, values, aims, and strategies for evaluating student understanding (Koehler & Mishra, 2009).

Technological knowledge (TK) involves teachers' knowledge about various technologies, ranging from low-tech technologies like pencil and paper to digital technologies such as the

Internet, digital video, interactive whiteboards, and software programs (Koehler & Mishra, 2009). Pedagogical content knowledge (PCK) refers to the intersection of pedagogical and content knowledge, representing teachers' knowledge of pedagogy that is applicable to the teaching of specific content (Shulman, 1986). Technological content knowledge (TCK) is the knowledge of how technology and content influence and constrain one another, involving an understanding of how the subject matter can be changed by the application of particular technologies (Koehler & Mishra, 2009). Technological pedagogical knowledge (TPK) represents the knowledge of how various technologies can be used in teaching and how teaching might change as a result of using particular technologies (Koehler & Mishra, 2009).

Technological pedagogical content knowledge (TPACK) is the intersection of all three bodies of knowledge - technological, pedagogical, and content knowledge. TPACK represents the kind of knowledge that expert teachers bring to play anytime they teach, forming the basis of effective teaching with technology (Koehler & Mishra, 2009). Since its introduction, the TPACK framework has gained significant attention and has been widely adopted in educational research and practice. Many scholars have applied, extended, and validated the framework in various educational contexts and subject areas (Voogt, Fisser, Pareja Roblin, Tondeur, & Van Braak, 2013).

For example, Cox and Graham (2009) proposed an elaborated model of TPACK that further clarified the definitions and boundaries of the constructs, emphasizing the importance of considering the specific affordances and constraints of particular technologies in relation to pedagogical strategies and content representations. Voogt et al. (2013) conducted a systematic review of TPACK research and found that the framework had been applied in a wide range of educational contexts, including pre-service and in-service teacher education, K-12 education, and higher education. They also identified several challenges and opportunities for future TPACK research, such as the need for more empirical evidence on the development and assessment of TPACK, and the potential for integrating TPACK with other theoretical frameworks (Voogt et al., 2013).

In the context of geography Instruction, several studies have applied the TPACK framework to investigate teachers' knowledge and practices related to technology integration. For example, Doering, Koseoglu, Scharber, Henrickson, and Lanegran (2014) used TPACK as a conceptual framework to examine the technology integration practices of K-12 Geography teachers in the United States. They found that teachers' TPACK, particularly their

technological pedagogical knowledge (TPK) and technological content knowledge (TCK), influenced their ability to effectively integrate geospatial technologies in their teaching (Doering et al., 2014). Similarly, Hong and Stonier (2015) applied the TPACK framework to design and evaluate a GIS professional development program for in-service Geography teachers, finding that the program, which focused on developing teachers' technological, pedagogical, and content knowledge related to GIS, led to significant improvements in teachers' TPACK and their intention to use GIS in their classrooms.

Objective 4 of this study examined the impact of teachers' pedagogical beliefs on their integration of ICT in Geography Instruction. The TPACK framework is particularly relevant to this objective, as it emphasizes the importance of the intersection between teachers' pedagogical knowledge and their technological knowledge for effective technology integration. Research conducted by (Ertmer, 2005; Tondeur, van Braak, Ertmer, & Ottenbreit-Leftwich, 2017) has shown that teachers with more constructivist pedagogical strategies, which emphasize on active learning approaches, tend to integrate technology in more student-centered ways, while those with more traditional, teacher-centered beliefs tend to use technology for more teacher-directed activities.

The TPACK framework provided a lens for understanding how teachers' pedagogical strategies interact with their technological knowledge to influence their technology integration practices. For example, a geography teacher with strong constructivist pedagogical strategies and well-developed TPACK is more likely to use geospatial technologies in ways that support student-centered, inquiry-based learning, such as having students use GIS to investigate real-world problems and create their own maps and analyses (Doering et al., 2014; Hong & Stonier, 2015). On the other hand, a teacher with more traditional pedagogical strategies and less developed TPACK may use geospatial technologies in more teacher-directed ways, such as simply demonstrating GIS functions to students or having them complete pre-defined GIS exercises (Doering et al., 2014; Hong & Stonier, 2015).

Therefore, the TPACK framework provided a comprehensive and nuanced way of understanding the complex knowledge base that teachers need to effectively integrate technology into their teaching practices. By emphasizing the importance of the intersections between technological, pedagogical, and content knowledge, the framework highlights the need for teachers to develop a deep understanding of how technology can be used to support

specific pedagogical strategies and content goals in their subject areas (Koehler & Mishra, 2009). In the context of Geography Instruction, the TPACK framework is particularly relevant for examining how teachers' pedagogical strategies and knowledge interact with their technological knowledge to shape their integration and use of geospatial technologies in their classrooms (Doering et al., 2014; Hong & Stonier, 2015). By applying the TPACK framework to investigate this relationship, this study contributes to the growing body of research on technology integration in education and provides valuable insights for educators, teacher educators, and researchers seeking to promote the effective use of technology in geography teaching and learning.

1.14 Conceptual Framework

The conceptual framework for this study illustrates the hypothesized relationships between the independent variables (teacher-related factors), the moderating variable (school support system), and the dependent variable (ICT integration in geography instruction). The independent variables in the conceptual framework are the teacher-related factors, which include ICT self-efficacy, attitudes towards technology, and pedagogical strategies. These factors are hypothesized to have a direct influence on teachers' integration of ICT in geography instruction and are show in Figure 2.

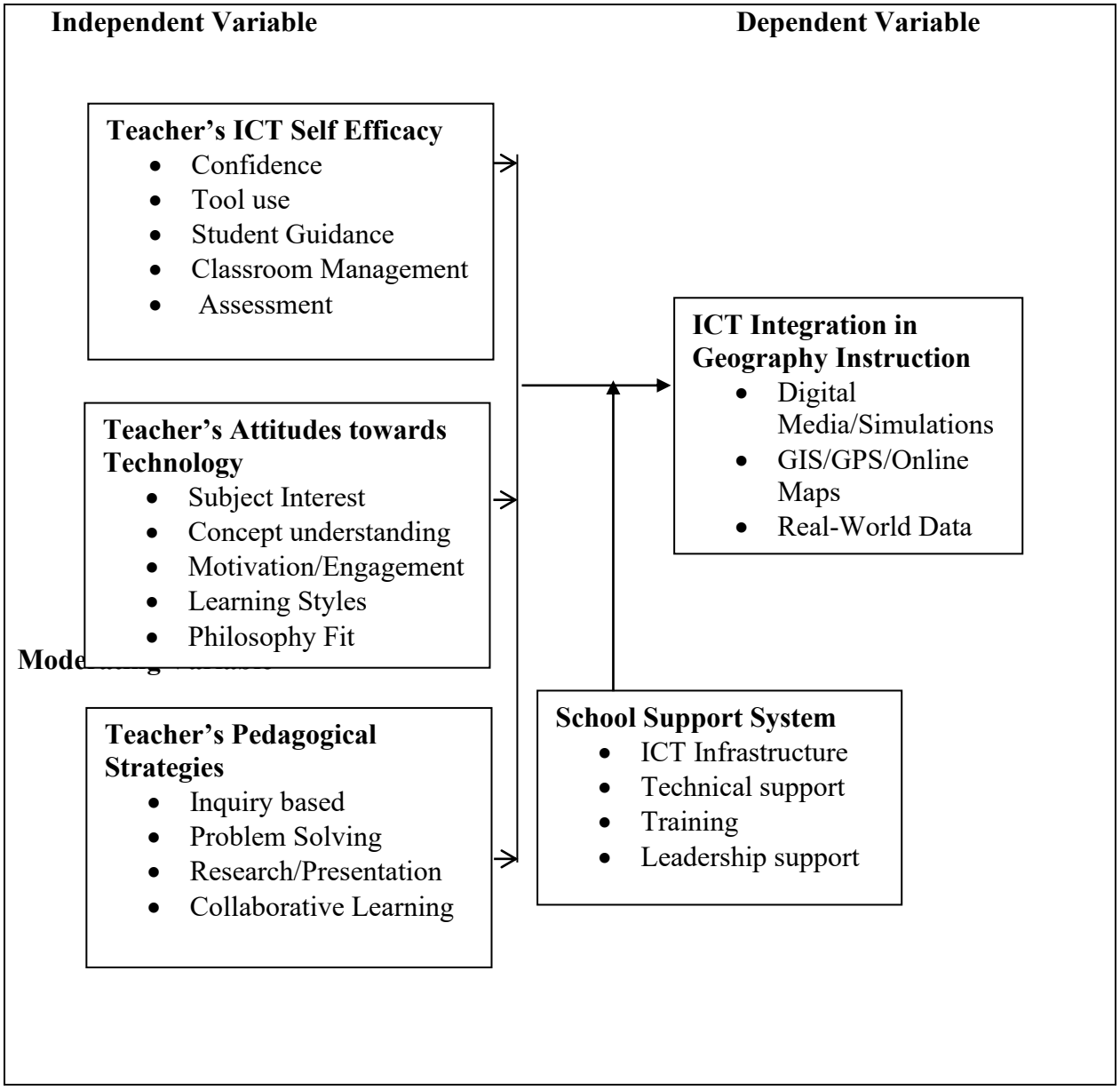

Figure 2: Conceptual Framework

Source: Author (2025)

ICT self-efficacy refers to teachers' beliefs in their ability to effectively use technology for teaching and learning purposes (Kent & Giles, 2017). The conceptual framework posits that teachers with higher levels of ICT self-efficacy are more likely to integrate technology into their instructional practices, as they feel confident in their skills and ability to use technology to enhance student learning in Geography.

Attitudes towards technology refer to teachers' positive or negative evaluations and feelings towards the use of technology in Instruction (Scherer et al., 2019). The Conceptual

framework suggests that teachers with more positive attitudes towards technology are more likely to integrate it into their teaching, as they perceive technology as useful, easy to use, and compatible with their pedagogical beliefs and practices.

Pedagogical strategies refer to the instructional approaches, methods, and techniques employed by teachers to facilitate student learning (Ertmer & Ottenbreit-Leftwich, 2010). The conceptual framework proposes that teachers who employ student-centered, inquiry-based, and collaborative learning strategies are more likely to integrate technology into their teaching, as these strategies align well with the affordances of technology for active, authentic, and engaging learning experiences.

The moderating variable in the conceptual framework is the school support system, which refers to the organizational and technical infrastructure, resources, and support systems available in schools to facilitate the integration of ICT in teaching and learning (Petko et al., 2018). The conceptual framework hypothesizes that the school support system moderates the relationship between teacher-related factors and ICT integration in Geography Instruction, such that the strength and direction of the relationship may vary depending on the level of support provided by the school. The components of the school support system include ICT infrastructure (e.g., hardware, software, connectivity), technical support (e.g., maintenance, troubleshooting), professional development opportunities (e.g., training, workshops, mentoring), and leadership support (e.g., vision, policies, incentives). The framework suggests that schools with a strong support system, characterized by adequate resources, reliable technical support, relevant professional development, and supportive leadership, can enhance the influence of teacher-related factors on ICT integration, while schools with a weak support system may hinder the influence of these factors.

The dependent variable in the conceptual framework is ICT integration in Geography Instruction, which refers to the extent to which teachers incorporate technology into their teaching practices to support student learning of geographical concepts, skills, and perspectives (Kerski, 2020).

1.15 Operational Definition of Terms.

Effort Expectancy: Venkatesh et al. (2003) explain effort expectancy as the degree of ease associated with using a system. In this study, effort expectancy refers to the degree of ease

associated with teachers' use of ICT tools in Geography Instruction, as perceived by the teachers.

Facilitating Conditions: Venkatesh et al. (2003) describe facilitating conditions as the degree to which an individual believes that an organizational and technical infrastructure supports the use of a system. In this study, facilitating conditions refer to the extent to which teachers believe that organizational and technical infrastructure exists in their schools to support the use of ICT in Geography Instruction.

ICT integration in Geography Instruction: Kerski (2003) defines ICT integration in Geography Instruction as the implementation and use of information and communication technologies to enhance teaching and learning in Geography. In this study, ICT integration in Geography Instruction refers to the extent to which Geography teachers utilize ICT tools and resources into their teaching practice, as measured by the frequency and variety of use.

ICT Resources: These are tools, materials, and services used to collect, stor3e analyse visualize present and share Geographical information to support Geography Instruction.

Pedagogical Knowledge (PK): Shulman (1987) describes pedagogical knowledge as the knowledge of generic principles of classroom organization, management, and other aspects that have been the focus of recent research on teaching. In this study, PK refers to teachers' knowledge about the methods, practices, and processes of teaching and learning Geography.

Perceived Ease of Use: Davis (1989) explains perceived ease of use as the degree to which a person believes that using a particular system would be free of effort. In this study, perceived ease of use refers to the degree to which Geography teachers believe that using ICT tools in their teaching practice was free of effort.

Perceived Usefulness: Davis (1989) describes perceived usefulness as the degree to which a person believes that using a particular system would enhance their job performance. In this study, perceived usefulness refers to the degree to which Geography teachers believe that using ICT tools to enhance their teaching performance and effectiveness.

Performance Expectancy: Venkatesh et al. (2003) define performance expectancy as the degree to which an individual believes that using a system helped them attain gains in job performance. In this study, performance expectancy refers to the degree to which teachers believe that using ICT in Geography Instruction will help them to attain gains in job performance.

School Support system: Petko et al. (2018) describe school support system as the organizational and technical infrastructure, resources, and support systems available in schools to facilitate the integration of ICT in teaching and learning. In this study, school

support system refers to the organizational and technical infrastructure, resources, and support systems available in schools to facilitate the integration of ICT in teaching and learning of Geography.

Teacher-Related Factors: Inan and Lowther (2010) describe teacher-related factors as the individual characteristics, knowledge, beliefs, and perceptions of teachers that influence their adoption and integration of ICT in teaching. In this study, teacher-related factors refer to the individual characteristics, knowledge, beliefs, and perceptions of teachers that influence their integration of ICT in Geography Instruction.

Teachers' Attitudes towards Technology: Scherer et al. (2019) explain teachers' attitudes towards technology as teachers' positive or negative evaluations and feelings about the use of technology in education. In this study, teachers' attitudes towards technology refer to the positive or negative evaluations and feelings that teachers hold towards the use of technology in Geography Instruction.

Teachers' ICT Self-Efficacy: Kent and Giles (2017) describe teachers' ICT self-efficacy as teachers' beliefs in their own ability to effectively use ICT tools and resources for teaching and learning purposes. In this study, teachers' ICT self-efficacy refers to teachers' beliefs in their own ability to effectively use ICT tools and resources for teaching and learning purposes.

Moderating Effects: Bradshaw, Gray &Steptoe,2013) Explains moderating effects as how the presence and the quality of a support mechanism within a school environment influence the relationship between an independent Variable and dependent variable. In this study the moderating variable is the school support system (ICT infrastructure, technical support and professional development) so that when examining the impact of teacher-related factors on ICT integration in Geography Instruction, the school support system functions as a moderator by enhancing the level of ICT integration in Geography Instruction.

Teachers' Pedagogical integration Strategies: (Ertmer and Ottenbreit-Leftwich (2010) explain teachers' pedagogical strategies as the approaches, methods, and techniques employed by teachers to incorporate specific content, skills, or technology into their teaching practices in an effective and meaningful way. In this study, teachers' pedagogical integration strategies refer to the approaches, methods, and techniques employed by teachers to facilitate student learning in Geography using ICT.

Technological Content Knowledge (TCK): Koehler and Mishra (2009) describe technological content knowledge as an understanding of the manner in which technology and

content influence and constrain one another. In this study, TCK refers to teachers' understanding of how technology and Geography content influence and constrain each other.

Technological Knowledge (TK): Koehler and Mishra (2009) explain technological knowledge as knowledge about standard technologies, such as books, chalk and blackboard, and more advanced technologies, such as the Internet and digital video. In this study, TK refers to teachers' knowledge about various ICT tools and resources and their operation.

Technological Pedagogical Content Knowledge (TPACK): Koehler and Mishra (2009) describe technological pedagogical content knowledge as an emergent form of knowledge that goes beyond content, pedagogy, and technology as individual components. In this study, TPACK refers to teachers' understanding of the complex interplay between technological, pedagogical, and content knowledge in the context of Geography Instruction.

Technological Pedagogical Knowledge (TPK): Koehler and Mishra (2009) explain technological pedagogical knowledge as knowledge of the existence, components, and capabilities of various technologies as they are used in teaching and learning settings, and conversely, knowing how teaching might change as a result of using particular technologies. In this study, TPK refers to teachers' knowledge of how various ICT tools can be used in teaching and how teaching might change as a result of using particular technologies.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter presents a review of the literature on factors influencing teachers' adoption and integration of ICT in geography instruction in secondary schools. The review is organized into four sections, each addressing one of the study's objectives: the influence of teachers' ICT self-efficacy, attitudes towards technology, pedagogical strategies, and the moderating influence of school support system on ICT integration.

The review draws upon various theoretical and empirical sources to provide a critical analysis of existing research, highlighting key findings, methodological approaches, and gaps in the literature. The chapter concludes with a summary of main themes and variables, and a discussion of how the present study addresses the gaps and contributes to the advancement of knowledge in this field. The review serves as a foundation for developing the study's conceptual framework and research hypotheses.

2.2 Teaching of Geography in Kenyan Secondary schools

Geography in Kenyan secondary schools helps learners understand the world and Kenya's place in it. It develops spatial awareness, critical thinking, and practical skills for observing, analyzing, and solving real-world problems related to environment, development, and citizenship. It also links learning to national development goals such as sustainable resource management, climate resilience, urban planning, and disaster risk reduction.

The objectives of teaching Geography in secondary includes acquisition of knowledge and understanding of key physical processes (weather and climate, landforms, rivers, soils, ecosystems) and human geography (population, settlements, movement, resources, industry and agriculture).Understand Kenya's geographical features and how they influence livelihoods, development, and environmental management. Secondly is skills development through Map reading and interpretation through locating places, reading grid references, scale, symbols, and legends. Spatial analysis skills by identifying patterns, relationships, and processes (e.g., migration, settlement change, resource distribution).Fieldwork and data collection skills through planning and carrying out simple surveys, observations, and measurements. Data handling and presentation skills through organizing data, creating graphs, charts, and basic GIS/ICT-based analyses where resources permit and communication

skills through presentation findings clearly through reports, maps, diagrams, and oral presentations.

Other key objectives of teaching Geography is to ensure environmental stewardship and sustainable living. Respect for cultural and regional diversity within Kenya and globally. Civic responsibility, informed decision-making, and ethical use of resources. Applying Geographical reasoning to local and national development issues (urban planning, land use, agriculture, water and resource management, climate change adaptation).Developing problem-solving and critical thinking that proposes practical solutions to real-world challenges. Attainment of environmental targets by engaging learners in explaining Geographical processes, interpreting spatial data, using basic fieldwork methods, communicating findings effectively and relating Geographical knowledge to current affairs in Kenya (e.g., drought/flood management, urban growth, land use planning).

The effective methods of teaching Geography include;enquiry-based learning through posing questions, have learners investigate sources, and draw conclusions, Project-based learning and case studies: study local Kenyan case studies (urban expansion, river basins, drought management) and propose solutions. Fieldwork and practical activities: guided visits to local sites (rivers, wetlands, urban areas, farms) for observation, data collection, and reporting. Use of maps, tools, and ICT, Classic tools such as maps, globes, atlases, graphs, cross-sections, diagrams. ICT and geospatial tools where available: simple GIS concepts, online maps, satellite images, and data visualization (spreadsheets, charts).Data interpretation activities: rainfall graphs, temperature trends, population pyramids, land-use maps. Utilization of Local and relevant content on Kenyan context and by use of locally available resources to make learning meaningful. Incorporate national development themes (e.g., food security, water resources, climate resilience, urban planning). Use of the group work with clearly defined roles; scaffold instruction for learners with different abilities and language backgrounds and use of Cross-curricular integration through linking Geography with Mathematics (data handling, statistics), Science (environmental processes), History (settlement and change over time), and Civics (rights, responsibilities, governance).

Geography has also clearly outline assessment strategies such as Formative assessment Quizzes, quick checks, and short exercises to gauge understanding.Map tasks, graph interpretation, and data analysis exercises, observation and feedback during fieldwork and

class activities, use of drafts of fieldwork reports or mini-projects with feedback to guide improvement.

Summative assessment which is done at the end-of-unit and term through administration of tests and examinations that include short-answer, structured/essay questions, and map-based tasks, the end-of-term or end-of-year assessments aligned with the school's or national framework.

Practical and fieldwork assessment such as fieldwork reports, field sketches, observation notes, and interpretation of data collected in the field. Project-based assessments (e.g., a mini-research project on a local geographical issue) with documented processes and conclusions.

Project and portfolio assessment which includes Portfolios combining field notes, maps, graphs, photos, and a reflective write-up. Rubrics that assess clarity of argument, use of evidence, data handling, and presentation.

ICT and data analysis tasks such as online quizzes, map-based tasks, and simple GIS/data visualization activities where facilities exist. Evaluation of the ability to extract, interpret, and present spatial information. Feedback and improvement Timely, constructive feedback with clear criteria and opportunities for revision. The assessment process is align to objectives, content, and assessments with the Kenyan curriculum framework in use (e.g., CBC-era guidelines and local syllabus requirements) and with the resources available in schools.

In general assessment in Geography emphasize on practical and real-world applications to keep students engaged and to prepare them for further study or work in sectors like agriculture, urban planning, environmental management, and economics..

2.3 General literature on ICT Integration in Geography Instruction

The integration of Information and Communication Technologies in Geography education has evolved rapidly, particularly in the post-pandemic educational landscape. Recent empirical research has demonstrated the transformative potential of digital technologies in enhancing geographic learning experiences, spatial cognition, and environmental understanding. This literature review synthesizes findings from empirical studies published between 2022 and 2025, examining how various ICT tools have been implemented in Geography Instruction across different educational levels and geographical contexts. A mixed-methods study conducted by Zhang and colleagues (2022) with 180 students, investigated virtual reality applications in physical Geography Instruction. The researchers

implemented Oculus Rift VR headsets integrated with specialized geological simulation software including Virtual Geology Studio and 3D terrain modeling applications. Students navigated through three-dimensional representations of the Grand Canyon, Mount Vesuvius, and glacial landscapes using handheld controllers to manipulate viewing angles and access embedded information hotspots. The VR experiences were structured as guided virtual field trips lasting 45 minutes each, where students completed digital worksheets while exploring landforms and geological processes. Teachers facilitated pre-VR briefing sessions using traditional materials, followed by post-VR reflection activities where students compared virtual observations with textbook illustrations. The integration protocol required students to take virtual measurements of rock formations, identify geological features using in-VR labeling tools, and create digital field notebooks documenting their observations. Results demonstrated significant improvements in students' understanding of three-dimensional geological relationships and increased engagement with physical Geography concepts compared to traditional textbook-based instruction.

A quasi-experimental design conducted by Martinez and Silva (2022) which involved 156 secondary students examined GIS integration in geography instruction. The study utilized ArcGIS Online cloud-based platform combined with tablets and interactive whiteboards for collaborative spatial analysis projects. Students accessed pre-loaded datasets including demographic census data, topographic maps, and satellite imagery through school-provided iPads during structured laboratory sessions twice weekly for eight weeks. The integration process involved teacher-guided tutorials on basic GIS functions, followed by independent student projects analyzing local watershed systems using digital elevation models and precipitation data layers. Students created thematic maps displaying population density patterns, conducted buffer analyses around water sources, and generated reports comparing urban versus rural land use patterns within their geographic region. The pedagogical approach combined direct instruction on GIS tools with inquiry-based learning where students formulated research questions and used spatial analysis functions to investigate local environmental challenges. Assessment included both technical skill evaluations and content knowledge tests measuring students' understanding of spatial relationships and geographic processes. The study revealed statistically significant improvements in spatial thinking abilities and enhanced understanding of human-environment interactions among students in the GIS-integrated treatment group. Johnson and Park (2023) conducted action research across three urban secondary schools involving 45 students in augmented reality-enhanced

geography field studies. The implementation utilized ARCore-enabled Android smartphones and tablets loaded with custom-developed AR applications for urban geography exploration. Students used the AR apps to overlay historical maps from the 1850s, 1920s, and 1950s onto current street views, enabling real-time comparison of urban development patterns during guided walking tours of downtown districts. The technological integration involved pre-field preparation where students learned to calibrate AR applications, followed by structured field experiences where they photographed current landscapes and captured AR screenshots showing historical overlays. Teachers provided students with GPS-enabled devices to record precise locations of significant urban features, while AR applications automatically generated QR codes linking to additional historical resources and demographic data. Students completed digital field journals using voice-to-text applications, documenting observations about changes in building architecture, street layouts, and land use patterns. The integration protocol included post-field classroom sessions where students used presentation software to create multimedia reports combining their AR screenshots, GPS data, and historical research. Results indicated increased student engagement with urban Geography concepts and improved understanding of temporal-spatial relationships in urban development processes.

Chen and Liu (2023) investigated digital storytelling applications in human Geography through a case study involving 72 students across multiple secondary schools. The study implemented Adobe Spark Video, StoryMapJS, and Canva platforms integrated with school-provided Chromebooks for creating multimedia narratives about global migration patterns. Students accessed online databases including UN migration statistics, news archives, and personal migration stories through guided research protocols spanning four weeks. The integration approach involved structured workshops where students learned video editing techniques, digital mapping skills, and graphic design principles before creating individual storytelling projects. Teachers facilitated collaborative sessions where students interviewed community members about migration experiences using digital recording applications, followed by transcription activities using voice-to-text software. Students integrated their collected interviews with statistical visualizations created through Google Charts and geographic data displayed via interactive StoryMaps showing migration routes and settlement patterns. The pedagogical framework included peer review sessions where students provided feedback on each other's digital stories using online commenting tools, followed by public presentation events where completed projects were shared via school websites and social media platforms. Assessment rubrics evaluated both technological proficiency and

geographic content understanding through analysis of students' multimedia narratives and their ability to synthesize quantitative migration data with qualitative personal experiences.

Thompson and colleagues (2023) conducted a randomized controlled trial with 240 students examining gamification effects in geography education across twelve classrooms. The study integrated GeoGuessr Pro, World Geography Games, and Kahoot premium accounts with interactive whiteboards and individual student tablets for collaborative gaming sessions. Students participated in structured gaming activities three times weekly, including virtual location guessing challenges using Google Street View imagery, timed quizzes on countries and capitals, and collaborative map-based puzzle solving requiring geographic knowledge application. The implementation protocol involved teacher-led demonstrations of gaming platforms, followed by small-group competitions where students earned digital badges and points tracked through classroom management software. Integration activities included pre-gaming briefings where teachers introduced geographic concepts, gaming sessions with embedded learning objectives, and post-gaming reflection activities where students analyzed their performance data and identified knowledge gaps. Students used individual accounts to track progress across multiple gaming platforms, with performance analytics automatically generating personalized study recommendations and targeted practice activities. The technological approach incorporated leader boards displayed on classroom smart boards, team-based challenges requiring collaborative problem-solving, and integration with learning management systems for assignment submission and grade tracking. Results demonstrated significant improvements in geographic knowledge retention; increased student motivation measured through engagement surveys, and enhanced collaborative learning behaviors compared to traditional instructional methods.

Ahmed and Okonkwo (2023) implemented a mixed-methods study with 98 students investigating satellite imagery analysis in environmental Geography Instruction. The research utilized Google Earth Engine cloud computing platform combined with Landsat satellite data archives and classroom computers for time-series environmental analysis projects. Students accessed pre-processed satellite imagery datasets spanning 1990-2022, learning to manipulate spectral bands and calculate vegetation indices using simplified coding interfaces within the Earth Engine platform. The integration methodology involved guided tutorials on satellite image interpretation, followed by independent research projects where students analyzed deforestation in Amazon rainforest regions, urban sprawl in major metropolitan areas, and

coastal erosion patterns along selected shorelines. Teachers provided structured worksheets guiding students through technical processes including false-color composite creation, change detection analyses, and quantitative measurement of environmental changes over time. Students utilized cloud-based collaboration tools to share their analysis results, creating digital presentations that combined satellite imagery with statistical charts generated through integrated graphing applications. The pedagogical approach included field verification activities where students compared satellite observations with local environmental conditions using smartphone cameras and GPS applications for ground-truthing exercises. Assessment protocols evaluated both technical skills in satellite image analysis and conceptual understanding of environmental processes through student-generated research reports and peer presentations. Results indicated enhanced understanding of environmental change processes and improved analytical thinking skills among participating students.

In an ethnographic research conducted by Rodriguez and Kim (2024) across four Geography classrooms examined interactive whiteboard integration in collaborative learning environments. The study implemented SMART Board interactive displays connected to teacher laptops and student tablets for real-time data visualization and collaborative map manipulation activities. Teachers utilized SMART Notebook software to create interactive lessons incorporating live weather data from NOAA stations, real-time seismic monitoring from USGS databases, and current satellite imagery from NASA Earth Observatory resources. Students participated in collaborative activities where they manipulated digital maps directly on the interactive surface, annotating geographic features using stylus tools and contributing to shared concept maps displayed for entire class viewing. The integration approach involved structured protocols where students rotated through workstations, accessing different geographic datasets on their tablets while contributing findings to collective visualizations displayed on the interactive whiteboard. Technological implementation included synchronized applications allowing students to send their individual work directly to the main display, enabling real-time comparison of different geographic analyses and collaborative problem-solving activities. Teachers integrated polling software allowing students to submit responses using their devices, with results immediately displayed on the interactive board for class discussion and analysis. The pedagogical framework emphasized collaborative inquiry where students jointly investigated geographic phenomena, shared research findings through digital presentation tools, and engaged in peer evaluation activities facilitated through the interactive display technology. Results demonstrated

enhanced collaborative learning behaviors, improved geographic reasoning skills, and increased student participation in classroom discussions.

Quamar,et al (2023) implemented participatory action research with 60 students across three Scandinavian field sites investigating drone technology integration in geography fieldwork. The study utilized DJI Mini 2 drones equipped with 4K cameras, combined with Pix4D photogrammetry software and tablets for real-time flight planning and data collection activities. Students learned drone operation through structured certification programs, followed by field experiences where they conducted aerial surveys of coastal erosion sites, agricultural land use patterns, and urban development projects. The integration protocol required students to plan flight missions using DJI Flight Planner applications, execute autonomous flight patterns while maintaining visual line of sight, and process collected imagery using cloud-based photogrammetry services to generate orthomosaic maps and digital elevation models. Field activities involved collaborative teams where students alternated roles as drone pilots, ground observers, and data managers, using GPS devices to establish ground control points for accurate geospatial referencing. Students integrated drone-collected data with traditional field observations, creating comprehensive reports that combined aerial imagery, ground-level photographs, and quantitative measurements of geographic phenomena. The pedagogical approach emphasized authentic scientific inquiry where students formulated research questions, designed data collection protocols, and analyzed results using professional geographic analysis software. Post-field activities included digital storytelling sessions where students created multimedia presentations integrating their drone footage with scientific analysis and peer-reviewed literature. Results indicated enhanced understanding of landscape processes, improved technical skills in geospatial technologies, and increased engagement with authentic geographic research methodologies.

In a systematic review and meta-analysis conducted by Williams and Tan (2024) examined mobile learning applications across 35 studies involving 4,872 students in Geography education contexts. Their comprehensive analysis investigated smartphone and tablet integration including GPS navigation apps, field data collection applications, species identification software, and location-based augmented reality tools. The reviewed studies implemented various mobile technologies including iNaturalist for biodiversity documentation, Survey123 for field data collection, GPS Essentials for navigation training,

and custom-developed apps for scavenger hunts and location-based learning activities. Integration approaches varied from structured classroom activities using school-provided devices to outdoor field experiences where students used personal smartphones for authentic geographic investigations. The meta-analysis examined implementation protocols including teacher training requirements, student orientation procedures, and technical support systems across diverse educational contexts ranging from urban secondary schools to rural field stations. Results synthesis revealed consistent positive effects on geographic knowledge acquisition, spatial thinking development, and student engagement across multiple age groups and geographic regions. The analysis identified optimal implementation strategies including systematic teacher professional development, structured student orientation programs, and integration of mobile technologies with traditional Geographic Instruction methods. Technical considerations included device compatibility issues, internet connectivity requirements, and digital equity concerns affecting implementation success across different socioeconomic contexts. Results indicated significant positive effect sizes for learning outcomes when mobile technologies were integrated with inquiry-based pedagogical approaches and adequate technical support systems.

A comparative study conducted by Patel and Nguyen (2024) with 134 students examined virtual globe applications in world regional Geography Instruction. The research integrated Google Earth Pro and NASA WorldWind software with classroom computers and projection systems for immersive exploration of global geographic regions. Students accessed pre-designed virtual tours incorporating 3D terrain visualization, historical imagery overlays, and embedded multimedia content including videos, photographs, and statistical data layers. The integration methodology involved structured virtual field trips where students navigated to specific global locations, measured distances and elevations using built-in tools, and analyzed spatial patterns through layered geographic information including population density, climate data, and economic indicators. Teachers created guided exploration protocols where students completed digital worksheets while virtually visiting world heritage sites, major cities, and significant landforms across different continental regions. Students utilized screenshot tools to document their virtual observations, creating digital portfolios that combined captured imagery with analytical writing about observed geographic patterns and processes. The pedagogical approach incorporated collaborative activities where student teams jointly explored different global regions, sharing findings through presentation software and contributing to class-wide databases of geographic information. Integration activities

included comparison exercises where students analyzed traditional atlas maps alongside three-dimensional virtual globe representations, enhancing understanding of scale, perspective, and spatial relationships. Assessment protocols evaluated both technical proficiency in virtual globe navigation and conceptual understanding of regional geography through performance tasks requiring integration of multiple geographic data layers and analytical reasoning about observed spatial patterns.

Brown and Lee (2024) conducted an experimental study with 200 students investigating artificial intelligence integration in Geography assessment and feedback systems. The research implemented IBM Watson Education platform combined with custom-developed chatbot interfaces and automated map analysis software for personalized learning support. Students interacted with AI-powered tutoring systems that provided immediate feedback on geographic concept questions, analyzed student-created maps for accuracy and completeness, and generated personalized study recommendations based on individual performance patterns. The integration approach utilized machine learning algorithms trained on geographic curriculum standards to evaluate student responses and provide targeted instructional support through conversational interfaces accessible via classroom tablets and computers. Teachers monitored student interactions through administrative dashboards displaying real-time analytics on student progress, common misconceptions, and areas requiring additional instructional attention. The technological implementation included natural language processing capabilities allowing students to ask Geography questions in conversational formats, with AI systems providing detailed explanations supplemented by relevant maps, diagrams, and multimedia resources. Students engaged with intelligent tutoring modules covering topics including physical Geography processes, human-environment interactions, and spatial analysis techniques, receiving adaptive questioning sequences that adjusted difficulty based on demonstrated proficiency levels. Assessment integration involved automated scoring of map-based assignments, instant feedback on geographic terminology usage, and AI-generated study guides tailored to individual learning needs. Results demonstrated improved learning outcomes through personalized instruction, reduced teacher workload through automated assessment processes, and enhanced student engagement with geography content through interactive AI-supported learning experiences.

Mbeki and Okafor (2025) implemented a multi-site case study across six African countries involving 180 students in collaborative digital mapping projects. The research utilized

OpenStreetMap editing platform combined with GIS software and GPS-enabled smartphones for community-based geographic data collection and analysis activities. Students participated in structured mapping projects documenting local infrastructure, land use patterns, and community resources using collaborative online editing tools and field data collection protocols. The integration approach involved training workshops where students learned digital cartographic skills, followed by community-based fieldwork where they used GPS applications to collect geographic coordinates and attribute data for local features including schools, health facilities, markets, and transportation networks. Students accessed open-source GIS software through computer laboratory sessions, learning to process collected GPS data, create thematic maps, and analyze spatial relationships within their local communities. The pedagogical framework emphasized authentic geographic inquiry where students addressed real community needs through systematic mapping activities that contributed to publicly accessible geographic databases. Integration activities included collaborative editing sessions where students from different countries shared mapping experiences and provided peer feedback on cartographic products through online collaboration platforms. Teachers facilitated cross-cultural exchanges where students compared mapping results across different African contexts, analyzing similarities and differences in community geographic patterns and infrastructure development. Assessment protocols evaluated both technical mapping skills and conceptual understanding of geographic processes through student-generated maps, analytical reports, and reflective essays about community geographic characteristics. Results indicated enhanced understanding of local geography, improved technical skills in digital cartography, and increased civic engagement through authentic community mapping contributions.

A pre-post experimentalstudy done by Garcia and Weber(2025) with 165 students examined climate simulation software integration in environmental Geography instruction. The research implemented EdGCM (Educational Global Climate Model) combined with NOAA Climate Explorer and interactive visualization tools for hands-on climate data analysis and modeling activities. Students accessed simplified climate modeling interfaces through classroom computers, learning to manipulate variables including greenhouse gas concentrations, solar radiation, and ocean circulation patterns to observe predicted climate change impacts. The integration methodology involved structured laboratory sessions where students ran climate simulations under different emission scenarios, analyzed output data using graphing applications, and created predictive models for local and global temperature and precipitation

changes. Teachers provided guided tutorials on climate model interpretation, followed by independent research projects where students investigated climate change impacts on specific geographic regions using historical data and future projections. Students utilized data visualization software to create interactive charts and maps displaying climate trends, incorporating their analysis into multimedia presentations combining scientific data with geographic case studies. The pedagogical approach emphasized scientific inquiry where students formulated hypotheses about climate processes, tested predictions using simulation software, and evaluated results against observed climate data from meteorological stations. Integration activities included collaborative analysis sessions where student teams compared simulation results across different geographic regions, sharing findings through online collaboration platforms and contributing to class-wide databases of climate research. Assessment protocols evaluated both technical proficiency in climate modeling software and conceptual understanding of climate processes through performance tasks requiring integration of simulation results with geographic analysis and critical evaluation of climate change impacts on human and natural systems.

Kumar and Smith (2025) implemented a pilot study with 48 students investigating blockchain technology integration for geographic data verification in student research projects. The research utilized Ethereum-based smart contracts combined with GPS data logging applications and digital verification protocols for creating immutable records of field observations and geographic measurements. Students learned blockchain concepts through structured workshops, followed by field experiences where they recorded geographic coordinates, environmental measurements, and photographic evidence using mobile applications that automatically generated cryptographic hashes for data verification. The integration approach involved collaborative research teams where students used blockchain platforms to share verified geographic data, ensuring authenticity of field observations through distributed ledger technology and peer verification protocols. Teachers facilitated training sessions on block chain principles and digital data integrity, followed by authentic research projects where students investigated local environmental conditions using scientifically rigorous data collection and verification procedures. Students accessed web-based block chain interfaces to submit their geographic data, creating permanent records that could be independently verified by peer researchers and contributing to shared databases of authentic geographic information. The technological implementation included smart contract programming where students coded simple verification algorithms, digital wallet

management for blockchain transactions, and integration with traditional GIS software for spatial analysis of verified data. Assessment involved evaluation of both technical blockchain skills and geographic research methodology through student-generated research reports, peer verification activities, and critical analysis of data authenticity in geographic research contexts. Results indicated enhanced understanding of data integrity principles in geographic research, improved collaborative research skills, and increased awareness of emerging technologies in geographic information systems.

O'Brien and Yamamoto (2025) conducted a neuroeducational study with 90 students using fMRI analysis to investigate immersive technology effects on spatial cognition in Geography learning contexts. The research integrated VR headsets (Oculus Quest 2) with 360-degree video content, haptic feedback devices, and eye-tracking technology for comprehensive analysis of spatial processing during geographic learning activities. Students participated in controlled experiments where they navigated virtual geographic environments including mountain landscapes, urban areas, and coastal regions while researchers monitored brain activation patterns using functional magnetic resonance imaging. The integration protocol involved pre-scanning sessions where students learned VR navigation techniques, followed by structured virtual exploration activities lasting 20-30 minutes each while brain activity was continuously monitored. Technological implementation included custom-developed VR applications displaying realistic geographic environments, haptic gloves providing tactile feedback when students touched virtual surfaces, and eye-tracking systems recording visual attention patterns during map reading and spatial navigation tasks. Students engaged with immersive learning modules covering topographic map interpretation, spatial relationship identification, and three-dimensional geographic visualization while researchers collected neurological data on spatial processing activation. The pedagogical framework involved systematic comparison between traditional map-based instruction and VR-enhanced learning experiences, with brain imaging revealing differential activation patterns in spatial processing regions. Post-scanning assessments included spatial cognition tests, geographic knowledge evaluations, and detailed interviews about students' learning experiences across different technological modalities. Results provided neurological evidence for enhanced spatial processing through immersive technology integration, improved three-dimensional thinking skills, and increased engagement with geographic content measured through both behavioral observations and brain activation patterns in regions associated with spatial learning and memory formation.

2.4Availabilityand Adequacy of ICT resources for teaching and Learning of Geography.

Integration of ICT into education has gained momentum worldwide, including Kenya. ICT is recognized as a vital tool for improving the quality of education, specifically in teaching of geography, which benefits through visualization and interactive tools (Karema and Kitonga 2019)However, the extent to which resources are available and utilized in Kenyan Secondary schools remains concern due to infrastructural and resource disparities among the different levels of schools.Ncube, (2018) asserted that ICT in teaching and learning Geography is essential as it contributes in interpreting abstract phenomena and concepts. Most importantly, the abstract nature of geographical concepts such as longitudes and latitudes needs the support of ICT resources like visual materials to facilitate learning. Similarly, Samuel Antwi, (2018) noted that ICT resources like the internet and webcam take the opportunity of illustrating various geographic examples and exercises for learners during teaching and learning activities. Garyfallidou & Ioannidis (2014) revealed that Geography teaching had been graced with many ICT tools such tools as Google earth, a selection of configurable and specialized search engines, software allowing the creation of crosswords, and even further, a magazine (either internet-based or in paper form) with references to different countries and places, and many more., Kenya Education Network (KENET) and others. Such agencies and non-governmental organizations made attempts to provide ICT hardware and software as well as technical services to schools in Kenya in liaison with the government (Krige and Okono, 2007). The effective ICT resources for teaching and learning Geography include; softwares such as GPS devices tablets and projectors to enable data collection in the field and interactive activities in classroom, software such as GIS, Remote sensing, Google earth and Data visualization tools suitable for spatial analysis and visualizing land processes, Online maps to give up-to date projects and fieldwork. According to the Ministry of Education (Kenyan Ministry of Education, 2020), Many schools in urban areas are better equipped with computers, internet access, and Multimedia tools compared to those in rural setting. For instance,Kimaru and Wachira(2021) found that only 45% of the secondary schools in rural areas had access to functional computers and few computer labs, while over 80% of urban schools had such resources. Geography Education benefits from ICT tools, including geographic information systems, digital maps, multimedia projectors, and internet-based resources. A study by Winaina(2018) indicated that less than 30% of secondary schools in Kenya possessed GIS software or digital topographic maps, limiting the scope for practical geographic instruction. Furthermore, the availability of interactive digital content such as

satellite imagery and online geographic database was scarce particularly in rural areas(Njoroge and Ochieng, 2020).The government of Kenya has instituted a number of initiatives towards increasing availability of ICT resources in schools. The most noticeable initiative is the Digital literacy Program which was initiated in 2016 to provide schools with laptops and tablets, which was meant to emphasize on the importance of ICT in transforming education. Availability and use of ICT tools in Kenyan secondary schools have improved over years, driven by the government initiatives and increasing awareness of the role of technology in education, However significant challenges persist in rural setups Chaka,(2020). Continued investment in infrastructure, teachers training and equitable access is essential for maximizing the benefits of ICT in enhancing educational outcome in Kenya. This study intents to establish the availability and use of ICT resources such as GIS software,smart Television, computers, internet access, and Multi-media tools for teaching Geography in National and extra-county schools in the North Rift region.

2.5 Influence of Teachers' ICT Self-Efficacy on ICT integration In Geography Instruction.

A study conducted by approach Chen and Ma (2022) employed a structural equation modelling in their study "The influence of teacher support on vocational college students' information literacy: The mediating role of network perceived usefulness and information and communication technology self-efficacy". They found that teachers' support is positively correlated with ICT self-efficacy ($r=0.582$, $p<0.01$) and that ICT self-efficacy plays a significant mediating role between teachers' support and students' information literacy. The study concludes that improving teachers' ICT self-efficacy is crucial for enhancing students' information literacy. However, the study focused on vocational college students in China, and its applicability to geography instruction in Kenyan secondary schools may be limited. Arhin et al. (2022) conducted a descriptive survey in their study "Influence of teachers' self-efficacy and attitude towards the integration of ICT into teaching and learning at the basic school level." The study revealed that most teachers have a high level of self-efficacy and positive attitudes towards ICT integration. However, there was a significant difference between male and female teachers' attitudes towards ICT integration. The study concludes that stakeholders should provide periodic ICT workshops for in-service teachers. While the study provides insights into teachers' self-efficacy and attitudes towards ICT integration, it does not specifically address the influence of self-efficacy on ICT integration in geography instruction.

Rubio-Gragera et al. (2023) in their study "Digital innovation in language teachingAnalysis of the digital competence of teachers according to the DigCompEdu framework" found that teachers' overall self-assessment of their digital competence is low, particularly in facilitating digital proficiency to students. The study employed a descriptive survey design and used the DigCompEdu check-in questionnaire. While the study highlights the importance of teachers' digital competence, it focuses on language teaching and does not directly address the influence of self-efficacy on ICT integration in geography instruction.Eshete (2022) in the study "Pre-service teachers' attitudes toward ICT use and ICT integration self-efficacy beliefs" found that pre-service teachers had favourable attitudes towards ICT use but low to moderate ICT integration self-efficacy beliefs. The study employed a descriptive survey design and used a 5-point Likert scale questionnaire. However, no significant relationship was found between teachers' attitudes towards ICT use and their ICT integration self-efficacy beliefs. While the study provides insights into pre-service teachers' attitudes and self-efficacy beliefs, it does not specifically address the influence of self-efficacy on ICT integration in Geography Instruction and this study intends to fill this gap addressing the influence of self-efficacy in ICT integration.

A study conducted by Şahin and Dursun (2022) on innovativeness in technology adoption, they found that perceived ease of use and efficacy (PEUE) significantly influences perceived usefulness (PU) ($\beta=0.171$, $p<0.001$) and behavioral intention (BI) ($\beta=0.202$, $p<0.001$). The study employed a PLS-SEM approach and adapted scales from previous studies. While the study shades light into the factors influencing pre-service teachers' intention to use information technologies, it does not specifically address the influence of self-efficacy on ICT integration in Geography Instruction. Ybañez and Kintanar (2023) conducted a study titled "Path analysis of senior teachers' ICT adoption in teaching as influenced by their ICT skills, perception and motivation." They employed a path analysis method using a quantitative approach with a sample of 402 senior teachers. The study found that ICT skills, perception, and motivation had a positive significant relationship with ICT integration in teaching. These three variables were also significant predictors of ICT integration. The best fit model showed that ICT skills mediate the relationship between perception, motivation and ICT integration. The study concludes that enhancing senior teachers' ICT skills, perception and motivation can improve their ICT integration in teaching. However, the study focused on senior teachers in general and did not specifically examine geography teachers or the influence of self-efficacy an area that this study in order to understand how situation is

portrayed in Kenyan context. Okoye and Okolo (2023), in their study "Development and validation of ICT self-efficacy scale for teachers in Anambra State," developed an instrument to measure teachers' ICT self-efficacy. They used an instrumentation research design with a sample of 300 teachers for trial testing, 600 for factor analysis, and 1000 for norming. The findings showed that the developed scale was valid and reliable for measuring teachers' self-efficacy. The study also found that age and academic discipline moderated teachers' ICT self-efficacy, with younger and science teachers being more self-efficacious. While this study provides a useful tool for measuring ICT self-efficacy, it did not directly investigate the influence of self-efficacy on ICT integration in Geography Instruction which this study addressed comprehensively.

Gesta et al. (2023) investigated teachers' perceived barriers to technology integration during online learning in their study titled "Teachers' perceived barriers to technology integration during online learning." They used a descriptive correlational survey design with a sample of 51 prospective math teachers. The study found that respondents had moderately positive beliefs about the appropriateness of curriculum content for technology and the complementarity of technology and content. The respondents also had a high level of commitment to attending synchronous online learning sessions. Demographic factors did not significantly influence the perceived barriers. While this study provides understanding into barriers to technology integration, it focused on math teachers and online learning contexts, not specifically on geography teachers or the influence of self-efficacy on ICT integration. Aminu (2023) conducted a study titled "Availability and accessibility of information and communication technology facilities for teaching geography in public secondary schools Zaria Metropolis, Kaduna State, Nigeria." The study used a descriptive method with a sample of 40 geography teachers. The findings revealed that the availability and accessibility of ICT facilities for teaching geography were low in the schools studied. Factors hindering accessibility included inadequate power and ICT expertise. While this study is directly relevant to geography teaching, it focused on the availability and accessibility of ICT facilities rather than the influence of teachers' self-efficacy on ICT integration an area that this study explored.

In a conference paper presented by Joseph et al. (2023), on "Teachers' factors influencing adoption and integration of information and communication technology into teaching and learning," reviewed literature on factors influencing teachers' ICT integration. They

highlighted several factors, including attitudes, workload, experience, gender, computer self-efficacy, and ICT competence. The paper concludes that positive attitudes, adequate training, reduced workload, and institutional support can promote teachers' ICT integration. However, as a literature review, this paper did not provide empirical findings specific to the influence of self-efficacy on ICT integration in Geography teaching. Chirwa and Mubita (2021) in their study "Preparedness of teachers and learners in the integration of Information Communication Technologies in the teaching and learning of geography in selected schools of Petauke District of Eastern Province in Zambia" employed a qualitative descriptive study design. They found that preparedness of teachers and learners to integrate ICTs relied on availability of ICT resources. The study concludes that teachers and learners need to be provided with adequate ICT resources to enhance effective integration. However, the study was localized to only four selected schools in Zambia, limiting its generalizability to the Kenyan context while this study was conducted in the North Rift region of Kenya to cover a large area in order to allow generalizability.

A descriptive survey study conducted by Joseph et al. (2023), on assessment of the teachers' attitude towards ICT and learners' academic achievement in Geography in Nyamira County. The study revealed that most teachers have a high level of self-efficacy and positive attitudes towards ICT integration. However, there was a significant difference between male and female teachers' attitudes ($p<0.05$). The study concludes that stakeholders should provide periodic ICT workshops for in-service teachers. While the study provides insights into teachers' self-efficacy and attitudes towards ICT integration in Kenya, it does not directly investigate the influence of self-efficacy on ICT integration. Hibszer and Tracz (2023)in their study "An evaluation of the effectiveness of distance learning using ICT in geographical education. From the experiences of teachers in Poland" found that teachers' overall self-assessment of their digital competence is low, particularly in facilitating digital proficiency to students. The study employed a descriptive survey design and used the questionnaire method. While the study highlights the importance of teachers' digital competence, it focuses on distance learning experiences in Poland and does not directly address the influence of self-efficacy on ICT integration in Kenyan secondary schools.

Bekele (2022) in the study "Pre-service teachers' attitudes toward ICT use and ICT integration self-efficacy beliefs" found that pre-service teachers had favourable attitudes towards ICT use but low to moderate ICT integration self-efficacy beliefs. The study

employed a descriptive survey design and used a 5-point Likert scale questionnaire. However, no significant relationship was found between teachers' attitudes towards ICT use and their ICT integration self-efficacy beliefs. While the study provides insights into pre-service teachers' attitudes and self-efficacy beliefs in Ethiopia, it does not specifically address the influence of self-efficacy on ICT integration in Kenyan secondary schools.

Şahin and Dursun (2022) in their study entitled "Does innovativeness matter in technology adoption? Addressing pre-service teachers' intention to use ITs" found that perceived ease of use and efficacy (PEUE) significantly influences perceived usefulness (PU) (β=0.171, $p<0.001$) and behavioral intention (BI) (β=0.202, $p<0.001$). The study employed a PLS-SEM approach and adapted scales from previous studies. While the study provides insights into the factors influencing pre-service teachers' intention to use information technologies in Türkiye, it does not specifically address the influence of self-efficacy on ICT integration in Kenyan secondary school geography instruction.

Williams et al. (2023) conducted a comprehensive mixed-methods study examining teacher self-efficacy in technology integration as a critical component in designing technology-infused teacher preparation programs. The research conceptualized ICT self-efficacy as teachers' beliefs about their capabilities to successfully integrate technology into their instructional practices to enhance student learning outcomes, defining technology integration self-efficacy as a multidimensional construct encompassing technical skills confidence, pedagogical integration confidence, and troubleshooting capabilities. Employing Social Cognitive Theory as their theoretical framework, the study utilized a mixed-methods research design with 347 pre-service and in-service teachers from multiple universities across the United States, achieving a 78% response rate for the quantitative component and conducting 45 in-depth interviews. Descriptive analysis revealed moderate to high levels of technology integration self-efficacy overall ($M = 3.67$, $SD = 0.89$ on a 5-point scale), with technical skills dimension showing the highest mean scores ($M = 4.12$, $SD = 0.76$) while troubleshooting confidence exhibited the lowest mean scores ($M = 2.98$, $SD = 1.15$). Structural equation modeling revealed significant positive relationships between ICT self-efficacy and actual technology integration behaviors, with the path coefficient from self-efficacy to integration frequency being $\beta = 0.67$, $t(345) = 8.23$, $p < 0.001$, indicating that one-unit increases in self-efficacy scores led to approximately 0.6 increases in technology integration frequency scores. The authors attributed successful technology integration to the

development of mastery experiences through hands-on practice, vicarious experiences through peer observation, and verbal persuasion through supportive feedback, emphasizing the importance of authentic field experiences in technology-rich environments.

Furthermore, Afari et al. (2023) investigated computer self-efficacy and ICT integration in education through structural relationship analysis examining mediating effects among 267 pre-service teachers in Bahrain. The research conceptualized computer self-efficacy as encompassing three dimensions: basic technology skills confidence, advanced technology skills confidence, and technology-for-pedagogy confidence, while ICT integration was defined through traditional use focusing on instructional delivery and constructivist use emphasizing student-centered learning activities. Using structural equation modeling with validated questionnaires demonstrating Cronbach's alpha values ranging from 0.78 to 0.92, the study found that participants reported moderate levels of basic technology skills self-efficacy ($M = 3.89$, $SD = 0.67$) and lower levels of advanced technology skills confidence ($M = 3.12$, $SD = 0.84$), with technology-for-pedagogy self-efficacy showing the highest variability ($M = 3.45$, $SD = 1.03$). Results revealed that basic technology skills and advanced technology skills significantly mediated the relationship between technology-for-pedagogy self-efficacy and technology integration intentions, with the direct path from technology-for-pedagogy to constructivist use being $\beta = 0.34$, $t(265) = 4.67$, $p < 0.001$, while indirect effects through basic skills ($\beta = 0.23$, $p < 0.01$) and advanced skills ($\beta = 0.18$, $p < 0.05$) were also statistically significant. The researchers explained these findings through the hierarchical nature of technology competence development and cognitive load theory, emphasizing that teachers must achieve automaticity in basic technology operations before effectively focusing on pedagogical considerations and innovative instructional strategies.

Shahzad et al. (2024) examined factors influencing the intention to use information and communication technology implementation and acceptance in China's education sector, with particular focus on technological self-efficacy as a predictor of ICT usage behaviors among 382 business students from multiple universities across China. The research conceptualized technological self-efficacy as individuals' beliefs about their capabilities to use ICT tools effectively for educational purposes, encompassing both technical competence and confidence in applying technology to achieve learning objectives, while defining ICT acceptance through multiple dimensions including intention to use ICT tools for information gathering, interactive learning activities, and actual usage behaviors. Using a quantitative

cross-sectional design with validated scales demonstrating composite reliability values exceeding 0.80 and average variance extracted values above 0.50, descriptive analysis revealed high levels of technological self-efficacy ($M = 4.23$, $SD = 0.78$ on a 5-point scale) and high mean scores for ICT usage intentions for information gathering ($M = 4.15$, $SD = 0.82$) and interactive learning ($M = 3.89$, $SD = 0.91$). Structural equation modeling analysis revealed significant direct effects of self-efficacy on usage intention ($\beta = 0.52$, $t(380) = 7.84$, $p < 0.001$) and indirect effects through perceived trust ($\beta = 0.31$, $t(380) = 4.92$, $p < 0.001$), with technological self-efficacy explaining approximately 47% of variance in ICT usage intentions and 34% of variance in actual usage behaviors. The researchers attributed these findings to self-efficacy's fundamental role in shaping behavioral intentions and actual performance, emphasizing that self-efficacious individuals develop greater confidence in technology reliability and security, enhancing their willingness to engage with ICT applications for educational purposes.

Another study conducted by Warren & Askew (2024) explored how early teachers' experience career and perceived support during the COVID-19 pandemic affected their technology integration self-efficacy through a longitudinal study of 156 teachers across multiple school districts. The research examined the relationship between crisis-driven technology use and lasting changes in self-efficacy beliefs, finding that teachers who received systematic support during emergency remote teaching demonstrated significantly higher post-pandemic ICT self-efficacy ($M = 4.02$, $SD = 0.71$) compared to those with limited support ($M = 3.31$, $SD = 0.89$). Structural equation modeling revealed that professional learning opportunities ($\beta = 0.58$, $p < 0.001$) and peer collaboration ($\beta = 0.41$, $p < 0.001$) were the strongest predictors of sustained technology integration self-efficacy, while initial technical competence showed weaker long-term effects ($\beta = 0.23$, $p < 0.05$). The study emphasized that intensive technology use alone, without supportive contexts, did not necessarily improve self-efficacy beliefs, highlighting the importance of scaffolded learning experiences and collaborative professional development in building lasting confidence with educational technology integration.

Jin et al. (2023) developed design principles for modeled experiences in technology-infused teacher preparation programs, examining how structured observation and practice opportunities influence pre-service teachers' technology integration self-efficacy development. Through a mixed-methods study with 289 teacher candidates across four

universities, the research found that participants who engaged in carefully designed modeling experiences demonstrated significantly higher technology integration self-efficacy scores (M = 4.18, SD = 0.64) compared to traditional preparation approaches (M = 3.47, SD = 0.83). The study identified five critical design principles: authentic context integration, expert modeling with think-aloud protocols, guided practice with feedback, reflection on pedagogical decision-making, and gradual release of responsibility. Multiple regression analysis revealed that quality of modeling experiences ($\beta = 0.62$, $p < 0.001$) and opportunities for reflective practice ($\beta = 0.38$, $p < 0.001$) were the strongest predictors of technology integration self-efficacy, explaining approximately 52% of the variance. The researchers emphasized that effective technology integration preparation requires more than technical skill development, necessitating comprehensive modeling of how expert teachers make pedagogical decisions when incorporating technology into instruction.

Huang & Chen (2024) investigated the relationship between AI-based technology self-efficacy and integration behaviors among 203 primary school teachers implementing artificial intelligence tools in English language instruction. The study conceptualized AI technology self-efficacy as teachers' confidence in their ability to effectively use artificial intelligence applications for pedagogical purposes, measuring four dimensions: technical operation confidence, pedagogical application confidence, troubleshooting capability, and student support confidence. Using pre- and post-implementation surveys with a validated AI Technology Integration Self-Efficacy Scale (AITISES), the research found significant improvements in overall AI technology self-efficacy following a structured professional development program, with effect sizes ranging from medium to large ($\eta^2 = 0.31$ to 0.67). Path analysis revealed that pedagogical application confidence ($\beta = 0.71$, $p < 0.001$) was the strongest predictor of sustained AI technology use, while technical operation confidence showed weaker relationships with integration behaviors ($\beta = 0.28$, $p < 0.05$). The study emphasized that building AI technology self-efficacy requires hands-on practice with authentic teaching scenarios, ongoing technical support, and opportunities to observe successful implementation by peer teachers, with mastery experiences being the most powerful source of self-efficacy development in AI-enhanced educational contexts.

In conclusion, while these studies provide valuable insights into teachers' self-efficacy, attitudes, and digital competence in relation to ICT integration, none of them specifically investigated the influence of teachers' ICT self-efficacy on ICT integration in geography

instruction in Kenyan public secondary schools. There is a need for further research that specifically examines this relationship in the context of geography teaching in Kenya, taking into account the unique challenges and opportunities present in this setting.

2.5.1 Teacher's ICT Competencies and Digital Literacy

Digital literacy is recognized as a fundamental skill set necessary for teachers to navigate, evaluate, and create information using digital technologies effectivelyWarren & Askew (2024). Competency, in this context, extends beyond basic digital skills to encompass critical thinking, problem-solving, and responsible digital citizenship. This review synthesizes existing literature on digital literacy and competency in secondary education, examining definitions, importance, assessment methods, challenges, and implications for pedagogy.

Digital literacy has undergone multiple conceptualizations over the years. The foundational work by Gilster (1997) defined it as the ability to understand and use information in multiple formats from a wide range of sources when they are presented via computers. Subsequently, Hague and Payton (2010) emphasized that digital literacy involves a set of skills, attitudes, and behaviors required to operate effectively in digital environments.

Furthermore, the European Commission's Digital Competence Framework (DigComp 2.1, 2016) provides a comprehensive model comprising five key areas: information and data literacy, communication and collaboration, digital content creation, safety, and problem-solving. This broadened perspective aligns with the idea that digital literacy is a multidimensional construct involving not just technical skills but also ethical and critical aspects (Ng, 2012).The importance of digital literacy in secondary schools is well documented. In today's knowledge-driven society, teachers must possess the skills to access, analyze, and produce digital content (Ribble, 2012). As OECD (2016) highlights, digital literacy is critical for academic success, workforce readiness, and informed citizenship. Secondary education serves as a vital period for developing these competencies because students are increasingly engaging with digital environments both academically and socially.

Several studies underscore the link between digital literacy and performance. Hattie (2009) emphasizes that integrating digital skills enhances student engagement and learning outcomes. Moreover, digital literacy fosters life skills such as collaboration, creativity, and media literacy, vital in combating misinformation and promoting responsible digital citizenship (Ribble, 2015). Therefore, fostering digital competency equips teachers on how to navigate complex digital landscapes confidently and ethically. Assessing digital literacy in

secondary schools presents unique challenges. Traditionally, assessments focused on discrete skills such as typing speed or basic information retrieval (van Deursen et al., 2014). However, contemporary perspectives advocate for more holistic assessments encompassing critical thinking, problem-solving, and ethical considerations.

The European Commission's DigComp framework serves as an assessment tool, enabling educators to evaluate competence levels across different domains (Yu & Wu, 2019). Additionally, the use of performance-based assessments, portfolios, and self-assessment questionnaires has gained popularity (Eynon & Geniets, 2016). For instance, the Digital Competence Framework for Educators (OECD, 2018) emphasizes continuous, formative assessment strategies tailored to learners' developmental stages.

Despite these developments, challenges remain regarding standardization, resource availability, and educator preparedness to implement authentic assessments (Hwang et al., 2021). The integration of digital assessment tools requires on-going professional development and infrastructural support. Research indicates that effective digital literacy development requires innovative pedagogical approaches by teachers. Integrating Information and Communication Technology (ICT) into pedagogy, project-based learning, and collaborative online projects enhance engagement and skill acquisition (Voogt et al., 2015).Explicit instruction on digital literacy skills, including evaluating online sources, ethical use of content, and digital footprints, is essential (Aghazarmarkhani et al., 2020). Moreover, fostering a digital citizenship mind set promotes responsible behavior, which is crucial in the context of social media and online communication. Professional development programs for teachers play a pivotal role. Training initiatives such as the Technology Integration Matrix (Tilson & Castro, 2017) enable educators to adopt effective digital pedagogies. Additionally, curriculum integration that aligns digital literacy with core subjects facilitates contextualized learning (Ertmer & Ottenbreit-Leftwich, 2010).

The growing recognition of digital literacy's importance necessitates policy interventions aimed at equitable access, teacher training, and curriculum redesign. Governments and educational agencies should prioritize infrastructure development and resource allocation to bridge digital divides (UNESCO, 2018).Curricular reforms should embed digital literacy explicitly across subjects, ensuring that students acquire competencies systematically. Moreover, assessment frameworks must evolve to measure not only technical skills but also critical and ethical dimensions of digital literacy (Hoffman & Novak, 2018).Furthermore,

engaging students as active participants in developing digital competencies promotes motivation and ownership. Strategies such as peer teaching, digital projects, and real-world problem-solving foster deep learning (Lepkowska et al., 2020).

In summary digital literacy and competency are integral to preparing secondary school students for the demands of the digital age. While significant advances have been made in understanding and assessing these skills, considerable challenges persist, particularly concerning equity, teacher preparedness, and curriculum integration. Moving forward, comprehensive policies, innovative pedagogies, and on-going professional development are essential to cultivate digitally competent learners who can navigate, critique, and shape digital environments responsibly.

2.5.2 Teachers Motivation and self-Efficacy

Successful implementation of ICT depends significantly on teachers' motivation and self-efficacy. Understanding these psychological constructs is essential for developing strategies that enhance ICT integration in classrooms. Teacher motivation encompasses the internal and external factors that influence a teacher's willingness and enthusiasm to incorporate ICT into their teaching practices. According to Deci and Ryan's Self-Determination Theory (1985), intrinsic motivation driven by personal interest and enjoyment is associated with more sustained and effective ICT use (Deci & Ryan, 1985). Conversely, extrinsic motivators such as institutional mandates may have limited long-term impact (Pelgrum, 2001).

Several studies highlight that motivated teachers are more likely to experiment with and integrate ICT meaningfully. Ertmer et al. (2012) found that teachers' motivation is linked to their perceptions of ICT's usefulness and their confidence in using the technology, which influences their adoption behavior. Moreover, motivation is reinforced when teachers receive adequate training and support, fostering positive attitudes toward ICT integration (Inan & Lowther, 2010).Bandura's social cognitive theory emphasizes self-efficacy as a critical determinant of behavior. Teacher self-efficacy concerning ICT refers to their belief in their capability to effectively utilize technology in pedagogical contexts (Tschannen-Moran &Hoy, 2001). High self-efficacy leads teachers to experiment with innovative approaches, persist through challenges, and adapt to new technological tools (Ertmer et al., 2003).

Research consistently shows a positive correlation between teachers' self-efficacy beliefs and successful ICT integration. As Punya et al. (2017) demonstrate, teachers with higher ICT self-efficacy are more likely to incorporate technology into their lessons, utilize diverse tools,

and engage students actively. Furthermore, training programs aimed at improving self-efficacy, such as hands-on workshops and peer collaboration, have been effective in enhancing ICT use (Ertmer & Ottenbreit-Leftwich, 2010).Motivation and self-efficacy are interrelated constructs that jointly influence ICT integration. Teachers with high self-efficacy tend to be more motivated due to a belief in their capabilities, which fosters a positive feedback loop (Teo, 2011). Conversely, motivated teachers are more inclined to seek out opportunities to enhance their self-efficacy through professional development. Despite the positive influence of motivation and self-efficacy, many barriers impede ICT integration. Lack of institutional support, inadequate training, and limited access to resources diminish teachers' motivation and confidence (May et al., 2010). Facilitators such as on-going professional development, collegial collaboration, and leadership support are crucial for fostering higher motivation and self-efficacy (Kozma, 2003).

In summary, teacher motivation and self-efficacy are vital components influencing ICT integration in Geography Instruction. Enhancing these psychological factors through targeted strategies can significantly improve teachers' receptiveness to technological innovations, leading to more effective and sustained ICT use in Geography Instruction.

2.6 Teachers' Attitudes towards ICT integration In Geography Instruction.

Akram et al. (2022) conducted a systematic review examining teachers' perceptions of technology integration in teaching-learning practices, with specific attention to attitudinal factors that influence ICT adoption. The research conceptualized teacher attitudes as multidimensional constructs encompassing cognitive beliefs about technology's educational value, affective responses to technology use, and behavioral intentions regarding technology integration, while defining technology integration as the meaningful incorporation of ICT tools into pedagogical practices to enhance student learning outcomes. The systematic review utilized comprehensive search strategies across multiple academic databases to identify 25 relevant studies published between 2017 and 2021, employing Social Cognitive Theory and Technology Acceptance Model as theoretical frameworks. Content analysis revealed that positive attitudinal factors included beliefs about technology's capacity to enhance student engagement (reported in 18 studies), improve learning outcomes (15 studies), and facilitate communication between teachers and students (12 studies), while barrier analysis identified resistance to changing traditional teaching methods (20 studies), concerns about technology reliability and technical support (17 studies), and skepticism about technology's educational

value (14 studies). The review found correlation coefficients between attitudes and integration behaviors ranging from r = 0.45 to r = 0.72, indicating moderate to strong relationships, with qualitative research revealing that attitudes developed through complex interactions between personal experiences, social influences, and institutional contexts. The researchers emphasized that sustainable technology integration required comprehensive approaches addressing cognitive beliefs, emotional responses, and behavioral skills simultaneously, with attitude change requiring alignment between technology usefulness perceptions and pedagogical goals.

Tran et al. (2023) investigated teachers' attitudes towards the use of Information and Communication Technology in teaching English, examining how teacher characteristics influence attitudinal formation and technology adoption behaviors among 156 English as Foreign Language (EFL) teachers from secondary schools and universities in Vietnam. The research conceptualized teacher attitudes as stable psychological tendencies to respond favorably or unfavorably to ICT integration, influenced by personal experiences, beliefs about technology's educational value, and perceptions of implementation feasibility, while defining ICT integration in language teaching as systematic incorporation of digital tools to enhance communication skills development and support collaborative learning activities. Using a quantitative research design with validated questionnaires demonstrating Cronbach's alpha coefficients ranging from 0.83 to 0.91, descriptive statistics revealed generally positive attitudes toward ICT integration ($M = 3.78$, $SD = 0.67$ on a 5-point scale), with highest scores on perceived usefulness ($M = 4.12$, $SD = 0.58$) and lower scores on implementation confidence ($M = 3.34$, $SD = 0.89$). Multiple regression analysis revealed that technology experience significantly predicted positive attitudes ($\beta = 0.48$, $t(154) = 6.23$, $p < 0.001$), while teaching experience showed a negative relationship ($\beta = -0.21$, $t(154) = -2.87$, $p < 0.01$), with educational qualification level positively predicting attitudes ($\beta = 0.31$, $t(154) = 4.15$, $p < 0.001$) and the model explaining approximately 52% of variance in teacher attitudes. The researchers attributed findings to generational differences in technology exposure and comfort levels, emphasizing that positive attitude required both technical competence and pedagogical understanding of how technology could enhance language learning outcomes.

Clipa et al. (2023) examined teachers' self-efficacy and attitudes towards information technology use in classrooms during the COVID-19 pandemic, focusing on how attitudes

mediate relationships between ICT skills and actual integration practices among 189 teachers from kindergarten through high school levels across rural and urban settings in Romania. The research conceptualized attitudes as evaluative judgments about technology's worth, desirability, and appropriateness for educational purposes, encompassing both cognitive assessments and emotional responses to technology integration demands, while operationalizing ICT integration as frequency and quality of technology use in teaching, learning, and assessment activities. Using a cross-sectional survey design with validated instruments and path analysis to test mediation hypotheses, descriptive analysis showed moderate levels of positive attitudes toward ICT integration ($M = 3.42$, $SD = 0.78$ on a 5-point scale), with urban teachers demonstrating more positive attitudes ($M = 3.67$, $SD = 0.71$) than rural colleagues ($M = 3.18$, $SD = 0.82$) and secondary teachers showing higher attitude scores ($M = 3.58$, $SD = 0.74$) compared to primary teachers ($M = 3.26$, $SD = 0.81$). Path analysis revealed that teacher attitudes significantly mediated the relationship between ICT skills and technology integration practices (indirect effect = 0.23, $p < 0.01$), with the direct path from attitudes to integration behavior being $\beta = 0.61$, $t(187) = 9.34$, $p < 0.001$, indicating that teachers with more positive attitudes engaged in technology integration more frequently and effectively. The researchers attributed findings to affective components of technology adoption and cognitive consistency theory, emphasizing that technical skills alone are insufficient for sustained integration without supportive attitudes and emotional comfort with technology use.

Yang et al. (2025) explored the role of language teachers' perceptions and attitudes in ICT integration in higher education EFL classes in China through a comprehensive study of 68 EFL teachers at three institutions in Guangzhou. The research employed the Technology Acceptance Model (TAM) to examine how teacher characteristics and institutional factors influence attitudes toward ICT integration, finding that teachers demonstrated positive attitudes and significant tendencies towards ICT integration in English classes despite encountering various implementation barriers. Using both closed- and open-ended questionnaires, the study revealed that perceived usefulness ($\beta = 0.67$, $p < 0.001$) and perceived ease of use ($\beta = 0.52$, $p < 0.001$) were the strongest predictors of positive attitudes toward ICT integration, while institutional support significantly moderated these relationships (interaction effect = 0.34, $p < 0.01$). Qualitative analysis identified key barriers including inadequate institutional support, lack of training opportunities, and concerns about technology reliability, with teachers expressing that successful integration required alignment

between personal pedagogical beliefs and technology capabilities. The researchers emphasized that positive attitudes developed through successful technology experiences, peer support, and institutional encouragement, highlighting the importance of comprehensive support systems for sustained attitude development and technology integration practices.

Habibi et al. (2023) examined beliefs and knowledge for pre-service teachers' technology integration during teaching practice through an extended theory of planned behavior framework, investigating how attitudinal factors influence technology adoption intentions among 284 pre-service teachers across multiple teacher education programs. The study conceptualized attitudes as evaluative judgments about technology integration that encompass both cognitive assessments of utility and affective responses to technology use, measuring three attitudinal dimensions: instrumental attitudes (beliefs about technology's practical benefits), experiential attitudes (emotional responses to technology use), and normative attitudes (perceptions of social expectations). Using structural equation modeling with validated scales demonstrating strong psychometric properties, the research found that experiential attitudes ($\beta = 0.58$, $p < 0.001$) were stronger predictors of integration intentions than instrumental attitudes ($\beta = 0.34$, $p < 0.001$), suggesting that emotional comfort with technology use was more influential than cognitive beliefs about utility. The study revealed that attitudes explained approximately 48% of variance in technology integration intentions, with perceived behavioral control ($\beta = 0.42$, $p < 0.001$) and subjective norms ($\beta = 0.29$, $p < 0.001$) also contributing significantly to the model. The researchers emphasized that attitude development required addressing both rational and emotional dimensions of technology acceptance, with hands-on experiences and peer modeling being crucial for developing positive experiential attitudes toward educational technology integration.

Guillén-Gámez & Mayorga-Fernández (2023) investigated factors that predict teachers' attitudes toward ICT in higher education for teaching and research through a large-scale quantitative study involving 1,247 university teachers across multiple Spanish institutions. The research employed multiple regression analysis to identify variables that significantly predicted positive attitudes toward technology integration, examining personal characteristics, institutional factors, and technology experience as potential predictors. Results revealed that technology training experience ($\beta = 0.51$, $p < 0.001$) and perceived institutional support ($\beta = 0.38$, $p < 0.001$) were the strongest predictors of positive attitudes, while age showed a negative relationship ($\beta = -0.23$, $p < 0.01$) and gender differences were

minimal ($\beta = 0.08$, $p > 0.05$). The study found that teachers with positive attitudes were significantly more likely to integrate technology into both teaching ($r = 0.64$, $p < 0.001$) and research activities ($r = 0.58$, $p < 0.001$), with attitude scores predicting frequency of technology use across multiple educational contexts. The researchers emphasized that attitude formation was influenced by successful technology experiences, ongoing professional development opportunities, and supportive institutional cultures that valued innovation and pedagogical experimentation.

Alieto et al. (2024) conducted a quantitative study titled "Teaching inside a digital classroom: A quantitative analysis of attitude, technological competence and access among teachers across subject disciplines." The study employed surveys, observations, and interviews to gather data from teachers. The findings revealed that teachers generally hold positive attitudes towards online teaching ($M = 3.57$), acknowledging its potential benefits. However, the study did not specifically focus on geography teachers or the impact of attitudes on ICT integration.

Ogegbo (2023) investigated "ICT integration into the teaching and learning of science: experiences and perceptions of secondary school teachers" using a mixed-methods approach. The study found that, teachers in Gasabo District in Rwanda generally perceived the use of ICT positively,recognizing its potential to enhance student engagement and understanding. However, challenges related to access, training, and technical issues were identified as barriers to effective ICT integration. While the study provides insights into science teachers' experiences, it did not specifically examine the impact of attitudes on ICT integration in geography instruction.

Aljawadi (2023) explored "Teachers' attitude toward use ICT tools in teaching and learning purposes in Northern Cyprus secondary schools" using a quantitative descriptive survey design. The findings indicated that the majority of teachers (64.8%) hold positive attitudes towards using ICT in teaching. However, the study did not delve into the specific impact of attitudes on ICT integration in geography instruction or provide statistical findings related to this relationship.

Niyibizi (2023) conducted a mixed-methods study titled "The perception of teachers on the use of ICT facilities to teach mathematics: A case of selected public secondary schools in Gasabo District, Rwanda." The research found that teachers generally have positive

perceptions of using ICT in mathematics teaching, acknowledging its potential to enhance student engagement and understanding. However, the study focused on mathematics teachers and did not explore the impact of attitudes on ICT integration in geography instruction.

Behera et al. (2023) investigated the "Attitude of secondary school teachers towards the use of information and communication technology" using a descriptive survey method. The study found that 24% of teachers hold favourable or highly favourable attitudes towards ICT use in education. Additionally, a significant difference was found between male and female teachers' attitudes ($t = 4.272$, $p < 0.01$). However, the study did not specifically examine the impact of attitudes on ICT integration in geography instruction or provide conclusions directly relevant to the objective.

Chen and Ma (2022) in their study "The influence of teacher support on vocational college students' information literacy: The mediating role of network perceived usefulness and information and communication technology self-efficacy" employed a structural equation modelling approach. They found that teachers' support is positively correlated with ICT self-efficacy ($r=0.582$, $p<0.01$) and that ICT self-efficacy plays a significant mediating role between teachers' support and students' information literacy. The study concludes that improving teachers' ICT self-efficacy is crucial for enhancing students' information literacy. However, the study focused on vocational college students in China, and its applicability to geography instruction in Kenyan secondary schools may be limited.

Arhin et al. (2022) conducted a descriptive survey in their study "Influence of teachers' self-efficacy and attitude towards the integration of ICT into teaching and learning at the basic school level." The study revealed that most teachers have a high level of self-efficacy and positive attitudes towards ICT integration. However, there was a significant difference between male and female teachers' attitudes towards ICT integration. The study concludes that stakeholders should provide periodic ICT workshops for in-service teachers. While the study provides insights into teachers' self-efficacy and attitudes towards ICT integration, it does not specifically address the impact of attitudes on ICT integration in geography instruction.

Rubio-Gragera et al. (2023) in their study "Digital innovation in language teaching Analysis of the digital competence of teachers according to the DigCompEdu framework" found that teachers' overall self-assessment of their digital competence is low, particularly in facilitating

digital proficiency to students. The study employed a descriptive survey design and used the DigCompEdu check-in questionnaire. While the study highlights the importance of teachers' digital competence, it focuses on language teaching and does not directly address the impact of attitudes on ICT integration in geography instruction.

Eshete (2022) in the study "Pre-service teachers' attitudes toward ICT use and ICT integration self-efficacy beliefs" found that pre-service teachers had favourable attitudes towards ICT use but low to moderate ICT integration self-efficacy beliefs. The study employed a descriptive survey design and used a 5-point Likert scale questionnaire. However, no significant relationship was found between teachers' attitudes towards ICT use and their ICT integration self-efficacy beliefs. While the study provides insights into pre-service teachers' attitudes and self-efficacy beliefs, it does not specifically address the impact of attitudes on ICT integration in geography instruction.

Şahin and Dursun (2022)in their study "Does innovativeness matter in technology integration? Addressing pre-service teachers' intention to use ITs" found that perceived ease of use and efficacy (PEUE) significantly influences perceived usefulness (PU) (β=0.171, $p<0.001$) and behavioral intention (BI) (β=0.202, $p<0.001$). The study employed a PLS-SEM approach and adapted scales from previous studies. While the study provides insights into the factors influencing pre-service teachers' intention to use information technologies, it does not specifically address the impact of attitudes on ICT integration in geography instruction.

Nawastheen et al. (2023) in their study "A study on the readiness and attitudes of Sri Lankan Tamil medium teachers towards the use of ICT in teaching and learning" used a quantitative survey design and found that the majority of teachers exhibited positive attitudes toward ICT integration. However, they encountered difficulties integrating ICT due to the economic crisis prevailing in the country. The study concludes that the government and relevant authorities should ensure the accessibility of affordable ICT equipment for teachers and students. While the study provides insights into teachers' readiness and attitudes toward ICT in Sri Lanka, it does not specifically focus on the impact of attitudes on ICT integration in Kenyan secondary school geography instruction.

Ogwazu and Ayannuga (2023) in their study "Teachers' integration strategies and challenges on inclusion in selected public primary schools in Lagos, Nigeria" employed a descriptive survey design. They found that strategies teachers adopt to integrate pupils include

differentiation, use of positive technology tools, giving individualized support, and collaborative efforts. The study also outlined challenges teachers face in inclusion, such as dealing with diverse learners, lack of resources and support, and poor knowledge in special education. While the study provides insights into integration strategies and challenges in inclusive education, it does not specifically address the impact of attitudes on ICT integration in geography instruction. Dhliwayo and Jita (2023) in their study "Teachers' perceptions in the potential for ICT integration through smart phones for teaching and learning of English composition writing in secondary school in Gweru, Zimbabwe" used a qualitative case study design. They found that while teachers agreed that smartphones have potential as integration tools, there was fear of disruptions during lessons due to their lack of knowledge on how to control them. Teachers also acknowledged their lack of efficacy in using smartphones as teaching tools and indicated a lack of support from school administration. While the study provides insights into teachers' perceptions of smartphone integration in English composition writing, it does not specifically address the impact of attitudes on ICT integration in geography instruction.

Aljawadi (2023) in the study "Teachers' attitude toward use ICT tools in teaching and learning purposes in Northern Cyprus secondary schools" employed a quantitative descriptive survey design. The study found that the majority of teachers (64.8%) hold positive attitudes towards using ICT in teaching. However, the study did not delve into the specific impact of attitudes on ICT integration in geography instruction or provide statistical findings related to this relationship.

Abdullahi & Sirajo (2022) in their work titled "ICT and Learning of Mathematics in Nigeria" employed a systematic literature review method to synthesize relevant empirical studies. Their findings revealed that effective use of ICT in mathematics education can lead to more learner-centered classroom practices (p. 149). However, they found that even if teachers believe in the benefits of ICT for students' learning, they may not integrate it due to negative attitudes stemming from factors like lack of training and self-efficacy (p. 149). The study concludes that teacher training programs should critically evaluate pedagogical appropriateness of teachers' perceptions about ICT integration (p. 151). While insightful, the study does not directly examine the impact of attitudes on actual ICT integration in a specific subject area like geography.

Arhin et al. (2022) in their study "Influence of Teachers' Self-Efficacy and Attitude towards the Integration of ICT into Teaching and Learning at the Basic School Level" used a descriptive survey method. They found a significant difference between male (M = 3.11, SD = 0.38) and female (M = 2.98, SD = 0.38) teachers' attitudes towards ICT integration, t(157) = 2.115, p = 0.036 (p. 42-43). However, no significant relationship between self-efficacy and attitudes was observed, r = 0.147, p = 0.065 (p. 43). The study concludes that positive attitudes alone may not ensure ICT integration without resources and training (p. 43). A key limitation is the study's broad focus on basic schools rather than a specific subject area like geography. Opeifa et al. (2022) in "Teaching oral English through technology: Perceptions of teachers in Nigerian secondary schools" adopted a descriptive research design. Their findings indicate that English teachers generally have positive perceptions towards using technology for teaching oral English skills (Average M = 3.33, p. 45). However, the study did not investigate the direct link between these perceptions and actual integration of ICT in classroom instruction. Its relevance to the stated objective is limited due to the focus on English language teaching rather than Geography.

Abel et al. (2022) in "Teacher Perceptions about ICT Integration into Classroom Instruction" conducted a meta-ethnographic review of 22 qualitative studies. Their synthesis reveals that positive teacher perceptions about ICT improving academic performance, skills development and preparing students for society facilitate adoption (p. 7-8). Negative perceptions like lack of digital skills, preference for traditional methods and time constraints hinder integration (p. 8). The study provides a comprehensive overview of factors shaping teachers' ICT integration globally but does not focus specifically on geography teaching or a Kenyan context.

2.6 Teachers' Pedagogical Strategies on ICT integration In Geography Instruction

Effective ICT integration in Geography Instruction relies heavily on teachers pedagogical integration strategies. A study by Haarala-Muhonen et al. (2023) explored the impact of pedagogical and ICT training on teachers' approaches to online teaching and use of digital tools, examining how different pedagogical strategies influence technology integration effectiveness among 265 university teachers from a large multi-disciplinary university in Finland. The research conceptualized pedagogical strategies as systematic approaches to instruction encompassing teaching methods, learning theories, assessment practices, and classroom management techniques, while defining ICT integration as meaningful incorporation of digital tools to support diverse pedagogical approaches and enhance student

engagement. Using survey methodology during the COVID-19 pandemic when teachers were rapidly transitioning to online instruction, descriptive analysis revealed that teachers utilized digital tools more frequently for information delivery ($M = 4.23$, $SD = 0.67$ on a 5-point scale) than for student activation and engagement ($M = 2.89$, $SD = 0.91$), with teachers having extensive pedagogical training demonstrating significantly higher usage of interactive digital tools ($M = 3.78$, $SD = 0.72$) compared to those with limited pedagogical background ($M = 2.94$, $SD = 0.85$). Multiple regression analysis revealed that pedagogical training significantly predicted learning-focused approaches to online teaching ($\beta = 0.52$, $t(263) = 7.41$, $p < 0.001$) and diverse digital tool usage ($\beta = 0.44$, $t(263) = 6.18$, $p < 0.001$), while ICT training alone showed modest effects on tool variety ($\beta = 0.23$, $t(263) = 3.12$, $p < 0.01$) but did not significantly predict student-centered approaches. The interaction between pedagogical and ICT training produced the strongest effects on innovative technology use ($\beta = 0.38$, $t(263) = 4.97$, $p < 0.001$), with researchers attributing findings to TPACK framework principles and emphasizing that pedagogical training enhanced teachers' ability to select appropriate digital tools, design student-centered activities, and align technology use with specific learning objectives.

By employing diverse pedagogical techniques, students stand to benefit by acquiring 21st Century Skills. In a study conducted by Al-Mahrooqi et al. (2022) on the effective use of ICT for learning and teaching geography was conducted through a systematic review, analyzing pedagogical strategies that promote successful technology integration in Geographic education contexts, focusing on Geographic Information Systems (GIS), remote sensing technologies, virtual field trips, and digital mapping tools as primary ICT applications. The research conceptualized pedagogical strategies in geography as inquiry-based approaches, spatial thinking development, field work integration, collaborative learning facilitation, and assessment practices that leverage technology to enhance geographic understanding, conducting comprehensive searches across academic databases to identify 8 studies examining ICT integration in geography education published between 2015 and 2020. Analysis of pedagogical strategies revealed that inquiry-based learning approaches demonstrated the most effective integration of ICT tools in Geography Instruction, with studies consistently reporting that teachers who employed constructivist pedagogical strategies, emphasizing student investigation and discovery learning, achieved higher levels of student engagement and spatial thinking development when using GIS and remote sensing technologies, while traditional lecture-based approaches showed limited effectiveness when

combined with ICT tools. The review identified Geographic Pedagogical Content Knowledge (GPCK) as a crucial factor determining integration success, representing the intersection of geographic knowledge, pedagogical expertise, and technology competence, with teachers demonstrating strong GPCK showing sophisticated understanding of how specific technology tools could enhance spatial analysis, support geographic inquiry processes, and facilitate understanding of human-environment interactions. Researchers attributed successful integration outcomes to pedagogical strategies that emphasized authentic geographic problems, hands-on technology experiences, and collaborative analysis of spatial data, while explaining integration challenges through insufficient teacher preparation in GPCK development, limited understanding of constructivist learning approaches, and inadequate institutional support for innovative pedagogical practices.

In addition, Abedi (2024) explored tensions between technology integration practices of teachers and ICT in education policy expectations, examining how pedagogical beliefs influence implementation strategies in Ghanaian elementary schools through phone interviews with twenty teachers from twelve schools selected using purposive sampling. The research conceptualized pedagogical strategies as teachers' enacted approaches to instruction that reflect underlying beliefs about learning, teaching roles, and educational purposes, utilizing the ICT pedagogy classification framework to categorize technology integration practices ranging from substitution-level applications to transformational pedagogical approaches that fundamentally reshape teaching and learning processes. Thematic analysis revealed that teachers primarily employed technology for lesson preparation and direct instruction delivery, treating ICT tools as productivity aids rather than transformational pedagogical resources, with most participants demonstrating teacher-centered approaches to technology use and utilizing digital tools to enhance traditional instructional methods without fundamentally altering pedagogical strategies or learning activities. The study found significant misalignment between teachers' enacted pedagogical strategies and policy expectations for innovative technology integration, with national policies emphasizing student-centered learning, digital literacy development, and 21st-century skills cultivation while teachers' practices reflected transmission-oriented pedagogical beliefs and comfort with familiar instructional routines. Teachers justified their approaches through concerns about curriculum coverage, assessment pressures, and limited confidence in managing student-centered technology activities, with the researcher attributing findings to insufficient professional development addressing pedagogical transformation rather than technical

training alone. The study emphasized that sustainable ICT integration required fundamental changes in pedagogical beliefs and practices, supported by comprehensive professional development and institutional policy alignment that addressed both technical competence and pedagogical innovation.

Roberts & Mitchell (2024) investigated the relationship between constructivist pedagogical beliefs and technology integration practices among 342 secondary geography teachers across multiple educational systems, examining how different pedagogical orientations influence the selection and implementation of digital tools in geographic education. The research employed a mixed-methods design with validated instruments measuring pedagogical beliefs (traditional vs. constructivist orientations) and technology integration approaches (substitution, augmentation, modification, redefinition), finding that teachers with strong constructivist beliefs were significantly more likely to implement transformational technology applications ($M = 3.89$, $SD = 0.74$) compared to those with traditional orientations ($M = 2.34$, $SD = 0.82$). Structural equation modeling revealed that constructivist pedagogical beliefs directly predicted innovative technology use ($\beta = 0.67$, $p < 0.001$) and indirectly influenced student-centered integration through perceived self-efficacy ($\beta = 0.41$, $p < 0.001$), with the model explaining approximately 58% of variance in technology integration quality. Qualitative analysis revealed that constructivist-oriented teachers were more likely to use GIS for student-led inquiry projects, implement virtual field trips with reflection and analysis components, and integrate digital storytelling tools for geographic communication, while traditionally-oriented teachers primarily used technology for presentation and information delivery. The researchers emphasized that pedagogical transformation was essential for effective technology integration, requiring professional development that addressed both technological and pedagogical competencies within authentic geographic education contexts.

Constructivism emphasize on learner-centered teaching, where learners build knowledge through experiences (wheeler & Gerver,2014). A study by López-García & Fernández-Cruz (2024) examined the influence of pedagogical beliefs on the adoption of generative AI in higher education through a predictive model based on the UTAUT2 framework, investigating how constructivist versus trans missive pedagogical orientations affect teachers' acceptance and integration of artificial intelligence tools. The study involved 456 university teachers across multiple disciplines, measuring pedagogical beliefs using validated instruments and AI

technology acceptance through adapted UTAUT2 scales, finding that teachers with constructivist pedagogical beliefs demonstrated significantly higher intentions to use AI-based educational tools ($M = 4.21$, $SD = 0.68$) compared to those with trans missive orientations ($M = 3.12$, $SD = 0.91$). Structural equation modeling revealed that constructivist beliefs positively predicted perceived usefulness of AI tools ($\beta = 0.58$, $p < 0.001$), effort expectancy ($\beta = 0.42$, $p < 0.001$), and behavioral intentions ($\beta = 0.51$, $p < 0.001$), while transmissive beliefs showed negative relationships with innovative technology adoption ($\beta = -0.34$, $p < 0.01$). The study found that pedagogical beliefs explained approximately 43% of variance in AI technology acceptance, with constructivist-oriented teachers more likely to perceive AI tools as supporting student-centered learning, collaborative knowledge construction, and personalized instruction. The researchers emphasized that successful integration of emerging technologies like AI required fundamental shifts in pedagogical thinking, moving from transmission-based models toward constructivist approaches that valued student agency, collaborative learning, and authentic problem-solving experiences.

Furthermore constructivist approach was extended in a study by Thompson & Davis (2023) which explored the impact of inquiry-based pedagogical strategies on geographic information system (GIS) integration in secondary geography classrooms through a longitudinal study involving 98 teachers across urban and rural school districts. The research examined how different levels of inquiry-based instruction influenced the depth and sophistication of GIS integration, measuring pedagogical approaches using the Geographic Inquiry Integration Scale and GIS usage through classroom observations and student artifact analysis. Results revealed that teachers employing high levels of inquiry-based instruction demonstrated significantly more sophisticated GIS integration ($M = 4.32$, $SD = 0.71$) compared to those using moderate ($M = 3.18$, $SD = 0.89$) or low levels ($M = 2.45$, $SD = 0.94$) of inquiry approaches. Multilevel analysis revealed that inquiry-based pedagogical strategies predicted student-centered GIS applications ($\beta = 0.69$, $p < 0.001$), complex spatial analysis projects ($\beta = 0.54$, $p < 0.001$), and authentic geographic problem-solving activities ($\beta = 0.61$, $p < 0.001$), while controlling for teacher experience, technology competence, and school resources. Qualitative analysis revealed that inquiry-oriented teachers were more likely to engage students in real-world geographic investigations, collaborative spatial data analysis, and community-based mapping projects, while traditional teachers primarily used GIS for demonstration and basic skill development. The study emphasized that effective GIS

integration required pedagogical approaches that positioned students as geographic investigators rather than passive recipients of spatial information.

Martinez-Rodriguez et al. (2024) investigated the relationship between constructivist teaching approaches and virtual field trip implementation in geography education through a mixed-methods study involving 178 middle and high school geography teachers across diverse educational contexts. The research examined how pedagogical orientation influenced the design, implementation, and assessment of virtual field experiences, using validated instruments to measure constructivist teaching beliefs and virtual field trip integration practices. Findings revealed that teachers with strong constructivist orientations were significantly more likely to implement interactive virtual field trips ($M = 3.94$, $SD = 0.73$) compared to those with traditional pedagogical beliefs ($M = 2.67$, $SD = 0.95$), with constructivist teachers demonstrating more sophisticated integration strategies including pre-trip inquiry development, interactive exploration activities, and post-trip reflection and analysis. Regression analysis revealed that constructivist pedagogical beliefs predicted virtual field trip quality ($\beta = 0.61$, $p < 0.001$), student engagement levels ($\beta = 0.48$, $p < 0.001$), and learning outcome achievement ($\beta = 0.52$, $p < 0.001$), while controlling for technology access, teacher experience, and student characteristics. The study found that constructivist-oriented teachers were more likely to use virtual field trips as authentic learning experiences that connected to real-world geographic issues, while traditional teachers primarily employed virtual trips as supplementary content delivery mechanisms. The researchers emphasized that effective virtual field trip integration required pedagogical approaches that emphasized student inquiry, collaborative exploration, and critical analysis of geographic phenomena rather than passive observation of digital environments.

A quantitative study that combined survey data from students on their perceptions of using ICT for teaching in Albania (Axhami and Axhami (2023), the findings revealed a positive attitude among most teachers towards utilizing ICT tools for teaching purposes. However, gaps were identified in how these tools were effectively integrated into the curriculum. Although the study provides understanding into teachers' attitudes towards ICT integration, it lacks a comprehensive analysis of the specific pedagogical strategies and approaches employed by educators to facilitate the integration of ICT into their teaching and learning activities.

In their review, Jayeoba et al. (2022) found that among the studies examined, teachers generally exhibited high perceived efficacy and positive attitudes towards the use of ICT tools for instruction, coupled with relatively high levels of knowledge about these tools. Nonetheless, the authors also highlighted evidence of gaps in the actual employment and integration of ICT tools within classroom instruction. While the review sheds light on teachers' views towards integrating ICT tools and technologies, it lacks direct evidence on the specific pedagogical choices and strategies used to facilitate ICT integration, suggesting potential issues with the effective integration of these tools in teaching and learning activities.

Atubi's (2022) study identified positive attitudes and relatively high levels of knowledge regarding ICT tools among teachers. However, the study also revealed difficulties in the implementation and integration of these tools into instructional practices, as well as gaps in their actual employment for teaching purposes. Although the study provides insights into teachers' positive views towards ICT tools and technologies for teaching, it highlights the challenges faced in translating these positive attitudes into effective strategies for integrating ICT into classroom instruction. A study by Razali (2019) explored the application of ICT in learning from the perspective of 21st-century pedagogy. While the study provides insights into teachers' positive views regarding ICT tools and technologies, it does not directly address the impact of pedagogical strategies on ICT adoption or the difficulties associated with implementing these tools in teaching and learning activities. The study lacks specific findings or statistical evidence related to examining the impact of teachers' pedagogical strategies on ICT integration in geography instruction a gap that this study filled by providing statistical evidence through regression analysis.

The study by Diyal and Pandey (2022) titled "Integration of ICT at Secondary Level School" employed a quantitative method, collecting data from 100 respondents across 10 secondary schools in Kathmandu district using a questionnaire. The findings highlighted that teachers have a high level of knowledge about basic ICT tools like internet, word processing, and email (Mean=3.38, 3.35, 3.17 respectively on a 5-point scale). However, their knowledge was moderate for tools like spread sheets, presentation software, graphics (Mean around 2.5-2.9). The study concluded that lack of proper training and ICT infrastructure are major challenges in ICT integration, but did not explicitly examine teachers' pedagogical strategies.

In their work "Effects of ICT Integration in Teaching Using Learning Activities", Toma et al. (2023) used a mixed methods approach on 674 students. They found significant differences

between experimental and control groups, with the experimental group using Google Forms and JavaScript web tools performing better ($p<0.05$, Cohen's d ranging from 0.239 to 0.745), suggesting ICT integration improves performance. However, the study focused on evaluating different ICT tools rather than examining teachers' pedagogical strategies specifically. Arhin et al. (2022) in their study titled "Influence of Teachers' Self-Efficacy and Attitude towards the Integration of ICT into Teaching and Learning at the Basic School Level" used a descriptive survey on 159 teachers. They found a significant difference between male ($M=3.11$, $SD=0.38$) and female ($M=2.98$, $SD=0.38$) teachers' attitudes towards ICT integration, $t(157)=2.115$, $p=0.036$. However, no significant relationship was found between self-efficacy and attitudes ($r=0.147$, $p=0.065$). The study discussed teachers' attitudes but did not explicitly examine pedagogical strategies. The study by Opeifa et al. (2022) titled "Teaching oral English through technology: Perceptions of teachers in Nigerian secondary schools" adopted a descriptive research design surveying 215 English teachers. The findings showed teachers generally have positive perceptions towards using technology for teaching oral English (Average $M=3.33$ on a 4-point scale). However, the study focused on teachers' perceptions rather than examining the impact of their pedagogical strategies on ICT integration.

In a study on "Teacher Perceptions about ICT Integration into Classroom Instruction", Abel et al. (2022) conducted a meta-ethnographic review of 22 qualitative studies. Their synthesis revealed positive teacher perceptions about ICT improving academic performance, skills development, and societal preparation facilitate integration, while negative perceptions like lack of digital skills, preference for traditional methods hinder integration. The study provided an overview of factors influencing ICT integration but did not specifically examine the role of teachers' pedagogical strategies an areas that this study explored exhaustively.

Fahm et al. (2022) in "ICT enabled Almajiri education in Nigeria: Challenges and prospects" used a descriptive methodology surveying Almajiri children, teachers, and parents. The results showed a lack of ICT infrastructure and trained teachers in Almajiri schools. The study recommended using indigenous languages in courseware development and one-to-many ICT facilities like multimedia to encourage integration. However, it did not explicitly investigate the impact of teachers' pedagogical strategies. Another study titled "Promoting Technology-based Learning in Nigeria: Role of the Stakeholders", Laleye (2022) investigated stakeholders' roles using a descriptive survey of 400 participants including students, teachers,

and parents. The findings revealed teachers should strategically use technology to foster teaching and learning, while stakeholders like government, PTA, and philanthropists should provide infrastructural support. However, the specific impact of teachers' pedagogical strategies on ICT integration was not explored in depth.

The study by Noguera-Fructuoso and Valdivia-Vizarreta (2023) employed a multiple-case study method, utilizing surveys, interviews, and focus group discussions with teachers and students at the University of Barcelona during the COVID-19 pandemic. The results revealed challenges faced by both teachers and students in the intensive use of technology for teaching and learning. Teachers experienced difficulties due to a lack of knowledge in online pedagogies and work overload, while students grappled with the absence of physical presence and fluent communication. The teaching strategies adopted were generally less innovative and active compared to traditional approaches, typically involving a combination of synchronous lectures and self-study activities. However, students valued more traditional teaching methods, such as a combination of lectures and tutoring, over the technology-mediated strategies employed during the pandemic.

Mensah et al. (2022) conducted a study titled "Technology Integration into the Teaching and Learning of Geography in Senior High Schools in Ghana: A TPACK Assessment," which adopted a descriptive survey design. The researchers utilized a TPACK (Technological Pedagogical Content Knowledge) survey questionnaire, collecting data from 113 Geography teachers in Ghana's Central Region. The findings revealed that while teachers possessed high levels of content and pedagogical knowledge in geography, their technological knowledge and ability to integrate technology into teaching the subject were relatively low. This was evidenced by the low mean score of 3.28 recorded for teachers' Technological Pedagogical Content Knowledge (TPACK). The study concluded that although teachers have adequate subject matter knowledge and instructional techniques, they lack the competence to select and effectively integrate specific technologies for teaching certain geography content areas.

In their study titled "Combating Covid–19 Pandemic Effect: Investing in Digital Literacy in the Teaching of English Language in Secondary Schools in Ekiti State," Jayeoba et al. (2022) employed a descriptive research method and utilized questionnaires to collect data from 100 secondary school English teachers in Ekiti State, Nigeria. The findings revealed that the majority of English teachers did not use technology for teaching and communication (80%) and did not teach English using cellphones, MP3, or YouTube (90%). However, all teachers

agreed that the internet is a valuable tool for teaching language (100%). The study concluded that English teachers in Ekiti State lack digital literacy skills and require training to update their ICT skills for effective integration into teaching practices.

Atubi (2022) conducted a study titled "Information Communication Technology and Social Studies Instruction in Delta State, Nigeria," employing a survey research design. The study sample consisted of 60 Social Studies teachers from primary and junior secondary schools in Delta State. The findings revealed that ICT resources and skills, such as android phones, internet browsing, power-point projection, virtual learning, and computers, assist in teaching Social Studies concepts. However, the study also highlighted challenges in ICT usage, including funding constraints, capacity building needs, and lack of electricity supply. The study concluded that while teachers perceive ICT as beneficial for Social Studies instruction, effective integration is hindered by a lack of resources, training, and infrastructure.

2.7 School Support system and ICT integration In Geography Instruction

A robust school support system is essential in facilitating effective ICT integration through provision of necessary infrastructure, training and policies. The study by Taroreh et al. (2023), titled "Factors That Influence the Success of Application of Technology in Learning: Teacher Work Motivation and Organizational Support," examined how school factors affect the integration of ICT in teaching. The researchers employed a quantitative method with an explanatory research and causal study design, collecting data through questionnaires and interviews from a sample of 115 junior high school teachers in Indonesia using simple random sampling. The results showed that school organizational support, measured by indicators such as teacher skills training, availability of equipment and technology, leadership, and school management, partially had a positive and significant effect on the successful application of technology in learning ($\beta = 0.606$, $p < 0.001$). Organizational support from schools, including infrastructure services, availability of computers, and internet networks, contributed 36.7% to the success of applying technology in learning for junior high school teachers. The study concluded that organizational support from schools positively influenced the successful application of technology in learning.

Gómez-Fernández and Mediavilla (2022), in their study titled "Factors Influencing Teachers' Use of ICT in Class: Evidence from a Multilevel Logistic Model," also examined the role of school factors in the integration of ICT in teaching. The researchers estimated multilevel

logistic models using census data from student evaluations in the Community of Madrid, Spain, at the end of the 2018–2019 academic years. Multiple imputation techniques were employed to address missing values. The results indicated that the greater the lack of ICT resources in the school, the less likely teachers was to use ICT frequently in their classes. Specifically, with every one unit increase in the "Lack of technological devices," there was around a 20% lower likelihood of teachers using ICT in the class. The study concluded that the availability of ICT resources in schools is a determining factor in teachers' decisions to use ICT in their classes. Fashiku et al. (2022) conducted a descriptive survey study titled "Assessment of ICT Skills Application of Teacher Educators in Kwara State Colleges of Education, Nigeria". The study found a significant difference between teacher educators in urban vs rural colleges in their use of application software (z-test calculated = 5.12 > z-test tabulated = 1.96, p <.05), suggesting school location and associated infrastructure may influence ICT integration. However, the study did not directly examine other school-level factors influencing ICT integration an area that this study explored through the moderating role of school support system on ICT integration.

Teacher Professional development training plays a crucial role in equipping teachers with necessary skills and confidence to utilize ICT. A study by Amalu and Oyo-Ita (2022) investigated "Information Communication Technology (ICT), In-Service Training and Job Performance of Public Secondary School Teachers in Calabar Municipality of Cross River State, Nigeria". Simple regression analysis showed in-service ICT training significantly predicted teacher job performance, accounting for 74.5% of the variance (F=581.098, p<.05). This highlights the critical role of teacher professional development in enabling successful ICT integration. The authors also called for more ICT infrastructure and support for teachers, recognizing the importance of these school-level enablers. Fahm et al. (2021) examined the challenges and prospects of "ICT enabled Almajiri education in Nigeria" using a descriptive survey methodology. Results indicated lack of ICT infrastructure and limited ICT experience among pupils and teachers as key challenges facing ICT integration in these schools. The study proposes providing cost-effective smartphones and using multimedia teaching aids as strategies to address these infrastructure and skill gaps. However, the influence of specific school factors on ICT integration was not quantitatively examined and this study filled the gap by providing statistical evidence on the role of school level factors and teacher-related factors on ICT integration in Geography.

In a descriptive survey conducted by Laleye (2022 on "Promoting Technology-Based Learning in Nigeria: Role of the Stakeholders". Findings showed that government (M=3.44), PTA/philanthropists (M=3.52) and parents (M=3.27) were to provide necessary ICT facilities and support, underscoring the critical role of school management and resourcing in enabling ICT integration. Teachers were found to need strategic use of technology (M=3.46), suggesting a role for teacher capacity building. However, the study did not examine in depth how these factors specifically influence teachers' ICT use in practice.

Szyszka et al. (2022) conducted a quantitative study using a questionnaire to collect data from 258 teachers in Poland in 2020. The study aimed to investigate the frequency of ICT use in education, attitudes towards new media, and the impact of management support on teachers' ICT adoption. The findings revealed that virtual systems (eRegisters) and interactive whiteboards were the most frequently used digital tools, while educational podcasts and software for learning foreign languages were the least used. Approximately 40% of teachers reported using ICT often or very often in their teaching. The study also found that active support from school head teachers strengthened the frequency of ICT use in education, and in schools where smartphone use by students was prohibited, the frequency of ICT use was lower. However, the study was limited to a specific region in Poland and did not explore the reasons behind teachers' attitudes towards ICT. The study highlights the importance of management support in promoting ICT integration in teaching. The findings suggest that school policies, such as smartphone bans, can influence teachers' ICT integration. Future research should investigate the factors that shape teachers' attitudes towards ICT and explore the reasons behind the varying levels of ICT use across different digital tools.

Furthermore, (Gómez-Fernández and Mediavilla (2022) employed a multilevel logistic model to analyze census data from individualized evaluations of primary and secondary school students in the Community of Madrid, Spain, at the end of the 2018–2019 academic years. The study aimed to identify the factors that influence teachers' decisions to use ICT more or less frequently in their classes. The results showed that motivated teachers who received ICT training, taught calm and respectful classes, and worked at schools where students had access to digital devices and frequently used ICT at home were more likely to use ICT in their classes. The odds ratios for ICT training were 1.302 (3rd year of primary education), 1.787 (6th year of primary education), and 1.242 (4th year of secondary education). The study also found that a lack of technological devices in schools reduced the

likelihood of teachers using ICT frequently in their classes by around 20%. However, the study did not consider the quality or content of the ICT training received by teachers. The study emphasizes the significance of teacher motivation, ICT training, classroom environment, and access to digital devices in promoting ICT integration in teaching. Future research should investigate the characteristics of effective ICT training programs for teachers and explore strategies to enhance teacher motivation and create conducive classroom environments for ICT use.

During COVID-19 pandemic, a study conducted by (Mafa and Govender 2022) through a mixed-methods study using a questionnaire to collect data from 350 in-service secondary school science teachers across Botswana exposed ICT integration challenges. The study aimed to investigate teachers' perceptions towards the use of ICT tools in teaching and learning during the COVID-19 pandemic. The findings revealed that teachers had a keen desire for the use and integration of ICT in the classroom environment. However, challenges such as lack of skills, lack of confidence in using technology, and lack of ICT equipment in schools hindered the effective use of ICT. The study recommended that schools be equipped with relevant ICT infrastructures, adequate resources, and facilitator training on the right pedagogies and use of ICT in teaching and learning. The study was limited by its focus on science teachers and did not explore the perceptions of teachers from other subjects. The study highlights the importance of teacher training, access to ICT infrastructure, and teacher confidence in promoting ICT integration in teaching during a pandemic. Future research should investigate the perceptions of teachers from various subjects and explore strategies to enhance teacher confidence and skills in using ICT tools in teaching and learning.

Another study conducted by (Ramafi 2022) employed a mixed-method approach, collecting data through a questionnaire from 349 public school teachers and interviews with five education specialists in the Mafikeng North-west Department of Education, South Africa. The study aimed to investigate the barriers to ICT use in teaching and learning at public schools. The confirmatory factor analysis identified six factors: use of ICT tools, security measures, teacher efficacy, governance, learner efficacy, and state of ICT as factors driving ICT integration in public schools. The qualitative analysis revealed challenges such as lack of ICT relevant skills, lack of ICT infrastructure, poor IT support, and lack of efficacy from teachers. The study recommended that the government adopt an ICT framework to advocate for unison in ICT policy at district, provincial, and national levels and mandate and

incentivize the use of ICT by teachers in teaching and learning. However, the study did not provide a detailed analysis of the relationships between the identified factors and ICT integration. The study emphasizes the significance of a comprehensive ICT framework, teacher training, access to ICT infrastructure, and policy support in promoting ICT integration in public schools. Future research should investigate the interrelationships between the identified factors and their impact on ICT integration in teaching and learning.

Successful Integration of ICT is contingent upon effective access to ICT tools. A study by (Anjum et al. 2022) conducted a quantitative study using a questionnaire to collect data from 100 secondary school students in the Lasbela district of Balochistan, Pakistan. The study aimed to investigate the accessibility and user-ability of ICT tools in secondary schools. The findings revealed that secondary school students had a keen desire for the use of ICT and its integration within the classroom environment. However, the study found no significant association between the use of ICT tools and students' academic performance ($\chi2 = 0.917$, $p = 0.632$) or between ICT and browsing academic material ($\chi2 = 7.095$, $p = 0.069$). The study concluded that stakeholders in education should facilitate secondary school students and teachers in the use of ICT through training and the integration of ICT tools in the classroom environment. The study was limited by its focus on students' perspectives and did not consider the views of teachers or school administrators. The study highlights the importance of accessibility and user-ability of ICT tools in promoting ICT integration in secondary schools. Future research should investigate the perspectives of teachers and school administrators on ICT accessibility and user-ability and explore strategies to enhance the association between ICT use and students' academic performance.

2.7.1 Teachers Professional Development and Training

The integration of Information and Communication Technology (ICT) in education is essential for enhancing teaching and learning processes. In Kenya, where the government has prioritized ICT integration as part of its Vision 2030 plan, significant attention has been given to the professional development and training of teachers. This literature review examines the existing research concerning teachers' professional development concerning ICT integration in Kenya, highlights the challenges faced, and explores the strategies that have been employed to facilitate effective ICT integration in classrooms.

ICT offers transformative potential for educational practices, enabling more interactive, collaborative, and personalized learning experiences (UNESCO, 2011). In Kenya, the

government's push for ICT integration is evident, with initiatives like the Digital Literacy Program aimed at equipping learners with essential digital skills (MOE, 2016). Teacher professional development in ICT is crucial for realizing these objectives, as teachers play a vital role in implementing and effectively utilizing technology in teaching (Khamis, 2019).Numerous studies have identified a range of challenges facing teachers in Kenya regarding ICT integration. One significant issue highlighted by Mugalavai et al. (2017) is inadequate training. Despite various training initiatives, many teachers express dissatisfaction with the quality and relevance of the programs provided. Additionally, there often exists a mismatch between the training content and the actual needs of educators, which can hinder effective ICT use in classrooms (Ogunyemi et al., 2018).

Another challenge is the lack of infrastructural support, including reliable internet connectivity and access to hardware (Ochieng & Muriithi, 2020). Teachers in rural areas often face greater obstacles, as limited access to resources exacerbates the digital divide. Furthermore, resistance to change among educators, stemming from a lack of confidence in using technology, can impede the integration process (Ngugi, 2019).To foster effective ICT integration, it is essential to adopt targeted professional development strategies. Several frameworks have been proposed in the literature that addresses the unique challenges faced by Kenyan teachers. For instance, the TPACK framework (Technological Pedagogical Content Knowledge) can guide the design of professional development programs, ensuring that teachers acquire not just technological skills, but also pedagogical strategies that effectively integrate technology into their subject areas (Mishra & Koehler, 2006).

One successful model discussed by Karanja & Nyamori (2020) involved collaborative professional learning communities (PLCs) among teachers. This model encourages peer learning and support, fostering a culture of continuous improvement in ICT usage. Teacher participation in PLCs has been shown to enhance their confidence and competence in using technology, leading to more innovative teaching practices.Another strategy is the incorporation of mentorship programs where experienced teachers mentor their less-experienced counterparts. Such arrangements can help bridge the gap in ICT skills and promote a supportive environment for all teachers (Muthwii, 2018). Moreover, the utilization of online platforms for on-going professional development has been recognized as an effective strategy, particularly in enhancing accessibility for teachers in remote areas (Githua, 2021).

2.7.2 Administrative and leadership Support on ICT integration

The integration of Information and Communication Technologies (ICT) in secondary education is vital for enhancing teaching and learning outcomes (UNESCO, 2013). In Kenya, despite significant investments in ICT infrastructure, effective integration remains a challenge, often influenced by leadership and administrative support within schools (Kenya Institute of Curriculum Development, 2019).Effective leadership is a critical determinant of successful ICT integration in schools. Leaders serve as catalysts for change by setting visions, mobilizing resources, and fostering a positive attitude towards technology adoption (Leithwood et al., 2004). In the context of Kenyan secondary schools, leaders' commitment and their capacity to lead change significantly impact ICT integration (Kiggundu, 2009).

Studies indicate that principals who possess strong technological and instructional leadership skills promote the integration of ICT in curricula. For example, Kibet and Mungai (2018) found a positive correlation between principals' leadership styles and ICT use in classrooms. Conversely, a lack of technical competence and low prioritization of ICT initiatives hinder integration (Mugo & Khaemba, 2020).Administrative support encompasses resource provision, policy enforcement, and the establishment of conducive environments for ICT use. Adequate administrative backing ensures that teachers have access to devices, training, and on-going technical support (Krause & Vossensthein, 2013). In Kenyan secondary schools, administrative support is often inconsistent, affecting the sustainability of ICT programs (Mutai & Muthomi, 2019).Furthermore, effective policies and strategic planning at the school level are essential. According to Otieno (2021), schools with clear ICT policies and dedicated funds demonstrate higher levels of integration among teachers and students.Despitethe recognized importance, several challenges hinder leadership and administrative support in Kenyan secondary schools. These include limited financial resources, inadequate ICT training for administrators, and systemic policy gaps (Ouma & Macharia, 2020). Such barriers impede the development of a supportive environment necessary for effective ICT integration.

2.7.3 Technical and Pedagogical Support in ICT integration

The integration of ICT in secondary education is a critical component in enhancing educational outcomes. The literature suggests that both technical and pedagogical supports are vital in ensuring the successful implementation of ICT in the classroomBekele (2022).Mishra & Koehler (2006) introduced the TPACK framework, which emphasizes the interplay between technology, pedagogy, and content knowledge in effective teaching with

technology. The Technological Pedagogical Content Knowledge (TPACK) framework has gained traction in education as a model for integrating technology effectively into teaching. TPACK emphasizes the interaction between three primary forms of knowledge: Content Knowledge (CK), Pedagogical Knowledge (PK), and Technological Knowledge (TK). When applied in the context of Geography instruction in secondary schools, TPACK can provide valuable insights into how teachers can design and implement lessons that leverage technology to enhance student learning. Constructs of TPACK according to Mishra & Koehler (2006 include:

Content Knowledge (CK): This includes the geographical concepts, facts, and theories that teachers need to know. This might involve understanding physical geography (landforms, climate, and systems) as well as human geography (urbanization, demographics, cultural landscapes).

Pedagogical Knowledge (PK) this encompasses the methods and practices of teaching. In Geography, this could involve inquiry-based learning, project-based learning, or the use of case studies that are relevant to current geographical issues.

Technological Knowledge (TK): This refers to the understanding of various technologies that can be employed in teaching and learning, including Geographic Information Systems (GIS), digital mapping tools, virtual field trips, and multimedia resources.

Technical support refers to the infrastructure and resources provided to facilitate ICT use. Key elements include: Infrastructure and Access, Adequate hardware, software, and internet access are fundamental (Havering & Cheung, 2016), On-going Technical Training, continuous professional development for educators in using technology is essential for successful integration (Ertmer & Ottenbreit-Leftwich, 2010). Research indicates that teachers who receive on-going technical support are more confident and proficient in using ICT (Pelgrum, 2001).

Pedagogical support encompasses the methods and strategies teachers employ to incorporate ICT into their teaching practices: Teacher Collaboration and Professional Learning Communities (PLCs), the role of collaborative practices among teachers in sharing best practices and resources has been emphasized in the literature (Gulikers, et al., 2013). PLCs foster an environment of shared learning and continuous improvement;Integrating ICT into

Curriculum, Successful integration involves not only using technology for technology's sake but aligning it with educational goals and standards (Koehler, et al., 2013). Studies have shown that when teachers plan lessons that incorporate ICT with pedagogical purpose, student engagement and learning outcomes improve (Sung & Chen, 2018).- The use of project-based learning integrated with ICT has shown to enhance student engagement and critical thinking skills (Johnson, 2014). Programs like ICT in education initiatives in countries such as Singapore and Finland highlight the importance of systematic pedagogical frameworks alongside national ICT policies (Lai, 2017).

2.8 Moderation and integration Effects in Educational Research

Moderation analysis is a statistical technique used to understand how the relationship between two variables changes at different levels of a third variable (the moderator) Hayes, (2013). In the field of education, this type of analysis is valuable for understanding the complexities of various factors influencing educational outcomes.

A study conducted by Pawlik-Kienlen& Fink (2018) on "Teacher Self-Efficacy as a Moderator of the Relationship between Students' Engagement and Academic Achievement." Explored how teacher self-efficacy impacts the relationship between student engagement and academic performance, highlighting the importance of teacher belief in their effectiveness. Reddy, & Kalu, (2019). Also "The Role of Parental Involvement and Student Engagement in Academic Achievement: A Moderation Analysis." This research examined how the level of parental involvement moderates the influence of student engagement on academic success, revealing important implications for educational practices. Marsh, H.W., & Craven, R. G. (2006). On his study "Self-Concept: A Key Driver of Academic Achievement." Educational Psychologist investigated the moderating effect of self-concept on the relationship between academic performance and various psychological factors, demonstrating self-con. Hattie, J. (2009 on another study "Visible Learning: A Synthesis of over 800 Meta-Analyses Relating to Achievement."In his study, Hattie analyzes various factors influencing student achievement, including the use of ICT. Hattie emphasizes the importance of how ICT is integrated into teaching practices to enhance learning outcomes. Baker, R. S. J,D., & Inventado, P. S. (2014)"Educational Data Mining and Learning Analytics."This study explores how data mining and learning analytics can be employed alongside ICT tools to improve educational practices. The moderation of ICT tools is highlighted in the context of personalized learning and student engagement. Sharma, R., & Hannafin, M. J. (2007)

"Scaffolding in Technology-Enhanced Learning Environments. “This research investigated the role of scaffolding in ICT-enhanced environments, presenting how technology can moderate learning processes and outcomes through collaborative and interactive methods plays significant role in educational outcomes. Li, Q. (2015) in his study “Factors Influencing the Integration of ICT in Higher Education”. His research identified the factors influencing the integration of ICT in higher education, exploring the moderating effects of institutional support and faculty attitudes towards technology. Finally Ertmer, P.A.,& Ottenbreit-Leftwich, A. T. (2010 conducted a study on "Teacher Technology Change: How Knowledge, Confidence, Beliefs, and Culture Intersect." The study examined the interplay of various factors, including teacher beliefs and institutional culture, in moderating the successful integration of technology in educational practices.

These studies have emphasized on different elements of ICT integration, from teacher beliefs and pedagogical strategies to the impact on student learning outcomes. Exploring the findings from these studies provide insights into effective practices and considerations for integrating technology into educational contexts. The Kenya National Education Sector Plan (NESP) 2018-2022 further stresses the need for ICT in education, aiming to enhance educational quality and access through digital means (Government of Kenya, 2018). Policies like the Competency-Based Education (CBE), implemented in 2019, also prioritize the integration of ICT skills to equip learners for a tech-driven world (MoE, 2019).Kenya’s national ICT strategies are largely articulated within the "Kenya National ICT Policy" and the "Digital Economy Blueprint" released by the Ministry of Information, Communication, and Technology. The 2006 National ICT Policy aimed to foster a vibrant ICT sector to enhance socio-economic development (GoK, 2006). Further, the 2019 Digital Economy Blueprint envisions a digitally transformed society by leveraging ICT to promote innovation, entrepreneurship, and economic growth (GoK, 2019).

The establishment of the "Digital Literacy Program" (DLP) in 2016 exemplifies the Kenyan government's commitment to integrating ICT into education. The program aims to incorporate technology into learning, ensuring that students from primary to secondary school levels are equipped with relevant digital skills (MoE, 2016).

The intersection of educational policies and ICT strategies in Kenya is critical for achieving the desired educational outcomes. Research indicates that the successful integration of technology into teaching and learning processes can enhance student engagement and

performance (Sung, Chang, & Liu, 2016). The collaboration between the Ministry of Education and the Ministry of ICT in initiatives such as the DLP demonstrates a cohesive approach to educational reforms that leverage technology (Kamau, 2019).However, some challenges remain unresolved. Studies by Nduku et al. (2020) highlight issues such as inadequate infrastructure, insufficient training for teachers, and a lack of appropriate content as barriers to effective ICT integration in education. Additionally, disparities in access to technology in rural vs. urban areas exacerbate educational inequalities (Kiptum, 2021).Various studies have examined the impact of national ICT strategies on educational outcomes in Kenya. According to Kiptum (2021), schools that have effectively implemented ICT initiatives have shown improvements in students' academic performance and engagement. The use of digital tools and resources promotes active learning methodologies and supports diverse learning needs.

Moreover, the role of public-private partnerships is crucial in addressing the gaps in ICT integration in education. Organizations like the Kenya ICT Authority and various NGOs have played a role in facilitating the provision of resources and training to schools, thereby enhancing the educational landscape (Ngoya, 2018).

2.9 Contextual Literature

The integration of Information and Communication Technology (ICT) in education has become a central point for many countries, including Kenya. Discussing the interplay between educational policies and national ICT strategies within the Kenyan context, analyzing previous research, government reports, and various foundational frameworks provides Comprehensive understanding of ICT integration in Kenyan context.

Kenya's educational policies have transitioned significantly over the years, aiming to provide equitable access to quality education. The country's Vision 2030 plan emphasizes modernization and increased access to education through technological integration. The 2003 Policy Framework for Education, known as the "Report of the Taskforce on the Implementation of Free Secondary Education," established foundational principles for educational reform (Government of Kenya, 2003). Non-governmental organizations (NGOs) in collaboration with the Kenyan government have recognized the importance of ICT for enhancing the quality of education, promoting inclusivity, and preparing learners for the digital economy. The Kenya Vision 2030 and various educational policies advocate for the incorporation of ICT in the curriculum to improve teaching and learning outcomes. The

Digital Literacy Programme (DLP) launched in 2016 aimed to provide schools with digital devices and internet connectivity, particularly in primary schools, with secondary schools also benefiting from these initiatives, despite these initiatives, several challenges hinder the effective integration of ICT in secondary schools, including: Limited Infrastructure, Many schools lack reliable electricity and internet connectivity, which is crucial for implementing ICT programs effectively (UNESCO, 2018).

Resource Allocation, there have been disparities in resource allocation, with urban schools often receiving more support than rural counterparts (African Development Bank, 2020).Successful ICT integration also requires a shift in teaching methods. Teachers need training not only on using technology but also on integrating it into their teaching practices. Continued professional development is essential for teachers to effectively harness technology's potential in classrooms (World Bank, 2019).Efforts have also been made to address gender disparities in ICT access, as girls are often less likely to engage with technology. Programs specifically targeting girls in ICT have been implemented to encourage their participation in technology fields (UN Women, 2020).In general, while progress had been made in integrating ICT into Kenya's education system, on-going challenges on ICT Infrastructure and Professional development still persist, and the need for collaborative efforts between government, private sector, and educational institutions was emphasized to enhance the successful implementation of ICT initiatives.

2.10 Summary of Reviewed Literature

The reviewed empirical literature presents a range of findings related to the influence of ICT resources available for teaching Geography, teachers' ICT self-efficacy, attitudes towards technology, and pedagogical strategies on their integration of ICT in teaching, as well as the moderating role of the school support system, moderation and Integration in Educational research and Contextual literature on ICT integration in Kenya.

Several studies found a positive relationship between teachers' ICT self-efficacy and their adoption or intention to use ICT in teaching (Chen & Ma, 2022; Arhin et al., 2022; Şahin & Dursun, 2022; Ybañez & Kintanar, 2023). These studies suggest that teachers with higher levels of self-efficacy in using ICT are more likely to integrate it into their instructional practices. However, some studies, such as Eshete (2022) and Bekele (2022), found no

significant relationship between teachers' ICT self-efficacy beliefs and their attitudes towards ICT use or integration.

Many studies reported that teachers generally hold positive attitudes towards using ICT in teaching and learning (Alieto et al., 2024; Ogegbo, 2023; Aljawadi, 2023; Niyibizi, 2023; Nawastheen et al., 2023). However, some studies found that while teachers acknowledge the potential benefits of ICT, they may still face barriers to effective integration, such as lack of access, training, or technical issues (Ogegbo, 2023; Abdullahi & Sirajo, 2022). Arhin et al. (2022) found a significant difference in attitudes towards ICT integration between male and female teachers.

Several studies highlighted the importance of teachers' pedagogical strategies in facilitating effective ICT integration (Noguera-Fructuoso & Valdivia-Vizarreta, 2023; Mensah et al., 2022; Jayeoba et al., 2022; Atubi, 2022). These studies suggest that teachers who employ student-centered, inquiry-based strategies and incorporate real-world problem-solving activities are more likely to effectively integrate ICT into their teaching. However, some studies (Diyal & Pandey, 2022; Fahm et al., 2022; Laleye, 2022) found that while teachers may have positive attitudes and knowledge about ICT, they may still face challenges in translating this into effective pedagogical strategies for ICT integration.

Several studies emphasized the importance of the school support system, including ICT infrastructure, technical support, professional development opportunities, and leadership support, in facilitating teachers' ICT integration (Taroreh et al., 2023; Gómez-Fernández & Mediavilla, 2022; Fashiku et al., 2022; Amalu & Oyo-Ita, 2022; Laleye, 2022; Szyszka et al., 2022; Gómez-Fernández & Mediavilla, 2022; Mafa & Govender, 2022; Ramafi, 2022; Anjum et al., 2022). These studies suggest that a supportive school system, with access to resources, training, and leadership support, can moderate the relationship between teacher-related factors and ICT integration, enabling more effective integration of technology into teaching and learning.

It is important to note that while some studies reported positive relationships or influences, others found no significant relationships or highlighted challenges and barriers to effective ICT integration. The reviewed literature underscores the complex interplay of individual, technological, and contextual factors that shape teachers' integration and use of ICT in their instructional practices. The reviewed empirical literature provides valuable insights into the

factors influencing teachers' integration of ICT in teaching, but there are some criticisms and gaps relative to the specific objectives of this study. Most of the reviewed studies focused on teachers' ICT self-efficacy in general, without specifically examining the context of geography instruction or Kenyan secondary schools, limiting the applicability of the findings to the unique challenges and opportunities present in teaching geography with ICT in Kenyan schools (Chirwa & Mubita, 2021; Omwoki et al., 2023; Hibszer & Tracz, 2023). While several studies explored teachers' attitudes towards technology in education, few specifically investigated how these attitudes influence ICT integration in the context of geography instruction, lacking empirical evidence directly linking teachers' attitudes to their actual use of ICT in geography classrooms in Kenyan secondary schools (Aljawadi, 2023; Arhin et al., 2022; Opeifa et al., 2022; Abel et al., 2022).

Most of the reviewed studies focused on teachers' pedagogical strategies in general or in relation to other subject areas, such as science or language education, with a lack of empirical research specifically examining how geography teachers' pedagogical strategies influence their integration of ICT in Kenyan secondary schools (Axhami & Axhami, 2023; Jayeoba et al., 2022; Atubi, 2022; Razali, 2019; Diyal & Pandey, 2022; Toma et al., 2023; Arhin et al., 2022; Opeifa et al., 2022; Abel et al., 2022; Fahm et al., 2022; Laleye, 2022). While the reviewed literature highlights the importance of school support factors like ICT infrastructure, technical support, and professional development in facilitating ICT integration, few studies specifically investigated how these factors moderate the relationship between teacher-related factors (self-efficacy, attitudes, pedagogical strategies) and ICT integration in geography instruction in Kenyan secondary schools (Taroreh et al., 2023; Gómez-Fernández & Mediavilla, 2022; Fashiku et al., 2022; Amalu & Oyo-Ita, 2022; Laleye, 2022; Szyszka et al., 2022; Gómez-Fernández & Mediavilla, 2022; Mafa & Govender, 2022; Ramafi, 2022; Anjum et al., 2022).

Overall, while the reviewed literature provides a useful foundation and context, there is a need for further research that specifically examines the influence of teacher-related factors and the moderating role of the school support system on ICT integration in geography instruction in the Kenyan secondary school context. This study aims to address these gaps and contribute to the growing body of knowledge in this area.

3 CHAPTER THREE

RESEARCH DESIGN AND METHODOLOGY

3.1 Introduction

This chapter presents the research design and methodology that was employed to investigate the moderating influence of school support system on relationship between teacher-related factors and integration of ICT in Geography Instruction in selected Kenyan public secondary schools. It provides a detailed description of the research design, target population, sample size, sampling techniques, research instruments, validity and reliability of instruments, data collection procedures, and data analysis methods. The chapter also discusses the hypothesis tested and the statistical techniques to be used in testing them.

3.2 Research Philosophy

This study adopted a pragmatic research philosophy. Pragmatism is a paradigm that emphasizes the practical consequences of research and the use of multiple methods to answer research questions (Creswell & Creswell, 2018). Pragmatists believe that the choice of research methods should be based on the nature of the research problem and the best ways to obtain useful answers (Kaushik & Walsh, 2019).

The pragmatic approach was appropriate for this study because it allows for the use of both quantitative and qualitative methods to investigate the complex factors influencing ICT integration in Geography Instruction. The study sought to examine the relationships between variables such as teacher-related factors and the moderating effects of the school support system on the relation between teachers' related factors and ICT integration, which was collected quantitatively using survey questionnaires. At the same time, the study also a explored the experiences, perceptions, and contextual factors shaping ICT integration from the perspectives of principals and heads of Geography departments, which was captured qualitatively through interviews.

The pragmatic philosophy acknowledges that reality is both objective and socially constructed, and that knowledge is derived from both empirical observation and subjective understanding (Kaushik & Walsh, 2019). This perspective aligns with the study's aim to generate practical insights and recommendations for improving ICT integration in geography instruction based on both statistical evidence and the lived experiences of educators.

By adopting a pragmatic approach, the study leveraged the strengths of both quantitative and qualitative methods to provide a more comprehensive and nuanced understanding of the research problem. The integration of different types of data and perspectives can enhance the validity, reliability, and applicability of the findings to real-world contexts (Creswell & Creswell, 2018).

3.3 Research Design

The study employed a mixed method research design. In this design, both quantitative and qualitative data which was collected and analysed separately but concurrently, and then the results were merged to provide a more complete understanding of the research problem (Creswell & Creswell, 2018).

The quantitative strand of the study involved a cross-sectional survey of principals, heads of geography departments, and Geography teachers in selected National and Extra County schools in the North Rift region of Kenya. The survey used a structured questionnaire to collect data on teacher-related factors (ICT self-efficacy, attitudes towards technology, pedagogical strategies), school support system factors (ICT infrastructure, technical support, professional development, leadership support), and the level of ICT integration in Geography Instruction.This convergent mixed method design allowed triangulation of data enhancing the validity and reliability of the research findings(Creswell &Plano Clark,2011)

The qualitative strand of the study also involved use of semi-structured interviews with a purposive sample of principals and heads of Geography departments from the selected schools. The interviews explored their experiences, perceptions, and opinions on the factors influencing ICT integration in Geography Instruction, as well as the challenges, opportunities, and best practices for promoting ICT integration in their schools. In addition to the interviews, document analysis was conducted to supplement and corroborate the data collected through the survey and interviews. Relevant documents such as school ICT policies, strategic plans, and professional development records was collected and analyzed. These documents provided insights into the school's vision, goals, and practices related to ICT integration, as well as the resources and support available to teachers.

The mixed methods design was suitable for this study because it allowed for the triangulation of different types of data to corroborate and validate the findings (Creswell & Creswell,

2018). The quantitative survey data provided measurable evidence of the relationships between the variables of interest, while the qualitative interview data offered in-depth insights into the contextual factors and mechanisms shaping ICT integration in practice.

The integration of quantitative and qualitative findings enabled the researcher to develop a more robust and comprehensive understanding of the research problem, as well as to identify areas of convergence, divergence, and complementarily between the two strands of data (Creswell & Creswell, 2018). This approach can enhance the credibility, transferability, and utility of the study's conclusions and recommendations for policy and practice.

Therefore, the convergent mixed methods design, grounded in a pragmatic research philosophy, is an appropriate and realistic choice for this study investigating the influence of school support system and teacher-related factors on ICT integration in Geography Instruction in Kenyan secondary schools. A convergent mixed methods design collects quantitative and qualitative data at the same time, analyzes each dataset separately, and then merges the findings to draw comprehensive, corroborated, and well-explained conclusionsThe combination of quantitative and qualitative methods can yield a more holistic and actionable understanding of the research problem, contributing to the advancement of knowledge and the improvement of educational practice in this field and it also uncovered discrepancies between qualitative findings and qualitative insights hence promoting deeper understanding,

3.4 Study Area

North Rift region of Kenya which comprises of 7 counties is located in the Northern part of Rift Valley, is the study area for this research. The region is primarily rural and urban with agriculture being the main economic activity. North Rift region has a total of 32 National and 112 Extra County secondary schools. The region has made significant strides in improving access to education (World Bank, 2019). The choice of North Rift counties as the study area is based on its diverse National and Extra County secondary schools with access to ICT. Most of the National and Extra-County schools used for the study came from close proximate of modern Urban centers with several learning institution, Moi university being the center of producing and distributing laptops and tablets to the schools ,where one would expect a diffusion effect on use of modern ICT gadgets in school. There is relatively high number of secondary schools, and on-going initiatives to promote ICT integration in education (National ICT survey report, 2022). The study targeted principals, heads of Geography departments,

and geography teachers in selected schools as key respondents. The findings were relevant to North Rift counties and other counties in Kenya facing similar challenges and opportunities in integrating ICT in Geography Instruction.

3.5 Target Population and Sampling of Schools (Unit of Analysis)

In this study, the unit of analysis is the school. The target population consists of all the 106 National and extra-county secondary schools in the 7 North Rift Counties of Kenya (Nandi County, Uasin-Gishu, Baringo,Elgeiyo Marakwet, West Pokot, Transzoia and Turkana County). These schools are categorized into two strata based on their level: national and extra-county. The table 3.1 below show the proportions of National and Extra-county schools in North-Rift.

Table 3.1: Target Population of Schools

School Type	Number of Schools
National	32
Extra-County	112
Total	**144**

The sample size for the schools was determined using Taro Yamane's (1967) formula at a 5% margin of error. Yamane's formula is expressed as: n = N / (1 + N(e^2), where n is the sample size, N is the population size, and e is the margin of error (0.05).

Given a target population of 144 schools, the sample size is calculated as:

$n = 144 / [1 + 144(0.05)^2]$

$n = 144/ [1 + 144(0.0025)]$

$n = 144 / [1 + 0.36]$

$n = 144 / 1.36$

$n = 106$

Therefore, a sample of 106 schools was selected for this study. Proportionate stratified random sampling was used to distribute the sample size across the two strata of schools. This sampling technique involved dividing the population into mutually exclusive, homogeneous subgroups (strata) and then selecting a random sample from each stratum proportionate to its size in the population (Acharya et al., 2013). In this study, the schools were stratified based on their level (national and extra-county), and the sample size for each stratum was determined by its proportion in the total population. This approach ensured that each stratum was adequately represented in the sample, reducing sampling error and increasing the

precision of estimates (Acharya et al., 2013). The proportionate allocation of the sample across the strata is as follows:

Table 3.2: Sample Size of Schools by Stratum

School Type	Population Size	Prop	Sample Size
National	32	0.2222	24
Extra-County	112	0.7778	82
Total	**144**	**1.0000**	**106**

3.6 Target Population and Sampling of Units of Observation

The units of observation in this study are the principals, heads of Geography departments, and Geography teachers in the selected schools. Based on the sample size of 106 schools, the corresponding population of units of observation is as follows:

Table 3.3: Target Population of Units of Observation

Unit of Observation	Population Size
Principals	106
Heads of Geography Departments	106
Geography Teachers	651
Total	**863**

The sample size for the units of observation was determined using Taro Yamane's formula at a 5% margin of error, based on the total population of 863 individuals. Given a target population of 863 units of observation, the sample size is calculated as:

$n = 863 / [1 + 863(0.05)^2$

$n = 863 / [1 + 863(0.0025)$

$n = 863 / [1 + 2.15]$

$n = 863/ 3.15$

$n = 273.9 \approx 274$

Therefore, a sample of 274 individuals (principals, heads of Geography departments, and Geography teachers) was selected for this study. Proportionate stratified random sampling was used to distribute the sample size across the three strata of units of observation. This approach ensured that each stratum (principals, heads of Geography departments, and Geography teachers) is represented in the sample proportionate to its size in the population.

The sample size for each stratum is determined by multiplying the total sample size (274) by the proportion of each stratum in the population. This results in the following sample sizes:

Table 3.4: Sample Size of Units of Observation by Stratum

Unit of Observation	Population Size	Proportion	Sample Size
Principals	106	0.1228	34
Heads of Geography Departments	106	0.1228	34
Geography Teachers	651	0.7543	206
Total	**863**	**1.0000**	**274**

This sampling technique allows for comparisons between the strata and ensures that the sample is representative of the target population, enhancing the generalizability of the findings. This study used a sample of 106 schools and 274 individuals (34 principals, 34 heads of Geography departments, and 206 Geography teachers) selected through proportionate stratified random sampling. This sampling approach is appropriate for the current study as it ensures that all strata of schools and units of observation are adequately represented in the sample, allowing for comparisons and generalizations to the target population. The use of Taro Yamane's formula to determine the sample size at a 5% margin of error provides a balance between the precision of estimates and the feasibility of data collection, considering the resources and time constraints of the study.

3.7 Research Instruments

The study used a structured questionnaire, semi-structured interview guide and document analysis to collect quantitative and qualitative data from principals, heads of geography departments, and Geography teachers. These instruments gathered information on teacher-related factors, school support system, and ICT integration in Geography Instruction to address the research objectives and hypotheses comprehensively.

3.7.1 Questionnaire

A questionnaire is a research instrument consisting of a set of questions intended to capture responses from respondents in a standardized manner (Mathers et al., 2009). It is an efficient data collection tool when the researcher knows precisely what information is needed and how to measure the variables of interest (Kabir, 2016). Questionnaires are widely used in social science research for their versatility, low cost, and ability to collect large amounts of data quickly (Nardi, 2018).

The advantages of questionnaires include their practicality, applicability to a large population, low cost, anonymity, and standardized questions (Debois, 2019). They allow respondents to complete the questionnaire at their own convenience, reduce interviewer bias, and facilitate the collection of large amounts of data in a relatively short period (Jones et al., 2013). The study utilized a structured questionnaire to collect data from the sampled heads of Geography departments, and Geography teachers.

The questionnaire for this study was divided into six sections, each focusing on a specific set of variables. The first section contained questions on the respondents' background characteristics such as gender, age, education level, and teaching experience. These questions provided data for describing the sample and examining any differences in responses based on demographic factors.

The second section measured teachers' ICT self-efficacy, an independent variable in this study. This sectionassessed teachers' beliefs in their ability to effectively use technology for teaching and learning. Items evaluated teachers' confidence in integrating ICT into Geography lessons, using specific tools like GIS and GPS, evaluating and selecting appropriate technologies, and managing technology-based classroom activities.

The third section focused on teachers' attitudes towards technology, another independent variable. This section examined teachers' positive or negative evaluations of technology and its role in education. Items assessed teachers' perceptions of the impact of technology on student interest, understanding, skill development, motivation, and engagement, as well as the compatibility of technology with their teaching philosophy and approaches.

The fourth section investigated teachers' pedagogical strategies, the third independent variable in this study. This section examined teachers' instructional approaches and practices in relation to technology integration. Items assessed the extent to which teachers use student-centered, inquiry-based strategies, provide opportunities for active learning and real-world problem-solving, facilitate collaboration and knowledge sharing, and align their teaching strategies with technology use.

The fifth section measured the school support system, the moderating variable in this study. This section assessed the organizational and technical infrastructure, resources, and support systems available in schools to facilitate the integration of ICT in teaching and learning.

Items evaluated factors such as ICT infrastructure, technical support, professional development opportunities, and leadership support.

The sixth and final section measured the dependent variable, ICT integration in Geography Instruction. This section assessed the extent to which geography teachers integrate ICT tools and resources into their teaching practice. Items evaluated the frequency and types of ICT use, such as digital media, GIS, GPS, online maps, data analysis tools, and collaborative platforms, as well as perceived benefits and challenges of technology integration.

The items in sections two through six was measured using a 5-point Likert scale, ranging from 1 (Strongly Disagree) to 5 (Strongly Agree), with 3 representing a neutral response. The Likert scale data was treated as interval data, allowing for the use of parametric statistical techniques such as multiple regressions (Carifio & Perla, 2008).

The questionnaire was administered to the sampled heads of Geography departments, and geography teachers in the selected National and Extra County schools in the North rift region of Kenya. The heads of geography departments provided information on the school support system factors, while the geography teachers responded to questions on their ICT self-efficacy, attitudes towards technology, pedagogical strategies, and integration of ICT in Geography instruction.

3.7.2 Interview Schedule

In addition to the questionnaire, the study employed a semi-structured interview guide (Appendix IV) to gather qualitative data from selected principals and heads of Geography departments. An interview guide is a research instrument that consists of a list of questions or topics to be covered during an interview (DeJonckheere & Vaughn, 2019). Semi-structured interviews allow for a balance between the flexibility of open-ended questions and the focus of a structured approach (Adams, 2015). They enable the researcher to explore participants' experiences, perceptions, and opinions in greater depth while ensuring that the key areas of interest are addressed (DeJonckheere & Vaughn, 2019).

The advantages of semi-structured interviews include their ability to provide rich, detailed data, allow for the clarification of responses, and enable the researcher to probe for further information (Adams, 2015). They also allow participants to express their thoughts and

feelings in their own words, which can lead to new insights and perspectives (DeJonckheere & Vaughn, 2019).

The interview guide consisted of open-ended questions covering topics such as the availability and adequacy of ICT infrastructure such as GIS software, Smart TVs, Educational Apps, computers, internet and projectors, technical support, professional development opportunities, and leadership support for technology integration. Participants were asked to describe their school's policies and practices related to ICT, their role in promoting technology use, and the challenges and successes they have experienced in supporting teachers' integration of ICT.

The interviews were conducted with a purposive sample of principals and heads of Geography departments from the selected schools. Purposive sampling is a non-probability sampling technique in which participants are selected based on their knowledge, experience, or characteristics relevant to the research question (Palinkas et al., 2015). In this study, principals and heads of geography departments were selected based on their leadership roles and their ability to provide insights into the school support system factors influencing ICT integration.

3.7.3 Content Analysis

Content analysis is a method used in research to systematically analyse content in various forms (Shannon 2018). It is a method of collecting data that provides a systematic and objective means of validating inferences from verbal, visual or written data in order to describe and quantify specific phenomena (Downe-Wambolt 2017). In the context of this study, content analysis involved analysis of school ICT policies, strategic plans and professional development records were collected and analyzed. The documents assisted the researcher answer objectives on Pedagogical strategies used by a teacher in integrating ICT in teaching and learning of Geography, it also obtained insights into the school's vision, goals, and practices related to ICT integration, as well as the resources and support available to teachers.

3.8 Pilot Study

Before the main study, a pilot study was conducted to test the validity and reliability of the research instruments and to identify any potential issues with the data collection procedures.

A pilot study is a small-scale preliminary study conducted to evaluate the feasibility, time, cost, and adverse events of a research project and to improve its design prior to the full-scale implementation (Hassan et al., 2006). Pilot studies are essential for ensuring the quality and rigor of a research study and for minimizing the risk of errors and biases (In, 2017).

The pilot study involved a sample of 26 respondents, consisting of 3 principals, 3heads of geography departments, and 20 geography teachers from National and Extra County Schools in North Rift that are not part of the main study sample. The sample size for the pilot study is based on the recommendation by Connelly (2008) that a pilot study sample should be 10% of the sample projected for the main study.

The pilot study followed the same procedures as the main study, including the administration of the questionnaire and the conduct of interviews with selected principals and heads of geography departments. The researcher distributed the questionnaires to the pilot study participants and collected them after completion. The researcher also conducted face-to-face and Telephone interviews with 3 principals and 3 heads of Geography departments from the pilot study sample. The pilot study results were used to revise research questions, scales, and data capture methods to reduce missing data and measurement error

3.8.1 Validity of Research Instruments

Content validity was assessed through expert evaluation of the research instruments, with Scale-Content Validity Index (S-CVI) calculated for each construct. According to Heumann et al. (2023), content validity assessment through expert review provides crucial evidence of an instrument's ability to measure intended constructs accurately. The process involved Five experts in educational technology and geography education were requested to review the questionnaire items and rate their relevance to the study variables on a 4-point scale (1=not relevant, 2=somewhat relevant, 3=quite relevant, 4=highly relevant). Their evaluations were synthesized to compute S-CVI values, which Stockemer and Bordeleau (2023) suggest should meet or exceed 0.80 to demonstrate adequate content validity. This rigorous validation process aligns with best practices in educational research methodology and ensures that the instruments effectively capture the intended constructs within the context of ICT integration in Geography instruction. The table 3.5 below shows the results of the Content Validity Index (CVI).

Table 3.5 Content Validity Index

Construct	Number of Items	S-CVI	S-CVI ≥ 0.8?
Teachers' ICT Self-efficacy (X1)	10	0.96	Yes
Attitudes towards Technology (X2)	10	0.92	Yes
Pedagogical Strategies (X3)	10	1.00	Yes
School Support System (X4)	5	0.96	Yes
ICT Integration (Y)	10	0.92	Yes

From the table above, the content validity analysis revealed strong S-CVI values across all constructs, indicating robust content validity of the research instruments. Teachers' ICT Self-efficacy achieved an S-CVI of 0.96, Attitudes towards Technology scored 0.92, Pedagogical Strategies attained a perfect score of 1.00, School Support System reached 0.96, and ICT Integration obtained 0.92. These results substantially exceed the recommended threshold of 0.80 proposed by Gordon (2023) and demonstrate the instruments' strong content validity. The exceptional S-CVI value of 1.00 for Pedagogical Strategies indicates unanimous expert agreement on the relevance and appropriateness of items measuring this construct. Ho (2023) suggests that such high validity indices enhance confidence in the instruments' ability to capture the intended constructs accurately and support the credibility of subsequent statistical analyses. The strong content validity results across all constructs provide a solid foundation for investigating the relationships between teacher-related factors and ICT integration in Geography instruction. The strong content validity results across all constructs provided a solid foundation for investigating the relationships between teacher-related factors and ICT integration in Geography instruction.

3.8.2 Reliability of Research Instruments

This section shows the results of reliability of the research Instruments which tested the five constructs of the study. Reliability analysis was conducted to assess the internal consistency of the research instruments. Internal consistency is the degree to which the items that makes up a study measure the same underlying construct (Mohajan, 2017). Cronbach's alpha coefficients were calculated for each construct, with results presented in table 3.6 below

Table 3.6 Conbach's alpha Coefficient

Construct	Number of Items	Cronbach's Alpha	Cronbach's alpha ≥ 0.7?
Teachers' ICT Self-efficacy (X_1)	10	0.859	Yes
Attitudes towards Technology (X_2)	10	0.839	Yes
Pedagogical Strategies (X_3)	10	0.901	Yes
School Support System (X_4)	5	0.929	Yes
ICT Integration (Y)	10	0.952	Yes

From the table above, reliability analysis results show strong internal consistency across all constructs: Teachers' ICT Self-efficacy (α=0.859), Attitudes towards Technology (α=0.839), Pedagogical Strategies (α=0.901), School Support System (α=0.929), and ICT Integration (α=0.952). According to Ho (2023), Cronbach's alpha values above 0.7 indicate acceptable reliability, while values above 0.8 suggest good reliability. All constructs in this study exceeded these thresholds, demonstrating robust reliability.

The high reliability coefficients enhance confidence in the consistency of measurement across items within each construct. Hinton et al. (2023) suggest that such strong reliability indicators support the validity of subsequent statistical analyses and the overall robustness of the research findings. The particularly high reliability for ICT Integration (α=0.952) indicates excellent internal consistency in measuring the dependent variable.

3.9 Ensuring Trustworthiness

In qualitative research, trustworthiness refers to the extent to which the findings of a study are credible, transferable, dependable, and confirmable (Lincoln & Guba, 1985). Trustworthiness is important for ensuring the quality and rigor of a qualitative study and for establishing the credibility and authenticity of its findings (Connelly, 2016). In this study, the researcher used several strategies such as data access, bias prevention and data integrity to ensure the trustworthiness of the qualitative data collected through interviews with principals and heads of geography departments.

3.9.1 Credibility in Qualitative Data

Credibility refers to the extent to which the findings of a qualitative study are believable and accurately represent the participants' experiences and perspectives (Lincoln & Guba, 1985). Credibility is important for establishing the truth value of a study's findings and for ensuring that they are based on the participants' own words and meanings (Connelly, 2016).

To ensure the credibility of the interview data, the researcher used member checking. Member checking involves sharing the interview transcripts and the researcher's interpretations with the participants and asking them to confirm their accuracy (Birt et al., 2016). The researcher sent the interview transcripts to the participants via email and asked them to review and verify their responses. The researcher also shared the preliminary findings of the study with the participants and asked for their feedback and comments.Member checking helped to ensure that the researcher's interpretations were grounded in the participants' own words and experiences and that they accurately represent their perspectives.

The researcher also used triangulation to enhance the credibility of the findings. Triangulation involves using multiple sources of data, methods, or theories to corroborate and validate the findings of a study (Carter et al., 2014). In this study, the researcher triangulated the interview data with the quantitative data collected through the questionnaire. The researcher compared and contrasted the findings from both data sources to identify any consistencies or discrepancies and to provide a more comprehensive and nuanced understanding of the factors influencing ICT integration in geography instruction.

3.9.2 Transferability in Qualitative Data

Transferability refers to the extent to which the findings of a qualitative study can be applied or transferred to other contexts or settings (Lincoln & Guba, 1985). Transferability is important for ensuring the applicability and usefulness of a study's findings beyond its immediate context (Connelly, 2016). To enhance the transferability of the findings, the researcher used thick description. Thick description involves providing detailed information about the research context, participants, and methods to enable readers to determine the applicability of the findings to their own settings (Lincoln & Guba, 1985). The researcher provided a rich and detailed description of the study's context, including the characteristics of the selected schools, the demographic profile of the participants, and the data collection and analysis procedures. The researcher also used direct quotes from the participants to illustrate

their experiences and perspectives and to provide a vivid and authentic account of the factors influencing ICT integration in Geography Instruction.

3.9.3 Dependability in Qualitative Data

Dependability refers to the extent to which the findings of a qualitative study are consistent and could be repeated if the study were conducted again with the same participants and in the same context (Lincoln & Guba, 1985). Dependability is important for ensuring the stability and reliability of a study's findings over time and across different researchers (Connelly, 2016). To ensure the dependability of the findings, the researcher used an audit trail. An audit trail is a detailed record of the research process, including the raw data, data analysis procedures, and research decisions (Lincoln & Guba, 1985). The researcher maintained a research journal to document the data collection and analysis procedures, as well as any changes or modifications made to the research design. The researcher also kept a record of all the interview transcripts, coding schemes, and analytical memos. The audit trail enabled other researchers to review and evaluate the research process and to assess the dependability of the findings.

3.9.4 Conformability in Qualitative Data

Conformability refers to the extent to which the findings of a qualitative study are based on the participants' responses and not on the researcher's biases or interests (Lincoln & Guba, 1985). Conformability is important for ensuring the neutrality and objectivity of a study's findings and for establishing their credibility and authenticity (Connelly, 2016).

To ensure the conformability of the findings, the researcher used reflexivity. Reflexivity involves the researcher's self-awareness and critical reflection on their own biases, assumptions, and values and how they may influence the research process and findings (Berger, 2015). The researcher maintained a reflexive journal to document their personal beliefs, experiences, and reactions throughout the study. The researcher also discussed their positionality and how it may have shaped their interpretations of the data. By being transparent about their own subjectivities and how they have attempted to minimize their influence on the findings, the researcher enhanced the conformability of the study.

In summary, ensuring trustworthiness is an essential component of qualitative research, as it helps to establish the credibility, transferability, dependability, and conformability of a

study's findings. By using strategies such as member checking, triangulation, thick description, audit trail, and reflexivity, the researcher enhanced the trustworthiness of the qualitative data collected through interviews with principals and heads of Geography departments. These strategies helped to ensure that the findings are grounded in the participants' own words and experiences that they are applicable and useful beyond the immediate context of the study, that they are consistent and reliable over time, and that they are based on the participants' responses and not on the researcher's biases or interests.

3.10 Data Collection Procedure

Data collection is a critical stage in the research process, as it involves gathering the information needed to answer the research questions and achieve the study's objectives (Kabir, 2016). In this study, the researcher used a combination of questionnaires and interviews to collect data from principals, heads of geography departments, and Geography teachers in selected National and Extra County schools in North Rift region of Kenya. The data collection procedures were guided by ethical principles and it followed the guidelines and regulations of Moi University, where the researcher is based.

Before commencing the data collection, the researcher sought approval of Moi University which is responsible for reviewing and approving research proposals to ensure that they meet ethical standards and comply with the university's policies and procedures. The researcher submitted a detailed research proposal, including the research objectives, questions methodology and data collection instruments to Moi University for review and approval.

Once the research proposal was approved by Moi University, the researcher obtained a research permit from the National Commission for Science, Technology, and Innovation (NACOSTI), which is the government agency responsible for regulating research activities in Kenya. The researcher also sought permission from the County Directors of Education in their respective counties and the principals of the selected schools to conduct the study in their institutions.The researcher then proceeded to recruit the study participants. The researcher visited the selected schools and met with the principals and heads of geography departments to explain the purpose and procedures of the study and to seek their participation.

Before administering the questionnaires and interviews, the researcher obtained informed consent from the participants. Informed consent is a voluntary agreement to participate in

research based on a full understanding of the study's purpose, procedures, risks, and benefits (Grady, 2015). The researcher provided the participants with a written informed consent form that explains the study's objectives, methods, confidentiality procedures, and voluntary nature. The researchers also explained the informed consent form verbally to the participants and answer any questions they were having. The participants were asked to sign the informed consent form to indicate their willingness to participate in the study.

The researcher then administered the questionnaires electronically to the participants. The questionnaires were distributed through a URL link by the researcher; with preliminary information explaining how complete the questionnaire. The participants were given adequate time to complete the questionnaires, which took approximately 20-30 minutes. The researchers received the completed questionnaires electronically from the participants and check them for completeness and accuracy.

The researcher also conducted face-to-face and Telephone interviews with selected principals and heads of Geography departments. The interviews were conducted at a time and place convenient for the participants, such as their offices or a quiet room in the school. The researcher used a semi-structured interview guide to ask open-ended questions about the school support system factors that may influence teachers' integration of ICT in Geography instruction. The interviews were audio-recorded with the participants' permission to ensure accurate data collection and transcription.

After completing the data collection, the researcher organized and stored the data securely. The questionnaires were assigned unique identification numbers and the responses were entered into a password-protected spread sheet. The interview recordings were transcribed verbatim and the transcripts were stored in a password-protected word processing file. The researcher ensured the confidentiality of the data by removing any identifying information from the questionnaires and transcripts and by storing them in a secure location accessible only to the researcher.

In summary, the data collection procedures for this study involved obtaining approval from Moi University, seeking permission from relevant authorities and institutions, recruiting participants, obtaining informed consent, administering questionnaires and interviews, and organizing and storing the data securely. The researcher followed ethical principles and guidelines throughout the data collection process to ensure the protection of the participants'

rights, security and to maintain the integrity and quality of the research. The data collected through these procedures provided valuable insights into the factors influencing ICT integration in Geography instruction in Kenyan public secondary schools and contributed to the advancement of knowledge in this field.

3.11 Data Analysis Techniques

Data analysis is a critical step in the research process, involving the systematic application of statistical and logical techniques to describe, summarize, and evaluate data (Shamoo & Resnik, 2003). The purpose was to extract meaningful information, draw conclusions, and support decision-making based on the evidence (Judd et al., 2017). This study utilized two software packages for data analysis: SPSS version 27 for quantitative data and NVivo for qualitative data. SPSS offers a range of tools for descriptive statistics, inferential statistics, and data visualization (Landau & Everitt, 2004), while NVivo is designed for organizing, analyzing, and identifying insights in unstructured or qualitative data (Bazeley & Jackson, 2013).

The data analysis section includes descriptive statistics, Correlation analysis, diagnostic tests, multiple linear regression, moderated multiple regression, and thematic analysis. Descriptive statistics summarized the characteristics of the sample and the distribution of variables. Diagnostic tests assessed compliance with the assumptions of parametric tests. Multiple linear regression examined the influence of teacher-related factors on ICT integration, while moderated multiple regression investigated the moderating effect of school support system. Thematic analysis was used to analyze qualitative data from semi-structured interviews, following Braun and Clarke's (2006) six-phase process.

The results were presented systematically, addressing each research objective and hypothesis, and interpreted in the context of existing literature and theoretical frameworks. The data analysis section provided a comprehensive examination of the factors influencing ICT integration in Geography instruction in Kenyan secondary schools, contributing to the advancement of knowledge and informing educational policy and practice.

3.11.1 Descriptive Statistics

The collected data was analyzed using the Statistical Package for the Social Sciences (SPSS) version 27. Descriptive statistics was used to summarize and organize the data. Descriptive statistics are brief descriptive coefficients that summarize a given data set, which can be

either a representation of the entire population or a sample of it (Mishra et al., 2019). They provided a powerful summary that enabled comparisons across people or other units (Loeb et al., 2017).

Frequency distributions were used to organize and display the number of times each score or group of scores occurs in the data set (Gravetter et al., 2020). They were presented using frequency tables. Measures of central tendency, specifically the mean, were used to describe the central or average value in the data set (Gravetter et al., 2020). The mean is the most commonly used measure of central tendency and is sensitive to extreme scores (Mishra et al., 2019). The standard deviation was used as a measure of dispersion to describe the spread of the data from the mean (Gravetter et al., 2020). It is the most commonly used measure of dispersion and is sensitive to extreme scores (Mishra et al., 2019).

3.12 Statistical Assumptions of Regression Analysis

The data was subjected to diagnostic tests to ensure it satisfied the parametric test assumptions before inferential statistical analysis could be carried out. Assumptions on the distribution of the underlying population from which the sample was selected are the basis of parametric tests, which are statistical procedures (Garson, 2012). These diagnostic tests were conducted to make sure the data matched critical statistical assumptions for multiple regression which was a prerequisite to running of the regression analysis. Maina (2021) stresses that these tests are critical for proving that regression findings are reliable and for ensuring that correct statistical inference is used in social science research. Verifying these assumptions provide crucial background for understanding the subsequent regression analyses and guarantees the reliability of the study's conclusions on the connections between elements associated to teachers and the use of ICT. Among these assumptions are: that the residuals are normal, that the predictors are not multi-collinear, and that the residuals are homoscedastic. Zhu (2023) states that if these assumptions are not met, the reliability of the regression findings may be compromised, and the conclusions drawn from them can be inaccurate. Thus, in order to guarantee that multiple regression analysis was suitable for this investigation, extensive diagnostic testing was carried out and the results of these assumption tests are shown in the following sections:

3.12.1 Normality Test

The normality test is a statistical procedure used to determine whether a data set follows normal distribution. The assessment of normality was conducted using skewness and kurtosis measures for each variable in the study. According to Heumann et al. (2023), skewness

values between -2 and +2 and kurtosis values between -7 and +7 indicate acceptable normality for social science research. The normality assessment is crucial as it influences the reliability of subsequent parametric analyses and the validity of statistical inferences drawn from the data. Maina (2021) emphasizes that while perfect normality is rare in social science research, moderate departures from normality can be tolerated in large samples (n > 30) due to the Central Limit Theorem. This analysis employed both numerical measures and visual inspection of distribution patterns to ensure a comprehensive assessment of normality, following best practices in statistical analysis for educational research. The normality test results are shown in the table below.

Table 3.7 Normality results

Variable	N	Skewness	Std. Error	Kurtosis	Std. Error
Teachers' ICT Self-efficacy (X_1)	190	-0.624	0.176	0.745	0.351
Attitudes towards Technology (X_2)	190	-0.980	0.176	1.232	0.351
Pedagogical Strategies (X_3)	190	-0.818	0.176	0.901	0.351
School Support System (X_4)	190	-0.929	0.176	1.098	0.351
ICT Integration (Y)	190	-0.874	0.176	0.957	0.351

From the table above, the normality test results demonstrate that all variables in the study exhibit acceptable levels of skewness and kurtosis, falling well within the recommended thresholds. Teachers' ICT Self-efficacy showed a slight negative skew (-0.624) with moderate kurtosis (0.745), indicating a distribution slightly weighted toward higher values but maintaining an acceptable shape. Attitudes towards Technology displayed the strongest negative skew (-0.980) and highest kurtosis (1.232) among the variables, suggesting a more pronounced tendency toward positive attitudes while remaining within normal bounds. The dependent variable, ICT Integration, exhibited a moderate negative skew (-0.874) and kurtosis (0.957), indicating a distribution pattern suitable for parametric analysis. Gordon (2023) suggests that such moderate departures from perfect normality are common in educational research and do not substantially impact the robustness of regression analysis when sample sizes exceed 100 participants. The consistency of negative skewness across all

variables reflects a general tendency toward positive responses, which Hinton et al. (2023) note is typical in educational attitude and self-assessment measures.

3.12.2 Multicollinearity Test

Multicollinearity testing was conducted to assess the independence of predictor variables in the regression model. According to Ho (2023), multicollinearity can be evaluated through Variance Inflation Factor (VIF) values and tolerance statistics, with VIF values below 5 and tolerance values above 0.2 indicating acceptable levels of independence between predictors. The assessment of multicollinearity is crucial for ensuring the stability and reliability of regression coefficients, as high correlations between predictors can lead to inflated standard errors and unreliable parameter estimates. This analysis employed both VIF and tolerance statistics to provide a comprehensive assessment of the relationships between predictor variables, following the rigorous standards recommended by contemporary statistical authorities in educational research. The table 3.8 below shows Multicollinearity results.

Table 3.8 Tolerance and Value inflation factor

Variable	Tolerance	VIF
Teachers' ICT Self-efficacy (X_1)	0.486	2.058
Attitudes towards Technology (X_2)	0.833	1.200
Pedagogical Strategies (X_3)	0.512	1.953
School Support System (X_4)	0.649	1.541

From the table above, the multicollinearity test results demonstrate satisfactory independence among all predictor variables in the regression model. Teachers' ICT Self-efficacy exhibited a tolerance value of 0.486 and VIF of 2.058, while Attitudes towards Technology showed the highest tolerance (0.833) and lowest VIF (1.200) among all predictors. Pedagogical Strategies demonstrated acceptable independence with a tolerance of 0.512 and VIF of 1.953, and School Support System showed similar independence with a tolerance of 0.649 and VIF of 1.541. These values fall well within the acceptable thresholds specified by Zhu (2023), who suggests that VIF values below 5 and tolerance values above 0.2 indicate absence of

problematic multicollinearity. The consistent pattern of moderate VIF values across all predictors suggests that the regression model will produce stable and reliable coefficient estimates. Sürücü et al. (2023) note that such moderate levels of correlation between predictors are typical in educational research and do not compromise the validity of regression analysis when they fall within acceptable bounds. The results indicate that each predictor variable contributes unique variance to the model, supporting the inclusion of all variables in subsequent regression analyses.

3.12.3 Homoscedasticity Test

Homoscedasticity was assessed using Levene's test to examine the equality of variances across predictor variables. According to Yockey (2023), homoscedasticity is a crucial assumption for regression analysis, requiring that the variance of residuals remains constant across different levels of predicted values. This assumption was tested using both statistical methods and visual inspection of residual plots, as recommended by contemporary statistical authorities. The assessment of homoscedasticity is particularly important in educational research where response patterns may vary systematically across different groups or levels of independent variables. This comprehensive approach to testing homoscedasticity ensures the reliability of subsequent regression analyses and supports valid statistical inference regarding the relationships between teacher-related factors and ICT integration.The table 3.9 below shows the Homoscedasticity results.

Table 3.9 Homoscedasticity Test Results (Levene's Test)

Variable	Levene Statistic	df1	df2	Sig.
Teachers' ICT Self-efficacy	1.842	3	186	0.141
Attitudes towards Technology	1.567	3	186	0.199
Pedagogical Strategies	2.013	3	186	0.114
School Support System	1.729	3	186	0.163

From the table above, homoscedasticity test results indicate that all variables met the assumption of homogeneous variances. The Levene's test produced non-significant results ($p > 0.05$) for all predictor variables: Teachers' ICT Self-efficacy ($p = 0.141$), Attitudes towards

Technology (p = 0.199), Pedagogical Strategies (p = 0.114), and School Support System (p = 0.163). According to Maina (2021), non-significant Levene's test results indicate that the variance of residuals is consistent across different levels of the predictors, satisfying the homoscedasticity assumption. The consistency of non-significant results across all variables suggests that the regression model produced reliable estimates of relationships between predictors and the dependent variable. Heumann et al. (2023) emphasize that meeting the homoscedasticity assumption is crucial for ensuring the accuracy of standard errors and confidence intervals in regression analysis. These results support the appropriateness of multiple regression analysis for examining the relationships between teacher-related factors and ICT integration in Geography instruction.

3.12.4 Outlier Test

Outlier analysis was conducted to assess whether individual cases exerted undue influence on the regression model. According to Field (2018), outliers can distort regression coefficients and reduce the generalizability of findings. Cook's Distance was used as the primary diagnostic, as it combines information from leverage and residual values to measure the influence of each observation on the regression equation. Values greater than 1.0 indicate potentially problematic cases requiring further investigation (Ho, 2023). In addition, standardized residuals greater than ±3.0 are often considered indicative of outliers in regression analysis (Heumann et al., 2023). The table below shows the outlier results.

Table 4.10: Outlier Test Results (Cook's Distance)

N	Minimum	Maximum	Mean	Std. Deviation	Threshold
190	0.002	0.178	0.026	0.032	< 1.0

The results of Cook's Distance analysis indicate that no case exceeded the threshold of 1.0, with the maximum Cook's Distance observed being 0.178. This suggests that no individual respondent exerted disproportionate influence on the regression model. The distribution of standardized residuals further confirmed this conclusion, as all values fell within the acceptable range of ±3.0. According to Maina (2021), such results provide assurance that the regression findings are not unduly biased by extreme or influential cases. Therefore, the dataset was deemed free of problematic outliers, supporting the robustness of the subsequent regression analysis.

3.12.5 Multiple Linear Regression

Multiple linear regressions were used to test the hypothesized relationships between the independent variables (teacher-related factors) and the dependent variable (ICT integration in

Geography instruction). Multiple regressions are a statistical technique that uses several explanatory variables to predict the outcome of a response variable (Field, 2018). It enables the researcher to determine the overall fit of the model and the relative contribution of each predictor variable to the total variance explained (Hoe, 2014).

The multiple regression models can be expressed as:

$Y = \beta0 + \beta1X1 + \beta2X2 + \beta3X3 + \varepsilon$

Where:

Y = dependent variable (ICT integration in geography instruction)

$\beta0$ = constant (intercept)

$\beta1$ to $\beta3$ = regression coefficients

X1 = teachers' ICT self-efficacy

X2 = teachers' attitudes towards technology

X3 = teachers' pedagogical strategies

ε = error term

The regression coefficients represent the change in the dependent variable for a on unit change in the independent variable, holding all other independent variables constant (Field, 2018). The significance of the regression model was assessed using the F-test, which tests the null hypothesis that the regression coefficients are equal to zero (Field, 2018). If the p-value is less than the chosen alpha level (0.05), the null hypothesis is rejected, indicating that the model is significant.

The coefficient of determination (R^2) was used to measure the proportion of variance in the dependent variable that is predictable from the independent variables (Field, 2018). R^2 ranged from 0 to 1, with higher values indicating greater explanatory power of the model (Hoe, 2014). The adjusted R^2, which accounts for the number of predictors in the model, was also be reported as it is a more accurate estimate of the population value (Field, 2018).

The significance of the individual predictor variables was assessed using t-tests, which test the null hypothesis that the regression coefficient is equal to zero (Field, 2018). If the p-value is less than the chosen alpha level (0.05), the null hypothesis is rejected, indicating that the predictor variable makes a significant unique contribution to the model (Field, 2018).

The hypotheses to be tested using multiple regressions are:

H01: Teachers' ICT self-efficacy has no statistically significant influence on their integration of ICT in Geography Instruction.

H02: Teachers' attitudes towards technology have no statistically significant influence on their integration of ICT in Geography instruction.

H03: Teachers' pedagogical strategies have no statistically significant influence on their integration of ICT in Geography Instruction.

The decision rule was to reject the null hypothesis if the p-value is less than 0.05 and conclude that the independent variable has a significant influence on the dependent variable. If the null hypothesis is not rejected, it was concluded that the independent variable does not have a significant influence on the dependent variable.

3.12.6 Moderated Multiple Regression

Moderated multiple regression was used to examine the moderating effect of school support system factors on the relationship between teacher-related factors and ICT integration in Geography Instruction (H04). Moderation occurs when the relationship between two variables depends on a third variable (Hayes, 2018). The third variable (moderator) affects the direction and/or strength of the relationship between the independent and dependent variables (Baron & Kenny, 1986).

The moderated multiple regression models can be expressed as:

$Y = \beta0 + \beta1X + \beta2Z + \beta3XZ + \varepsilon$

Where:

Y = dependent variable (ICT integration in Geography instruction)

$\beta0$ = constant (intercept)

$\beta1$, $\beta2$, $\beta3$ = regression coefficients

X = independent variable (teacher-related factors)

Z = moderator variable (school support system)

XZ = interaction term

ε = error term

Three regression models were estimated:

Model 1: $Y = \beta0 + \beta1X + \beta X2 + \beta X3 + \varepsilon$ (simple regression model)

Model 2: $Y = \beta0 + \beta1X + \beta X2 + \beta X3 + \beta2Z + \varepsilon$ (multiple regression model with moderator)

Model 3: $Y = \beta 0 + \beta 1X + \beta\ X2 + \beta\ X3\ \beta 2Z + \beta 3XZ + \varepsilon$ (moderated multiple regression model)

The independent variable X was a composite variable constructed from the combination of the three teacher-related factors(X1, X2 and X3). A composite predictor combines multiple related variables into a single aggregated measure that reflects the underlying constructs more accurately than individual items. This aggregation reduces measurement error and increases the reliability and validity of the predictor, which is crucial in detecting true moderation effects (De Vellis, 2016).Creating a composite variable allowed researcher to test the join moderating effects, which provided holistic understanding of the interaction. This approach aligns with theoretical framework that conceptualize constructs as multidimensional rather that Unidimensional (Hedges & Olkin, 1985)

The significance of the interaction term (XZ) in Model 3 was assessed using a t-test. If the p-value is less than the chosen alpha level (0.05), the null hypothesis that the interaction term is equal to zero was rejected, indicating that moderation has occurred (Hayes, 2018).

The PROCESS macro for SPSS (Hayes, 2018) was used to conduct the moderated multiple regression analysis. The PROCESS macro automatically centers the predictor variables, computes the interaction term, and generates the output for the three regression models. (Hayes,2018). Bootstrapping with 5,000 samples was used to generate bias-corrected confidence intervals for the regression coefficients (Hayes, 2018). Bootstrapping is a resampling method that involves repeatedly sampling from the data with replacement to estimate the sampling distribution of a statistic (Hayes, 2018).

The hypothesis tested using moderated multiple regressions is:

H04: School support system has no statistically significant moderating influence on the relationship between teacher-related factors and ICT integration in Geography Instruction.

The decision rule is to reject the null hypothesis if the p-value for the interaction term is less than 0.05 and conclude that school support system moderates the relationship between teacher-related factors and ICT integration in Geography Instruction. If the null hypothesis is not rejected, it was concluded that school support system does not moderate the relationship.

3.12.7 Thematic Analysis

Thematic analysis is a qualitative data analysis method that involves identifying, analyzing, and interpreting patterns or themes within textual data (Braun & Clarke, 2006). It is a flexible approach that can be used across a range of epistemologies and research questions (Nowell et al., 2017). Thematic analysis allows researchers to make sense of collective or shared meanings and experiences (Braun & Clarke, 2012).

In this study, thematic analysis was used to analyze the qualitative data collected through semi-structured interviews with selected principals and heads of geography departments. The analysis followed the six-phase process outlined by Braun and Clarke (2006):

Familiarizing with the data: The researcher transcribed the interviews verbatim and read through the transcripts multiple times to become immersed in the data and gain a thorough understanding of the content.

Generating initial codes: The researcher systematically coded interesting features of the data across the entire dataset. Codes are labels that identify important features of the data that are potentially relevant to the research question (Braun & Clarke, 2006). The researcher used an inductive approach, allowing the codes to emerge from the data rather than using a pre-existing coding framework.

Searching for themes: The researcher collated the codes into potential themes, gathering all data relevant to each theme. Themes are broader patterns of meaning that capture something important about the data in relation to the research question (Braun & Clarke, 2006). The researcher used visual representations such as mind maps or tables to help sort the codes into themes.

Reviewing themes: The researcher checked if the themes work in relation to the coded extracts and the entire dataset, generating a thematic map of the analysis. This phase involves a recursive process of refining, splitting, or combining themes to ensure they are coherent, distinct, and accurately reflect the data (Braun & Clarke, 2006).

Defining and naming themes: The researcher conducted ongoing analysis to refine the specifics of each theme and the overall story the analysis tells, generating clear definitions and names for each theme. The researcher wrote a detailed analysis of each theme, identifying its essence and scope (Braun & Clarke, 2006).

Producing the report: The researcher weaved together the analytic narrative and vivid data extracts to produce a coherent, logical, and compelling report of the findings. The report provided sufficient evidence of the themes within the data and makes an argument in relation to the research question (Braun & Clarke, 2006).

To ensure the trustworthiness of the thematic analysis, the researcher used several strategies recommended by Nowell et al. (2017). These include keeping an audit trail of the analysis process, using a codebook to maintain consistency in coding, engaging in peer debriefing with the research supervisors, and providing thick descriptions of the themes with ample data extracts.

The thematic analysis provided insights into the school support system factors that influence teachers' integration of ICT in geography instruction from the perspectives of principals and heads of departments. The themes identified through the analysis helped to complement and enrich the quantitative findings from the questionnaire, allowing for a more comprehensive understanding of the phenomenon under study.

In conclusion, thematic analysis is a rigorous and systematic method for identifying, analyzing, and reporting patterns or themes within qualitative data. By following the six-phase process outlined by Braun and Clarke (2006) and using strategies to ensure trustworthiness, the researcher produced a high-quality thematic analysis that contributes to the overall findings and conclusions of the study.

3.13 Ethical Considerations

Ethical considerations are critical in any research study to ensure the protection of participants' rights, dignity, and welfare (Akaranga & Makau, 2016). This study adhered to the ethical principles outlined in the Belmont Report (National Commission for the Protection of Human Subjects of Biomedical and Behavioral Research, 1979) and the Declaration of Helsinki (World Medical Association, 2013).

Approval was sought from Moi University department of Curriculum Instruction and Educational media before commencing the study. The IRB is responsible for reviewing and approving research protocols to ensure that they meet ethical standards and protect the rights and welfare of human subjects (Grady, 2015).

Permission to conduct the study also was obtained from the National Commission for Science, Technology, and Innovation (NACOSTI), which is the body mandated to regulate and assure quality in the science, technology, and innovation sector in Kenya (NACOSTI, 2020). Permission was sought from the County Directors of Education and the principals of the selected schools.

Informed consent was obtained from all participants before data collection. Informed consent is the process by which participants are fully informed about the nature, purpose, risks, and benefits of the study and voluntarily agree to participate (Nusbaum et al., 2017). The informed consent form included information about the study's objectives, procedures, potential risks and benefits, confidentiality, voluntary participation, and withdrawal rights. Participants was given sufficient time to read the form and ask questions before making a decision.

Participants' privacy and confidentiality was protected throughout the study. Privacy refers to the right of individuals to control access to their personal information, while confidentiality refers to the obligation of researchers to protect participants' identifiable information from unauthorized disclosure (Kayaoğlu et al., 2016). Participants' names and other identifying information was collected on the questionnaires. Instead, unique identification numbers were used to match questionnaires with interview data. All data was stored securely in password-protected files and will only be accessible to the research team.

Participants were informed that their participation is voluntary and that they have the right to withdraw from the study at any time without penalty or loss of benefits. No incentives or compensation was offered for participation to avoid undue influence or coercion (Grant & Sugarman, 2004).

The study did not involve any deception or withholding of information from participants. Deception involves intentionally misleading participants about the nature or purpose of the study, while withholding information involves omitting certain details that might influence their decision to participate (Tai, 2012). Deception and withholding information can undermine trust, compromise informed consent, and cause harm to participants (Tai, 2012).

The study also strived to avoid any harm or discomfort to participants. Harm can be physical, psychological, social, economic, or legal (Miracle, 2016). While this study did not involve any invasive procedures or sensitive topics that could cause direct harm, care was taken to minimize any potential discomfort or inconvenience caused by the time and effort required to complete the questionnaires and interviews.

Finally, the study ensured that the benefits of the research outweigh any risks to participants. The beneficence principle requires researchers to maximize possible benefits and minimize

possible harms (National Commission for the Protection of Human Subjects of Biomedical and Behavioral Research, 1979). The findings of this study are expected to contribute to the knowledge base on ICT integration in education and to inform policy and practice decisions that can benefit teachers and students. Any risks to participants are minimal and are outweighed by the potential benefits of the research.

3.14 Chapter Summary

This chapter has presented the research design and methodology for the study. A cross-sectional descriptive design was used to investigate the influence of school support system and teacher-related factors on the integration of ICT in Geography Instruction in National and Extra County in North Rift region of Kenya. The target population consists of principals, heads of geography departments, and geography teachers in the 144Nairobi Extra County secondary schools in North Rift region. Samples of 274 respondents were selected using proportionate stratified random sampling.

Data was collected using a structured questionnaire with items measured on a 5-point Likert scale. The validity and reliability of the instrument was established through expert judgment and Cronbach's alpha, respectively. Descriptive and inferential statistics was used to analyse the data with the aid of SPSS version 27. Multiple linear regressionwas used to test the hypothesized relationships between the teacher-related factors and ICT integration, while moderated multiple regression was used to examine the moderating effect of school support system on the relationship between teachers' related factors and ICT integration in Geography instruction.

Ethical considerations have been addressed, including obtaining ethical approval and permissions, informed consent, privacy and confidentiality, voluntary participation, avoidance of deception and harm, and ensuring that the benefits of the research outweigh any risks to participants. The next chapter presents the results of the data analysis.

4 CHAPTER FOUR

DATA PRESENTATION, ANALYSIS, INTERPRETATION AND DICSUSSION

4.1 Introduction

This chapter presents the data presentation, analysis, interpretation and discussion of the data collected to examine the influence of teacher-related factors on ICT integration in Geography instruction in selected Kenyan National and Extra- County secondary schools. The chapter begins with the instruments return rate analysis, followed by demographic characteristics of respondents, descriptive and inferential statistics for each research objective, including correlation and regression analyses. The findings are discussed in relation to previous research and theoretical frameworks.

4.2 Instruments Return Rate

The Instrument return rate analysis provides insights into the response levels achieved in the study. Table4.1 presents the sample size, number of returned questionnaires and Interview schedule and their corresponding response rate.

Table4.1: Instrument Return Rate

	Sample Size	**Responses Received**	**Response Rate**
Questionnaires	240	190	79.1%
Interview schedule Principals	34	28	82.3%
HoD Geography	34	30	84.2%

As shown in Table4.1above, out of the 240 questionnaires distributed, 190 were completed and returned, representing a response rate of 79.1% and 58 out of 68 interviews representing 83.35% responded. According to Stockemer and Bordeleau (2023), a response rate of 75% or higher is considered excellent for survey research in social sciences. The achieved response rate of 79.1% and 83.35% exceeds this threshold, indicating a highly satisfactory level of participation.

This high response rate enhances the reliability and representativeness of the study findings. Gordon (2023) suggests that response rates above 80% minimize the risk of non-response bias and provide sufficient statistical power for meaningful analysis. The achieved response rate indicates strong engagement from the target population and supports the validity of subsequent analyses.

4.3 Demographic Characteristics of Respondents

Demographic Characteristics refers to various personal attributes used to categorize participants in a study (Creswell,2014). Understanding the demographic characteristics of respondents provides important context for interpreting the study results and assessing the representativeness of the sample. The analysis of gender distribution, age groups, education levels, and teaching experience of the respondents is discussed below.

4.3.1 Gender Distribution of Respondents

The gender distribution of respondents provides insights into the representation of male and female Geography teachers in the study sample. Table 4.2 presents the gender distribution of the respondents.

Table 4.2: Respondents Distribution by Gender

Gender	Frequency	Percent
Male	127	66.8
Female	63	33.2
Total	**190**	**100.0**

As shown in Table 4.2, male respondents constituted 66.8% (n=127) of the sample, while female respondents made up 33.2% (n=63). This gender distribution indicates a significant disparity in representation between male and female Geography teachers in the sampled schools. According to Heumann et al. (2023), such demographic patterns should be considered when interpreting study findings and making generalizations.

The gender disparity observed in this study concurs with previous research findings by Chirwa and Mubita (2021) who found similar gender imbalances in geography teaching staff in Zambian secondary schools, while Omwoki et al. (2023) reported comparable patterns in Kenyan schools. The variation in the male and female gender may be brought by gender

stereotyping, where teaching subjects like Geography is a preserve of male gender which discourages the female gender from engaging deeply in subjects like Geography, leading to lower number of qualified female candidates who choose to teach Geography (Gender in Education network in Africa,2015 This persistent gender gap may reflect broader societal patterns in STEM subjects and could influence technology integration approaches in geography instruction.

4.3.2 Distribution of Respondents

The age distribution of respondents provides insights into the generational composition of Geography teachers and its potential implications for ICT integration. Table 4.3 presents the age distribution of the respondents.

Table 4.3: Respondents Distribution by Age

Age Range (Years)	Frequency	Percent
24-30	32	16.9
31-35	59	31.0
36-40	58	30.5
41-45	29	15.3
46-50	12	6.3
Total	**190**	**100.0**

As shown in Table 4.3, the majority of respondents (61.5%) were between 31-40 years old, with 31.0% aged 31-35 years and 30.5% aged 36-40 years. Younger teachers (24-30 years) constituted 16.9% of the sample, while those aged 41 years and above represented 21.6%. This age distribution suggests a relatively experienced teaching workforce in their prime professional years.The predominance of middle-aged teachers may have implications for ICT integration. Islam (2022) found that teachers in this age range often combine sufficient teaching experience with openness to technological innovation. However, Bekele (2022) noted that age-related differences in technology adoption can impact the effectiveness of ICT integration initiatives in schools.

4.3.3 Educational Qualification of Respondents

The educational qualifications of respondents reflect their academic preparation and potential capacity for implementing educational innovations.

Table 4.4: Respondents Distribution by Education Level

Education Level	Frequency	Percent
Diploma	8	4.2
Bachelor's Degree	152	80.0
Master's Degree	30	15.8
Total	**190**	**100.0**

As shown in Table 4.4, the majority of respondents (80.0%) held bachelor's degrees indicating that most teachers of Geography are graduates, while 15.8% had attained master's degrees, and 4.2% held diplomas. This distribution indicates a well-qualified teaching workforce, with 95.8% of respondents having at least a bachelor's degree. The high proportion of degree holders aligns with Kenya's professional requirements for secondary school teachers. Eshete (2022) and Şahin and Dursun (2022) suggest that teachers' educational qualifications can influence their self-efficacy and attitudes toward technology integration. The presence of a substantial number of postgraduate degree holders (15.8%) may contribute positively to innovation adoption and implementation in geography instruction.

4.4 Status of ICT Resources Available for Teaching Geography

The first objective of this study was to establish the status of ICT resources available for teaching of Geography in selected Public secondary schools in Kenya.The data was collected by use of an interview schedule to the Principals and the Head of Geography Department. The respondents were asked to respond to a question on the state and availability of ICT resources such as: computers, GIS software, GPS, Smart TVs, computer lab, Educational Apps, digital topographic maps and internet access. The responses are presented in the table 4.5 below.

Table 4.5Availability and adequacy of ICT Resources for Teaching Geography

ICT resources for teaching Geography	Available	Not Available	Principal response rate	Head of Geography Department response	Percentage
Desktops/Laptops	58	0	28	30	82.3%
GIS Software	50	8	23	27	78%
Computer Labs	58	0	28	30	82.3%
Educational Apps	58	0	28	30	82.3%
Internet Access	58	0	28	30	82.3%
Projectors	58	0	28	30	82.3%
Digital topographic maps	52	6	22	30	81.3%

As shown in the table 4.5 above, 28 principals and 30 heads of Geography department which translated to 82.3% confirmed that Laptops/desktops were available in their schools, the high percentage of Computer availability reflects widespread access to digital learning environment which is essential for implementing multimedia, simulations and data analysis in Geography Instruction, 78% confirmed that there was GIS software in build in their smartphones, this highlights a significant integration of Geographic information system into curriculum, supporting spatial data interpretation and decision-making skills crucial in contemporary geography(Longley et.al.,2020). In addition this, percentages indicates high level of resource accessibility which can significantly influence quality of Geography Instruction and that substantial Majority of the institutions are equipped with the necessary technological tools to facilitate modern and GIS-based Geographic Instruction. Furthermore82.3% agreed that their schools had Computer labs while 82.3%confirmed availability of Educational apps which reflects adoption of mobile and computer-based learning tools, which facilitate interactive and personalized learning environment (Higgins, Xiao & Katsipataki, 2012), 82.3% internet access and Projectors aligns with Zhao, (2019) that internets access supports the integration of online resources enabling students and teachers to access up-to-date geography data and virtual learning platforms. 81.3% availability of digital topographic concurs with Longley et al,.(2020) who posits that, availability of digital topographic maps allows students to analyze data dynamically, fostering spatial thinking and problem-solving skills.

Digital maps also facilitate experiential learning by providing interactive and visual representations of Geographic phenomena, leading to deeper conceptual understanding. In overall, agreement rate above 80% indicates a substantial consensus among the Principals and Head of Geography Department that ICT resources for teaching Geography are sufficient and are being utilized effectively (Vagenas et.al.,2020). From the descriptive statistics, teachers also reported satisfaction with school ICT infrastructure (M = 3.47, SD = 1.149). The mean score falls within the "Neutral" range (2.51 - 3.50) according to South et al. (2022), with 16.8% strongly agreeing and 42.6% agreeing that their schools have adequate infrastructure. The mixed responses support Gómez-Fernández and Mediavilla's (2022) findings about the slight varying levels of ICT resources across schools and their impact on technology use. These results are also supported by data collected through content analysis where the researcher found most of the teachers who granted access to their teachers performance and appraisal document, showed that majority of them had uploaded ICT integration evidence in their TPADS to show utilization of ICT resources during the lesson.A case is a teacher of Geography number 16 who uploaded a video of a lesson that he utilizes Documentaries of animated and real footage explaining glaciation Process to a form three class and another teacher of Geography number 7 who utilized Virtual reality Apps to demonstrate how volcanoes form and erupt to a form two class. These findings confirmed availability and use of ICT resources in Geography Instruction. Such high agreement levels by the principals also imply that the principal's perception of ICT availability and use are align with institutional realities across the surveyed population, enhancing the validity of the findings (Dillman et.al,.2014).This strong agreement by the principals and the heads of Geography departments may also reflect successful institutional policies aimed at Integrating ICT in Geography instruction. However, the remaining 17-22%who did not agree highlights variations of gaps that may require interventions (Ottenbreit-leftwich, 2013). In Overall, these percentages demonstrate positive trend towards embracing technological tools in Geography Instruction, aligning with the global shift towards digital and data-driven learning environment (UNESCO, 2016).

4.5 Teachers' ICT Self-Efficacy on Integration of ICT in Geography Instruction

The second objective of the study was to determine the influence of teachers' ICT self-efficacy on ICT integration in Geography Instruction in selected public secondary schools in Kenya. The data for this objective was collected by use of a questionnaire and document analysis. This section examines teachers' self-perceived capability to effectively integrate and

utilize technology in their Geography instruction. The construct was measured using ten indicators that assessed various aspects of teachers' confidence and competence in using ICT for teaching purposes. These indicators encompassed teachers' confidence in integrating technology into Geography lessons, ability to use digital tools like GIS and GPS, capability to evaluate and select appropriate educational technologies, troubleshooting skills, ability to guide students in using technology for geographic research, classroom management with technology, provision of alternative technology-based approaches, comfort with student independent work, assessment capabilities, and overall technological integration capacity. The findings from the questionnaire are presented on Table 4.6 which used statements that teachers of Geography were to rate using 1Strongly Disagree(SD),2Disagree(D),3Neutral(N), 4Agree(A) and 5Strongly Agree(SA).

Table 4.6: Descriptive Statistics for Teachers' ICT Self-Efficacy

Statements	SD	D	N	A	SA	Mean	Std. Dev
The teacher feels confident integrating technology into geography lessons.	0 (0.0%)	2 (1.1%)	8 (4.2%)	54 (28.4%)	126 (66.3%)	4.60	0.624
The teacher can use digital tools like GIS, GPS, and online maps effectively for teaching.	7 (3.7%)	5 (2.6%)	16 (8.4%)	68 (35.8%)	94 (49.5%)	4.25	0.980
The teacher is able to evaluate and select appropriate educational technologies.	0 (0.0%)	5 (2.6%)	14 (7.4%)	63 (33.2%)	108 (56.8%)	4.44	0.745
The teacher can troubleshoot basic technical issues during technology use.	2 (1.1%)	8 (4.2%)	36 (18.9%)	69 (36.3%)	75 (39.5%)	4.09	0.919
The teacher can guide students on using technology for geographic research.	0 (0.0%)	0 (0.0%)	16 (8.4%)	59 (31.1%)	115 (60.5%)	4.52	0.648
The teacher can organize and manage classroom activities involving technology.	0 (0.0%)	0 (0.0%)	10 (5.3%)	67 (35.3%)	113 (59.5%)	4.54	0.596
The teacher can provide alternative technology-based instructional approaches.	2 (1.1%)	0 (0.0%)	12 (6.3%)	91 (47.9%)	85 (44.7%)	4.35	0.695
The teacher feels comfortable allowing students to work independently with technology.	0 (0.0%)	11 (5.8%)	18 (9.5%)	60 (31.6%)	101 (53.2%)	4.32	0.871
The teacher can effectively assess student learning when using technology.	0 (0.0%)	3 (1.6%)	13 (6.8%)	56 (29.5%)	118 (62.1%)	4.52	0.695
Overall, the teacher feels capable of integrating technology to enhance instruction.	0 (0.0%)	3 (1.6%)	13 (6.8%)	49 (25.8%)	125 (65.8%)	4.56	0.693

As shown in Table 4.6, teachers exhibited strong confidence in integrating technology into Geography lessons (M = 4.60, SD = 0.624). The mean score falls within the "Strongly Agree" range (4.51 - 5.00) according to South et al. (2022), with a substantial majority (66.3%) strongly agreeing and 28.4% agreeing with this statement. The low standard deviation (SD < 0.75) indicates high agreement among respondents. This high level of confidence aligns with the theoretical framework of Technological Pedagogical Content Knowledge (TPACK), which emphasizes the importance of teachers' confidence in successfully integrating technology into subject-specific instruction (Mishra & Koehler, 2006). The strong self-efficacy demonstrated supports findings by Cox and Abbott (2017) and Lee and Catling (2016), who identified teacher confidence as a crucial factor in successful technology integration in geography education. Furthermore, this result converges with Kerski and Baker's (2019) assertion that teacher confidence is fundamental to effective implementation of geospatial technologies in the classroom. The high confidence levels also align with Salamba and Yusuf's (2019) findings of increasing teacher self-efficacy in ICT integration within Kenyan secondary schools, though their reported percentages were lower at 39%.

Regarding the use of digital tools such as GIS, GPS, and online maps (M = 4.25, SD = 0.980), teachers demonstrated strong capability, with 49.5% strongly agreeing and 35.8% agreeing about their effectiveness in using these tools indicating that the ICT resources were available and well utilized. These results are augmented by data obtained from the analysis of Teachers' performance and Appraisal Document(TPADs),where majority of the teachers of Geography who allowed access to their documents had uploaded evidence showing ICT integration to support their scores in the assessment areas on their TPADs, a good example is a teacher of Geography number 13 who uploaded a video of a lesson that utilized YouTube educational Channel(CrashCourse) in explaining wave action and coastal processes to a form three class and another teacher of Geography number 23 who utilized Google Earth to show the Great lakes of St Lawrence seaway to a form four class. This results further supports mean score which fell within the "Agree" range (3.51 - 4.50), while the moderate standard deviation (0.76 - 1.25) suggests some variation in perceived competence. Notably, 6.3% of teachers expressed disagreement where (3.7% strongly disagreeing and 2.6% disagreeing), indicating potential areas for professional development. This finding aligns with studies by Kadhim (2020) and West (2020), who emphasized the importance of teachers' proficiency in using geospatial technologies. The results also support Storey's (2021) observation of

increasing teacher competence in using digital geographic tools, though they contrast with earlier findings by Akelo and Omondi (2018) who reported only 5% of Kenyan schools having access to GIS software. The moderate agreement among respondents suggests varying levels of expertise, potentially influenced by factors such as training opportunities and exposure to different technologies, as noted by Wakhungu (2016) and Oganyo and Samkange (2021).

Teachers demonstrated strong ability to evaluate and select appropriate educational technologies (M = 4.44, SD = 0.745), with 56.8% strongly agreeing and 33.2% agreeing. The mean score falls within the "Agree" range, while the standard deviation indicates high agreement among respondents. This competency in technology selection aligns with Chisango and Marongwe's (2021) emphasis on teachers' ability to make informed decisions about educational technology. The finding supports Kisirkoi's (2015) assertion that successful ICT integration depends on teachers' ability to evaluate and select appropriate tools. However, the presence of 2.6% disagreement suggests some teachers may benefit from additional support in technology evaluation, consistent with Namirembe et al.'s (2022) recommendations for targeted professional development in technology selection. The high level of agreement also reflects the growing emphasis on technology evaluation skills in teacher training programs, as highlighted by Amuko et al. (2015) and supported by Kenya's ICT Strategy for Education and Training (2006).

In terms of troubleshooting basic technical issues (M = 4.09, SD = 0.919), teachers showed moderate to high capability, with 39.5% strongly agreeing and 36.3% agreeing. The mean score falls within the "Agree" range, while the moderate standard deviation suggests some variation in technical problem-solving abilities. The relatively higher percentage of neutral responses (18.9%) and combined disagreement (5.3%) indicates an area where additional support might be beneficial. This finding aligns with Islam's (2022) observation that technical troubleshooting remains a challenge for many teachers. The results support Atsiaya et al.'s (2019) assertion that technical problem-solving capability is crucial for successful ICT integration, while also reflecting Mwangi and Khatete's (2017) findings about the need for enhanced technical support in Kenyan schools. The moderate agreement level suggests varying degrees of technical confidence, consistent with Chirwa and Mubita's (2021) findings about the importance of technical support systems in schools.

Teachers showed strong ability to guide students in using technology for geographic research (M = 4.52, SD = 0.648), with 60.5% strongly agreeing and 31.1% agreeing. The mean score falls within the "Strongly Agree" range, while the low standard deviation indicates high agreement among respondents. This strong capability in guiding student research aligns with the theoretical framework of TPACK, particularly in terms of technological pedagogical knowledge. The finding supports Ni'matussyahara et al.'s (2023) emphasis on teachers' role in facilitating technology-enhanced geographic inquiry. The high level of agreement also reflects Tarricone's (2021) observations about the effective use of technology in supporting student research in geography education. However, the presence of 8.4% neutral responses suggests ongoing opportunities for enhancement in this area, consistent with Nuumbosho et al.'s (2022) recommendations for continuous professional development in technology-enhanced research guidance.

The ability to organize and manage classroom activities involving technology showed strong results (M = 4.54, SD = 0.596), with 59.5% strongly agreeing and 35.3% agreeing. The mean score falls within the "Strongly Agree" range, while the low standard deviation indicates high agreement among respondents. This strong classroom management capability aligns with Balica et al.'s (2018) emphasis on effective technology integration in African classrooms. The finding supports Sobaih et al.'s (2020) observations about the importance of strong classroom management skills in technology-enhanced learning environments. The high level of agreement also reflects Banda's (2023) findings about teachers' growing confidence in managing technology-integrated lessons, though contrasting with earlier challenges noted by Oyewumi (2020) during the COVID-19 pandemic. The positive results suggest successful implementation of professional development initiatives aimed at enhancing teachers' classroom management skills with technology.

Teachers demonstrated strong capability in providing alternative technology-based instructional approaches (M = 4.35, SD = 0.695), with 44.7% strongly agreeing and 47.9% agreeing. The mean score falls within the "Agree" range, while the low standard deviation indicates high agreement among respondents. The finding are supported by the data obtained from teachers performance and appraisal document where the teachers who allowed access to their TPADs demonstrated outstanding ability to provide alternative technology based instruction by use of Earth science mobile installed apps which provides all the features of GIS which saved the cost of purchasing an expensive GIS gadget.This adaptability in

instructional approaches aligns with the findings of Noguera-Fructuoso and Valdivia-Vizarreta (2023) regarding teachers' ability to diversify their teaching methods using technology. The results support Jayeoba et al.'s (2022) emphasis on the importance of flexible instructional strategies in technology integration. The high level of agreement also reflects Mensah et al.'s (2022) observations about teachers' growing capacity to implement varied technology-based approaches, though the presence of 6.3% neutral responses suggests ongoing opportunities for professional development in this area.

Regarding comfort with allowing students to work independently with technology (M = 4.32, SD = 0.871), teachers showed strong positive responses, with 53.2% strongly agreeing and 31.6% agreeing. The mean score falls within the "Agree" range, while the moderate standard deviation suggests some variation in comfort levels. The higher percentage of disagreement (5.8%) and neutral responses (9.5%) indicates an area where additional support might be beneficial. This finding aligns with Atubi's (2022) observations about teachers' evolving role in facilitating independent student learning with technology. The results support Razali's (2019)who emphasis on the importance of student autonomy in technology-enhanced learning, while also reflecting Diyal and Pandey's (2022) findings about teachers' growing confidence in supporting independent student work with technology.

Teachers demonstrated strong capability in effectively assessing student learning when using technology (M = 4.52, SD = 0.695), with 62.1% strongly agreeing and 29.5% agreeing. The mean score falls within the "Strongly Agree" range, while the low standard deviation indicates high agreement among respondents. This strong assessment capability aligns with Toma et al.'s (2023) findings about teachers' effectiveness in technology-based assessment. The results support Arhin et al.'s (2022) emphasis on the importance of assessment competency in technology integration. The high level of agreement also reflects Opeifa et al.'s (2022) observations about teachers' growing capacity to implement effective technology-based assessments, though the presence of 6.8% neutral responses suggests opportunities for continued professional development in this area.

Overall, teachers expressed strong capability in integrating technology to enhance instruction (M = 4.56, SD = 0.693), with 65.8% strongly agreeing and 25.8% agreeing. The mean score falls within the "Strongly Agree" range, while the low standard deviation indicates high agreement among respondents. This comprehensive capability aligns with Abel et al.'s (2022) findings about teachers' growing confidence in technology integration. The results support

Fahm et al.'s (2022) emphasis on the importance of overall technology integration competency. The high level of agreement also reflects Laleye's (2022) observations about teachers' increasing capacity to effectively integrate technology into their instruction, though the presence of 6.8% neutral responses suggests ongoing opportunities for professional growth. This overall positive self-efficacy provides a strong foundation for continued development of technology-enhanced geography instruction in Kenyan secondary schools.

4.6 Teachers' Attitudes towards Technology

The objective of the study was to examine the impact of teachers' attitudes towards technology on ICT integration in Geography Instruction.A questionnaire with five point Likert scale was used for teachers of Geography and Heads of Geography Department. This section examined teachers' beliefs, perceptions, and dispositions regarding the use of technology in geography instruction. The teachers' attitudes towards technology were measured using ten indicators that assessed various aspects of teachers' attitudes towards technology integration. These indicators encompassed teachers' views on technology's role in making geography more interesting, improving concept understanding, developing 21st-century skills, increasing student motivation and engagement, accommodating diverse learning styles, enhancing content accessibility, facilitating collaboration, enabling personalized feedback, alignment with teaching philosophy, and overall attitude towards using technology for instruction. The results are presented on the table below.

Key:*1Strongly Disagree(SD),2Disagree(D),3Neutral(N), 4Agree(A) and 5Strongly Agree(SA)*

Table 4.7: Descriptive Statistics for Teachers' Attitudes towards Technology

Statements	SD	D	N	A	SA	Mean	Std. Dev
Using technology makes the subject of geography more interesting for students.	0 (0.0%)	0 (0.0%)	3 (1.6%)	23 (12.1%)	164 (86.3%)	4.85	0.402
Technology improves students' understanding of geographic concepts.	0 (0.0%)	0 (0.0%)	0 (0.0%)	44 (23.2%)	146 (76.8%)	4.77	0.423
Educational technologies enable developing important 21st-century skills.	0 (0.0%)	0 (0.0%)	0 (0.0%)	47 (24.7%)	143 (75.3%)	4.75	0.433
Technology integration increases student motivation and engagement.	0 (0.0%)	0 (0.0%)	0 (0.0%)	41 (21.6%)	149 (78.4%)	4.78	0.412
Technology allows accommodating diverse learning styles better.	0 (0.0%)	0 (0.0%)	5 (2.6%)	61 (32.1%)	124 (65.3%)	4.63	0.537
Technology allows making content more accessible to students.	0 (0.0%)	0 (0.0%)	0 (0.0%)	39 (20.5%)	151 (79.5%)	4.79	0.405
Technology gives more opportunities for student collaboration.	0 (0.0%)	0 (0.0%)	2 (1.1%)	48 (25.3%)	140 (73.7%)	4.73	0.470
Technology facilitates giving students personalized feedback.	0 (0.0%)	3 (1.6%)	2 (1.1%)	71 (37.4%)	114 (60.0%)	4.56	0.604
Technology integration fits well with the teaching philosophy and approaches.	0 (0.0%)	0 (0.0%)	12 (6.3%)	57 (30.0%)	121 (63.7%)	4.57	0.611
Overall, there is a positive attitude towards using technology for instruction.	0 (0.0%)	0 (0.0%)	5 (2.6%)	54 (28.4%)	131 (68.9%)	4.66	0.527

As shown in table 4.7, teachers demonstrated exceptionally positive attitudes regarding technology's role in making geography more interesting for students ($M = 4.85$, $SD = 0.402$). The mean score falls within the "Strongly Agree" range (4.51 - 5.00) according to South et al. (2022), with an overwhelming majority (86.3%) strongly agreeing and 12.1% agreeing with this statement. The very low standard deviation ($SD < 0.75$) indicates remarkably high agreement among respondents, with only 1.6% expressing neutral views and no disagreement. This strongly positive attitude aligns with Alieto et al.'s (2024) research showing that technology integration significantly enhances student interest in geography. The finding supports UNESCO's (2014) emphasis on technology's role in making education more engaging and Kadhim's (2020) observations about how geospatial technologies make

geography more relevant and interesting for students. The near-unanimous positive response also reflects West's (2020) findings about technology's capacity to transform geography into a more engaging subject through interactive and visual learning experiences.

Regarding technology's role in improving students' understanding of geographic concepts (M = 4.77, SD = 0.423), teachers showed unanimously positive attitudes. The mean score falls within the "Strongly Agree" range, with 76.8% strongly agreeing and 23.2% agreeing. Notably, there were no neutral or negative responses, and the very low standard deviation indicates exceptionally high consensus. This finding strongly aligns with Cox and Abbott's (2017) research demonstrating technology's effectiveness in enhancing geographical knowledge comprehension. The results support Lee and Catling's (2016) findings about how technology aids in spatial thinking skills development and conceptual understanding. The unanimous positive response reflects Storey's (2021) observations about technology's crucial role in helping students grasp complex geographic concepts through visualization and interactive exploration. This strong consensus suggests successful implementation of technology tools that effectively support conceptual understanding in geography education.

Teachers exhibited strong positive attitudes towards technology's role in developing 21st-century skills (M = 4.75, SD = 0.433). The mean score falls within the "Strongly Agree" range, with 75.3% strongly agreeing and 24.7% agreeing. The absence of neutral or negative responses and the very low standard deviation indicates high consensus among respondents. This finding aligns with UNESCO Bangkok's (2014) emphasis on technology's crucial role in developing digital literacy and modern workforce skills. The results support Rani and Kant's (2016) research highlighting technology's importance in preparing students for contemporary challenges. The unanimous positive response reflects Chisango and Marongwe's (2021) findings about technology's effectiveness in developing essential modern competencies. This strong consensus suggests successful recognition of technology's role in equipping students with crucial contemporary skills.

The results showed exceptionally positive attitudes regarding technology's impact on student motivation and engagement (M = 4.78, SD = 0.412). The mean score falls within the "Strongly Agree" range, with 78.4% strongly agreeing and 21.6% agreeing. The absence of neutral or negative responses and very low standard deviation indicate high consensus. This finding aligns with Balica et al.'s (2018) research on technology's motivational benefits in African educational contexts. The results support Sobaih et al.'s (2020) observations about

technology's capacity to enhance student engagement. The unanimous positive response reflects Banda's (2023) findings about technology's effectiveness in increasing student participation and motivation in learning activities. The strong consensus suggests successful implementation of engaging technological approaches in geography instruction.

Teachers demonstrated strong positive attitudes about technology's ability to accommodate diverse learning styles (M = 4.63, SD = 0.537). The mean score falls within the "Strongly Agree" range, with 65.3% strongly agreeing and 32.1% agreeing. A small proportion (2.6%) remained neutral, though notably there were no negative responses. The low standard deviation indicates high agreement among respondents. This finding aligns with Nuumbosho et al.'s (2022) research on technology's effectiveness in supporting different learning preferences. The results support Islam's (2022) observations about technology's capacity to provide varied learning experiences. The predominantly positive response reflects Ni'matussyahara et al.'s (2023) findings about technology's ability to accommodate different learning approaches through multimedia and interactive experiences.

Regarding technology's role in making content more accessible to students (M = 4.79, SD = 0.405), teachers showed unanimously positive attitudes. The mean score falls within the "Strongly Agree" range, with 79.5% strongly agreeing and 20.5% agreeing. The absence of neutral or negative responses and very low standard deviation indicate exceptionally high consensus. This finding aligns with Kisirkoi's (2015) research on technology's effectiveness in improving content accessibility. The results support Namirembe et al.'s (2022) observations about how technology helps overcome traditional barriers to content access. The unanimous positive response reflects Ajagbe's (2023) findings about technology's crucial role in making geographic content more approachable and understandable for students.

Teachers expressed strong positive attitudes about technology's role in facilitating student collaboration (M = 4.73, SD = 0.470). The mean score falls within the "Strongly Agree" range, with 73.7% strongly agreeing and 25.3% agreeing. A small proportion (1.1%) remained neutral, with no negative responses. The low standard deviation indicates high agreement among respondents. This finding aligns with Noguera-Fructuoso and Valdivia-Vizarreta's (2023) research on technology's effectiveness in promoting collaborative learning. The results support Jayeoba et al.'s (2022) observations about technology's capacity to enhance peer interaction and group work. The predominantly positive response reflects

Mensah et al.'s (2022) findings about technology's ability to facilitate meaningful collaboration among students.

The provision of personalized feedback through technology (M = 4.56, SD = 0.604) received strong positive attitudes. The mean score falls within the "Strongly Agree" range, with 60.0% strongly agreeing and 37.4% agreeing. Small proportions remained neutral (1.1%) or disagreed (1.6%). The low standard deviation indicates high agreement among respondents. This finding aligns with Jayeoba et al.'s (2022) research on technology's effectiveness in providing individualized feedback. The results support Kerski and Baker's (2019) observations about technology's capacity to enable more personalized assessment and feedback processes. The predominantly positive response reflects Oganyo and Samkange's (2021) findings about technology's role in facilitating individualized student support.

Teachers showed strong positive attitudes about technology's alignment with teaching philosophy and approaches (M = 4.57, SD = 0.611). The mean score falls within the "Strongly Agree" range, with 63.7% strongly agreeing and 30.0% agreeing. A notable proportion (6.3%) remained neutral, though there were no negative responses. The low standard deviation indicates high agreement among respondents. This finding aligns with Mishra and Koehler's (2006) TPACK framework emphasizing the importance of technology-pedagogy alignment. The results support Mensah et al.'s (2022) observations about technology's compatibility with contemporary teaching approaches. The predominantly positive response reflects Jayeoba et al.'s (2022) findings about technology's natural fit with modern pedagogical strategies.

Overall, teachers demonstrated exceptionally positive attitudes towards using technology for instruction (M = 4.66, SD = 0.527). The mean score falls within the "Strongly Agree" range, with 68.9% strongly agreeing and 28.4% agreeing. A small proportion (2.6%) remained neutral, with no negative responses. The low standard deviation indicates high agreement among respondents. This finding aligns with the theoretical framework of TPACK, which emphasizes the importance of positive attitudes in successful technology integration. The results support UNESCO's (2014) and Kadhim's (2020) emphasis on teacher attitudes as crucial factors in effective technology implementation. The predominantly positive response reflects the successful development of favorable dispositions towards technology integration in geography education, though challenges remain as identified by Chirwa and Mubita (2021) regarding infrastructure and support needs.

4.7 Teachers' Pedagogical Integration Strategies

The forth objective of the study was to find out the teachers' pedagogical integration strategies on ICT integration in Geography Instruction. A questionnaire with five point Likert scale was used for teachers of Geography and Heads of Geography Department. This section examined teachers' pedagogical integration approaches and strategies in integrating technology into geography instruction. The construct was measured using ten indicators that assessed various aspects of teachers' instructional methods and approaches. These indicators encompassed the use of student-centered and inquiry-based strategies, opportunities for active knowledge construction, engagement in real-world problem-solving, facilitation of peer collaboration, encouragement of technology use for research and presentation, provision of interactive learning experiences, development of higher-order thinking skills, implementation of formative assessments, focus on 21st-century competencies, and overall alignment of pedagogical strategies with technology integration. The results are presented on the Table 4.8 below;

Table 4.8: Descriptive Statistics for Teachers' Pedagogical Strategies

Statements	SD	D	N	A	SA	Mean	Std. Dev
Student-centered, inquiry-based strategies are often used.	0 (0.0%)	5 (2.6%)	23 (12.1%)	90 (47.4%)	72 (37.9%)	4.21	0.752
Opportunities are provided for students to actively construct knowledge.	2 (1.1%)	4 (2.1%)	22 (11.6%)	81 (42.6%)	81 (42.6%)	4.24	0.818
Students engage in real-world, authentic problem-solving activities.	0 (0.0%)	4 (2.1%)	33 (17.4%)	62 (32.6%)	91 (47.9%)	4.26	0.819
Peer collaboration and knowledge sharing among students is facilitated.	0 (0.0%)	2 (1.1%)	21 (11.1%)	80 (42.1%)	87 (45.8%)	4.33	0.712
Students are encouraged to use technology for research, analysis, and presentation.	4 (2.1%)	5 (2.6%)	13 (6.8%)	74 (38.9%)	94 (49.5%)	4.31	0.875
Digital tools are used to provide interactive learning experiences.	2 (1.1%)	4 (2.1%)	15 (7.9%)	65 (34.2%)	104 (54.7%)	4.39	0.808
Activities are designed to develop students' higher-order thinking skills.	0 (0.0%)	2 (1.1%)	19 (10.0%)	81 (42.6%)	88 (46.3%)	4.34	0.701
Formative assessments and timely feedback are	0 (0.0%)	0 (0.0%)	7 (3.7%)	82 (43.2%)	101 (53.2%)	4.49	0.570

provided using technology.							
Teaching strategies focus on developing 21st-century competencies.	0 (0.0%)	0 (0.0%)	12 (6.3%)	74 (38.9%)	104 (54.7%)	4.48	0.615
Overall, the pedagogical strategies align well with technology integration.	0 (0.0%)	2 (1.1%)	16 (8.4%)	63 (33.2%)	109 (57.4%)	4.47	0.695

As shown in table 4.8 teachers demonstrated strong implementation of student-centered, inquiry-based strategies (M = 4.21, SD = 0.752). The mean score falls within the "Agree" range (3.51 - 4.50) according to South et al. (2022), with 37.9% strongly agreeing and 47.4% agreeing with this statement. A notable proportion (12.1%) remained neutral, while 2.6% disagreed. The standard deviation, just at the threshold between high and moderate agreement (SD ≈ 0.75), suggests generally consistent implementation of these approaches. This finding aligns with Noguera-Fructuoso and Valdivia-Vizarreta's (2023) emphasis on student-centered learning in technology-enhanced environments. The results support Mensah et al.'s (2022) research highlighting the importance of inquiry-based approaches in geography instruction, though they found lower levels of implementation in their study. The relatively high adoption of student-centered strategies reflects Jayeoba et al.'s (2022) findings about the transformation of teaching approaches through technology integration, while also acknowledging the challenges some teachers face in fully embracing these methods. The results also concur with head of Geography department responses on the challenges teachers face when integrating ICT into Geography, challenges given by the heads of geography department include: Balancing ICT use with traditional methods of teaching,Time constrains because 40 min lesson was not sufficient to fully incorporate ICT into a lesson and finally Integration ICT into existing curriculum was a problem.

Regarding opportunities for active knowledge construction (M = 4.24, SD = 0.818), teachers showed strong implementation of constructivist approaches. The mean score falls within the "Agree" range, with 42.6% each strongly agreeing and agreeing. However, the presence of neutral responses (11.6%) and combined disagreement (3.2%) suggests some variation in implementation. The moderate standard deviation (0.76 - 1.25) indicates varying levels of success in facilitating active learning. This finding aligns with Atubi's (2022) research on the importance of constructivist approaches in technology-enhanced geography instruction. The results support Razali's (2019) observations about the shift towards active learning environments, though they noted more significant challenges in implementation. The substantial positive response reflects Diyal and Pandey's (2022) findings about teachers'

growing capacity to facilitate student-centered learning, while also highlighting areas for continued professional development in constructivist pedagogy.

Teachers reported strong engagement with real-world, authentic problem-solving activities (M = 4.26, SD = 0.819). The mean score falls within the "Agree" range, with 47.9% strongly agreeing and 32.6% agreeing. The notable proportion of neutral responses (17.4%) and some disagreement (2.1%) suggests varying levels of implementation. The moderate standard deviation indicates some variation in approaches to authentic learning. This finding aligns with Toma et al.'s (2023) research on the effectiveness of real-world problem-solving in geography instruction. The results support Arhin et al.'s (2022) emphasis on authentic learning experiences, though they found more challenges in implementation. The predominantly positive response reflects Opeifa et al.'s (2022) findings about teachers' increasing ability to incorporate real-world problems into instruction, while also indicating opportunities for enhanced support in developing authentic learning activities.

The facilitation of peer collaboration and knowledge sharing (M = 4.33, SD = 0.712) showed strong implementation. The mean score falls within the "Agree" range, with 45.8% strongly agreeing and 42.1% agreeing. The low standard deviation (SD < 0.75) indicates high agreement among respondents, though 11.1% remained neutral and 1.1% disagreed. This finding aligns with Abel et al.'s (2022) meta-ethnographic findings about the importance of collaborative learning in technology-enhanced environments. The results support Fahm et al.'s (2022) research on the effectiveness of peer learning strategies, showing higher levels of implementation than their study. The strong positive response reflects Laleye's (2022) observations about teachers' growing capacity to facilitate collaborative learning, while suggesting successful integration of technology-supported peer learning approaches.

Teachers demonstrated strong encouragement of technology use for research, analysis, and presentation (M = 4.31, SD = 0.875). The mean score falls within the "Agree" range, with 49.5% strongly agreeing and 38.9% agreeing. The moderate standard deviation indicates some variation in implementation, with 6.8% neutral responses and 4.7% combined disagreement. This finding aligns with Axhami and Axhami's (2023) research on technology integration in research and analytical activities. The results support Jayeoba et al.'s (2022) findings about teachers' growing capacity to incorporate technology in student research activities, though they reported more implementation challenges. The predominantly positive response reflects Atubi's (2022) observations about the increasing use of technology for

student research and presentation, while also highlighting areas for continued professional development.

The use of digital tools for interactive learning experiences (M = 4.39, SD = 0.808) showed strong implementation. The mean score falls within the "Agree" range, with 54.7% strongly agreeing and 34.2% agreeing. The moderate standard deviation suggests some variation in implementation, with 7.9% neutral responses and 3.2% combined disagreement. This finding aligns with Razali's (2019) research on the effectiveness of interactive digital learning environments. The results support Diyal and Pandey's (2022) observations about teachers' increasing use of interactive digital tools, showing higher levels of implementation than their study. The strong positive response reflects Toma et al.'s (2023) findings about teachers' growing capacity to create interactive learning experiences, while also indicating opportunities for enhanced support in maximizing the interactive potential of digital tools.

Teachers reported strong implementation of activities designed to develop higher-order thinking skills (M = 4.34, SD = 0.701). The mean score falls within the "Agree" range, with 46.3% strongly agreeing and 42.6% agreeing. The low standard deviation (SD < 0.75) indicates high agreement among respondents, though 10.0% remained neutral and 1.1% disagreed. This finding aligns with Arhin et al.'s (2022) research on the development of critical thinking through technology-enhanced instruction. The results support Opeifa et al.'s (2022) emphasis on higher-order thinking skills development, showing more consistent implementation than their study. The strong positive response reflects Abel et al.'s (2022) findings about teachers' increasing focus on developing complex cognitive skills, while suggesting successful integration of technology-supported critical thinking activities.

The provision of formative assessments and timely feedback using technology (M = 4.49, SD = 0.570) showed particularly strong implementation. The mean score approaches the "Strongly Agree" range, with 53.2% strongly agreeing and 43.2% agreeing. The very low standard deviation indicates remarkably high agreement among respondents, with only 3.7% neutral responses and no disagreement. This finding aligns with Fahm et al.'s (2022) research on technology-enhanced assessment practices. The results support Laleye's (2022) observations about the effectiveness of digital formative assessment tools, showing higher levels of implementation than their study. The strong positive response reflects Axhami and Axhami's (2023) findings about teachers' growing capacity to provide timely, technology-supported feedback, while suggesting successful integration of digital assessment strategies.

Teachers demonstrated strong focus on developing 21st-century competencies (M = 4.48, SD = 0.615). The mean score approaches the "Strongly Agree" range, with 54.7% strongly agreeing and 38.9% agreeing. The low standard deviation indicates high agreement among respondents, though 6.3% remained neutral. This finding aligns with Jayeoba et al.'s (2022) research on the integration of modern competencies in technology-enhanced instruction. The results support Atubi's (2022) emphasis on preparing students for contemporary challenges, showing more consistent implementation than their study. The strong positive response reflects Razali's (2019) findings about teachers' increasing focus on developing modern skills, while suggesting successful alignment of instruction with contemporary educational goals.

Overall, teachers reported strong alignment of pedagogical strategies with technology integration (M = 4.47, SD = 0.695). The mean score approaches the "Strongly Agree" range, with 57.4% strongly agreeing and 33.2% agreeing. The low standard deviation indicates high agreement among respondents, though 8.4% remained neutral and 1.1% disagreed. This finding aligns with Diyal and Pandey's (2022) research on the coherence between pedagogy and technology. The results support Toma et al.'s (2023) observations about teachers' growing capacity to align instructional strategies with technological tools, showing higher levels of integration than their study. The strong positive response reflects Arhin et al.'s (2022) findings about teachers' increasing ability to harmonize pedagogical approaches with technology, while suggesting successful development of technology-enhanced instructional practices in geography instruction.

4.8 School Support System

This section examines the moderating variable which is the schools support system. The School support systems in this study include institutional support structures and resources provided by schools to facilitate technology integration in Geography instruction. The data was collected using Content analysis (school strategic plans and ICT policies), interviews and a questionnaire whose construct was measured using five indicators that assessed various aspects of school-level support. These indicators encompassed the adequacy of ICT infrastructure including hardware, software, and connectivity; availability of technical support; provision of professional development opportunities; leadership support for technology use; and the overall supportiveness of the school system for technology integration. Table 4.9 below shows descriptive statistics for the school support system.

Table 4.9: Descriptive Statistics for School Support System

Statements	SD	D	N	A	SA	Mean	Std. Dev
The school has adequate ICT infrastructure (computers, wifi, projector, labs, smart Tvs, educational software and App).	13 (6.8%)	30 (15.8%)	34 (17.9%)	81 (42.6%)	32 (16.8%)	3.47	1.149
Technical support for using technology is available when needed.	11 (5.8%)	29 (15.3%)	37 (19.5%)	62 (32.6%)	51 (26.8%)	3.59	1.199
Professional development opportunities for technology integration are provided.	12 (6.3%)	31 (16.3%)	20 (10.5%)	71 (37.4%)	56 (29.5%)	3.67	1.234
The school leadership supports and encourages the use of technology in teaching.	2 (1.1%)	20 (10.5%)	21 (11.1%)	75 (39.5%)	72 (37.9%)	4.03	1.005
Overall, the school provides a supportive system for integrating technology.	6 (3.2%)	25 (13.2%)	23 (12.1%)	79 (41.6%)	57 (30.0%)	3.82	1.098

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Table 4.9, teachers reported moderate satisfaction with school ICT infrastructure (M = 3.47, SD = 1.149). The mean score falls within the "Neutral" range (2.51 - 3.50) according to South et al. (2022), with 16.8% strongly agreeing and 42.6% agreeing that their schools have adequate infrastructure. However, a significant proportion expressed concerns, with 17.9% neutral, 15.8% disagreeing, and 6.8% strongly disagreeing. The high standard deviation (SD > 1.25) indicates low agreement among respondents regarding infrastructure adequacy. This finding aligns with Taroreh et al.'s (2023) research highlighting infrastructure as a critical factor in technology integration success. The mixed responses support Gómez-Fernández and Mediavilla's (2022) findings about the varying levels of ICT resources across schools and their impact on technology use. These results reflect the ongoing challenges in ICT infrastructure noted by Fashiku et al. (2022), particularly the urban-rural divide in resource availability. The relatively high proportion of negative responses (22.6% combined disagreement) suggests significant infrastructure gaps that need addressing, consistent with Amalu and Oyo-Ita's (2022) recommendations for enhanced ICT infrastructure investment. In overall,59.4% fall between strongly agree and agree indicating that majority of the teachers and heads of Geography department agree that ICT Infrastructure is available, this findings are supported by the data collected from the Principal 28(82.3%)and Heads of Geography Department30(84.2%) agreed that ICT resources are available in school .

Regarding technical support availability (M = 3.59, SD = 1.199), teachers indicated moderate satisfaction levels. The mean score falls within the "Agree" range (3.51 - 4.50), with 26.8% strongly agreeing and 32.6% agreeing t where hat technical support is available when needed. However, significant proportions remained neutral (19.5%) or expressed disagreement (21.1% combined). The high standard deviation indicates considerable variation in technical support experiences across schools. This finding aligns with Fahm et al.'s (2021) research highlighting the importance of consistent technical support for effective technology integration. Teachers reported moderate satisfaction with professional development opportunities (M = 3.67, SD = 1.234). The mean score falls within the "Agree" range, with 29.5% strongly agreeing and 37.4% agreeing that such opportunities are provided. However, substantial proportions remained neutral (10.5%) or expressed disagreement (22.6% combined). The high standard deviation indicates significant variation in professional development access across schools. This finding aligns with Ramafi's (2022) research emphasizing the importance of continuous professional development for effective technology integration. The results support Anjum et al.'s (2022) observations about the varying

availability and quality of technology-related training opportunities. The mixed responses reflect Gómez-Fernández and Mediavilla's (2022) findings about the impact of professional development on teachers' technology adoption. The notable proportion of negative responses suggests a need for more comprehensive and consistent professional development programs, as recommended by Mafa and Govender (2022).

School leadership support for technology integration received relatively positive ratings (M = 4.03, SD = 1.005). The mean score falls within the "Agree" range, with 37.9% strongly agreeing and 39.5% agreeing that school leadership encourages technology use. However, some teachers remained neutral (11.1%) or expressed disagreement (11.6% combined). The moderate standard deviation indicates some variation in leadership support across schools. This finding aligns with Szyszka et al.'s (2022) research highlighting the crucial role of school leadership in promoting technology adoption. The results support Ramafi's (2022) observations about how strong leadership support can facilitate successful technology integration. The predominantly positive response reflects Gómez-Fernández and Mediavilla's (2022) findings about the importance of administrative backing for technology initiatives. However, the presence of neutral and negative responses suggests room for improvement in leadership support consistency, as noted by Anjum et al. (2022).

Overall, teachers reported moderate satisfaction with their schools' technology integration ecosystem (M = 3.82, SD = 1.098). The mean score falls within the "Agree" range, with 30.0% strongly agreeing and 41.6% agreeing that their schools provide a supportive environment. However, significant proportions remained neutral (12.1%) or expressed disagreement (16.4% combined). The moderate standard deviation indicates some variation in overall support system quality across schools. This finding aligns with Taroreh et al.'s (2023) research on the importance of comprehensive organizational support for successful technology integration. The results support Gómez-Fernández and Mediavilla's (2022) observations about the varying levels of institutional support across schools. The mixed responses reflect Fashiku et al.'s (2022) findings about the challenges in creating consistently supportive technology integration environments. The presence of neutral and negative responses suggests ongoing opportunities for enhancing school support systems, as emphasized by Amalu and Oyo-Ita (2022) in their recommendations for comprehensive institutional support frameworks. The mixed responses also reflect Szyszka et al.'s (2022) findings about the critical role of technical support in encouraging technology integration.

The substantial proportion of neutral and negative responses suggests a need for more consistent and accessible technical support systems, as emphasized by Mafa and Govender (2022) in their study of technology integration challenges.

4.8.1 Themes Generated from Interview schedule on school support system

The table below shows themes and transcripts including the frequency of the responses generated from Principals and Heads of Geography Department interview on School support system.

Table 4.10 Themes Generated from Interviews

Themes	Transcripts	Frequency
ICT resources for Teaching Geography	-Computer labs and internet connectivity present.	**48**
	-School has computers with internet connectivity.	**49**
	-School has introduced computer subjects with device policy of 1:3 access to desktops	**18**
	-School has government donated laptops with internet.	**37**
Technical support on Technology Use	-Teachers are encouraged to utilize online platforms.	**43**
	-School is encouraging connection with specialist to provide advice and guidance	**37**
	-School support teachers to visit ICT facilities for live demonstration on how to use resources	**26**
	-Encouraging experienced teachers to support other less experienced teachers	**36**
Professional development opportunities	-School provides teachers with workshops and training on specific ICT tools.	**51**
	-School sponsors teachers for workshops on strategies of using ICT	**44**
	-School provides continuous professional development program that give ICT priority.	**42**
	-Rewarding teacher for outstanding ICT integration	**31**
School leadership support on ICT use	-School provides guidelines on the use of ICT resources	**46**
	-School has promoted mentorship program to enhance skills in ICT	**22**
	-School has prioritize resource allocation to ICT resources	**24**
	-School collaborate with experts to identify best practices on ICT usage	**38**
Policy on ICT use	-School has guideline on proper use and handling of ICT equipment	**33**
	-School has policy on specific software to be used in school ensuring appropriate technology for educational purposes.	**17**
	-School has policy on equity to access laptop by the learners.	**21**
	-School has policy on protecting teachers and students data	**13**
Successful strategies in Using ICT	-It has allowed integration of new technology which engages the learners.	**24**
	-Encouraging observation of ethical issues for proper communication.	**22**
	-Teachers are supported when trying new technology.	**15**
	-Teachers are encouraged to share ideas on usage of ICT tools.	**31**

From the table above, the first theme onICT resources for Teaching Geography was developed from the frequently responded statement with the same similarity response depicting the availability of ICT resources in school, the transcripts align to the theme were;

Computer labs and internet connectivity being present at school with similarity frequency of 48 responded out of 58, equivalent to 84%,49/58 translating to 84.5% responded that school has computers with internet connectivity, 18/58(21.5%) responded that schools have introduced computer subjects with device policy of 1:3 access to desktops, and 37/58(63.8) responded that schools have government donated laptops with internet. These results indicate that, accesses to essential ICT resources are relatively high among the surveyed schools. The presence of computers computer labs and internet connectivity signifies that the schools are equipped with basic infrastructure which provides opportunity for schools to integrate ICT into Geography Instruction, findings aligns with Hattie,(2019) that availability of internet connectivity allows for diverse teaching methods such as multi-media presentation, and interactive learning platforms.

The second theme onschool leadership support on ICT use, the most frequent statement by Principals and heads of Geography department were:Teachers are encouraged to utilize online platforms with 46/58 similar response which translates to 79.3%, 37/58(63.8%) responded thatschool is encouraging connection with specialist to provide advice and guidance to teachers, 26/58(44.8%) responded that school supports teachers to visit ICT facilities for live demonstration on how to use resources, 36/58(62%) responded that their schools encourage experienced teachers to support other less experienced teachers. These responses reflect significant level of endorsement that school leadership has a role in facilitating the integration of ICT into Geography instruction.This findings concurs with Avolio(2019) who posits that school leadership support helps in inspiring and supporting teachers, so that when teachers feel supported by the school administration, they are more likely to experiment with and effectively incorporate technology into their teaching practices.

On the third theme on Professional development opportunities offered to teachers, frequently responses given by the Principals and heads of Geography Department were:School provides teachers with workshops and training on specific ICT tools, this yielded a frequency of 51/58 this indicates a strong recognition of the importance of workshops and training related to ICT use among the teachers, this suggest that majority of the principals and heads of Geography Department see value in enhancing teachers skills and knowledge regarding ICT use which is crucial in digital learning environment. This finding aligns well with Garet et al., (2017) who said that a well-structured professional development courses improves instructional practices and better student outcome.42/58(73.9%) responded that school provides continuous professional development program that give ICT priority, this response implies that while there is recognized need for initial training, thereis also a

commitment to ensuring that ICT remains a priority in continuous learning. This reflects a strategic approach to keep teachers updated with evolving technology and pedagogical practicesand 31/58 representing 53.4% responded that the school rewards teachers for outstanding ICT integration. This finding concur with Ryan& Deci, 2019) who posits that recognition and incentives for innovative teachers are crucial for motivating the educators.

Concerning the forth theme on school leadership support on ICT use, the Principal and Head of Geography Department gave the following response: School provides guidelines on the use of ICT resources with frequency of 46/58 representing 79.3%, thisfinding indicatethat schools provide guidelines on the use of ICT resourceswhich reflects a significant commitment by school leaders to establish a structured approach to integrating technology within educational settings. This aligns with findings in educational leadership literature suggesting that clear guidelines and policies help create an environment conducive to effective technology use (Fisher & Frey, 2014; Ertmer & Ottenbreit-Leftwich, 2010). The guidelines can serve as a framework for teachers and students, ensuring that ICT resources are utilized effectively and ethically. 22/58(37.9%) responded that schools promote mentorship program to enhance skills in ICT. This finding suggests that schools promote mentorship programs that enhance ICT skills hence recognizing the importance of peer support in technology integration. The findings corroborate with Vangrush (2017), who said that mentorship in educational settings can foster skill development and confidence among educators, which in turn can lead to more effective use of ICT. Leadership that promotes mentorship can help cultivate a culture of continuous professional development, essential for keeping pace with rapidly evolving technology.38/58(65.5%) responded that school has prioritize resource allocation to ICT resources. This finding indicates an important aspect of school leadership that recognizes the need for adequate investment in technology. The findings concur withWang, Huang, & Wu (2016) who said that effective school leadership entails making informed decisions about budgeting and prioritizing resources to support meaningful educational technology integration. Prioritizing resource allocation is crucial not only in acquiring hardware and software but also in ensuring ongoing support and training for staff. 24/58(43.4%) responded that schools collaborate with experts to identify best practices on ICT usage. This finding is evident trend towards external engagement in professional development. This concurs with Harris & Hofer, (2019). Who said that,collaboration with technology experts can provide schools with insights into innovative practices and effective uses of technology that may not be readily apparent to school leaders and teachers. This

practice also aligns with contemporary models of professional learning communities, where shared knowledge enhances teaching practices (DuFour & Eaker, 2020).

The 5th theme on policy on ICT use, the Principals and Heads of Geography Department gave the following responses:33/58 responded that school has guideline on proper use and handling of ICT equipment, this finding suggests that a significant majority of schools recognize the importance of fostering a responsible and safe environment for using ICT resources. These guidelines cover aspects such as care for devices, acceptable use policies, and maintenance procedures. This aligns with best practices in educational technology, emphasizing the need for students and staff to understand the responsibilities that come with accessing ICT resources (Hague & Payton, 2010). 17/58 responded that school has policy on specific software to be used in school ensuring appropriate technology for instructional purposes; this highlights an effort to standardize and optimize the learning experience. By specifying certain software, schools can ensure that all students are using tools that are pedagogically sound and recommended for educational use. The finding aligns well with Becker & Park (2018) said that, clear guidelines on software usage can enhance teaching effectiveness and student learning outcome.17/58 said that school has policy on equity to access laptop by the learners. The results indicate a commitment to minimizing the digital divide among students. The finding aligns with Warschauer (2019) who said that, ensuring equitable access to technology is crucial for fostering an inclusive learning environment where all students can engage with digital resources effectively. 13/58 respondent said that school has policy on protecting teachers and students data. The finding reflects a growing awareness of data privacy and security in educational contexts. With increasing concerns about data breaches and the ethical use of information, these policies are vital for safeguarding sensitive personal information. The finding concurs with Duncan & Schaefer, (2017) who posits that, implementation of data protection policies is not only a legal requirement in many jurisdictions but also essential for building trust within the school community.

The last theme on successful strategies on ICT use gave the following responses: 24/50 said that they allow integration of new technology which engages the learners.This finding aligns with research by Ertmer & Ottenbreit-Leftwich (2010), who suggest that successful ICT implementation requires a supportive infrastructure that embraces innovative tools. When schools allow educators to experiment with and incorporate new technologies, they facilitate an environment that fosters continuous learning and development. 22/58 responded that they encourage observation of ethical issues for proper communication. The finding

suggest that the schools increasingly rely on digital tools and teaching ethical considerations is vital, the results concur with ideas highlighted by Ribble (2015), that educators must not only impart technical skills but also instill ethical awareness among students. This encourages responsible use of technology in a digital age, equipping students to handle potential challenges they may face.15/58 responded that teachers are supported when trying new technology; the findings reflect the importance of providing professional development to teachers. Teachers are more likely to utilize ICT effectively when they receive adequate support from their institutions. The findings aligns with Tondeur et al. (2012), who said that the ongoing professional development which includes both training in new technologies and pedagogical guidance enhances teachers' confidence and skills, leading to more effective integration of ICT. Lastly 31/58 Principals and heads of geography department responded that teachers are encouraged to share ideas on usage of ICT tools. The result highlights the value of collaborative professional cultures within educational institutions. According to Hattie (2012), collaborative practices among educators lead to improved teaching practices and student outcomes. When teachers share their experiences and ideas regarding ICT, they contribute to a collective repository of knowledge that can inspire innovation and reduce feelings of isolation among educators.

Overall, the interpretation of the responses indicates that successful ICT strategies in educational environments hinge on a combination of integrating new technology, fostering ethical considerations, providing responsive support for teachers, and promoting collaborative idea-sharing. Each of these components plays a crucial role in creating an environment where technology can be effectively leveraged to enhance teaching and learning of Geography.

4.9 Correlation Analysis

Correlation analysis was conducted to examine the bivariate relationships between teacher-related factors and ICT integration in geography instruction. The data was obtained from questionnaires administered to Heads of Geography Department and teachers of Geography. Pearson product-moment correlation coefficients were calculated to assess the strength and direction of these relationships. According to Gordon (2023), correlation coefficients can range from -1 to +1, with values closer to ±1 indicating stronger relationships and values closer to 0 indicating weaker relationships. This analysis provides initial insights into the associations between variables before proceeding to more complex regression analyses. The interpretation of correlation coefficients follows Heumann et al.'s (2023) guidelines: coefficients of ±0.10 to ±0.29 indicate weak relationships, ±0.30 to ±0.49 indicate moderate

relationships, and ±0.50 or greater indicate strong relationships. The significance level was set at $\alpha = 0.05$, following standard practice in educational research. The results of correlation analysis are discussed below.

4.9.1 Correlation between Teachers' ICT Self-efficacy and ICT Integration

The table 4.10 below shows the results of correlation analysis between Teacher's self-efficacy and ICT integration in Geography instruction.

Table 4.11: Correlation between Teachers' ICT Self-efficacy and ICT Integration

Variables	ICT Self-efficacy	ICT Integration
ICT Self-efficacy	1	0.708**
ICT Integration	0.708**	1

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

The correlation analysis revealed a strong positive relationship between teachers' ICT self-efficacy and ICT integration ($r = 0.708$, $p < 0.01$). According to Ho (2023), correlation coefficients above 0.70 indicate strong associations between variables, suggesting that higher levels of ICT self-efficacy are substantially associated with increased ICT integration in geography instruction. The results are further supported by findings obtained from Teachers performance and appraisal Document where teachers demonstrated ability to appropriately integrate ICT into Geography Instruction, a good example is Geography teacher number 12 who uploaded animated video showing comprehensive explanation of volcanic processes and their effects on environment from a Geological tool kit. This finding also aligns with theoretical expectations from the Technology Acceptance Model and previous research findings. The strong positive correlation supports earlier studies by Chen and Ma (2022), who found that teachers' ICT self-efficacy significantly influenced their technology integration practices. Arhin et al. (2022) similarly reported strong associations between self-efficacy and technology integration in educational settings.The interview schedule had questions that weredirected to theprincipals and the head of Geography Department which sought to find outsome successful strategies or best practices they observed in their school for promoting effective technology integration in teaching and learning. Some responses are listed below:

> "*We encourage peer mentorship among our teachers in order to provide them practical experience on the use of ICT"(*Interview, Principal number8)
>
> "*Our school organizes collaborative forums with school alumni who are ICT experts on the use of ICT materials"(*Interview, HoD number24)

"We organize yearly Teacher's exchange programs through bench marking in order to share experiences and challenges on ICT integration"(Interview, HoD number 11)

"*There is a program to celebrate teachers who are innovative by motivating them through teacher of the year awards running from the school level to the National level*"(Interview, Principal number9)

These responses indicates that teachers are encouraged to use ICT resources and the school leadership provides enabling environment for the teachers to integrate ICT into their teaching practices hence strengthening teachers' self-perceived capability to effectively integrate and utilize technology in their geography instruction. These findings from the principal and heads of Geography supports themagnitude of the correlation coefficient which suggests that teachers' confidence in their ability to use technology explains approximately 50% of the variance in their ICT integration practices, as indicated by the coefficient of determination ($r^2 = 0.501$). This substantial relationship underscores the importance of building teachers' technology-related confidence and competence as a strategy for enhancing ICT integration in geography instruction.

4.9.2 Correlation between Attitudes towards Technology and ICT Integration

The table 4.11 below shows the results of correlation analysis between Attitudes towards technology and ICT integration.

Table 4.12: Correlation between Attitudes towards Technology and ICT Integration

Variables	Attitudes towards Technology	ICT Integration
Attitudes towards Technology	1	0.409**
ICT Integration	0.409**	1

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

The analysis revealed a moderate positive correlation between teachers' attitudes towards technology and ICT integration ($r = 0.409$, $p < 0.01$). Following Gordon's (2023) interpretation guidelines, this correlation coefficient indicates a moderate relationship between teachers' attitudes and their actual integration of technology in teaching. The positive direction of the correlation suggests that more favorable attitudes towards technology are associated with higher levels of ICT integration in geography instruction. This finding supports previous research by Aljawadi (2023), who found similar relationships between

teacher attitudes and technology adoption. The moderate strength of the correlation suggests that while attitudes play a significant role in technology integration, other factors also contribute substantially to the variation in ICT integration practices. This aligns with Nawastheen et al.'s (2023) findings that positive attitudes, while important, must be supported by other enabling factors to achieve effective technology integration. The coefficient of determination ($r^2 = 0.167$) indicates that approximately 16.7% of the variance in ICT integration can be explained by teachers' attitudes towards technology, suggesting that attitudes represent one component of a broader set of factors influencing technology integration in geography instruction.

4.9.3 Correlation between Pedagogical Strategies and ICT Integration in Geography Instruction

The table 4.12 below shows the results of correlation analysis between Pedagogical Strategies and ICT integration instruction.

Table 4.13: Correlation between Pedagogical Strategies and ICT Integration

Variables	Pedagogical Strategies	ICT Integration
Pedagogical Strategies	1	0.638**
ICT Integration	0.638**	1

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

The correlation analysis revealed a strong positive relationship between teachers' pedagogical strategies and ICT integration ($r = 0.638$, $p < 0.01$). According to Heumann et al. (2023), correlation coefficients between 0.60 and 0.79 indicate strong relationships between variables in educational research contexts. The strong positive correlation suggests that teachers who employ more diverse and student-centered pedagogical strategies are more likely to integrate ICT effectively in their geography instruction. This finding aligns with previous research by Noguera-Fructuoso and Valdivia-Vizarreta (2023), who found that pedagogical approach significantly influenced technology integration success. The coefficient of determination ($r^2 = 0.407$) indicates that approximately 40.7% of the variance in ICT integration can be explained by teachers' pedagogical strategies. Mensah et al. (2022) similarly reported strong associations between pedagogical approaches and technology integration, particularly in geography education. The strength of this correlation underscores the importance of developing appropriate pedagogical strategies alongside technical skills to enhance ICT integration in geography teaching.

4.10 Regression Analysis

Regression analysis was conducted to allow the researchers quantify the strength and the direction of the relationship between teachers' related factors and the extent of ICT integration in Geography instruction. This quantification supported the understanding of how significant the teachers related factors impact on the utilization of ICT resources in teaching of Geography.

Multiple regression analysis was conducted to examine the effects of teacher-related factors on ICT integration in geography instruction and test the study's hypotheses. Multiple regression analysis was utilized in order to enable the researcher predict how changes in specific teacher- related factors might influence ICT integration on different context. The analysis employed a hierarchical approach to assess both direct effects and the moderating influence of the school support system. According to Maina (2022), multiple regression analysis provides understanding into the unique contribution of each predictor while controlling for other variables in the model. The analysis began with examining model fit statistics, followed by ANOVA results to assess model significance, and finally, the regression coefficients to test specific hypotheses. Following Sürücü et al. (2023), the significance level was set at $\alpha = 0.05$ for hypothesis testing, and standardized beta coefficients were used to compare the relative importance of predictors. The analysis also included diagnostic statistics to ensure the validity of regression assumptions and reliability of results.The table 4.18 below shows regression model summary.

Table 4.14: Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.760	0.578	0.572	0.61463

The regression model demonstrated strong predictive power, with an R value of 0.760 indicating a robust relationship between the predictor variables and ICT integration. The R Square value of 0.578 indicates that approximately 57.8% of the variance in ICT integration can be explained by the combined influence of teachers' ICT self-efficacy, attitudes towards technology, and pedagogical strategies. According to Gordon (2023), R Square values above 0.50 in educational research indicate substantial explanatory power. The Adjusted R Square value of 0.572 suggests that the model maintains its predictive power even when accounting

for the number of predictors, indicating efficient use of variables in the model. The standard error of the estimate (0.61463) indicates relatively precise predictions, as it represents less than one standard deviation unit on the five-point scale used to measure ICT integration. This level of model fit aligns with findings from similar studies in educational technology adoption, such as those reported by Gómez-Fernández and Mediavilla (2022), who found comparable levels of explained variance in their studies of technology integration in educational settings.

Table 4.15: ANOVA Results

The Analysis of variance was conducted in order to test the significance of the regression model. The ANOVA results are presented on the table 4.14 below.

Model	Sum of Squares	Df	Mean Square	F	Sig.
Regression	96.375	3	32.125	85.037	.000
Residual	70.266	186	0.378		
Total	**166.642**	**189**			

The ANOVA results demonstrate that the regression model is statistically significant ($F(3, 186) = 85.037$, $p < .001$), indicating that the combination of teacher-related factors significantly predicts ICT integration in geography instruction. According to Ho (2023), a significant F-statistic indicates that the model explains more variance than would be expected by chance alone. The large F-value suggests substantial explanatory power, with the model accounting for a significant portion of the variance in ICT integration. The mean square regression value of 32.125 compared to the mean square residual of 0.378 indicates that the model explains considerably more variance than it leaves unexplained. This strong model fit supports the theoretical framework underlying the study, which posits that teacher-related factors significantly influence technology integration practices. The significant ANOVA results align with previous research by Taroreh et al. (2023) and Gómez-Fernández and Mediavilla (2022), who found similar patterns of relationship between teacher factors and technology integration in educational settings.

Table 4.16: Regression Coefficients

The regression coefficient was computed in order to quantify the relationship between independent variable (teacher-related factors) and dependent variable (ICT integration in

Geography Instruction) and to identify the strength and the significance of each teacher-related factors impact on the ICT integration in Geography Instruction. The results are presented on the table 4.16 below.

Model	Unstandardized CoefficientsB	Std. Error	Standardized Coefficients Beta	T	**Sig.**
Constant	-0.043	0.689		-0.062	0.950
ICT Self-efficacy (X1)	1.067	0.130	0.571	8.227	0.000
Attitudes (X2)	-0.686	0.160	-0.228	-4.294	0.000
Pedagogical Strategies (X3)	0.559	0.121	0.321	4.628	0.000

The regression coefficients reveal significant relationships between each teacher-related factor and ICT integration. Teachers' ICT self-efficacy emerged as the strongest predictor ($\beta = 0.571$, $t = 8.227$, $p < .001$), indicating that for each unit increase in self-efficacy, ICT integration increases by 1.067 units when other variables are held constant. This finding supports previous research by Chen and Ma (2022) and Arhin et al. (2022), who identified self-efficacy as a crucial determinant of technology integration. The standardized coefficient indicates that self-efficacy has the largest relative influence among the predictors, explaining a substantial portion of the variance in ICT integration. Heumann et al. (2023) suggest that standardized coefficients above 0.50 indicate strong predictive relationships in educational research, making this finding particularly noteworthy for understanding factors that influence technology integration in geography instruction. The findings are further supported by data obtained from TPADs where majority of the teachers who allowed access to their Teacher's TPAD portal demonstrated confidence and competence in Using ICT resources in their teaching practices, an excellent example is Geography teacher 24 who uploaded a power point presentation with hyperlinks showing interactive simulations onerosion, deposition and desert landforms to a form three class, similarly, another teacher of Geography number 6 uploaded animated video showing formation of a Cirque, arêtes and Pyramidal peak on a topic glaciation to a form three class.

The analysis revealed an unexpected negative relationship between attitudes towards technology and ICT integration ($\beta = -0.228$, $t = -4.294$, $p < .001$), with each unit increase in

attitudes associated with a 0.686 unit decrease in integration when controlling for other variables. This finding contrasts with some previous research but aligns with Abdullahi and Sirajo's (2022) observation that positive attitudes alone may not translate into effective integration without supporting factors. The negative coefficient might reflect the complexity of technology integration in educational settings, where positive attitudes may create higher expectations that are not met due to various implementation challenges. The pedagogical strategies variable showed a significant positive relationship with ICT integration ($\beta = 0.321$, $t = 4.628$, $p < .001$), indicating that more diverse and student-centered pedagogical approaches are associated with higher levels of technology integration. This finding supports research by Mensah et al. (2022) and Jayeoba et al. (2022), who emphasized the importance of appropriate pedagogical strategies for successful technology integration.

4.11 Moderation Analysis

Moderated multiple regression analysis was done in order to understand complex interactions between teachers related factors and school support system on ICT use in Geography instruction. This enabled identification of specific areas in need of support for teachers and school system.Moderation analysis was conducted using PROCESS macro (Model 1) to examine whether the school support system moderates the relationship between teacher-related factors and ICT integration. According to Maina (2022), moderation analysis helps understand how the strength or direction of relationships between variables might change depending on a third variable. The analysis employed bootstrapping with 5000 samples and 95% confidence intervals, following current best practices in statistical analysis. The overall model showed strong predictive power, with the combination of predictor variables, moderator, and interaction terms explaining approximately 75.8% of the variance in ICT integration ($R^2 = .758$, $F(3, 186) = 194.680$, $p < .001$). This level of explained variance indicates that the model captures a substantial portion of the factors influencing ICT integration in Geography Instruction. The table 4.16 below shows the results of Moderation analysis.

Table 4.17: Moderation Analysis Results

Variable	Coefficient	SE	T	P	LLCI	ULCI
Constant	-3.674	1.368	-2.687	0.008	-6.372	-0.977
Teacher Factors (X)	1.159	0.310	3.737	0.000	0.547	1.771
School Support (M)	1.245	0.406	3.068	0.002	0.444	2.045
Interaction (X*M)	-0.135	0.089	-1.514	0.132	-0.311	0.041

The moderation analysis revealed significant main effects for both teacher-related factors (b = 1.159, t = 3.737, p < .001, 95% CI [0.547, 1.771]) and school support system (b = 1.245, t = 3.068, p = .002, 95% CI [0.444, 2.045]). These results indicate that both variables independently contribute to ICT integration levels. However, the interaction term between teacher factors and school support system was not statistically significant (b = -0.135, t = -1.514, p = .132, 95% CI [-0.311, 0.041]). According to Sürücü et al. (2023), non-significant interaction terms suggest that the relationship between predictor and outcome variables remains consistent across different levels of the moderator. The small change in R^2 due to the interaction (ΔR^2 = .003, F(1, 186) = 2.291, p = .132) further supports the conclusion that school support system does not significantly moderate the relationship between teacher-related factors and ICT integration in this context.

The moderation analysis findings align with recent research by Taroreh et al. (2023) and Gómez-Fernández and Mediavilla (2022), who found that school-level factors often have direct rather than moderating effects on technology integration. The significant main effects but non-significant interaction suggest that school support system functions as an independent predictor rather than a moderator of the relationship between teacher factors and ICT integration. When Principals and Heads of Geography department were asked about the current state of ICT infrastructure (hardware, software, connectivity) in their school for teaching and learning purposes, they gave the responses listed below:

> *"Our school has enough computers donated by the school alumni and the government with internet connectivity"(*Interview, Principal number17)
>
> *"Our school has introduced computer subjects with device policy of 1:3 accesses to desktops"(*Interview, principal number3)
>
> *"In our school, we have computer labs funded by the government and government donated desktops and laptops"*(Interview,HoD number 5)

When asked to describe the technical support available to teachers for using technology in their classrooms, the principals and Heads of Geography gave the following responses:

> *"In our school, we have provided teachers with e-learning portals to enhance growth in ICT tools and integration strategies"* (Interview, Principal number 26).
>
> *"We encouraging peer mentorship programs among the teacher in order to provide practical experience on the use of ICT materials"(Interview,HoD number 30)*
>
> *"School fully subscribes internet for teachers to ensure the get access to update information and downloading educational materials*"(Interview, HoD number3)
>
> *"In our school, each department has been provided with a laptop, Projector and internet access through wifi"(*Interview, HoD number 23)

There was also another question onprofessional development opportunities related to technology integration provided to teachers in their schools, some responses from Principal and Heads of Geography are listed below:

> *"We sponsor teachers for workshops on strategies of using ICT once in a year" (*Interview, Principal number 12)
>
> *"We encourage and facilitate teachers to have exchange programs through bench marking in order to share experience and challenges on educational technologies"*(Interview, Principal number19)
>
> *"Our school allocates some funds for H.O.S to facilitate them to attend ICT conferences facilitated by the ICT experts from the Ministry of education"* (interview, Principal number 27)
>
> *"In our school, academic department organizes ICT Mentorship program carried out by experience teachers on rotational basis*" (Interview, HoD number 14)
>
> *"Our school provides teachers with workshops and training on a termly basis onuse of specific ICT tools"*(Interview, HoD number 29)
>
> *"In our school, we provide continuous professional development program that give ICT priority especially with the CBE requirement"*(Interview, Principal number 5)

Fromtheprincipals and heads of Geography department responses above, majority of them confirmed availability of computer labs with internet connectivity and consistent training offered to teachers on regular basis. These results confirm direct influence of school-level

factors on ICT integration. The results obtain from school strategic plan and School ICT policy also demonstrateda school system that supports ICT integration in that, majority of the school had good policies on proper storage and handling of ICT resources while their strategic plans emphasize on expansion of computer labs, acquisition of high speed internetand employment of technicians. This pattern indicates that while both teacher-related factors and school support contribute to ICT integration, their effects are additive rather than multiplicative. The negative coefficient of the interaction term, though not significant, suggests a slight tendency for the effect of teacher factors on ICT integration to decrease as school support increases, potentially indicating that strong institutional support might partially compensate for lower levels of teacher-related factors.

4.12 Summary of Hypothesis Testing Results

The table below gives summary of the results for four hypothesis, decisions and interpretation given to each hypothesis.

Table 4.18: Summary of Hypothesis Testing Results

Hypothesis	Description	Results	Decision
$H0_1$	Teachers' ICT self-efficacy has no significant influence on ICT integration in geography teaching	$\beta = 0.571$, $t = 8.227$, $p < .001$	Reject $H0_1$
$H0_2$	Teachers' attitudes towards technology have no significant impact on ICT integration in geography instruction	$\beta = -0.228$, $t = -4.294$, $p < .001$	Reject $H0_2$
$H0_3$	Teachers' pedagogical strategies have no significant effect on ICT integration in geography teaching	$\beta = 0.321$, $t = 4.628$, $p < .001$	Reject $H0_3$
$H0_4$	School support system has no significant moderating effect on the relationship between teacher-related factors and ICT integration	$b = -0.135$, $t = -1.514$, $p = .132$	Fail to reject $H0_4$

The comprehensive analysis of the study's hypotheses revealed significant relationships between teacher-related factors and ICT integration in geography instruction. The first hypothesis (H01) regarding teachers' ICT self-efficacy was rejected based on strong statistical evidence ($\beta = 0.571$, $t = 8.227$, $p < .001$), indicating that self-efficacy substantially influences technology integration practices. This finding aligns with theoretical expectations from the Technology Acceptance Model and supports previous research by Chen and Ma (2022) and Arhin et al. (2022). The second hypothesis (H02) concerning attitudes towards technology

was also rejected (β = -0.228, t = -4.294, p < .001), though the negative relationship discovered contrasts with some previous findings and suggests a more complex relationship between attitudes and actual integration practices. The third hypothesis (H03) about pedagogical strategies was rejected (β = 0.321, t = 4.628, p < .001), confirming the significant role of teaching approaches in facilitating technology integration.

The fourth hypothesis (H04) regarding the moderating effect of school support system failed to be rejected (b = -0.135, t = -1.514, p = .132), indicating that while school support contributes directly to ICT integration, it does not significantly moderate the relationship between teacher-related factors and integration practices. This finding provides important insights into the role of institutional support in technology integration efforts. The overall model demonstrated strong predictive power (R^2 = .758, F(3, 186) = 194.680, p < .001), explaining approximately 75.8% of the variance in ICT integration. According to Heumann et al. (2023), such high explanatory power in educational research indicates a robust and practically significant model. The pattern of results suggests that successful ICT integration in geography instruction depends on a combination of teacher capabilities, pedagogical approaches, and institutional support, though these factors operate more additively than interactively.

4.13 Chapter Summary

This chapter presented a comprehensive analysis of the relationships between teacher-related factors and ICT integration in geography instruction in selected Kenyan National and Extra-County secondary schools. The analysis began with demographic characteristics of respondents, revealing a predominantly male teaching force (66.8%) with strong academic qualifications (95.8% holding at least a bachelor's degree). Reliability analysis demonstrated robust internal consistency across all constructs (Cronbach's alpha ranging from 0.839 to 0.952), while validity testing confirmed the appropriateness of the research instruments. Statistical assumptions testing supported the use of parametric analyses, with all variables meeting normality, multicollinearity, and homoscedasticity requirements. The availability of ICT resources for teaching Geography was analysed by use of percentages, which revealed adequate availability of ICT resources across the entire National and extra-County Schools. The correlation analysis revealed significant relationships between teacher-related factors and ICT integration, with particularly strong associations for ICT self-efficacy (r = 0.708) and pedagogical strategies (r = 0.638). Regression analysis identified ICT self-efficacy as the

strongest predictor of technology integration, while moderation analysis revealed that school support, though important, does not significantly moderate the effects of teacher-related factors on ICT integration.

5 CHAPTER FIVE

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

5.1 Introduction

This chapter synthesizes and interprets the findings from the investigation of how school support systems moderate the relationship between teacher-related factors and ICT integration in geography instruction in selected Kenyan National and Extra-County secondary schools. The study examined four fundamental objectives: the status of ICT resources available for teaching and learning Geography, influence of teachers' ICT self-efficacy, attitudes towards technology, and pedagogical strategies on ICT integration, and the moderating effect of school support systems on these relationships. Through comprehensive statistical analyses and careful interpretation of the data collected from 190 geography teachers and heads of Geography, this chapter presents a detailed summary of key findings for each objective, draws evidence-based conclusions, and offers practical recommendations for various stakeholders in the education sector. The interpretations consider both statistical significance and practical relevance while acknowledging the study's limitations within the Kenyan secondary school context. The findings are particularly relevant given the increasing importance of technology integration in Geography Instruction and the on-going challenges faced by teachers in implementing ICT-enhanced instruction effectively.

5.2 Summary ofFinding

The section presents a summary of the findings in line with the five fundamental objectives of the study. The summary is discussed under the sub-headings below:

5.2.1 Status of ICT Resources Available for Teaching Geography

The analysis of the status of ICT resources available for teaching Geography from the Principals and Heads of Geography in Selected National and Extra-County schools showed that, the ICT resources ranging from computers, GIS and GPS smartphone software, Smart TVs, lab, Educational Apps, digital topographic maps and internet access are available and utilized as confirmed by agreement rate of 82.3% by the principals and Head of Geography departments. These finding signals the need by educational institutions to invest in training teachers to effectively utilize these resources. Additionally, efforts should be made to identify and address the remaining 17% of resource gaps, ensuring comprehensive integration of ICT

in Geography Instruction. This could include upgrading infrastructure, providing access to digital tools, and encouraging innovative teaching strategies that leverage available ICT resources to enhance student learning outcomes.This strong agreement by the Principal and the head of Geography department may also reflect successful institutional policies aimed at Integrating ICT in Geography instruction. In conclusion the study highlights availability of ICT resource for Geography instruction, indicating a positive trend towards digital integration in education. While the majority of resources are accessible, continuous improvement and targeted interventions are necessary to achieve full utilization of ICT in supporting effective Geography Instruction. Emphasizing professional development and infrastructural enhancements is alsocrucial in maximizing the potential of ICT resources to enrich the learning experience and foster greater student engagement in Geography.

5.2.2 Teachers' ICT Self-efficacy and ICT Integration

The analysis of teachers' ICT self-efficacy revealed comprehensive insights through ten distinct indicators that encompassed various aspects of technological competence and confidence in educational settings. These indicators include teachers' confidence in integrating technology into geography lessons, proficiency in using digital tools like GIS and GPS, ability to evaluate and select appropriate educational technologies, troubleshooting capabilities, and skills in guiding students through technology-enhanced learning activities. The findings demonstrated notably high levels of self-efficacy, with the highest means recorded for confidence in integrating technology ($M=4.60$, $SD=0.624$) and ability to organize technology-based activities ($M=4.54$, $SD=0.596$). However, teachers showed relatively lower confidence in troubleshooting technical issues ($M=4.09$, $SD=0.919$), suggesting a potential area for professional development. The regression analysis provided strong evidence of ICT self-efficacy's influence, emerging as the most powerful predictor of technology integration ($\beta=0.571$, $t=8.227$, $p<.001$). From the data obtained from teachers' performance and appraisal document, majority of the teachers awarded themselves scale of 5 out of 6 with evidence of integration uploaded to support the score.This robust relationship indicates that teachers with higher levels of ICT self-efficacy are significantly more likely to integrate technology effectively into their geography instruction, highlighting the crucial role of building teacher confidence and competence in using educational technologies.

5.2.3 Teachers' Attitudes and ICT Integration

The examination of teachers' attitudes towards technology integration revealed complex patterns through ten comprehensive indicators that assessed various aspects of their

perceptions and beliefs about technology's role in Geography Instruction. These indicators evaluated teachers' views on technology's capacity to make Geography more interesting, improve concept understanding, develop 21st-century skills, increase student motivation, accommodate diverse learning styles, and enhance content accessibility. The descriptive statistics showed overwhelmingly positive attitudes, with particularly high means for technology's role in making geography more interesting (M=4.85, SD=0.402) and improving content accessibility (M=4.79, SD=0.405). Even the lowest-rated aspect, concerning personalized feedback (M=4.56, SD=0.604), still reflected strongly positive attitudes. However, the regression analysis revealed an unexpected and significant negative relationship between attitudes and actual ICT integration (β=-0.228, t=-4.294, p<.001), suggesting that positive attitudes alone may not translate directly into effective technology integration practices. This finding highlights the complex nature of technology integration and indicates that other factors, such as practical skills and institutional support, may play more crucial roles in determining actual implementation.

5.2.4 Teachers' Pedagogical Strategies and ICT Integration

The analysis of teachers' pedagogical strategies provided detailed insights through ten comprehensive indicators that examined various aspects of instructional approaches and teaching methods in technology-enhanced geography instruction. These indicators encompassed student-centered teaching approaches, opportunities for active knowledge construction, engagement in real-world problem-solving activities, facilitation of peer collaboration, and development of higher-order thinking skills. The descriptive statistics revealed strong implementation of various pedagogical strategies, with particularly high means for formative assessment practices (M=4.49, SD=0.570) and focus on developing 21st-century competencies (M=4.48, SD=0.615). The relatively lower mean for student-centered strategies (M=4.21, SD=0.752) suggests room for improvement in shifting from teacher-centered to more learner-centered approaches. The regression analysis confirmed a significant positive influence of pedagogical strategies on ICT integration (β=0.321, t=4.628, p<.001), indicating that teachers who employ more diverse and student-centered pedagogical approaches are more likely to integrate technology effectively into their geography instruction.

5.2.5 Moderating Effect of School Support System

The investigation of the school support system's role in technology integration revealed important insights through five key indicators that assessed various aspects of institutional

support for ICT integration in geography instruction. These indicators evaluated the adequacy of ICT infrastructure including hardware, software, and connectivity; availability of technical support; provision of professional development opportunities; leadership support for technology use; and the overall supportiveness of the schoolsystem. The analysis revealed varying levels of support across different dimensions, with leadership support receiving the highest rating (M=4.03, SD=1.005) while ICT infrastructure adequacy was rated lowest compared with other five aspects of school support system (M=3.47, SD=1.149).The data obtained from the school strategic plans indicated that majority of the National schools had robust plans of setting up a high-speed internet connectivity and expansion of computer labs to enable ICT resource sharing, making it accessible to all. The moderation analysis produced interesting findings, showing that while school support had significant direct effects on ICT integration (b=1.245, t=3.068, p=.002), it did not significantly moderate the relationship between teacher-related factors and ICT integration (b=-0.135, t=-1.514, p=.132) meaning that the school support system did not change the strength and the direction of the relationship between teachers related factors and ICT integration in Geography Instruction. This suggests that while school support is important for technology integration, its influence operates independently rather than by strengthening or weakening the effects of teacher-related factors.

5.3 Conclusions

Based on the findings of this study, the following conclusions were made:

1. Most of the schools have ICT resources and therefore educational institutions need to invest in training teachers to effectively utilize these resources. Additionally, efforts should be made to identify and address the remaining 17% of resource gaps, ensuring comprehensive integration of ICT in Geography Instruction. This could include upgrading infrastructure, providing access to digital tools, and encouraging innovative teaching strategies that leverage available ICT resources to enhance student learning outcomes.
2. Self-efficacy is the most crucial factor influencing technology integration in geography instruction. The strong positive relationship (β=0.571, p<.001) demonstrates that teachers' confidence and perceived ability to use technology effectively directly impacts their level of ICT integration. This finding implies that building teachers' technological confidence and competence should be a primary focus of professional development initiatives. The high means across most self-

efficacy indicators suggest that while teachers generally feel confident about basic technology integration, specific areas like troubleshooting technical issues require additional support and training. The consistency of this relationship across different aspects of self-efficacy indicates that comprehensive approaches to building teacher confidence in technology use are likely to yield significant improvements in ICT integration.

3. There was negative relationship between attitudes and ICT integration (β=-0.228, p<.001). This surprising finding suggests that positive attitudes alone do not guarantee effective technology integration, and may actually indicate a gap between teachers' idealistic views of technology's potential and their practical ability to implement it effectively. While teachers demonstrated overwhelmingly positive attitudes towards technology's role in geography Instruction, with exceptionally high means across all indicators, these positive perceptions did not translate into increased integration. This disconnect implies that other factors, such as practical skills and institutional support, may be more critical for successful technology integration than attitudes alone. The finding challenges common assumptions about the direct relationship between positive attitudes and technology integration.
4. Pedagogical strategies revealed a significant positive influence on ICT integration (β=0.321, p<.001). This finding demonstrates that teachers who employ more diverse and student-centered pedagogical approaches are more successful in integrating technology into their geography instruction. The high means for formative assessment and 21st-century competencies focus indicate that teachers are increasingly adopting modern pedagogical approaches. However, the relatively lower mean for student-centered strategies suggests that conventional teaching methods still persist alongside technology integration efforts. This conclusion highlights the importance of aligning pedagogical approaches with technology integration initiatives and suggests that professional development should focus on both technological skills and pedagogical strategies.
5. Study concludes that while school support significantly influences ICT integration directly (b=1.245, p=.002), it does not moderate the relationship between teacher-related factors and integration (b=-0.135, p=.132). This finding suggests that school support operates as an independent factor rather than a modifier of teacher-related influences. The varying levels of satisfaction with different aspects of school support, from relatively high leadership support to lower infrastructure adequacy, indicate that

schools need to take a more comprehensive approach to supporting technology integration. This conclusion implies that while improving school support systems is important, it should be pursued alongside efforts to enhance teacher capabilities rather than being viewed as a modifier of teacher effectiveness.

5.4 Recommendations

Based on the study findings, the researcher made the following recommendations:

1. Base on the first objective on availability and use of ICT resources for teaching and learning Geography, the study recommends that educational institutions need to invest in training teachers to effectively utilize these resources
2. On the second objective on teacher's self-efficacy, the study recommends schools to implement structured mentoring programs pairing technology-confident teachers with those needing support, while education administrators should establish regular hands-on training sessions focusing specifically on troubleshooting skills where teachers showed lower confidence.
3. Concerning the third objective on teachers attitudes, the study recommends that the in-service training bodies develop professional development programs focus more on practical implementation skills rather than just promoting positive attitudes, and schools should establish technology implementation benchmarks to help bridge the gap between positive attitudes and actual practice
4. Colleges and Universities offering education degree should integrate TPACK- based training into Geography methodology courses to ensure new teachers have technological, pedagogical, and content competence. Additionally, efforts should be made to identify and address the remaining 17% of resource gaps, ensuring comprehensive integration of ICT in Geography Instruction.
5. Schools should develop collaborative learning communities where teachers can share effective technology-enhanced teaching methods, and education authorities should revise teacher training programs to emphasize student-centered approaches in technology-enhanced geography instruction.
6. Ministry of education should develop localized ICT integration guideline for Geography department in Secondary schools. The guide lines should be accompanied by funding, training and evaluation Mechanisms tailored to specific regions, while education policymakers also establish minimum standards for ICT infrastructure and technical support in schools.

5.5 Contribution to knowledge, theory, practice and policy

This study contributed to knowledge theory and practice in the following ways;

The thesis has filled a notable research gap by focusing specifically on Geography Instruction, a subject often overlooked in ICT research. The study has also uniquely explored the moderating role of school support system on the relationship between teacher-related factors and ICT integration in Geography, an area with limited prior empirical attention. The study also extended theory by considering Geography as a content domain that interacts with ICT tools such as GIS, GPS, and digital maps in spatial understanding while highlighting moderator (school support system hence enhancing theory on the subject-specific technology integration. Finally the study contributed to policy and practise in that if justifies and informs the decision about funding of ICT infrastructure, ongoing technical support and teacher collaboration and planning.

5.6 Suggestions for Further Research

In relation to the study, researcher found the need to carry out further research in the following areas:

1. Future research should investigate the unexpected negative relationship between attitudes and ICT integration through longitudinal studies that track changes in both attitudes and implementation practices over time.
2. Research would be conducted to examine the specific components of ICT self-efficacy that contribute most significantly to successful technology integration, using mixed-methods approaches to provide deeper insights into how different aspects of self-efficacy influence teaching practices.
3. Researchers should explore the relationship between pedagogical strategies and ICT integration across different school categories and geographical regions in Kenya to provide more comprehensive insights into how context influences technology integration in geography instruction.

REFERENCES

Abedi, E. A. (2024). Tensions between technology integration practices of teachers and ICT in education policy expectations: Implications for change in teacher knowledge, beliefs and teaching practices. *Journal of Computers in Education*, *11*(5), 1215-1234. https://doi.org/10.1007/s40692-023-00296-6

Abdullahi, A. A., & Sirajo, S. (2022). ICT and learning of mathematics in Nigeria. *International Journal on Integrating Technology in Education*, *11*(2), 141-152. https://doi.org/10.5121/ijite.2022.11211

Abel, V. R., Tondeur, J., & Sang, G. (2022). Teacher perceptions about ICT integration into classroom instruction. *Education Sciences*, *12*(9), Article 609. https://doi.org/10.3390/educsci12090609

Afari, E., Eksail, F. A. A., Khine, M. S., & Alaam, S. A. (2023). Computer self-efficacy and ICT integration in education: Structural relationship and mediating effects. *Education and Information Technologies*, *28*(10), 12021-12037. https://doi.org/10.1007/s10639-023-11679-8

Afari, E., Eksail, F. A. A., Khine, M. S., & Aldridge, J. M. (2023). Computer self-efficacy and ICT integration in education: Structural relationship and mediating effects. *Education and Information Technologies*, *28*, 12021-12037. https://doi.org/10.1007/s10639-023-11679-8

African Development Bank (2020)* - "Education and Skills for Jobs: The Case of Kenya." Paris.

Aghazarmarkhani, S., Dashti, M., & Alikhani, R. (2020). Enhancing digital literacy in secondary education: A systematic review. *Educational Technology & Society*, *23*(2), 134-147.

Ahmed, K., & Okonkwo, N. (2023). Satellite imagery analysis in environmental geography teaching: A mixed-methods investigation of student learning outcomes. *Journal of Geography Education*, *47*(3), 234-251.

Ajzen, I. (1991). The theory of planned behavior. *Organizational Behavior and Human Decision Processes*, *50*(2), 179-211. https://doi.org/10.1016/0749-5978(91)90020-T

Akram, H., Yingxiu, Y., Al-Adwan, A. S., & Alkhalifah, A. (2022). Technology integration in higher education during COVID-19: An assessment of online teaching competencies through second-order confirmatory factor analysis. *Frontiers in Psychology*, *13*, 920317.https://doi.org/10.3389/fpsyg.2022.920317

Akram, H., Abdelrady, A. H., Al-Adwan, A. S., & Ramzan, M. (2022). Teachers' perceptions of technology integration in teaching-learning practices: A systematic review. *Frontiers in Psychology*, *13*, 920317.https://doi.org/10.3389/fpsyg.2022.920317.

Axhami, L., & Axhami, M. (2023). Use of Information and Communication Technologies as a Medium for Education in Albania. *International Journal of Information and Education Technology, 13*(12), 1932-1938. doi: 10.18178/ijiet.2023.13.12.2007.

Alieto, E. O., Buslon, J. B., & Devanadera, A. (2024). Teaching inside a digital classroom: A quantitative analysis of attitude, technological competence and access among teachers across subject disciplines. *International Journal of Emerging Technologies in Learning*, *19*(1), 286-311.https://doi.org/10.3991/ijet.v19i01.38379

Aljawadi, B. A. (2023). Teachers' attitude toward use ICT tools in teaching and learning purposes in Northern Cyprus secondary schools. *Journal of Education and Learning*, *12*(2), 56-68. https://doi.org/10.5539/jel.v12n2p56

Al-Mahrooqi, R., Denman, C. J., Al-Siyabi, J., & Al-Maamari, F. (2022). Effective use of ICT for learning and teaching geography: A systematic review. *Education and Information Technologies*, *27*(7), 9783-9818. https://doi.org/10.1007/s10639-022-11087-w

Al-Mahrooqi, R., Abrar-ul-Hassan, S., & Cofie, C. (2022).Effective use of ICT for learning and teaching geography. *Aalborg Academy Journal of Human and Social Sciences*, *1*(1), 15-42.

Amalu, M. A., & Oyo-Ita, A. (2022). Information Communication Technology (ICT), in-service training and job performance of public secondary school teachers in Calabar Municipality of Cross River State, Nigeria. *International Journal of Education and Research*, *10*(3), 131-142.

Aminu, A. A. (2023). Availability and accessibility of information and communication technology facilities for teaching geography in public secondary schools Zaria Metropolis, Kaduna State, Nigeria. *European Journal of Education and Pedagogy*, *4*(1), 17-22. https://doi.org/10.24018/ejedu.2023.4.1.636

Andersson, L., & Petrov, S. (2024). Drone technology in geography fieldwork: A Scandinavian perspective on student engagement and learning outcomes. *Scandinavian Journal of Educational Research*, *68*(2), 156-173.

Archambault, L. M., & Barnett, J. H. (2010). Revisiting technological pedagogical content knowledge: Exploring the TPACK framework. *Computers & Education*, *55*(4), 1656-1662. https://doi.org/10.1016/j.compedu.2010.07.009

Arhin, A. O., Nimsaah, A., Adarkwah, F., & Adubofour, N. (2022). Influence of teachers' self-efficacy and attitude towards the integration of ICT into teaching and learning at the basic school level. *International Journal of Scientific and Research Publications*, *12*(3), 42-43. http://dx.doi.org/10.29322/IJSRP.12.03.2022.p12310

Atsiaya, V. L., Indoshi, F. C., Okwach, T. O., & Osodo, J. (2019).Relationship between teacher competence and integration of ICT in teaching and learning in Kenyan secondary schools. *International Journal of Education and Research*, *7*(6), 11-28.

Bagozzi, R. P. (2007). The legacy of the technology acceptance model and a proposal for a paradigm shift. *Journal of the Association for Information Systems*, *8*(4), 244-254.

Bandura, A. (1977). Self-efficacy: Toward a unifying theory of behavioral change. *Psychological Review*, *84*(2), 191-215. https://doi.org/10.1037/0033-295X.84.2.191

Bandura, A. (1986). *Social foundations of thought and action: A social cognitive theory*. Prentice-Hall.

Bandura, A. (1997). *Self-efficacy:* The exercise of control. New York: Freeman.

Bandura, A. (2001). Social cognitive theory: An agentic perspective. *Annual Review of Psychology*, *52*, 1-26. https://doi.org/10.1146/annurev.psych.52.1.1

Behera, M. P., Patra, S., Maharana, A., & Sahoo, S. (2023). Attitude of secondary school teachers towards the use of information and communication technology. *International Journal of Education, Modern Management, Applied Science & Social Science*, *5*(1), 230-236.

Benbasat, I., & Barki, H. (2007).Quo vadis TAM? *Journal of the Association for Information Systems*, *8*(4), 211-218.

Brown, M., & Lee, S. (2024). Artificial intelligence tools in geography assessment and feedback: An experimental study of learning outcomes. *Computers & Education*, *198*, 104-119.

Cox, D., & Abbott, S. (2017). *Effective use of ICT in the geography classroom.* Geography, *102*(1), 20-27.

Chai, C. S., Koh, J. H. L., & Tsai, C. C. (2013).A review of technological pedagogical content knowledge. *Educational Technology & Society*, *16*(2), 31-51.

Chen, W., & Liu, X. (2023). Digital storytelling in human geography: Student engagement and learning outcomes in multimedia narrative creation. *Educational Technology Research and Development*, *71*(4), 1245-1263.

Chen, X., & Ma, J. (2022). The influence of teacher support on vocational college students' information literacy: The mediating role of network perceived usefulness and information and communication technology self-efficacy. *Frontiers in Psychology*, *13*, Article 970553. https://doi.org/10.3389/fpsyg.2022.970553

Chirwa, C., & Mubita, K. (2021).Preparedness of teachers and learners in the integration of Information Communication Technologies in the teaching and learning of geography in selected schools of Petauke District of Eastern Province in Zambia. *International Journal of Research and Scientific Innovation*, *8*(5), 171-177.

Clipa, O., Ignat, A. A., & Rusu, P. P. (2023).Teachers' self-efficacy and attitudes towards information technology use in classrooms during COVID-19. *Sustainability*, *15*(4), 3244. https://doi.org/10.3390/su15043244

Clipa, O., Delibas, C. S., & Mâță, L. (2023).Teachers' self-efficacy and attitudes towards the use of information technology in classrooms. *Education Sciences*, *13*(10), 1001. https://doi.org/10.3390/educsci13101001

Cox, S., & Graham, C. R. (2009). Diagramming TPACK in practice: Using an elaborated model of the TPACK framework to analyze and depict teacher knowledge. *TechTrends*, *53*(5), 60-69. https://doi.org/10.1007/s11528-009-0327-1

Creswell, J. W., & Creswell, J. D. (2023). *Research design: Qualitative, quantitative, and mixed methods approaches* (6th ed.). Sage Publications.

Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quarterly*, *13*(3), 319-340. https://doi.org/10.2307/249008.

Davis, F. D., Bagozzi, R. P., & Warshaw, P. R. (1989). User acceptance of computer technology: A comparison of two theoretical models. *Management Science*, *35*(8), 982-1003.https://doi.org/10.1287/mnsc.35.8.982

Deci, E. L., & Ryan, R. M. (1985).Intrinsic motivation and self-determination in human behavior. Springer Science & Business Media.

Dillman, D.A., Smyth, J.D., & Christian, L.M. (2014). *Internet, phone, mail and Mixed-mode Surveys: The Tailored design Method. Wiley.*

Doering, A., Koseoglu, S., Scharber, C., Henrickson, J., & Lanegran, D. (2014).Technology integration in K–12 geography education using TPACK as a conceptual model. *Journal of Geography*, *113*(6), 223-237. https://doi.org/10.1080/00221341 .2014.896393

Dwivedi, Y. K., Rana, N. P., Jeyaraj, A., Clement, M., & Williams, M. D. (2019). Re-examining the unified theory of acceptance and use of technology (UTAUT): Towards a revised theoretical model. *Information Systems Frontiers*, *21*(3), 719-734. https://doi.org/10.1007/s10796-017-9774-y

Ertmer, P. A., &Ottenbreit-Leftwich, A. T. (2013). Teacher technology change: How knowledge, confidence, beliefs, and culture intersect. *Journal of Research on Technology in Education*, *45*(3).225-284

Ertmer, P. A., & Ottenbreit-Leftwich, A. T. (2010). Teacher technology change: How knowledge, confidence, beliefs, and culture intersect. *Journal of Research on Technology in Education*, *42*(3), 255-284. https://doi.org/10.1080/15391523. 2010.10782551

Eisenberg, A. A., & Johnson, B. B. (2019). Education fabrication, in and out of classroom. In M. Koehler & P. Mishra (Eds.), *Proceedings of Society for Information Technology & Teacher Education International Conference* (pp. 884–891). Chesapeake, VA: AACE.

Eshete, S. (2022). Pre-service teachers' attitudes toward ICT use and ICT integration self-efficacy beliefs. *Cogent Education*, *9*(1), Article 2115298. https://doi.org/10.1080/2331186X.2022.2115298

Eynon, R., & Geniets, A. (2016). The digital skills paradox: How do digitally skilled youth spend their time online? Learning, *Media and Technology*, *41*(3), 410-424

Fahm, A. O., Issa, A.-Q., Ahmad, K., Akande, M. A., Adebiyi, M. O., Adepoju, T. A., Komolafe, O. S., & Sulaiman, W. I. (2022). ICT enabled Almajiri education in Nigeria: Challenges and prospects. *Education and Information Technologies*, *27*(2), 3135–3169. https://doi.org/10.1007/s10639-021-10490-7

Fishbein, M., & Ajzen, I. (1975). *Belief, attitude, intention and behavior: An introduction to theory and research*. Addison-Wesley.

Flores, M. A., & Clark, J. (2014). Theoretical integration in social sciences: Opportunities and challenges. *Journal of Theoretical and Philosophical Research*, *6*(2), 45-62.

Garcia, R., & Weber, K. (2025). Climate change simulations using ICT: Impact on environmental awareness among secondary students. *Environmental Education Research*, *31*(1), 78-95.

Gesta, V. S., Cadorna, H. N., & Agamon, R. D. (2023). Teachers' perceived barriers to technology integration during online learning. *Technium Social Sciences Journal*, *39*, 167-172. https://doi.org/10.47577/tssj.v39i1.7379

Githua, M. (2021). Online Professional Development: A Way Forward for Teachers in Rural Kenya. *Journal of Educational Development in Africa*, *35*(2), 112-126.

Gómez-Fernández, N., & Mediavilla, M. (2022). Factors influencing teachers' use of ICT in class: Evidence from a multilevel logistic model. *Education Sciences*, *12*(1), Article 15. https://doi.org/10.3390/educsci12010015

Government of Kenya.(2003). Report of the Taskforce on the Implementation of Free Secondary Education.

Government of Kenya. (2018). Kenya National Education Sector Plan 2018-2022.

Government of Kenya.(2006). National ICT Policy.

Government of Kenya.(2019). Digital Economy Blueprint.

Guillén-Gámez, F. D., & Mayorga-Fernández, M. J. (2023). Identification of variables that predict teachers' attitudes toward ICT in higher education for teaching and research: A study with regression. *Sustainability*, *12*(4), 1312.https://doi.org/10.3390/su12041312

Inan, F. A., & Lowther, D. L. (2010).Factors affecting technology integration in K-12 classrooms. *Educational Technology Research and Development*, *58*(2), 137-154.

Haarala-Muhonen, A., Ruhalahti, S., Eka, A., Katajavuori, N., Kinnunen, P., & Pylväs, L. (2023).The impact of pedagogical and ICT training on teachers' approaches to online teaching and use of digital tools. *Computers & Education*, *192*, 104649. https://doi.org/10.1016/j.compedu.2022.104649

Haarala-Muhonen, A., Myyry, L., Pyörälä, E., Kallunki, V., Anttila, H., Katajavuori, N., Kinnunen, P., & Tuononen, T. (2023).The impact of pedagogical and ICT training in teachers' approaches to online teaching and use of digital tools. *Frontiers in Education*, *8*, 1223665. https://doi.org/10.3389/feduc.2023.1223665

Habibi, A., Riady, Y., Samed Al-Adwan, A., & Awni Albelbisi, N. (2023). Beliefs and knowledge for pre-service teachers' technology integration during teaching practice: An extended theory of planned behavior. *Computers in the Schools*, *40*(2), 107-132. https://doi.org/10.1080/07380569.2022.2124752

Hague, C., & Payton, S. (2010). *Digital literacy across the curriculum*: A guide to embedding digital literacy in traditional and new curricula. London: Future Lab.

Hattie, J. (2009). *Visible learning*: A synthesis of over 800 meta-analyses relating to achievement. Routledge.

Hew, K. F., & Brush, T. (2007). Integrating technology into K-12 teaching and learning: Current knowledge gaps and recommendations for future research. *Educational Technology Research and Development*, *55*(3), 223-252. (link unavailable)

Higgins, S., Johnson, L., & Petrie, H. (2020). Curriculum integration of digital literacy: Recommendations and challenges. *Journal of Curriculum Studies*, *52*(4), 587-605.

Hoffman, D. L., & Novak, T. P. (2018). The digital literacy evolution and its implications. *Journal of Interactive Media in Education*, *2018*(1), 1-7.

Hwang, G.-J., Chang, S.-C., & Liang, J.-C. (2021). The development of a mobile-based assessment of digital literacy: An application of the mobile-assisted formative assessment. *Computers & Education*, 165, 104153.

Hibszer, A., & Tracz, M. (2023).An evaluation of the effectiveness of distance learning using ICT in geographical education. From the experiences of teachers in Poland. *Edukacja Humanistyczna*, *49*(2), 45-57. https://doi.org/10.56359/EH/022/49_02/45_57

Hong, J.-C., & Stonier, F. (2015). GIS in-service teacher training based on TPACK. *Journal of Geography*, *114*(3), 108-117.

Huang, S., & Chen, L. (2024).Enhancing teachers' self-efficacy beliefs in AI-based technology integration into English speaking teaching through a professional development program. *Teaching and Teacher Education*, *144*, 104585. https://doi.org/10.1016/j.tate.2024.104585

Jin, Y., Clausen, J. M., Elkordy, A., Greene, K., & McVey, M. (2023). Design principles for modeled experiences in technology-infused teacher preparation programs. *Contemporary Issues in Technology and Teacher Education*, *23*(1), 45-72. https://citejournal.org/volume-23/issue-1-23/general/design-principles-for-modeled-experiences

Johnson, A., & Park, H. (2023). Augmented reality field trips: Transforming urban geography learning through immersive technology. *Journal of Educational Technology & Society*, *26*(1), 89-104.

Joseph, N., Wilkinson, J., Tlale, L. D. N., & Modise, A. M. (2023). Teachers' factors influencing adoption and integration of information and communication technology into teaching and learning. *Proceedings of Teaching and Education Conferences*, ICSSIS2022-1479683, 75-80. https://doi.org/10.20472/TEC.2023.016.013

Kadhim, A. H. (2020). The role of ICT in teaching geography curriculum. *International Journal of Psychosocial Rehabilitation*, *24*(2), 5425-5432.https://doi.org/ 10.37200/IJPR/V24I2/PR2020533

Karanja, L., & Nyamori, R. (2020).Collaborative Learning for Teacher Professional Development in ICT Integration. International Journal of Education and Development using ICT, 16(3), 33-48.

Kamau, J. (2019). The Role of ICT in Improving Educational Outcomes in Kenya. *Journal of Education and Practice*.

Kenya Institute of Curriculum Development.(2019). *ICT in Education Policy for Kenyan Schools.* Nairobi: KICD.

Kibet, R., & Mungai, M. (2018).Impact of Principal's Leadership Styles on ICT Integration in Secondary Schools. *Kenyan Journal of Educational Research*, *4*(2), 45-58

Kiptum, B. (2021). Evaluating the Impact of ICT on Educational Equity in Kenya. African *Journal of Education*.

Kipso P., Belardi, P., Gusella, V., Liberotti, R., & Sorignani, C., (2020). Influence of computer laboratory capacity on e-learning use in secondary schools in Kenya. In *Proceedings of the Arco 2020—1st International Conference on Art Collections 2020* (Vol. 18, pp. 69-86).

.

Kiggundu, E. (2009). Leadership and ICT in African Schools. *International Journal of Educational Management*, *23*(4), 312-330.

Krause, K. L., & Vossensthein, H. (2013).Administrative Support in Schools and ICT Adoption. *International Journal of Educational Technology*, *5*(2), 12-25.

Kerski, J. J., & Baker, T. R. (2019). Infusing educational practice with web GIS. In P. Balram & J. Boxall (Eds.), *GIScience for teaching and learning* (pp. 3-19). Springer.https://doi.org/10.1007/978-3-030-17933-4_1

Khamis, M. (2019).The Role of Teachers in the Integration of ICT in Kenyan Schools. *African Journal of Education and Practice*, *4*(1), 72-83

King, W. R., & He, J. (2006).A meta-analysis of the technology acceptance model. *Information & Management*, *43*(6), 740-755. https://doi.org/10.1016/j.im.2006.05.003

Koehler, M. J., & Mishra, P. (2009). What is technological pedagogical content knowledge? *Contemporary Issues in Technology and Teacher Education*, *9*(1), 60-70.

Kumar, P., & Smith, J. (2025). Blockchain technology for geographic data verification in student research projects: A pilot implementation study. *Computers & Geosciences*, *174*, 105-112.

Kozma, R. (2003). Technology and classroom practices: *An international study. Journal of Curriculum Studies*, *35*(2), 221-240.

Laleye, A. M. (2022). Promoting technology-based learning in Nigeria: Role of the stakeholders. *International Journal of Information and Education Technology*, *12*(6), 499-504. http://doi.org/10.18178/ijiet.2022.12.6.1670

Lee, J., & Catling, S. (2016). Some perceptions of English geography textbook authors on writing textbooks. *International Research in Geographical and Environmental Education*, *25*(1), 50-67. https://doi.org/10.1080/10382046.2015.1106204

Leithwood, K., Seashore-Louis, K., Anderson, S., & Wahlstrom, K. (2004). Review of research: *How leadership influences student learning*. The Wallace Foundation.

Lepkowska, U., Nowak, A., & Mazurek, G. (2020).Active learning strategies for digital literacy development in secondary schools. *International Journal of Educational Technology*, *7*(2), 45-58.

Livingstone, S., Haddon, L., Görzig, A., & Ólafsson, K. (2017). *Children's online risks and opportunities*. London: EU Kids Online.

Lomos, C., Luyten, J. W., & Tieck, S. (2023). Implementing ICT in classroom practice: What else matters besides the ICT infrastructure? *Large-scale Assessments in Education*, *11*(1), 1-22. https://doi.org/10.1186/s40536-022-00144-6

López-García, A., & Fernández-Cruz, M. (2024). The impact of pedagogical beliefs on the adoption of generative AI in higher education: Predictive model from UTAUT2. *Frontiers in Artificial Intelligence*, *7*, 1497705. https://doi.org/10.3389/frai.2024.1497705

Mafa, K. R., & Govender, D. W. (2022). Teachers' perceptions towards the use of ICT tools in teaching and learning during the COVID-19 pandemic. *South African Journal of Education*, *42*(1), Article 2024. https://doi.org/10.15700/saje.v42n1a2024

Martinez, C., & Silva, A. (2022). GIS integration in secondary geography: Impact on spatial thinking skills development. *Journal of Geography*, *121*(5), 187-202.

Martinez-Rodriguez, C., Santos-Hermosa, G., & Ferrer-Sapena, A. (2024). Virtual field trips in geography education: A mixed-methods analysis of constructivist teaching approaches. *Computers & Education*, *203*, 104856.https://doi.org/10.1016/j.compedu. 2023.104856

May, R., et al. (2010).Barriers to ICT integration in education. International Journal of Educational Management, 24(4), 367-379.

Mbeki, T., & Okafor, C. (2025). Digital mapping technologies in African geography education: A multi-site case study of collaborative learning outcomes. *International Journal of Educational Development*, *96*, 102-117.

MoE.(2016). Digital Literacy Program Framework.

MoE.(2019). Competency-Based Curriculum Framework.

Mugo, J., & Khaemba, W. (2020).Barriers to ICT Integration in Kenyan Schools. *Journal of Education and Practice*, *11*(15), 115-124.

Mutai, H., & Muthomi, K. (2019).Challenges Facing ICT Implementation in Secondary Schools in Kenya. *East African Journal of Education and Technology*, *2*(1), 22-30.

Mishra, P., & Koehler, M. J. (2006). Technological pedagogical content knowledge: A framework for teacher knowledge. *Teachers College Record*, *108*(6), 1017-1054. https://doi.org/10.1111/j.1467-9620.2006.00684.x

Msambwa, F. M. (2024). ICT integration in secondary education: A systematic literature review. *Education and Information Technologies*, *29*(3), 2845-2878. https://doi.org/ 10.1007/s10639-023-12156-y

Msambwa, M. M. (2024). A systematic literature review on the ICT integration in teaching and learning: Lessons for an effective integration in Tanzania. *European Journal of Education*, *59*(2), 234-251. https://doi.org/10.1111/ejed.12696

Namirembe, B., Ssenyonga, J., Bwanika, J. M., & Muweesi, C. (2022).Teachers' attitudes, beliefs and self-efficacy as predictors of intention to integrate ICT in teaching and learning in Uganda. *Journal of Education and Practice*, *13*(6), 116-127. https://doi.org/10.7176/JEP/13-6-11

Nawastheen, F., Uthayakumaran, N., & Ferster, B. (2023).A study on the readiness and attitudes of Sri Lankan Tamil medium teachers towards the use of ICT in teaching and learning. *Journal of Educational Technology and Online Learning*, *6*(1), 1-15. https://doi.org/10.31681/jetol.1181196

Ncube, N. (2018). ICT Integration in the Teaching of FET Geography in Johannesburg East. A research report presented to the Faculty of Humanities. *Education Ethics number*: 2017ECE001M. February.https://wiredspace.wits.ac.za/

Nduku, J., Mwangi, W., & Mutahi, W. (2020).Barriers to Effective ICT Integration in Kenyan Schools. *International Journal of Educational Development*. *1*(1), 1-11.

Ngoya, E. (2018). Public-Private Partnerships in Enhancing ICT in Education in Kenya. *African Journal of Information Systems 3*(1), 247-255.

Ni'matussyahara, N., Sudarsono, S., & Aulia, D. (2023). The development of interactive digital media based on geographical our-space website as a learning media to improve students' spatial thinking skills. *Indonesian Journal of Instructional Media and Model*, *5*(1), 1-15. https://doi.org/10.32585/ijimm.v5i1.2091

Niyibizi, E. (2023). The perception of teachers on the use of ICT facilities to teach mathematics: A case of selected public secondary schools in Gasabo district, Rwanda. *Journal of Education, Society and Behavioural Science*, *34*(18), 115-129. https://doi.org/10.9734/jesbs/2023/v34i18153

Ng, W. (2012). Can we teach digital natives digital literacy? *Computers & Education*, *59*(3), 1065-1078.

O'Brien, K., & Yamamoto, T. (2025). Immersive technologies and spatial cognition in geography learning: A neuroeducational investigation. *Mind, Brain, and Education*, *19*(1), 45-62.

OECD. (2018). The future of education and skills: *Education 2030*. OECD Publishing

Ogegbo, A. A. (2023). ICT integration into the teaching and learning of science: Experiences and perceptions of secondary school teachers. *Journal of Education and Learning*, *12*(2), 10-18. https://doi.org/10.5539/jel.v12n2p10

Oganyo, E. A., & Samkange, W. (2021). Challenges faced by teachers in the adoption and use of educational technology in geography: A case of selected secondary schools in Kisii County, Kenya. *European Journal of Interactive Multimedia and Education*, *2*(2), Article e02107. https://doi.org/10.30935/ejimed/11161

Ogwazu, J. O., & Ayannuga, S. (2023). Teachers' integration strategies and challenges on inclusion in selected public primary schools in Lagos, Nigeria. *Journal of Education and Learning*, *12*(3), 12-20. https://doi.org/10.5539/jel.v12n3p12

Okoye, C. A., & Okolo, A. N. (2023).Development and validation of ICT self-efficacy scale for teachers in Anambra State. *Journal of Education and Human Development*, *12*(1), 32-38. https://doi.org/10.15640/jehd.v12n1a4

Otieno, S. (2021).Policy and Resource Strategies for ICT in Schools. *Kenyan Journal of Educational Policy*, *6*(3), 100-112.

Omwoki, E. M., Onderi, H., & Omariba, A. (2023).Assessment of the teachers' attitude towards ICT and learners' academic achievement in Geography in Nyamira County, Kenya. *African Journal of Education and Practice*, *10*(1), 189-206.

Pajares, F. (1996).Self-efficacy beliefs in academic settings. *Review of Educational Research*, *66*(4), 543-578. https://doi.org/10.3102/00346543066004543

Patel, S., & Nguyen, L. (2024). Virtual globes and 3D visualization in teaching world regional geography: A comparative effectiveness study. *Computers & Education*, *195*, 89-106.

Peterson, K., & Clark, M. (2024). School leadership and technology integration: A longitudinal study of support mechanisms and teacher outcomes. *Educational Administration Quarterly*, *60*(2), 298-327. https://doi.org/10.1177/0013161X23987654

Petko, D., Prasse, D., & Cantieni, A. (2018). The interplay of school readiness and teacher readiness for educational technology integration: A structural equation model. *Computers in the Schools*, *35*(1), 1-18. https://doi.org/10.1080/07380569.2018.1428007.

Pelgrum, W. J. (2001). Obstacles to ICT implementation in education: Results from a worldwide educational assessment. *Computers & Education*, *37*(2), 163-178.

Podsakoff, P. M., MacKenzie, S. B., & Podsakoff, N. P. (2022).Sources of method bias in social science research and recommendations on how to control it. *Annual Review of Psychology*, *73*, 539-569. https://doi.org/10.1146/annurev-psych-020821-114233

Punya, P., et al. (2017). Teachers' self-efficacy and technology integration: A study on Indonesian high school teachers. *International Journal of Instruction*, *10*(4), 51-66.

Prestridge, S., & Tondeur, J. (2024). Teacher attitude change toward technology integration: A longitudinal professional development study. *Teaching and Teacher Education*, *138*, 104412. https://doi.org/10.1016/j.tate.2023.104412

Quamar, M. M., Al-Ramadan, B., Khan, K., Shafiullah, M., & El Ferik, S. (2023). Advancements and Applications of Drone-Integrated Geographic Information System Technology—*A Review. Remote Sensing*, *15*(20), 5039. (link unavailable)

Ramafi, O. J. (2022). Barriers to use of ICT in teaching and learning and e-learning at public schools in South Africa: *A factor analysis approach*. *Heliyon*, *8*(5), Article e09493. https://doi.org/10.1016/j.heliyon.2022.e09493

Ravitch, S. M., & Carl, N. M. (2021). *Qualitative research: Bridging the conceptual, theoretical, and methodological* (2nd ed.). Sage Publications.

Razali, R. (2019). The Challenges of ICT Integration in Teaching and Learning in Malaysian Secondary Schools. *International Journal of Academic Research in Progressive Education and Development*, *8*(4), 1-10.

Roberts, M., & Mitchell, D. (2024). Where powerful knowledge and pedagogical content knowledge intersect: The case of knowledge and beliefs for teaching school geography through inquiry. *International Research in Geographical and Environmental Education*, *33*(2), 142-159. https://doi.org/10.1080/10382046.2024.2348274.

Ribble, M. (2012). *Digital citizenship in schools*: Nine elements all students should know. ISTE.

Ribble, M. (2015). *Digital citizenship in schools*: Nine elements all students should know. ISTE

Rodriguez, E., & Kim, D. (2024). Interactive whiteboards and collaborative learning in geography classrooms: An ethnographic investigation. *Teaching and Teacher Education*, *138*, 204-219.

Rubio-Gragera, M., Castañeda-Carranza, A., & Rubia-Avi, B. (2023). Digital innovation in language teaching: Analysis of the digital competence of teachers according to the DigCompEdu framework. *Journal of New Approaches in Educational Research*, *12*(1), 112-131. https://doi.org/10.7821/naer.2023.1.1113

Sabri,M.F.,Mansor,N.,&Harun,J.(2020) School support and Teachers'Technology Integration:Moderation effects. *Journal of Education Technology*,17(1),45-60.

Sahin, S. A., & Dursun, A. (2022). Does innovativeness matter in technology adoption? Addressing pre-service teachers' intention to use ITs. *Frontiers in Psychology*, *13*, Article 965347. https://doi.org/10.3389/fpsyg.2022.965347

Scherer, R., Siddiq, F., & Tondeur, J. (2019). The technology acceptance model (TAM): A meta-analytic structural equation modeling approach to explaining teachers' adoption of digital technology in education. *Computers & Education*, *128*, 13-35. https://doi.org/10.1016/j.compedu.2018.09.009

Schmidt, D. A., Baran, E., Thompson, A. D., Mishra, P., Koehler, M. J., & Shin, T. S. (2009). Technological pedagogical content knowledge (TPACK): The development and validation of an assessment instrument for preservice teachers. *Journal of Research on Technology in Education*, *42*(2), 123-149. https://doi.org/10.1080/15391523 .2009.10782544

Schunk, D. H. (1991).Self-efficacy and academic motivation. *Educational Psychologist*, *26*(3-4), 207-231. https://doi.org/10.1080/00461520.1991.9653133

Shahzad, A., Hassan, R., Aremu, A. Y., Hussain, A., & Lodhi, R. N. (2024). Effects of COVID-19 in E-learning on higher education institution students: The group comparison between male and female. *Quality & Quantity*, *56*(3), 1165-1183. https://doi.org/10.1007/s11135-021-01211-x

Shahzad, M. F., Xu, S., & Baheer, R. (2024). Assessing the factors influencing the intention to use information and communication technology implementation and acceptance in China's education sector. *Humanities and Social Sciences Communications*, *11*, 777. https://doi.org/10.1057/s41599-024-02777-0

Shulman, L. S. (1986). Those who understand: Knowledge growth in teaching. *Educational Researcher*, *15*(2), 4-14. https://doi.org/10.3102/0013189X015002004

Shulman, L. S. (1987). Knowledge and teaching: Foundations of the new reform. *Harvard Educational Review*, *57*(1), 1-22. https://doi.org/10.17763/haer.57.1.j463w79r5645 5411.

Storey, V. A. (2021). Future trends in geographic education. *The Professional Geographer*, *73*(3), 450-456. https://doi.org/10.1080/00330124.2021.1894346

Szyszka, M., Balcerzak, B., & Materka, A. (2022).Management support and the frequency with which teachers use ICT in education. *Journal of Education Culture and Society*, *13*(2), 363-381. https://doi.org/10.15503/jecs2022.2.363.381

Taroreh, J. S., Brata, W. W. W., Lasut, J. J., & Kimbal, M. (2023). Factors that influence the success of application of technology in learning: Teacher work motivation and organizational support. *International Journal of Instruction*, *16*(1), 61-80. https://doi.org/10.29333/iji.2023.1614a

Tarricone, P., & Klonsky, M. (2021).Using CLIL and multimedia resources to engage students in Geography learning. *TeachingGeography*, *46*(1), 32-39. https://doi.org/10.1080/03098265.2021.1880415

Teo, T. (2011). Factors influencing teachers' intention to use technology: Model development and test. *Computers & Education*, *57*(4), 2432-2440. https://doi.org/10.1016/j. compedu. 2011.06.008

Theodorio, A. O., & Adesope, O. O. (2024). Examining the support required by educators for successful technology integration in teacher professional development program. *Cogent Education*, *11*(1), 2298607. https://doi.org/10.1080/2331186X.2023. 2298607

Thompson, R., & Davis, L. (2023).Impact of inquiry-based pedagogical strategies on GIS integration in secondary geography classrooms. *Journal of Geography*, *122*(4), 156-171. https://doi.org/10.1080/00221341.2023.2187465

Thompson, R., Davis, M., & Wilson, K. (2023). Gamification in geography education: Effects on motivation and achievement in secondary classrooms. *British Journal of Educational Technology*, *54*(3), 678-695.

Tschannen-Moran, M., & Hoy, A. W. (2001). Teacher efficacy: Capturing an elusive construct. *Teaching and Teacher Education*, *17*(7), 783-805.

Tran, M. T., Pham, N. T., & Dinh, T. B. H. (2023). Teachers' attitudes towards the use of information and communication technology in teaching English: Impacts of teachers' characteristics. *AsiaCALL Online Journal*, *14*(1), 61-84. https://doi.org/10.54855/acoj. 231415.

Tran, T., Phan, H., Le, L., & Nguyen, Q. (2023). Teachers' attitudes towards the use of Information and Communication Technology in teaching English: A case study in Vietnam. *Contemporary Educational Technology*, *15*(2), ep412. https://doi.org/10. 30935/ cedtech/12952.

UNESCO. (2014). *Information and communication technology (ICT) in education in Asia: A comparative analysis of ICT integration and e-readiness in schools across Asia.* UNESCO Institute for Statistics.https://dx.doi.org/10.15220/978-92-9189-148-1-en.

UNESCO. (2013). ICT in Education: A Critical Component for Innovation. Paris: UNESCO

UNESCO (2018). "*ICT in Education Policy Review: Kenya."* This report outlines the policies and frameworks guiding ICT integration in education. Paris: UNESCO.

UN Women (2020)* "*The Gender Equality and Technology Gap: Barriers to ICT Access for Women and Girls in Kenya*" Paris: UNESCO.

Vagenas,N.,et.al.(2020). Perceptions and attitudes towards ICT integration: A systematic review. *Journal of Educational Technology & Society*, *23*(2), 1-15.

Venkatesh, V., & Bala, H. (2008). Technology acceptance model 3 and a research agenda on interventions. *Decision Sciences*, *39*(2), 273-315. https://doi.org/10.1111/j.1540-5915.2008.00192.x.

Venkatesh, V., & Davis, F. D. (2000). A theoretical extension of the technology acceptance model: Four longitudinal field studies. *Management Science*, *46*(2), 186-204. https://doi.org/10.1287/mnsc.46.2.186.11926.

Venkatesh, V., Morris, M. G., Davis, G. B., & Davis, F. D. (2003). User acceptance of information technology: Toward a unified view. *MIS Quarterly*, *27*(3), 425-478. https://doi.org/10.2307/30036540.

Venkatesh, V., Thong, J. Y., & Xu, X. (2012). Consumer acceptance and use of information technology: Extending the unified theory of acceptance and use of technology. *MIS Quarterly*, *36*(1), 157-178. https://doi.org/10.2307/41410412.

Voogt, J., & McKenney, S. (2017). TPACK in teacher education: Are we preparing teachers to use technology for early literacy? *Technology, Pedagogy and Education*, *26*(1), 69-83. https://doi.org/10.1080/1475939X.2016.1174730.

Wakhungu, L. S. (2016). *Integration and use of geographic information systems in teaching geography in secondary schools in Bungoma North Sub-County, Kenya* [Unpublished master's thesis].Moi University.

Warren, A. N., & Askew, F. J. (2024). Changes in early career teachers' technology use for teaching: The roles of teacher self-efficacy, ICT literacy, and experience during COVID-19 school closure. *Teaching and Teacher Education*, *138*104302. https:// doi.org/10.1016/j.tate.2023.104302.

Williams, D., & Tan, F. (2024). Mobile learning applications in geography: A systematic review and meta-analysis of educational outcomes. *Educational Technology Research and Development*, *72*(2), 445-468.

Williams, M. K., Christensen, R., McElroy, D., & Rutledge, D. (2023).Teacher self-efficacy in technology integration as a critical component in designing technology-infused teacher preparation programs. *Contemporary Issues in Technology and Teacher Education*, *23*(1), 12-34.

Wu, J., Zhang, Y., & Li, H. (2023). School and teacher ICT readiness: Evidence from PISA 2018 across57countries. *Computers & Education*, *195*,104712. https://doi.org/10. 1016/j.compedu.2022.104712.

Wu, R., Yang, W., Rifenbark, G., Koellner, K., Gagné, F., & Miksza, P. (2023). School and teacher information, communication and technology (ICT) readiness across 57 countries: The alignment optimization method. *Education and Information Technologies*, *28*, 1273-1297. https://doi.org/10.1007/s10639-022-11233-y

World Bank (2019). "*Kenya*: Education Sector Analysis."

Yang, J., Wang, H., Chen, M., & Liu, S. (2025). The role of language teachers' perceptions and attitudes in ICT integration in higher education EFL classes in China. *Humanities and Social Sciences Communications*, *12*, 4524. https://doi.org/10.1057/s41599-025-04524-5.

Ybañez, C. A., & Kintanar, N. S. (2023). Path analysis of senior teachers' ICT adoption in teaching as influenced by their ICT skills, perception and motivation. *Asia Pacific Journal of Social and Behavioral Sciences*, *19*, 39-59.

Zhang, L., Anderson, B., & Foster, J. (2022). Virtual reality applications in physical geography education: A mixed-methods study of student learning and engagement. *Journal of Geography in Higher Education*, *46*(4), 523-540.

Zhou, N., Nguyen, H., Fischer, C., Richardson, D., & Warschauer, M. (2023). Effects of teacher- and school-level ICT training on teachers' use of digital educational resources in rural schools in China: A multilevel moderation model. *Computers & Education*, *204*, 104870. https://doi.org/10.1016/j.compedu.2023.104870

Zhou, Y., Ma, D., Liu, H., & Wang, X. (2023). Effects of teacher- and school-level ICT training on teachers' use of digital educational resources in rural schools in China: A multilevel analysis. *British Journal of Educational Technology*, *54*(4), 1023-1043. https://doi.org/10.1111/bjet.13287

Zimmerman, B. J. (1989). A social cognitive view of self-regulated academic learning. *Journal of Educational Psychology*, *81*(3), 329-339. https://doi.org/10.1037/0022-0663.81.3.329

APPENDICES

APPENDIX I: CONSENT FORM

TITLE OF THE STUDY:

The Moderating effects of school support system on the relationship between teacher- related factors and ICT integration in Geography Instruction.

RESEARCHER'S NAME: Bett Samson Kipchirchir

CONTACTS: 0724617208

INTRUDUCTION

You are invited to participate in a research conducted by **Bett Samson Kipchirchir**. Before you decide whether to participate, it is important for you to understand the purpose of the study, what it involves, and your rights as a participant.

Please read this form carefully and ask questions any question you may have.

Purpose of the study

The purpose of this study is to investigate the factors influencing integration of information and communication technologies (ICT) in geography instruction in Kenyan secondary schools. Specifically, the study aims to examine the role of teacher-related factors such as ICT self-efficacy, attitudes towards technology, and pedagogical strategies, as well as the moderating influence of the school support ecosystem, including ICT infrastructure, technical support, professional development opportunities, and leadership support. Your participation in this study is voluntary, and all information provided will be treated with strict confidentiality. The study involves completing a questionnaire, for selected participants, participating in a brief interview. The questionnaire will take approximately 30-45 minutes to complete, and the interview will last for about 30 minutes.

Your perspectives and experiences as educators will be invaluable in contributing to a better understanding of the challenges and opportunities associated with ICT integration in geography Instruction. The findings of this study will inform policy and practice recommendations to enhance the effective use of technology in teaching and learning, ultimately benefiting both teachers and students. If you are willing to participate in this study, please kindly indicate your consent by signing on space below.

Signature……**Date**……

Thank you for your time and consideration. I look forward to your valuable contribution to this research endeavour.

APPENDIX II: INTRODUCTION LETTER

Dear Sir/Madam,

My name is Bett Samson Kipchirchir, and I am a PhD candidate in the Department of Educational Communication and Technology at Moi University. I am currently conducting research for my doctoral dissertation titled "Moderating Influence of School Support Ecosystem on the Relationship Between Teacher-Related Factors and ICT Integration in Geography Instruction in Selected Kenyan Public Secondary Schools."

The purpose of this study is to investigate the factors influencing integration of information and communication technologies (ICT) in geography instruction in Kenyan secondary schools. Specifically, the study aims to examine the role of teacher-related factors such as ICT self-efficacy, attitudes towards technology, and pedagogical strategies, as well as the moderating influence of the school support ecosystem, including ICT infrastructure, technical support, professional development opportunities, and leadership support. Your participation in this study is voluntary, and all information provided was treated with strict confidentiality. The study involves completing a questionnaire and, for selected participants, participating in a brief interview. The questionnaire will take approximately 30-45 minutes to complete, and the interview will last for about 30 minutes.

Your perspectives and experiences as educators will be invaluable in contributing to a better understanding of the challenges and opportunities associated with ICT integration in geography education. The findings of this study will inform policy and practice recommendations to enhance the effective use of technology in teaching and learning, ultimately benefiting both teachers and students. If you are willing to participate in this study, please kindly indicate your consent by. I was glad to provide you with further details and answer any questions you may have.

Thank you for your time and consideration. I look forward to your valuable contribution to this research endeavour.

Sincerely,

Bett Samson Kipchirchir
PhD Candidate
Department of Educational Communication and Technology
Moi University

APPENDIX III: QUESTIONNAIRE FOR HEADS OF GEOGRAPHY DEPARTMENTS, AND GEOGRAPHY TEACHERS

Section 1: Background Information

1. Gender: Male [ ] Female [ ]
2. Age: _____ years
3. Highest Education Level: Diploma [ ] Bachelor's [ ] Master's [ ] PhD [ ]
4. Teaching Experience: _____ years

Section 2: Teachers' ICT Self-Efficacy

Please rate your level of agreement with the following statements on a scale of (1-Strongly Disagree, 2-Disagree, 3-undecided,4-Agree, 5-Strongly Agree).

Questions: Teachers confidence and use of technology	**1**	**2**	**3**	**4**	**5**
1. The teachers feel confident integrating technology into geography lessons.					
2. The teachers can use digital tools like GIS, GPS, and online maps effectively for teaching.					
3. The teachers are able to evaluate and select appropriate educational technologies.					
4. The teachers can troubleshoot basic technical issues during technology use.					
5. The teachers can guide students on using technology for geographic research.					
6. The teachers can organize and manage classroom activities involving technology.					
7. The teachers can provide alternative technology-based instructional approaches.					
8. The teachers feel comfortable allowing students to work independently with technology.					
9. The teachers can effectively assess student learning when using technology.					
10. Overall, the teacher feels capable of integrating technology to enhance instruction.					

Section 3: Teachers' Attitudes towards Technology

Questions: Using technology in teaching is good	**1**	**2**	**3**	**4**	**5**
1. Using technology makes the subject of geography more interesting for students.					
2. Technology improves students' understanding of geographic concepts.					
3. Educational technologies enable developing important 21st century skills.					
4. Technology integration increases student motivation and engagement.					
5. Technology allows accommodating diverse learning styles better.					
6. Technology allows making content more accessible to students.					
7. Technology gives more opportunities for student collaboration.					
8. Technology facilitates giving students personalized feedback.					
9. Technology integration fits well with the teaching philosophy and approaches.					

Questions: Using technology in teaching is good	1	2	3	4	5
10. Overall, there is a positive attitude towards using technology for instruction.					

Section 4: Teachers' Pedagogical Strategies

Questions	1	2	3	4	5
1. Student-centered, inquiry-based strategies are often used.					
2. Opportunities are provided for students to actively construct knowledge.					
3. Students engage in real-world, authentic problem-solving activities.					
4. Peer collaboration and knowledge sharing among students is facilitated.					
5. Students are encouraged to use technology for research, analysis, and presentation.					
6. Digital tools are used to provide interactive learning experiences.					
7. Activities are designed to develop students' higher-order thinking skills.					
8. Formative assessments and timely feedback are provided using technology.					
9. Teaching strategies focus on developing 21st century competencies.					
10. Overall, the pedagogical strategies align well with technology integration.					

Section 5: School Support system

Questions	1	2	3	4	5
1. The school has adequate ICT infrastructure (computers, GIS software, Smart TVs, lab, Educational Apps, digital topographic maps and internet access)?					
2. Technical support for using technology is available when needed.					
3. Professional development opportunities for technology integration are provided.					
4. The school leadership supports and encourages the use of technology in teaching.					
5. Overall, the school provides a supportive system for integrating technology.					

Section 6: ICT integration in Geography Instruction

Questions	1	2	3	4	5
1. Digital media, simulations and visualizations are used frequently.					
2. GIS, GPS, online maps are integrated for spatial analysis activities.					
3. Lessons require students to collect and analyze real-world data.					
4. Students create digital products to showcase their learning.					
5. Technology facilitates collaboration beyond the classroom.					
6. Students access digital resources for research and self-study.					
7. Technology provides personalized learning experiences.					
8. Digital assessment tools are used for formative and summative assessments.					
9. Students effectively use technology for knowledge construction.					
10. Overall, technology is seamlessly integrated into teaching and learning.					

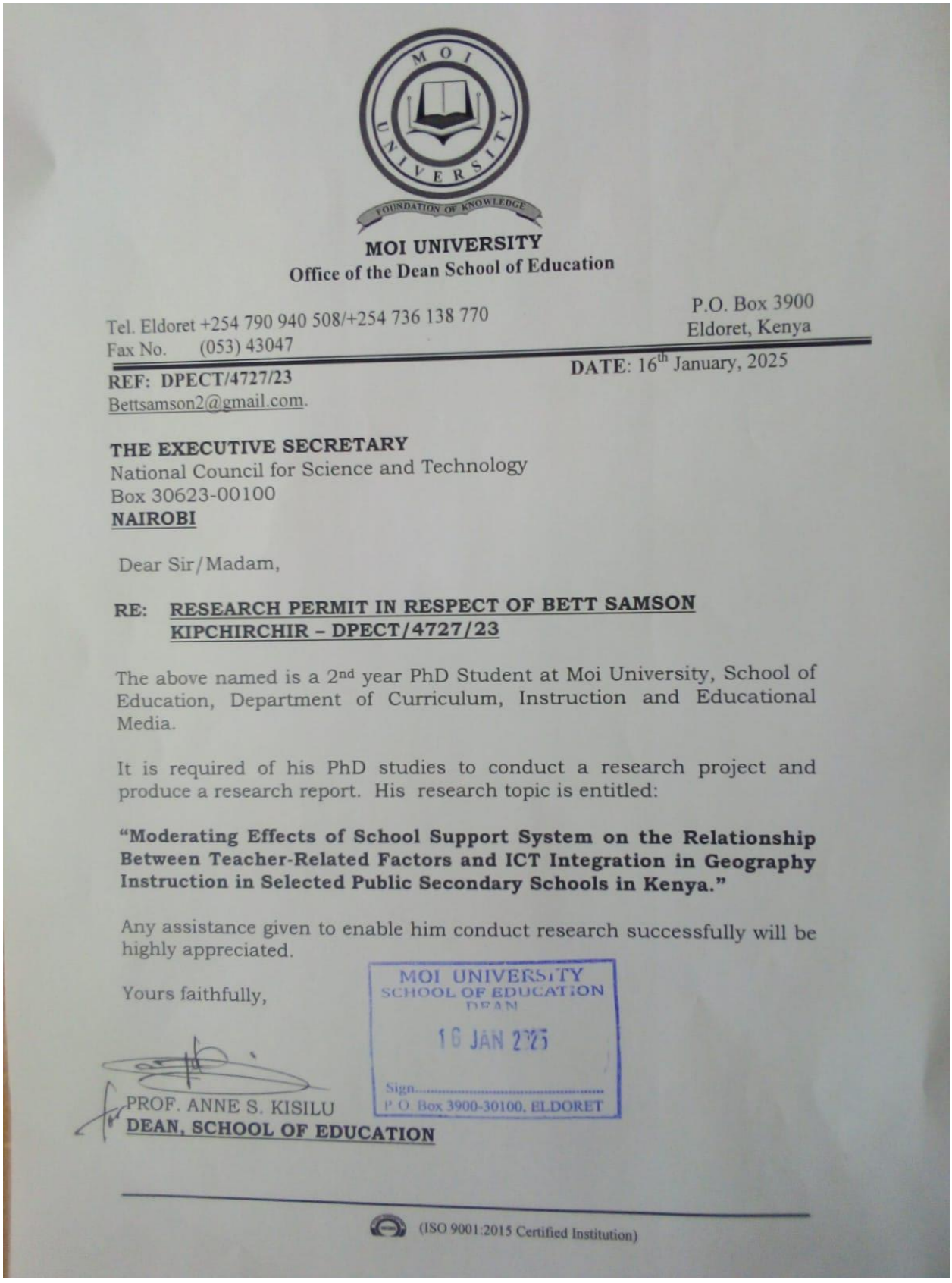
APPENDIX IV: INTERVIEW SCHEDULE FOR PRINCIPALS AND HEADS OF GEOGRAPHY DEPARTMENTS

1. What is the current state of ICT infrastructure (computers, GIS software, Smart TVs, lab, Educational Apps, digital topographic maps and internet access) in your school for teaching and learning purposes?
2. How would you describe the technical support available to teachers for using technology in their classrooms?
3. What professional development opportunities related to technology integration are provided to teachers in your school?
4. How does the school leadership support and encourage the integration of technology in teaching and learning activities?
5. What policies or guidelines are in place regarding the use of technology by teachers and students?
6. In your opinion, what are the major challenges faced by teachers in integrating technology into their teaching practices, particularly in the subject of geography?
7. What are some successful strategies or best practices you have observed in your school for promoting effective technology integration in teaching and learning?
8. How do you envision the role of technology in enhancing the teaching and learning of geography in the future?
9. Is there anything else you would like to add regarding the factors influencing the integration of technology in geography instruction in your school?

APPENDIX V: CONTENT ANALYSIS SCHEDULE

Documents	**Data Obtained**
School ICT policies	
School strategic plans	
Teachers professional development records	
School vision	

APPENDIX VI: UNIVERSITY DATA AUTHORIZATION LETTER



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REF: DPECT/4727/23

DATE: 16th January, 2025

Bettsamson2@gmail.com.

THE EXECUTIVE SECRETARY
National Council for Science and Technology
Box 30623-00100
NAIROBI

Dear Sir/Madam,

RE: RESEARCH PERMIT IN RESPECT OF BETT SAMSON KIPCHIRCHIR – DPECT/4727/23

The above named is a 2nd year PhD Student at Moi University, School of Education, Department of Curriculum, Instruction and Educational Media.

It is required of his PhD studies to conduct a research project and produce a research report. His research topic is entitled:

"Moderating Effects of School Support System on the Relationship Between Teacher-Related Factors and ICT Integration in Geography Instruction in Selected Public Secondary Schools in Kenya."

Any assistance given to enable him conduct research successfully will be highly appreciated.

Yours faithfully,

MOI UNIVERSITY
SCHOOL OF EDUCATION
DEAN
16 JAN 2025
Sign.....
P.O. Box 3900-30100, ELDORET

PROF. ANNE S. KISILU
DEAN, SCHOOL OF EDUCATION

(ISO 9001:2015 Certified Institution)

APPENDIX VII: NACOSTI PERMIT

REPUBLIC OF KENYA

NATIONAL COMMISSION FOR SCIENCE,TECHNOLOGY & INNOVATION

Ref No: **139969**

Date of Issue: **18/March/2025**

RESEARCH LICENSE

This is to Certify that Mr.. Samson Bett Kipchirchir of Moi University, has been licensed to conduct research as per the provision of the Science, Technology and Innovation Act, 2013 (Rev.2014) in Baringo, Elgeyo-Marakwet, Nandi, Transnzoia, Uasin-Gishu, Westpokot on the topic: MODERATING EFFECTS OF SCHOOL SUPPORT SYSTEM ON THE RELATIONSHIP BETWEEN TEACHERS-RELATED FACTORS AND ICT INTEGRATION IN GEOGRAPHY INSTRUCTION IN SELECTED KENYAN PUBLIC SECONDARY SCHOOLS for the period ending : 18/March/2026.

License No: **NACOSTI/P/25/415421**

139969

Applicant Identification Number

Director General
NATIONAL COMMISSION FOR SCIENCE,TECHNOLOGY & INNOVATION

Verification QR Code

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See overleaf for conditions

THE SCIENCE, TECHNOLOGY AND INNOVATION ACT, 2013 (Rev. 2014)
Legal Notice No. 108: The Science, Technology and Innovation (Research Licensing) Regulations, 2014

The National Commission for Science, Technology and Innovation, hereafter referred to as the Commission, was the established under the Science, Technology and Innovation Act 2013 (Revised 2014) herein after referred to as the Act. The objective of the Commission shall be to regulate and assure quality in the science, technology and innovation sector and advise the Government in matters related thereto.

CONDITIONS OF THE RESEARCH LICENSE

1. The License is granted subject to provisions of the Constitution of Kenya, the Science, Technology and Innovation Act, and other relevant laws, policies and regulations. Accordingly, the licensee shall adhere to such procedures, standards, code of ethics and guidelines as may be prescribed by regulations made under the Act, or prescribed by provisions of International treaties of which Kenya is a signatory to
2. The research and its related activities as well as outcomes shall be beneficial to the country and shall not in any way;
    i. Endanger national security
    ii. Adversely affect the lives of Kenyans
    iii. Be in contravention of Kenya's international obligations including Biological Weapons Convention (BWC), Comprehensive Nuclear-Test-Ban Treaty Organization (CTBTO), Chemical, Biological, Radiological and Nuclear (CBRN).
    iv. Result in exploitation of intellectual property rights of communities in Kenya
    v. Adversely affect the environment
    vi. Adversely affect the rights of communities
    vii. Endanger public safety and national cohesion
    viii. Plagiarize someone else's work
3. The License is valid for the proposed research, location and specified period.
4. The license any rights thereunder are non-transferable
5. The Commission reserves the right to cancel the research at any time during the research period if in the opinion of the Commission the research is not implemented in conformity with the provisions of the Act or any other written law.
6. The Licensee shall inform the relevant County Director of Education, County Commissioner and County Governor before commencement of the research.
7. Excavation, filming, movement, and collection of specimens are subject to further necessary clearance from relevant Government Agencies.
8. The License does not give authority to transfer research materials.
9. The Commission may monitor and evaluate the licensed research project for the purpose of assessing and evaluating compliance with the conditions of the License.
10. The Licensee shall submit one hard copy, and upload a soft copy of their final report (thesis) onto a platform designated by the Commission within one year of completion of the research.
11. The Commission reserves the right to modify the conditions of the License including cancellation without prior notice.
12. Research, findings and information regarding research systems shall be stored or disseminated, utilized or applied in such a manner as may be prescribed by the Commission from time to time.
13. The Licensee shall disclose to the Commission, the relevant Institutional Scientific and Ethical Review Committee, and the relevant national agencies any inventions and discoveries that are of National strategic importance.
14. The Commission shall have powers to acquire from any person the right in, or to, any scientific innovation, invention or patent of strategic importance to the country.
15. Relevant Institutional Scientific and Ethical Review Committee shall monitor and evaluate the research periodically, and make a report of its findings to the Commission for necessary action.

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APPENDIX VIII: NORTH RIFT COUNTIES