

Barriers to Teaching and Learning Computer Studies in Senior Grades: Evidence from Government Secondary Schools in Mufulira District, Zambia

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Abstract: *The integration of computer technology in Zambian secondary schools especially in the senior grades of government institutions in Mufulira District faces significant challenges, "...including poor ICT infrastructure, limited internet access, and shortages of trained teachers". This study investigated the barriers to effective teaching and learning of Computer Studies in selected senior grades of government secondary schools in Mufulira District. A mixed-methods research design was employed, integrating both quantitative and qualitative approaches. Data were collected from 252 participants using questionnaires, semi-structured interviews, focus group discussions, classroom observations, and document reviews. Findings revealed that most schools had inadequate and outdated ICT infrastructure, including computers, projectors, printers, and reliable internet. Teachers were often undertrained, relying on theoretical instruction due to limited access to practical tools. Other key issues included overcrowded classes, minimal technical support, and learners' low digital competency. The study concludes that both infrastructural deficiencies and teacher capacity gaps hinder effective curriculum delivery. It recommends that the Ministry of Education, in collaboration with partners, invest in upgrading ICT facilities, enhance teacher training, provide consistent technical support, and improve access to affordable, stable internet in schools to equip learners with essential digital skills.*

Keywords: Computer Studies, ICT in Education, Teaching Barriers, Digital Literacy, Government Schools

1. Introduction

Background

The integration of Computer Studies is widely recognised as essential for improving learning outcomes and preparing learners for participation in a technology-driven society. When effectively implemented, digital technologies support collaborative and active learning, increase learner motivation, deepen conceptual understanding, and promote problem-solving and lifelong learning skills (OECD, 2021; UNESCO, 2023). Globally, the use of digital tools is regarded as central to improving the quality and relevance of education in an increasingly networked and knowledge-based economy.

However, research consistently shows that successful ICT integration is not achieved through access to equipment alone. Effective implementation depends on teachers' digital competencies, institutional readiness, ongoing financial support, and curriculum alignment (Tondeur et al., 2021; Scherer et al., 2021). The World Economic Forum further emphasizes that digital and computational skills are essential for the Fourth Industrial Revolution, highlighting the importance of Computer Studies in preparing learners for future labour markets (World Economic Forum, 2020).

Countries such as the United Kingdom, Singapore, Australia, China, and member states of the European Union have implemented large-scale initiatives to strengthen teachers' digital skills and improve the pedagogical use of technology in schools (European Commission, 2019).

These systems demonstrate that sustained professional development and systemic support are key to effective ICT integration.

Across Africa, similar policy commitments exist, but implementation remains constrained by inadequate infrastructure, insufficient teacher preparedness, and limited financial resources. UNESCO and the World Bank report that many African education systems continue to face major challenges related to connectivity, equipment shortages, and weak technical support, particularly in rural and low-income contexts (World Bank, 2022; Trucano, 2016).

Evidence from Kenya's ICT and education reforms under Vision 2030 indicates growing adoption of digital technologies in schools and their potential to enhance digital literacy and learning outcomes. However, studies also note persistent disparities between urban and rural schools, particularly in access to infrastructure and trained teachers (Republic of Kenya, 2019; UNESCO, 2023).

In Zambia, policy efforts to support ICT in education date back to the Draft National ICT Policy of 2006, which emphasized ICT as a driver of equitable, inclusive, and high-quality education. This commitment was reinforced through the National ICT Policy of 2007, which recognized the role of technology in improving teaching and learning across the education system (Republic of Zambia, 2007). Despite these policy advances, practical implementation has been limited by persistent resource constraints, infrastructure shortages, and capacity gaps.

International literature also demonstrates that access alone does not guarantee effective ICT use. Meaningful integration depends on teacher capacity, school leadership, and sustained institutional support (Selwyn, 2019; Tondeur et al., 2020).

When implemented effectively, ICT has been shown to enhance knowledge sharing, promote digital literacy, and support innovative pedagogical practices (Scherer et al., 2021; UNESCO, 2023). However, inadequate funding, unreliable infrastructure, and limited professional development continue to restrict schools' ability to integrate ICT into everyday teaching and learning.

The Zambia Education Curriculum Framework (2013) positions Computer Studies as a key subject for preparing learners to participate in a knowledge-based economy. The framework emphasizes the development of basic technological skills, problem-solving abilities through programming, and understanding of the social and economic impacts of technology (Ministry of Education, Zambia, 2013). ICT is also viewed as a tool for reducing educational disparities between urban and rural schools by improving access to information and communication resources.

Nevertheless, achieving these curriculum goals remains challenging. Shortages of functional computers, limited internet connectivity, and insufficient teacher preparation continue to hinder the development of the knowledge, skills, and attitudes required by the curriculum.

Although previous studies have documented challenges such as inadequate infrastructure, insufficient teacher training, and limited ICT resources, there remains a significant gap in understanding how these factors interact to influence the quality of Computer Studies education in rural senior secondary (Grades 10–12) government schools in Zambia. Much of the international literature focuses on well-resourced, urban, or private school contexts, limiting its applicability to rural Zambian settings.

International studies have examined ICT use across diverse educational contexts. Research in Singapore and the United States has shown that ICT integration is generally stronger in urban and well-resourced schools, where access to modern hardware and aligned curricula supports effective learning (Lim & Smith, 2007; Guzdial, 2015). Similarly, global analyses report that digital divides are strongly shaped by geography and school type, with rural and public schools facing greater constraints related to outdated hardware, limited connectivity, and curriculum misalignment (Tinio, 2003; Van Dijk, 2020). These challenges differ markedly from the rural, bilingual (English and informal Bemba), government-school context of Mufulira District.

Regional research further highlights persistent urban–rural inequalities in ICT access and implementation. Studies in South Africa and across Sub-Saharan Africa document infrastructure shortages, uneven ICT policy implementation, and limited institutional capacity, particularly in rural and low-income communities (Spaull & Jansen, 2019; Czerniewicz et al., 2020).

Other regional analyses identify substantial policy practice gaps and continuing teacher-capacity constraints that limit meaningful ICT integration in schools (UNESCO, 2022; Trucano, 2016).

In Zambia, existing research has documented significant ICT-related barriers in secondary schools, including inadequate infrastructure, limited access to computers and internet connectivity, and insufficient teacher capacity for effective ICT integration (Mulenga & Masumba, 2019; ZANEC, 2022). Studies of rural districts have further highlighted shortages of equipment, poor connectivity, and low teacher preparedness (World Bank, 2022; UNESCO, 2022). However, few studies have focused specifically on senior secondary Computer Studies in Mufulira District. As a result, the literature reveals a clear gap: a lack of district-level research examining the combined effects of infrastructural, pedagogical, and teacher-training challenges on Computer Studies education in rural senior secondary schools in Zambia. This study seeks to address that gap.

In the 21st century, equipping learners with digital literacy and computational skills is essential for personal and national development. The effective teaching of Computer Studies remains hindered in many developing regions, adversely affecting the development of a skilled workforce and perpetuating the global digital divide. Addressing the specific barriers in a district like Mufulira is critical for improving educational equity, informing targeted policy interventions, and ensuring Zambian learners acquire the skills required to thrive in the digital age. This study holds social value by promoting digital inclusion, enhancing student outcomes with 21st-century skills, and informing sustainable educational improvements.

2. Statement of the Problem

Although the Zambian Government, through the National ICT Policy (2007), acknowledges the importance of Computer Studies in equipping learners with digital and computational skills for the 21st century, the effective teaching and learning of Computer Studies in senior government secondary schools remains a challenge. Evidence shows that implementation remains constrained by inadequate infrastructure, unreliable electricity, limited internet access, shortages of trained teachers, and insufficient instructional materials (Republic of Zambia, 2012; National Assembly of Zambia, 2019; Mwale & Simui, 2021).

The policy envisioned the integration of Computer Studies in all government schools to support innovative and lifelong learning. However, in practice, many schools particularly in Mufulira District continue to experience serious constraints in the investment of ICT infrastructure such as inadequate ICT equipment, insufficient computers, unreliable electricity and internet access, limited instructional materials, and inadequately trained teachers.

Most studies conducted in Zambia have generally highlighted challenges in ICT integration in schools but have not sufficiently examined how these challenges interact and collectively affect the quality of teaching and learning of Computer Studies at the senior secondary level.

The studies have tended to focus broadly on ICT availability and policy implementation, while giving limited attention to school-level realities and subject-specific instructional challenges.

Therefore, despite the existence of ICT policies and government efforts to improve ICT provision in schools, it remains unclear why effective teaching and learning of Computer Studies has not been fully realized in senior government secondary schools in Mufulira District. Furthermore, there is limited evidence on the specific barriers faced, their root causes, and how they impact learning outcomes. This study therefore seeks to address this gap by examining the barriers to effective teaching and learning of Computer Studies in selected government secondary schools in Mufulira District.

3. Purpose of the Study

The purpose of this study is to explore and analyze the key barriers that hinder the effective teaching and learning of Computer Studies in senior grades (Grades 10–12) within selected government secondary schools in Mufulira District, Copperbelt Province, Zambia. Specifically, the study seeks to examine the availability of ICT infrastructure and teaching resources, assess the level of teacher training and preparedness, and investigate the challenges faced by both teachers and learners in implementing the Computer Studies curriculum. By identifying these barriers, the study aims to generate context-specific recommendations to inform education stakeholders and policymakers in improving access, delivery, and quality of Computer Studies education in rural and underserved school settings.

4. Objectives of the Study

The principal objective of the study is to examine and evaluate the barriers to effective teaching and learning of Computer Studies in senior grades at selected government secondary schools in Mufulira District, Copperbelt Province.

The objectives of the study were to:

- 1) Investigate the availability of ICT equipment and materials needed to teach Computer Studies to senior grades in selected government schools in Mufulira District.
- 2) Assess the level of teacher training in teaching Computer Studies to senior grades in selected government schools in Mufulira District.
- 3) Establish the barriers faced by teachers and learners in using computers for the teaching and learning process.

5. Significance of the Study

To my knowledge, no study has been conducted to comprehensively examine the barriers to implementing the Computer Studies curriculum in senior secondary schools in Mufulira District. Therefore, the findings of this study may be useful to the Ministry of Education and policymakers in determining the extent to which ICT policies and curriculum objectives are being implemented and achieving the desired impact in schools.

The findings may also provide education stakeholders with insights into the availability of ICT infrastructure, teacher preparedness, and curriculum implementation challenges. Learners will benefit from better resources, trained teachers, and relevant materials, fostering digital literacy, critical thinking, and career readiness. School administrators will understand gaps in resources and training, enabling investments to improve academic outcomes, while parents will see enhanced educational prospects and career preparation for their children. Furthermore, curriculum developers may use the findings to design practical, competency-based curricula aligned with classroom realities and industry demands.

The Ministry of Education and policymakers will be equipped to make informed decisions on resource allocation, teacher training, and technology integration, driving systemic improvements in education. Finally, the study will contribute to the existing body of knowledge and provide a foundation for future research on Computer Studies education in Zambia

6. Literature Review

Theoretical Foundations

The study is grounded in three key theoretical frameworks that collectively inform the analysis of teaching and learning processes in Computer Studies: Social Constructivist Theory, the Technological Pedagogical Content Knowledge (TPACK) framework, and the Education Production Function Theory Social Constructivist Theory (Vygotsky, 1978)

Social Constructivist Theory (Vygotsky, 1978):

Social Constructivist Theory, as advanced by Vygotsky (1978), provides a strong pedagogical and motivational foundation for this study. The theory posits that knowledge is constructed through social interaction and collaboration, emphasizing learning as a socially mediated process. Within this framework, the teacher plays a critical role as a facilitator who provides scaffolding temporary instructional support that enables learners to perform tasks they would not be able to complete independently.

Central to Vygotsky's theory is the concept of the Zone of Proximal Development (ZPD), which refers to the gap between a learner's actual level of independent performance and their potential level of development when supported by a more knowledgeable other, such as a teacher or peer.

As Vygotsky (1978, p. 86) explains, the ZPD is:

“The distance between the actual development level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers”.

This theoretical perspective is particularly relevant to Computer Studies, where learners frequently engage with abstract and technically complex tasks such as programming, debugging, and algorithm design. Such tasks typically require guided instruction, modeling, and continuous feedback to support learners' progression within their ZPD. In contexts where schools face barriers such as inadequate ICT resources and insufficiently trained teachers, the essential social

interactions and scaffolding processes necessary for effective learning are significantly disrupted, thereby limiting learners' opportunities to achieve higher levels of cognitive and technical competence. Contemporary research further supports the relevance of Social Constructivist principles in technology-enhanced learning environments. Studies have shown that digital scaffolding tools and collaborative learning platforms can effectively support learners' engagement and achievement by facilitating guided practice and peer interaction within the ZPD (Belland et al., 2015; Hwang et al., 2020; Kao & Hwang, 2017). These findings reinforce the importance of adequate ICT infrastructure and teacher capacity in enabling socially mediated, scaffolded learning experiences, particularly in subjects such as Computer Studies.

Application to Computer Studies Education

Vygotsky's theory emphasizes collaborative learning, peer support, and guided practice in Computer Studies classrooms. Strategies such as pair programming, group problem-solving, and teacher demonstrations help learners gradually internalize new skills. Scaffolding allows teachers to adjust support based on learners' diverse prior knowledge an important need in Mufulira District. While beginners require close guidance, more advanced students benefit from independent or extended tasks.

However, limited computers, insufficient teacher training, and restricted interaction time can constrain progress within the ZPD. Overall, Vygotsky's Social Constructivist Theory provides a useful lens for promoting active participation, deeper understanding, and key digital competencies when adequate resources are available.

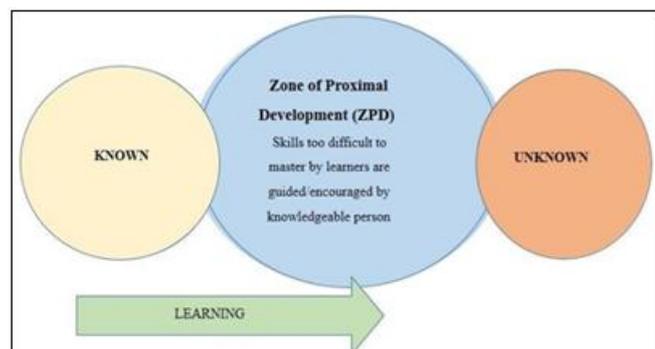


Figure 1: Vygotsky's Social Constructivist Theory

Technological Pedagogical Content Knowledge (TPACK) Framework Mishra & Koehler, 2006

This is a leadership and competency theory for educators. It argues that effective technology integration requires the intersection of three knowledge domains: Technological Knowledge (TK), Pedagogical Knowledge (PK), and Content Knowledge (CK). The framework is used to analyze teacher preparedness and identify gaps where a lack of integration among these domains creates instructional barriers.

The Technological Pedagogical Content Knowledge (TPACK) framework, developed by Mishra and Koehler (2006), provides a useful theoretical lens for analysing teacher preparedness in integrating ICT into teaching and learning. The framework emphasises the dynamic interaction among three core domains technological knowledge, pedagogical

knowledge, and content knowledge and demonstrates how their intersection supports effective instructional practice. In Computer Studies education, TPACK is particularly relevant because teachers must not only understand subject-specific content, but also employ appropriate pedagogical strategies while meaningfully incorporating digital tools into their lessons. The framework outlines the following components:

- **Technological Knowledge (TK):** Understanding and utilising digital tools, software applications, coding platforms, and other ICT resources during instruction.
- **Pedagogical Knowledge (PK):** Applying effective instructional strategies such as scaffolding, inquiry-based learning, and collaborative learning to support learner engagement.
- **Content Knowledge (CK):** Mastery of core computer science concepts, including programming, data management, and networking principles.

By integrating these domains, teachers are better equipped to deliver Computer Studies lessons that promote active learning, problem-solving, and hands-on engagement.

For example, using interactive environments such as Scratch for beginners or Python IDEs for advanced learners aligns with TPACK principles and enhances practical learning opportunities. The framework also highlights the importance of Technological Pedagogical Knowledge (TPK), which focuses on how technology shapes teaching approaches, enabling the use of flipped classrooms, gamified activities, and real-world applications.

Collectively, the TPACK framework underscores the need for teachers to develop holistic competencies that support effective and meaningful ICT integration in secondary school settings.

Education Production Function Theory (Hanushek, 1986)

This theory adopts a systems theory and economic input-output perspective on educational management. It models the education system as a production process where inputs (e.g., teacher quality, infrastructure, materials) determine outputs (student learning outcomes). This theory frames the identified barriers as critical input failures that systematically hinder the production of desired educational outcomes.

The Education Production Function Theory, advanced by Hanushek (1986), conceptualises education as a production process in which various inputs such as teacher quality, infrastructure, and learning resources directly influence outputs in the form of student learning outcomes. As an economic-based framework, it emphasises that improvements in key educational inputs are likely to yield better academic performance, increased skill acquisition, and enhanced learner productivity.

In the context of Computer Studies education, the theory underscores several critical inputs that shape learner outcomes:

• **Teacher Expertise:** Competent and well-trained teachers with strong subject knowledge and appropriate pedagogical skills significantly improve learners' understanding of computer-related concepts.

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- **Access to Technology:** Adequate availability of functional computers, stable internet connectivity, and relevant software enables learners to practise and develop essential programming and digital skills.
- **Curriculum Design:** A structured, relevant, and practically oriented curriculum facilitates critical thinking, creativity, and real-world application of computer science concepts.
- **Student Engagement:** Interactive, hands-on, and project-based learning approaches promote deeper understanding and greater retention of ICT skills.

Applying the Education Production Function Theory allows policymakers and educators to identify gaps in educational inputs such as insufficient infrastructure, inadequate teacher preparation, or limited access to technology and make evidence-based decisions aimed at strengthening Computer Studies instruction.

Together, Vygotsky's Social Constructivist Theory, the TPACK Framework, and the Education Production Function Theory provide a comprehensive theoretical foundation for understanding the barriers and enablers of effective teaching and learning of Computer Studies in Zambian secondary schools.

Prior Studies on the core topic

Global literature consistently emphasizes the role of Computer Studies and computing education in driving innovation, enhancing STEM performance, and preparing learners for participation in technology-driven economies. Research shows that early exposure to programming, computational thinking, and digital literacy contributes to improved problem-solving skills, creativity, and academic achievement across STEM subjects (Wing, 2006; Grover & Pea, 2013; Voogt et al., 2015).

These competencies are increasingly recognized as essential for developing a workforce capable of meeting the demands of knowledge-based and digitally oriented economies (OECD, 2019).

Empirical studies from Europe, Asia, and Australia further indicate that structured instruction in programming and computational thinking enhances learners' cognitive development and supports positive learning outcomes, particularly in well-resourced school systems (Bocconi et al., 2016; Kalelioğlu, 2015).

However, much of this evidence is drawn from contexts with strong ICT infrastructure, high levels of teacher training, and sustained policy support. As a result, the direct transferability of these findings to low-resource and developing-country contexts remains limited, highlighting the need for localized research that accounts for infrastructural, pedagogical, and capacity-related constraints.

Across sub-Saharan Africa, research consistently identifies Computer Studies and ICT education as critical for promoting digital inclusion, enhancing employability, and supporting participation in knowledge-based economies. However, effective implementation is frequently constrained by shortages of trained teachers, inadequate ICT infrastructure,

unreliable electricity supply, and uneven policy implementation (UNESCO, 2014; Trucano, 2016; Policy Monitoring and Research Centre [PMRC], 2020). Much of this literature focuses on urban schools or broad grade ranges, providing limited insight into the specific challenges faced by rural senior secondary schools, where resource constraints and teacher shortages are often more severe.

Zambian studies similarly recognize Computer Studies as essential for developing digital skills aligned with national development priorities, including Vision 2030. Evidence indicates that while Computer Studies has been introduced in secondary schools, many institutions particularly outside major urban centres continue to face significant challenges related to the availability of qualified Computer Studies teachers, computer laboratories, and supporting infrastructure (Shafika, 2007; PMRC, 2020; Mulauzi et al., 2020). Nevertheless, much of the existing research concentrates on urban contexts such as Lusaka and other major towns, and gives limited attention to senior secondary grades, where the practical and technical demands of Computer Studies are greatest.

Overall, the literature confirms the importance of Computer Studies for digital inclusion and employability but reveals a clear gap concerning the experiences of rural government secondary schools, particularly at the senior secondary level. This gap is especially evident in district-level contexts such as Mufulira District, where localized evidence on the combined effects of infrastructural, pedagogical, and teacher-capacity constraints remains limited.

ICT Infrastructure

Existing studies consistently highlight severe ICT infrastructure shortages in rural educational contexts, where disparities in access to devices, connectivity, and support services hinder effective teaching and learning.

Research in sub-Saharan Africa has shown that rural schools disproportionately suffer from inadequate digital resources, limited internet connectivity, and uneven distribution of ICT equipment compared with their urban counterparts, contributing to entrenched digital divides and educational inequalities (Shabangu & Jita, 2024; Duma et al., 2023). In South Africa, rural schools frequently lack reliable internet access and functional digital tools, which exacerbates the disadvantage faced by learners and teachers in these settings (Mpumuje, 2024; Shabangu & Jita, 2024).

Similar conditions have been documented beyond Africa. For example, comparative research on rural schools' digital access in multiple countries highlights persistent digital inequalities that result from insufficient ICT infrastructure and limited capacity building for teachers (Ofosu-Asare, 2025). These studies consistently identify outdated hardware, weak connectivity, and inadequate maintenance systems as major obstacles to technology integration in rural classrooms, limiting opportunities for meaningful digital learning (Shabangu & Jita, 2024; Duma et al., 2023).

Local Zambian studies, though more limited, echo these broader patterns. Insights from research on rural Zambian secondary and primary schools confirm that ICT

infrastructure remains inadequate, with few functional computer laboratories, frequent power outages, and limited professional development for teachers in technology integration (Chama, 2025; Kaumba et al., 2021). Although these findings align with the infrastructural challenges reported in Mufulira District, few studies focus specifically on senior secondary Computer Studies in this rural district.

Teacher Training

A global gap in ICT teacher preparation has been widely reported. The UNESCO Global Education Monitoring Report shows that many low- and middle-income countries face serious shortages of teachers with adequate digital and pedagogical skills. This limits the effective use of technology in classrooms (UNESCO, 2023). The report also emphasizes that providing technology alone is not enough. Teachers need structured and continuous professional development to support meaningful and effective use of ICT for teaching and learning.

International research supports this view. Large-scale studies from OECD countries show that ongoing professional development improves teachers' confidence, instructional quality, and ability to teach digital and coding skills.

Teachers who receive regular ICT-focused training are more likely to integrate technology into their lessons and support better student learning outcomes (OECD, 2019; Tondeur et al., 2017; Voogt et al., 2013). However, most of this evidence comes from well-resourced and urban school systems. This limits its direct relevance to rural contexts such as Mufulira District, where schools face more severe resource constraints. Regional studies in Sub-Saharan Africa also report low levels of ICT-trained teachers and highlight the need for targeted, context-specific capacity-building. World Bank and UNESCO analyses show that in many African countries, fewer than one-third of secondary school teachers have received formal training in ICT integration. This reduces teachers' ability to use technology effectively in classroom practice (World Bank, 2020; UNESCO, 2021).

In Zambia, international and regional reports consistently identify limited teacher capacity, weak access to professional development, and shortages of ICT subject specialists as major barriers to effective Computer Studies instruction. Policy and research institutions report that many teachers lack programming and practical ICT skills and therefore rely heavily on theory-based teaching (Policy Monitoring and Research Centre [PMRC], 2020; UNESCO, 2013). These challenges are especially serious in rural districts, highlighting the need for localized and continuous professional development focused on senior secondary Computer Studies.

Learners' and Teachers' Perceptions

Perceptions of learners and teachers play a critical role in the adoption and effective use of ICT in education. International research consistently shows that positive attitudes toward computers and digital learning are associated with higher levels of engagement, motivation, and interest in technology-related careers. Studies in Europe and OECD countries indicate that learners who are exposed to practical and relevant ICT curricula are more likely to develop positive perceptions of computing and express interest in coding and

digital careers (OECD, 2021; European Commission, 2020). Similarly, teachers' perceptions strongly influence classroom integration, with research showing that teachers who view ICT as useful for enhancing learning are more likely to adopt learner-centred and technology-supported pedagogies (Ertmer & Ottenbreit-Leftwich, 2010).

However, these findings are largely based on urban and well-resourced school contexts, which differ substantially from rural settings such as Mufulira District. In many developing and rural contexts, limited access to computers, unreliable electricity, and poor connectivity negatively affect both learner and teacher attitudes toward ICT.

Studies in Sub-Saharan Africa report that rural learners often feel excluded from digital learning opportunities, which reduces motivation and confidence in using technology (UNESCO, 2021; World Bank, 2020).

Teachers in these settings frequently express positive attitudes toward ICT in principle but report frustration due to infrastructure gaps and lack of institutional support, which limits sustained classroom use (Tondeur et al., 2021).

Regional evidence further shows that inadequate infrastructure and limited exposure shape perceptions and confidence. Research in East and Southern Africa indicates that rural learners are more likely to view computers as intimidating due to infrequent access, while teachers report challenges in maintaining learner motivation when practical ICT activities cannot be consistently implemented (Trucano, 2016; UNESCO, 2022). These conditions contrast with urban contexts, where regular access supports more positive perceptions and routine use.

In Zambia, available studies similarly suggest that limited access to ICT resources and inconsistent exposure negatively influence both learner and teacher perceptions. Research has found that learners in rural and peri-urban schools often lack confidence in using computers and associate ICT with difficulty due to limited hands-on practice, while teachers express willingness to use ICT but cite infrastructure shortages and lack of support as major barriers (Mulenga & Masumba, 2019; Policy Monitoring and Research Centre [PMRC], 2023; UNESCO, 2022). Although these studies provide important insights, they do not specifically focus on senior secondary Computer Studies in Mufulira District, highlighting the need for localized research on how perceptions interact with access, training, and instructional quality in rural government schools.

ICT Teacher Preparation and Professional Development

Perceptions play an important role in the adoption of ICT in classrooms. Globally, research shows that both students and teachers generally have positive attitudes toward ICT and recognize its potential to improve engagement and learning. However, positive attitudes alone are not enough. Effective ICT use also requires adequate teacher training, professional support, and clear pedagogical integration (Ertmer et al., 2012; Hew & Brush, 2007; Lei & Zhao, 2007). These studies show that teachers' beliefs, confidence, and access to support strongly influence how ICT is used in practice.

Research from developed countries further shows that students' interest in coding, digital creation, and computational thinking increases when they receive hands-on and well-supported ICT instruction. Practical activities and guided learning help to strengthen positive attitudes and improve learning outcomes (Grover & Pea, 2013; Yadav et al., 2016).

In Sub-Saharan Africa, learner and teacher perceptions are strongly influenced by limited access to resources. Studies in Tanzania and similar low-resource contexts report that shortages of computers, unreliable electricity, and poor internet connectivity reduce learner motivation and teacher confidence, even when attitudes toward ICT are generally positive (Mtebe & Raisamo, 2014; Sife et al., 2007). These findings suggest that structural challenges prevent positive perceptions from being translated into effective classroom practice.

In Zambia, available policy and research evidence also indicates generally positive attitudes toward digital learning. However, these attitudes are limited by inadequate infrastructure, restricted access to ICT resources, and insufficient teacher training (PMRC, 2020; UNESCO, 2013). Most existing studies focus on mixed grade levels or urban settings, with limited evidence specific to rural senior secondary Computer Studies learners and teachers. This highlights the need for localized, district-level research in rural areas such as Mufulira District.

Barriers to Teaching and Learning Computer Studies

Key barriers to effective ICT integration in education include poor infrastructure, limited teacher training, and teaching challenges. International evidence shows that many low-income and developing countries lack adequate ICT facilities, reliable electricity, and internet connectivity in schools. UNESCO reports that these shortages continue to widen the digital divide and recommends sustained investment to improve digital learning environments (UNESCO, 2023). Similarly, the International Telecommunication Union notes that many schools in low-income countries are not connected to reliable broadband, which limits meaningful use of digital technologies for teaching and learning (ITU, 2022).

Studies from the United States show that rural schools often face outdated equipment, limited broadband access, and uneven access to digital tools. These challenges reduce student engagement and weaken the quality of instruction (National Center for Education Statistics [NCES], 2019; U.S. Department of Education, 2021). Research from well-resourced countries also shows that strong digital systems with universal access can reduce infrastructure-related barriers. However, these conditions are not common in low-resource settings (OECD, 2021).

Regional studies in Sub-Saharan Africa show that infrastructure and training problems remain widespread. World Bank and UNESCO reports document that rural power cuts, limited access to computers, and poor internet connectivity continue to weaken ICT-supported learning.

These studies call for targeted investment in both infrastructure and teacher capacity (UNESCO, 2023; World

Bank, 2022). Research in East and Southern Africa also identifies low levels of teacher ICT skills and outdated curricula as major barriers to effective classroom integration of technology (Trucano, 2016).

In Zambia, policy and education sector studies confirm that many rural schools face unreliable electricity, inadequate ICT laboratories, and limited opportunities for continuous teacher professional development. These challenges reduce the effectiveness of teaching and learning in technology-related subjects (Policy Monitoring and Research Centre [PMRC], 2020; World Bank, 2021). Although these findings reflect the situation in many rural areas, there is still limited local evidence on how these barriers specifically affect senior secondary Computer Studies learners and teachers in rural districts such as Mufulira.

Key Themes in Education

Although this study is situated within an educational context rather than a management or business environment, several cross-cutting themes help explain how resources, instructional practices, and school-level conditions influence learning outcomes. A central analytical lens used in this study is the Education Production Function Theory, which conceptualizes the schooling system as a process where educational inputs—such as teacher quality, infrastructure, learning materials, and ICT resources are transformed into outputs such as learner achievement, digital skills, and academic progression.

In this perspective, inputs are viewed as managerial investments, and their effective utilisation reflects school-level decision-making, planning, and instructional management. Teacher qualification, access to functional computers, availability of internet resources, and classroom organisation all contribute to the “production” of learning outcomes. Inefficiencies or shortages in these inputs, therefore, result in lower educational outputs.

This theme aligns with broader literature showing that educational quality is shaped by both human capital (teacher expertise, pedagogical competence) and material resources (ICT infrastructure, learning tools). As such, even though explicit management or business models are not central to this write up, the Education Production Function provides an economic and structural framework for understanding how resource allocation and instructional capacity influence student performance in Computer Studies.

7. Conceptual Framework

A conceptual framework provides a structured, visual or narrative representation of the key relationships among variables in a study, clarifying how they relate to the research problem (Ravitch & Riggan, 2018).

It identifies the major constructs under investigation such as barriers, contexts, and outcomes and illustrates their presumed interactions and influences (Maxwell, 2013). By articulating these relationships, the framework aligns theoretical foundations with empirical inquiry, guiding the design, data collection, analysis, and interpretation of findings (Mertens & Wilson, 2019).

In this study, the conceptual framework (Figure 2) demonstrates how multiple interrelated barriers, including infrastructure, teacher capacity, and pedagogical challenges, influence the effective teaching and learning of Computer Studies in senior secondary schools in Mufulira District.

Independent Variables (Barriers)

The model identifies six categories of independent variables that constrain Computer Studies education:

- **Teacher-Related Barriers:** Insufficient training, limited ICT integration skills, and resistance to technological change.
- **Learner-Related Barriers:** Low prior exposure to computers, limited digital skills, and difficulty engaging with abstract technical content.
- **Infrastructure and Resource Barriers:** Inadequate computers, unreliable internet connectivity, and frequent power outages.
- **Equity and Inclusion Barriers:** Limited support for learners with disabilities and disparities in access to ICT resources.
- **Curriculum-Related Barriers:** Outdated syllabi, inadequate practical activities, obsolete materials, and insufficient time for hands-on learning.
- **Policy and Administrative Barriers:** Weak policy implementation, inadequate funding, and challenges in managing Computer Studies programmes.

Dependent Variable

The dependent variable is the effective teaching and learning of Computer Studies, reflected in learner comprehension, engagement, practical competence, and academic performance.

Moderating Factors (Proposed Solutions)

The model also identifies interventions that can moderate or reduce the negative effects of the barriers. These include:

- **Teacher professional development**, addressing deficits in technological, pedagogical, and content knowledge, as highlighted in the TPACK framework.
- **Investment in ICT infrastructure**, consistent with the Education Production Function Theory, which posits that improved inputs lead to stronger learning outputs.
- **Learner-centred and interactive instructional approaches**, in line with Social Constructivist principles of scaffolding, collaboration, and guided practice.
- **Supportive government policies and adequate funding**, which strengthen system-level governance and create enabling conditions for sustainable ICT integration.

Relationships and Impact

The conceptual model shows that six interconnected barriers hinder effective Computer Studies instruction, including limited teacher training, inadequate infrastructure, outdated curricula, and weak policy support. In contrast, well-resourced schools with trained teachers and supportive policies achieve better curriculum delivery and learning outcomes. Overall, the framework highlights how these factors interact and provides a basis for targeted interventions to improve Computer Studies implementation in government senior secondary schools. The conceptual framework in (Figure 2) demonstrates how multiple interrelated barriers, including infrastructure, teacher capacity, and pedagogical challenges, influence the effective teaching and learning of Computer Studies in senior secondary schools in Mufulira District.

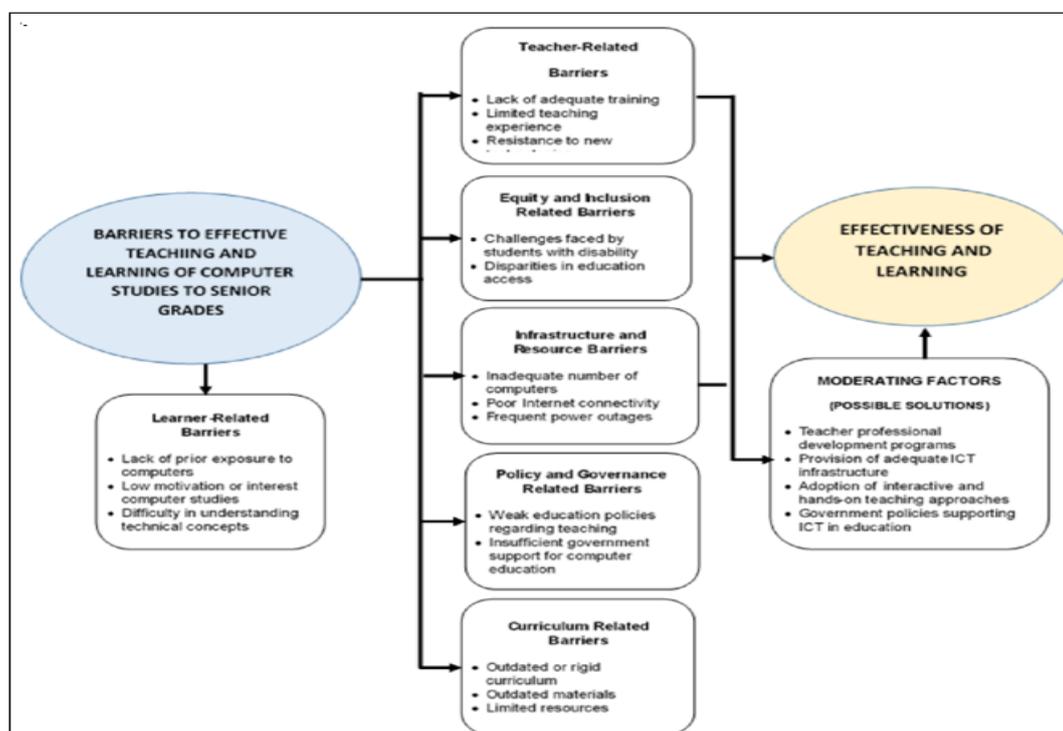


Figure 2: Conceptual Framework

Data Analysis

Quantitative and qualitative data were analyzed separately and subsequently integrated to provide a comprehensive

understanding of the findings. Quantitative data were cleaned, organized, and processed using descriptive statistics including frequencies, percentages, and means with the aid of the

Statistical Package for the Social Sciences (IBM SPSS Statistics) (Field, 2018).

Results are presented in tables and simple graphical displays, such as bar charts and pie charts, to facilitate interpretation and comparison across variables (Pallant, 2020).

Qualitative data from interviews and focus group discussions were analyzed using thematic analysis, a systematic process of identifying, coding, and categorizing patterns within the data (Braun & Clarke, 2006). Transcripts were coded iteratively, and codes were grouped into themes that aligned with the study objectives. To enhance the **trustworthiness** of the findings, triangulation was employed by comparing quantitative and qualitative results, thereby strengthening the validity and reliability of the conclusions (Creswell & Plano Clark, 2018).

8. Findings and Results

The study’s findings are presented based on quantitative and qualitative data collected from learners, teachers, Heads of Department, head teachers, and Education Standards Officers. The results are organized according to the research questions changed into themes and supported by tables, figures, and participant quotations.

Data were obtained through observations, semi-structured interviews, and document analysis.

The study addressed the following research questions:

- 1) What Computer Studies equipment and materials are available in selected government schools in Mufulira District?
- 2) How does teacher training affect the teaching of Computer Studies?
- 3) What challenges do teachers and learners face when using computers in teaching and learning?

Availability of Computer Studies Equipment

The results of the study showed that many government schools in Mufulira District do not have enough computers or related materials to meet the needs of all learners. In several schools, there were fewer than ten computers, and only a few were working. In some cases, schools had only one or two usable computers. This made it difficult for learners to get hands-on practice, which is important for learning how to use computers. From the teacher responses, In low-resource schools, only 20–33% of computers were functional, severely limiting hands-on practice. Higher-resource schools fared better, with 65–77% of computers working, but teachers still reported that resources were inadequate. These findings highlight widespread concern over insufficient computer equipment, which hinders effective Computer Studies instruction.

The quantitative results showed that most of the sampled government secondary schools had very few working computers, old equipment, limited learning materials, and poor internet access. The qualitative data supported this, showing that practical lessons were hard to teach because less than half of the computers in these low-resource schools were working, as shown in Table 1.

Table 1: Availability and Condition of Computers in sampled schools

School	Location	Total Computers	Working Computers	% Working	Remarks
School A	Low Resource Area	15	5	33%	Not enough – Only a few are usable
School B	Low Resource Area	10	3	30%	Not enough – Cannot serve the whole class
School C	Low Resource Area	10	2	20%	Very few – Hardly useful for teaching
School D	High Resource Area	30	23	77%	Fair – Most computers are working
School E	High Resource Area	40	26	65%	Fair – Many are working, but still not enough

Overall, these findings indicate widespread teacher concern over inadequate computer resources, which limits the effective teaching and learning of Computer Studies in the district for example, at school C, one teacher remarked,

"We have so few working computers that it feels like we are being left behind in our efforts to provide a modern education. Out of the total computers available, only a small percentage are functional, and this means that our learners rarely get the hands-on experience they need to develop essential digital skills. It is incredibly frustrating to see outdated, malfunctioning equipment that is barely capable of running the software required for our curriculum".

The distribution of functional computers across the five selected government secondary schools is further illustrated in **Figure 2**. The pie chart provides a visual representation of the proportion of working computers in each school, highlighting differences in ICT availability and readiness for supporting Computer Studies instruction

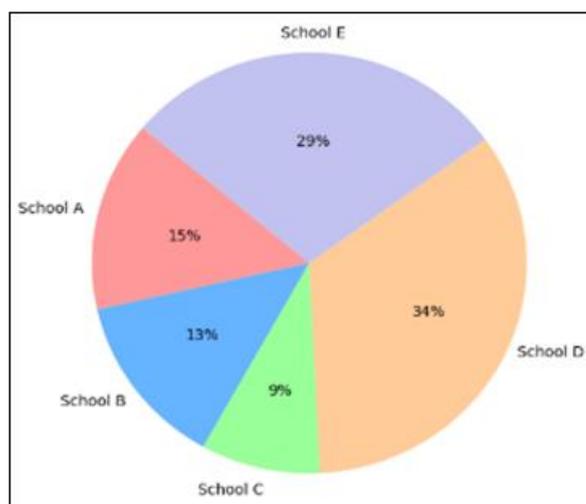


Figure 2: Pie chart showing Percentage of working computers in Selected Government Secondary Schools, Mufulira District

Condition and functionality of Computer Equipment

Participants (Teachers T1 and T2, and Learner L1 and L2) expressed the view that the condition of computer equipment in schools is poor, noting that many computers are old and inadequately maintained. The integration of quantitative and qualitative data provided a clear picture of the functionality and operational status of computer equipment across the schools. The details are summarized in **Table 2**.

Table 2: Condition and Functionality of Computers in Selected Schools

School	Total Computers	Working Computers	% Working	Condition Remarks
School A	15	5	33.30%	Many old and slow, often unrepaired
School B	10	3	30.00%	Very limited use, repairs delayed
School C	10	2	20.00%	Mostly broken, rarely used
School D	30	23	76.70%	Good but some outdated, manageable
School E	40	26	65.00%	Fair condition, occasional breakdowns

The distribution of functional computers across the five selected schools is further visually illustrated in Figure 3 using the bar chart highlighting the disparity between lower-resourced schools (A, B, and C) and better-resourced schools (D and E).

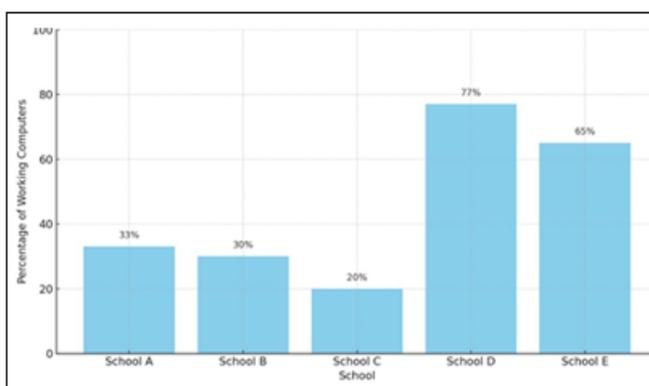


Figure 3 shows the percentage of working computers in five selected government schools (A–E) in Mufulira District

The findings show that Schools A–C, located in lower-resourced areas, had the lowest proportions of working computers (20%–33.3%), mainly due to old, slow, and unrepaired equipment. In contrast, Schools D and E had higher percentages (65%–76.7%), though they still faced occasional breakdowns and outdated machines, indicating that resources, while better, were not yet optimal for effective teaching and learning.

The study concludes that the condition of computer equipment in Mufulira District's government schools varies significantly by location and available resources. Most low resource schools suffer from old and poorly maintained equipment, which limits learners' opportunities for effective hands-on computer practice. To improve Computer Studies education, it is essential to increase investment in modern, functional

ICT infrastructure, and establish systems for timely maintenance and repair.

Availability of Teaching and Learning Materials

The findings of the study revealed that a majority of the selected government secondary schools in Mufulira District continue to face significant challenges related to the availability of essential teaching and learning materials, particularly textbooks and teachers' guides. Participants consistently noted that in many instances, a single textbook was shared among several learners, thereby limiting opportunities for effective lesson participation, independent study, and homework completion. Teachers further indicated that the lack of updated teaching guides negatively affected their ability to adequately plan lessons, implement learner-centred methodologies, and assess learners in alignment with the current Computer Studies syllabus.

To provide a clearer understanding of the extent of this challenge, **Table 3** presents the estimated percentage of learners with access to textbooks in each of the five selected schools, accompanied by remarks describing the nature of material shortages observed.

Table 3: Availability of Teaching and Learning Materials

School	Estimated % of Learners with Access to Textbooks	Remarks
School A	30%	Very Low – One book shared among many learners
School B	35%	Low – Not enough for effective teaching
School C	25%	Very Low – Teaching affected due to lack of books
School D	70%	Fair – Most learners have access
School E	65%	Fair – Teaching supported by available materials

The table clearly demonstrates that Schools A, B, and C are critically under-resourced, with less than 40% of learners having access to textbooks. In contrast, Schools D and E show relatively better provision, though still not at optimal levels required for equitable access. The graphical presentation that follows further illustrates these disparities across the selected schools.

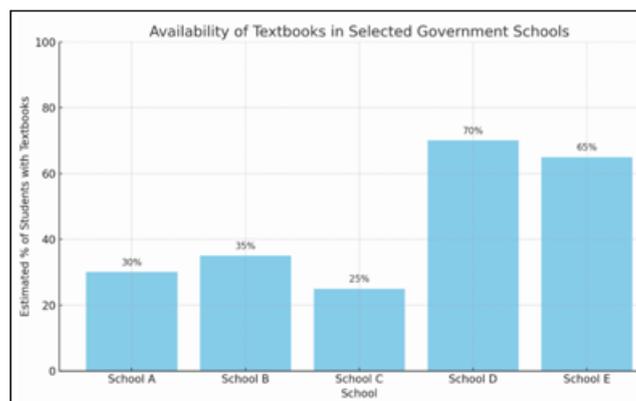


Figure 4: Bar Chart showing the availability of Teaching and Learning Materials

Figure 4’s bar chart clearly highlights disparities in textbook access among the selected schools. Schools A, B, and C recorded very low access levels, ranging from 25% to 35%, indicating severe shortages that negatively affect effective teaching and learning. In contrast, Schools D and E showed relatively better access at 70% and 65%, though still below optimal levels.

Overall, the chart highlights significant gaps in the provision of teaching and learning materials, with most schools lacking sufficient textbooks to adequately support the Computer Studies curriculum. The findings show clear disparities in textbook availability. Schools A, B, and C are severely under-resourced, with less than 40% learner access, while Schools D and E are better resourced but still insufficient. These inequalities hinder effective teaching and learning and call for targeted interventions to ensure equitable access to learning materials.

Internet Access

The study examined internet connectivity across five selected government schools in Mufulira District. It was found that internet access was generally poor, with most schools either lacking connectivity or experiencing unreliable service. This lack of access made it difficult for both teachers and learners to engage in online learning or practice internet-based skills, which are crucial in Computer Studies.

According to the teachers, the absence of internet routers, networking cables, and access points was another major limitation. At this school, they reported that while learners were supposed to learn about web browsing, email communication, and cloud-based tools, the school had no internet infrastructure in place. As one teacher put it,

“We are expected to teach learners how to search online and use digital communication tools, but we have no internet connection ourselves. It’s like teaching swimming without a pool”.

They argued that without supporting infrastructure, practical ICT teaching remains theoretical and ineffective.

Another teacher says that

“Even when the internet works, it is very slow and only one or two people can use it at a time. Teachers feel unhappy because this problem makes it hard to teach Computer Studies the right way, and learners do not learn the skills they need”.

Out of the five schools surveyed, three (60%) had no internet access at all (Schools A, B, and C), while two schools (40%) School D and E had some form of internet access, though it was reported to be intermittent and not always reliable.

The study revealed significant disparities in internet access. Schools A, B, and C had no internet connectivity, while Schools D and E had limited and unreliable access, restricting effective use of digital resources in teaching and learning as shown by **Table 4**.

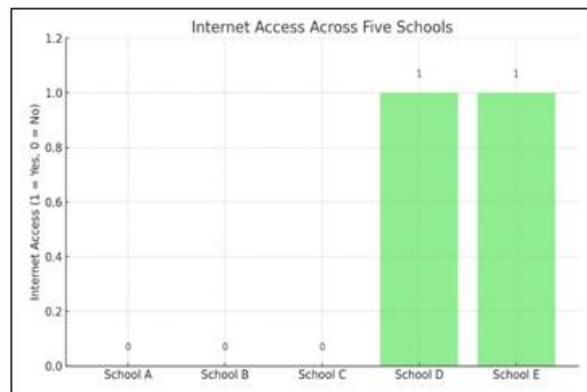


Table 4: Internet Access Status in Selected Government Schools

School	Internet Access	Remarks
School A	No	No internet – learners and teachers cannot access online resources
School B	No	No internet – learners and teachers cannot access online resources
School C	No	No internet – learners and teachers cannot access online resources
School D	Yes	Available – but limited and sometimes unreliable
School E	Yes	Available – but limited and sometimes unreliable

The data collected from the five schools (School A, B, C, D, and E) indicates a clear disparity in internet access across different learning environments. As shown in the bar chart below, 60% of the schools (A, B, and C) reported having no internet access, while only 40% (D and E) had some level of connectivity. However, even in schools that had internet, the service was often unreliable and insufficient for regular use in teaching and learning. This situation poses a serious challenge to the effective implementation of the Computer Studies curriculum

Without internet access, learners and teachers are unable to explore online learning resources, engage in web-based assignments, or practice essential digital skills such as email communication, web browsing, and use of cloud tools all of which are integral to modern computer literacy.

The gap is even more pronounced in schools located in low-resource areas (Schools A, B, and C), where the digital divide further limits the quality of education compared to better equipped schools (Schools D and E).

To address these challenges, it is essential for the Ministry of Education and other stakeholders to prioritize the provision of reliable internet infrastructure and to invest in updating and maintaining computer equipment across all schools.

Ensuring equitable access to modern technology and internet services will enhance digital learning, bridge the digital divide, and support the development of 21st-century skills among learners throughout the district

The results show clear inequalities in digital infrastructure across the five schools. This lack of internet access limits effective implementation of the Computer Studies curriculum, as learners and teachers cannot use online

resources or practice key digital skills. The problem is most severe in low-resource schools, widening the digital divide between schools in the district.

Overall, Computer Studies equipment and internet services in Mufulira District are inadequate, outdated, and poorly maintained. These challenges reduce opportunities for practical learning and skill development. The findings highlight the need for the Ministry of Education and other stakeholders to invest in reliable internet infrastructure and improved computer equipment to support equitable and effective digital learning.

In conclusion, the study concludes that the availability of Computer Studies equipment and materials in government

schools within Mufulira District is generally insufficient, outdated, and poorly maintained. Although some resources exist, they are not adequate to meet the needs of effective teaching and learning. In particular, internet connectivity in these schools is largely inadequate, especially in low-resource environments. This lack of access severely limits teachers' ability to deliver the full scope of the Computer Studies curriculum and restricts learners' opportunities to develop essential practical digital skills.

Academic Qualifications of the Respondents

The study gathered data on academic and professional qualifications from ESOs, Head Teachers, Heads of Department, and Computer Studies Teachers using interviews, observations, and document analysis.

Table 5: Academic Qualifications of Respondents

Category	No. of Respondents	PhD	Master's Degree	Bachelor's Degree	Diploma	Certificate	Total
ESOs	2	0	1	1	0	0	2
Head Teachers	5	0	2	3	0	0	5
Teachers	15	0	1	5	9	0	15
Grand Total							22

Table 5, shows the academic qualifications of the respondents, including Education Standards Officers (ESOs), head teachers, and teachers. Overall, a total of 22 respondents participated in the study. None of the respondents held a PhD qualification. Furthermore, the bar chart in **figure 5** below illustrates this distribution showing that 45.5% of respondents held Bachelor's degrees, 40.9% held Diplomas, and only 13.6% held Master's degrees. This pattern suggests that while most respondents meet basic professional qualification requirements, there is limited representation of postgraduate-level training.

Among the two ESOs, one held a Master's degree and one held a Bachelor's degree. Of the five head teachers, two had Master's degrees while three held Bachelor's degrees, indicating relatively higher academic qualifications within school leadership.

In contrast, the majority of classroom teachers held Diploma qualifications. Out of 15 teachers, nine (60%) had Diplomas, five held Bachelor's degrees, and only one had a Master's degree. No respondents reported holding only Certificate-level qualifications. These results suggest that while school leaders are generally well qualified at degree level, most Computer Studies teaching is conducted by Diploma-holding teachers. This may have implications for subject depth, pedagogical capacity, and the effective implementation of Computer Studies, particularly in a rapidly evolving digital and technological field

The findings show that teacher training significantly affects Computer Studies instruction. Diploma-level teachers reported difficulties with practical syllabus components, while limited advanced qualifications and absence of PhD-level expertise reduced professional support and curriculum oversight. Overall, the results highlight a gap between general qualifications and the specialised training needed, underscoring the need for stronger subject-specific training and continuous professional development

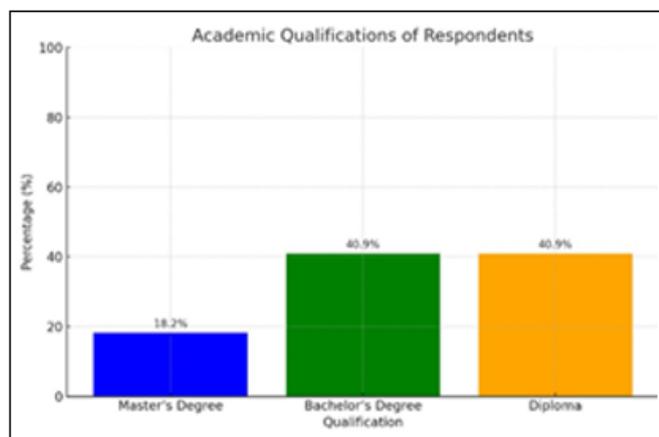


Figure 5: Bar Chart Showing Academic Qualifications of Respondents

Overall, the findings indicate that the teaching and school leadership workforce in the study is largely composed of Diploma and Bachelor's degree holders, with relatively few respondents possessing advanced academic qualifications. This may have implications for the depth of pedagogical expertise, leadership capacity, and specialized skills required for effective implementation of Computer Studies and ICT integration in schools, particularly in technically demanding subject areas.

Challenges Teachers and Learners Face When Using Computers

Level of Computer Studies Teachers Training

The study found that many Computer Studies teachers lacked specialised training, reducing their confidence and effectiveness in teaching practical components such as programming and troubleshooting. Several teachers were assigned to the subject without formal preparation, and limited professional development further weakened instructional capacity. Because of the lack of full training, many teachers reported experiencing difficulties when

teaching practical topics such as programming, networking, and the use of advanced software.

As a result, most teachers focused on basic theoretical lessons rather than practical sessions, due to a lack of confidence in delivering hands-on activities.

This made Computer Studies lessons predominantly theoretical and limited the learners' opportunity to develop essential practical skills. See the table below showing the level of training of computer studies teachers

Overall, inadequate training emerged as a key barrier to effective Computer Studies teaching, highlighting the need for targeted teacher development programmes.

Additionally, when asked about the effect of teacher training on Computer Studies teaching, a male teacher from School E stated:

“I was not trained in Computer Studies and only know the basics, so I struggle to support learners in programming and troubleshooting”.

These findings highlight the need for specialised training and continuous professional development for Computer Studies teachers.

Inadequate training has led to largely theoretical teaching, limiting practical skills acquisition and effective implementation of the curriculum in government secondary schools. **Table 6** below presents the distribution of teachers according to their level of training.

Table 6: showing the level of training of Computer Studies teachers

Category	Number of Teachers	Percentage (%)
Teachers with formal training in Computer Studies and specialized in teaching it	3	20%
Teachers with no formal training in Computer Studies but teaching it	4	26.70%
Teachers with formal training in Computer Studies but not specialized in teaching it	5	33.30%
Teachers not trained but trying to learn while teaching	3	20%
Total	15	100%

The bar chart in **Figure 6** shows the level of training among Computer Studies teachers based on the study findings.

The bar chart below shows the level of training among Computer Studies teachers based on the study findings

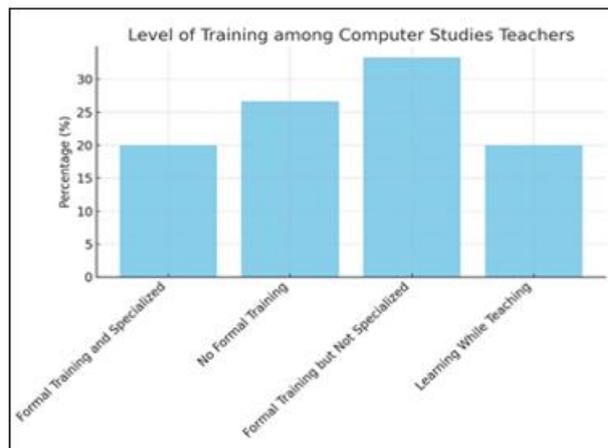


Figure 6: Level of Training of Computer Studies Teachers

The study revealed that the level of training among Computer Studies teachers in government schools was generally low.

Out of 15 teachers interviewed, only 20% had formal training and specialized in the subject. About 26.7% were teaching without formal training, while 33.3% had some formal training but were not specialized.

Additionally, 20% of the teachers were trying to learn while teaching. Due to the lack of full training, many teachers struggled to deliver practical lessons in areas like programming and networking, focusing mostly on theory.

Head Teachers and Heads of Department confirmed that the shortage of specialized teachers affected the quality of teaching and slowed student progress.

For example, one female Head Teacher explained that “The shortage of trained teachers often forced the school to assign Computer Studies classes to staff members who only had general ICT knowledge, without any specific specialization in the subject.

Similarly, one male Head of Department observed that, “Although some teachers showed interest and willingness to teach the subject, the lack of deep content knowledge lowered the overall quality of instruction and slowed down the learners' progress.”

Another teacher in a separate interview reported the following statement:

“Even though I have basic ICT knowledge, I need more specialized training to teach Computer Studies properly and help my learners learn better. Without formal training, I sometimes feel unprepared, especially when learners ask deeper questions that require expert knowledge..”.

From the foregoing remarks, we can note that without enough properly trained teachers, the teaching of Computer Studies faced significant challenges in government schools. Therefore, there is a strong need for more specialized training programs to ensure that teachers are equipped to deliver both theoretical knowledge and practical skills effectively in Computer Studies.

In conclusion, the study found that only 20% of teachers were formally trained and specialised in Computer Studies, while 80% lacked adequate preparation, leading to mainly theoretical teaching. Instruction was further hindered by limited resources, technical faults, power outages, overcrowded classes, and minimal hands-on practice, restricting learners' development of practical digital skills.

These findings show a strong need for professional development to improve both the theory and practice of Computer Studies teaching in government schools.

9. Discussion

The first objective was to Investigate the availability of ICT equipment and materials needed to teach Computer Studies to senior grades in selected government schools in Mufulira District.

The quantitative data revealed a significant shortage of ICT resources in most of the surveyed schools. In low-resource schools (e.g., Schools A, B, and C), fewer than 35% of computers were operational, resulting in high student- to- computer ratios that limited learners' opportunities for hands-on practice during lessons.

Key ICT tools, including printers, scanners, projectors, and interactive boards, were mostly absent. Only better-funded schools (for example, Schools D and E) possessed some of these devices, though often in insufficient quantities to support effective instruction.

Furthermore, a majority of the schools lacked reliable internet access; approximately 60% had no connectivity, and those with access experienced frequent disruptions.

These patterns mirror global trends in resource-constrained environments. UNESCO (2023) reports that limited ICT infrastructure and connectivity in low-income and developing countries continue to widen the educational digital divide, reducing opportunities for meaningful digital learning. Similarly, the World Bank (2021) highlights that inadequate technology infrastructure and weak connectivity constrain the use of digital tools in education, undermining student engagement and learning outcomes.

These findings align with the Education Production Function Theory, which posits that effective educational outcomes depend on the quality and availability of inputs such as learning materials, technology, and school infrastructure (Hanushek & Woessmann, 2015). In the context of practical subjects like Computer Studies, the lack of functional ICT resources disrupts lesson delivery and limits students' acquisition of digital competencies.

The second objective was to Assess the level of teacher training in teaching Computer Studies to senior grades in selected government schools in Mufulira District.

Quantitative data indicated that only 20% of Computer Studies teachers in the surveyed schools were formally trained and specialized in the subject. Approximately 26.7% were teaching without any formal ICT-related training, while

33.3% had received limited basic training but were not subject specialists. A further 20% were acquiring ICT skills informally while teaching. This shortage of qualified Computer Studies teachers undermines the effective delivery of the curriculum, particularly for practical components.

Teachers without adequate professional preparation often rely heavily on theoretical instruction and experience difficulties facilitating hands-on, skills-based learning. This pattern is consistent with the Technological Pedagogical Content Knowledge (TPACK) framework, which emphasizes that effective ICT instruction requires the integration of content knowledge, pedagogical knowledge, and technological knowledge (Mishra & Koehler, 2006; Koehler et al., 2013). When teachers lack competence in one or more of these domains, particularly technological and pedagogical knowledge, their ability to deliver effective Computer Studies lessons is significantly constrained.

Global evidence confirms a persistent gap in ICT teacher preparation, especially in low- and middle-income countries. The UNESCO Global Education Monitoring Report highlights that many education systems face shortages of teachers with adequate digital competencies, limiting schools' capacity to integrate technology effectively into teaching and learning (UNESCO, 2023). Similarly, OECD data show that a substantial proportion of teachers worldwide have not received sufficient formal or in-service training in ICT use for instruction, which negatively affects classroom integration (OECD, 2021).

The World Bank further emphasizes that teacher quality and professional development are among the most influential factors in improving student learning outcomes.

Investments in structured teacher training, particularly in digital competencies, have been shown to yield substantial returns in instructional effectiveness and student achievement (World Bank, 2018). In contexts such as rural Zambia, limited access to continuous professional development exacerbates these challenges, contributing to reliance on outdated, theory-based teaching approaches.

The third research objective was to Establish the barriers faced by teachers and learners in using computers for the teaching and learning process.

Qualitative findings revealed a wide range of challenges affecting both teachers and learners, particularly in low-resourced schools.

Limited access to computers

Learners were frequently required to share computers, significantly reducing opportunities for hands-on practice and skill development. Similar findings have been reported in East African contexts, where limited equipment has been shown to result in more passive learning and reduced student engagement (Mtebe & Raisamo, 2014).

Poor basic computer skills among learners

Many learners entered senior grades with minimal prior exposure to computers, limiting their ability to keep pace with Computer Studies lessons. Research across African school

systems indicates that low levels of digital literacy among learners constitute a major barrier to effective ICT curriculum implementation (UNESCO, 2023; Trucano, 2016).

Frequent equipment breakdowns and lack of technical support

Outdated and poorly maintained equipment frequently broke down, disrupting lessons. The absence of school-based ICT technicians resulted in long repair delays. Studies in Sub-Saharan Africa show that weak maintenance systems and lack of technical support significantly reduce the usability of school ICT resources (World Bank, 2022; UNESCO Institute for Statistics, 2014).

Lack of internet access

More than half of the schools lacked internet connectivity, limiting access to online learning platforms, tutorials, and digital resources. UNESCO (2023) identifies school connectivity as one of the most urgent digital learning gaps in low-income and rural contexts, with major implications for equitable access to digital learning opportunities.

Large class sizes

Overcrowded classrooms made it difficult for teachers to provide individual support during practical Computer Studies lessons. Evidence from global education research indicates that large class sizes, particularly in technology-based subjects, constrain learner engagement and reduce opportunities for effective formative assessment (World Bank, 2022).

10. Theoretical Interpretation

These challenges are consistent with the **Education Production Function Theory**, which emphasizes that educational outcomes depend on the availability and quality of key inputs such as infrastructure, learning materials, technology, and teacher capacity (Hanushek & Rivkin, 2010; Hanushek, 2020). The lack of adequate ICT inputs in these schools disrupts lesson delivery, particularly for a practical subject such as Computer Studies.

In addition, **Social Constructivist Theory** underscores the importance of interaction, collaboration, and guided practice in learning (Vygotsky, 1978). Limited access to computers and insufficient practical sessions restrict meaningful learner–teacher and peer interaction, undermining conditions necessary for effective skill development.

11. General Interpretation

Taken together, the findings indicate that the teaching and learning of Computer Studies in Mufulira District are constrained by inadequate infrastructure, limited technical support, large class sizes, and low levels of learner digital literacy. These barriers contribute to widening disparities between well-resourced and poorly resourced schools, reinforcing the digital divide and negatively affecting both access and quality of education.

12. Conclusion

This study concludes that the effective teaching and learning of Computer Studies in senior government secondary schools in Mufulira District is significantly constrained by inadequate ICT infrastructure, limited teacher training, and contextual challenges. Most schools lacked functional computers, reliable internet connectivity, and essential ICT support equipment, limiting practical instruction and learner engagement.

The findings further show that many teachers teaching Computer Studies were not formally trained or specialized in the subject, leading to heavy reliance on theory-based instruction and reduced confidence in delivering practical components such as programming and troubleshooting.

As a result, learners were denied meaningful hands-on experiences, negatively affecting the acquisition of essential digital skills.

The study therefore recommends that the Ministry of Education, in collaboration with key stakeholders, should prioritize investment in ICT infrastructure, ensure the provision of reliable internet connectivity, establish effective technical support systems, and strengthen specialized and continuous professional development for Computer Studies teachers.

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