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An investigation to determine the readiness of Biology teachers to integrate Information and Communication Technology (ICT) in the teaching of Biology:

A case study of

Selected secondary schools Wakiso District, Uganda.

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DECLARATION

We the undersigned, hereby declare that this report is an original copy and contains information that has not been presented to any other higher institution of learning for award of diploma or degree.

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DEDICATION

We dedicate this work, first and above all, to the Almighty God, whose grace has carried us from the first lecture to the final page. To our beloved parents and families, whose sacrifices, prayers and unwavering faith in us made this journey possible. We are equally indebted to our supervisor, Dr. Lugolole Robert, whose patient guidance, scholarly insight and steady encouragement shaped this study from its earliest idea to its completed form.

Finally, to every Biology teacher in Uganda who strives to bring the classroom closer to a changing world, this work is humbly offered.

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LIST OF ACRONYMS

A-Level	Advanced Level
AI	Artificial Intelligence
BT	Biology Teacher (interview participant code, e.g., BT01–BT07)
CI	Confidence Interval
COVID-19	Coronavirus Disease 2019
ICT	Information and Communication Technology
M	Mean
NCDC	National Curriculum Development Centre
O-Level	Ordinary Level
PhET	Physics Education Technology
SD	Standard Deviation
SPSS	Statistical Package for the Social Sciences
STEM	Science, Technology, Engineering, and Mathematics
TAM	Technology Acceptance Model
TPACK	Technological Pedagogical Content Knowledge
UGX	Uganda Shillings
UNESCO	United Nations Educational, Scientific and Cultural Organization
UTAUT	Unified Theory of Acceptance and Use of Technology

ABSTRACT

The integration of Information and Communication Technology (ICT) in secondary school teaching has the potential to enhance learner-centred instruction and support the teaching of complex and abstract biological concepts. However, the availability of ICT resources does not necessarily translate into meaningful classroom integration, as teachers' attitudes, confidence, curriculum expectations and institutional conditions may influence their readiness to use technology. In Uganda, limited subject-specific empirical evidence exists regarding the readiness of Biology teachers to integrate ICT into Biology teaching, particularly within Wakiso District. This study therefore investigated the readiness of Biology teachers in selected secondary schools in Wakiso District, Uganda, to integrate ICT into Biology teaching. Specifically, the study examined teachers' attitudes towards ICT integration and their perceptions of the extent to which the Biology curriculum supports ICT integration.

The study adopted a pragmatist paradigm and employed a convergent parallel mixed-methods design. Data were collected from 40 Biology teachers through structured questionnaires and from seven Biology teachers through semi-structured interviews across nine selected secondary schools. Quantitative data were analysed using descriptive statistics and one-sample t-tests, while qualitative data were analysed using Braun and Clarke's reflexive thematic analysis, supported by NVivo for data management and coding. The quantitative scales demonstrated acceptable to good internal consistency, with Cronbach's alpha of 0.82 for the attitude composite and 0.80 for the curriculum-support composite.

CHAPTER ONE

1.0 INTRODUCTION

1.1Background

The growing presence of digital technologies in everyday life has placed increasing pressure on education systems globally to reconsider how teaching and learning are organized, particularly in science disciplines. The integration of Information and Communication Technology (ICT) into teaching and learning is widely promoted as a strategy for improving access to knowledge and developing skills relevant to the modern world. Digital tools such as computers, projection systems, interactive displays, and online learning resources have expanded opportunities for delivering content in more interactive and learner-centred ways, moving beyond traditional teacher-centred approaches. However, challenges such as inadequate teacher training, limited technological infrastructure, and low levels of digital literacy among educators continue to hinder effective ICT integration (Msafiri, Kangwa & Lianyu, 2023). Furthermore, teacher perceptions of technology integration are strongly influenced by the availability of professional development opportunities and institutional support (Akram et al., 2022). The COVID-19 pandemic further highlighted the importance of technology in maintaining continuity of learning and exposed disparities in access to digital devices, internet connectivity, and teacher preparedness for technology-supported instruction (Olema, 2021).

Globally, the use of ICT in Biology teaching has gained considerable attention because of the nature of the subject itself, which involves complex processes, microscopic structures, and living systems that are difficult to observe in a traditional classroom setting. ICT tools such as virtual laboratories, simulations, animations, and digital microscopy have been found to make biological concepts more visible and easier to understand. Studies conducted in Bangladesh, for example, found that biology teachers generally hold positive attitudes towards using ICT in their lessons and acknowledge that it helps students better understand biological processes by allowing them to observe living phenomena that would otherwise be invisible to the naked eye (Farhan, Kazi & Chakraborty, 2024). Although ICT has the potential to support achievement of learning outcomes through interactive environments and virtual simulations, its effectiveness largely depends on teachers' ability to apply technology in pedagogically meaningful ways (Tondeur et al., 2022). Differences in teacher attitudes and confidence further contribute to uneven ICT integration across many school systems (Akram et al., 2022).

In Africa, the adoption of ICT in schools has progressed slowly due to resource constraints and limited professional support for teachers. Studies indicate that even where computers are available, they are rarely used to support active classroom learning (Mbabazi, Tusiime & Abiodun, 2022). This limited utilisation is often associated with inadequate training opportunities, insufficient technical resources, and limited institutional encouragement for teachers to integrate digital teaching methods. Agyei (2021) similarly observed that across Sub-Saharan Africa, capacity-building efforts in ICT have not consistently translated into meaningful classroom practice, as many teachers continue to face structural and attitudinal barriers that prevent effective technology use even after training. Within Africa, efforts to integrate ICT specifically into Biology teaching have been documented in several countries. In Nigeria, for instance, studies have confirmed that ICT facilities in secondary schools are generally limited, and even where they exist, they are not always used to support biology instruction (Olawale & Yusuf, 2023). Teachers in many Nigerian schools reported challenges such as lack of personal computers, poor internet connectivity, and limited knowledge of subject-specific ICT applications for biology lessons (Ojo & Okunola, 2023).

At the East African regional level, the integration of ICT in education remains uneven across countries. A study examining the use of instructional technologies across Tanzania, Kenya, Uganda, Rwanda, and Sudan found that while digital tools such as computers, tablets, and internet-enabled devices are increasingly being introduced into schools in these countries, their effective use in subject teaching continues to be limited by common challenges including teacher unfamiliarity with technology, time constraints, negative attitudes toward change, insufficient human resources, and a lack of government support for maintaining and upgrading equipment (Suliman, Wenlan & Sleiman, 2024). Despite these challenges, the review confirmed that technology use in classrooms across the region has been linked to increased student engagement, improved learner interaction, and better academic performance, which reinforces the case for sustained investment in teacher ICT capacity building across all East African countries (Suliman et al., 2024).

Country-level evidence from across the region further illustrates the complexity of ICT integration in education. In Kenya, efforts to use educational technology to develop critical thinking among secondary school learners have been documented, with research showing that teachers who receive ICT professional development are better positioned to design lessons that promote deeper understanding and problem-solving in science subjects (Kibirige, 2023). Rwanda has made the most notable strides among East African nations in deploying ICT in education; the government has invested heavily in digital infrastructure and developed structured ICT teacher training programmes aligned to UNESCO's ICT

Competency Framework for Teachers (UNESCO, 2024). However, a study on ICT integration in selected rural secondary schools in Rwanda's Burera District found that despite national-level investment, implementation at the school level remains inconsistent, with teachers in remote areas still facing difficulties related to unreliable electricity, poor connectivity, and limited access to locally relevant digital teaching materials (Mpumuje, 2024). In Tanzania, research on teachers' technological literacy for ICT integration in the competency-based curriculum found that while secondary school teachers are increasingly aware of the need to use digital tools, many still lack the subject-specific technological knowledge required to effectively embed ICT into their teaching practice (Kalinga, 2024). This finding is particularly relevant for Biology teaching, where subject-specific digital tools are indispensable for visualising microscopic structures, biological processes, and living systems. Taken together, the East African regional evidence points to a consistent pattern: the availability of ICT hardware alone is insufficient to drive effective integration in subject teaching; what is equally necessary is targeted, subject-specific teacher preparation and sustained institutional support.

Uganda shares many of the same regional challenges. A study on primary school teachers' difficulties in implementing ICT in STEM subjects in the post-pandemic era found that inadequate infrastructure, limited teacher training, and the absence of tailored support for specific subjects continued to hinder meaningful ICT use even among teachers who expressed willingness to integrate technology (Kibirige, 2023). At the national level, the Government of Uganda has developed several policy frameworks to promote ICT integration and strengthen teacher capacity. These include the ICT in Education Policy (2006), the National Teacher Policy (2019), the Education Digital Agenda Strategy (2021–2025), and the National ICT Policy (2014), all of which emphasise teacher digital competence and the integration of ICT into teaching and learning. Despite these policy efforts, the gap between policy intention and classroom practice remains wide. Olema (2021) found that ICT adoption readiness among teachers in Ugandan secondary schools remained low, with many lacking confidence and technical competencies to integrate digital tools into instruction. Similarly, Mukhula et al. (2021) reported that schools in Uganda continue to use computers mainly for administrative purposes rather than instructional activities.

Biology as a subject provides significant opportunities for ICT integration because it involves abstract and complex concepts that can be better understood through visualisation tools, simulations, and multimedia presentations. The use of virtual laboratories and technology-enhanced environments has been shown to improve students' understanding of biological concepts and increase motivation to learn (Santos

& Prudente, 2022; Reginald, 2023). However, the integration of ICT in Biology teaching remains uneven due to differences in teacher attitudes, professional competence, and availability of technological resources. Studies indicate that although teachers may hold positive attitudes towards ICT, effective integration requires adequate training and institutional support (Islam et al., 2024). Logistical barriers, insufficient training, and time constraints also limit the use of digital tools such as simulations in secondary school classrooms (Campos & Benarroch, 2025).

Wakiso District is one of Uganda's most urbanised and populous districts, hosting a large number of both government-aided and private secondary schools. Despite its relative proximity to the capital city Kampala and comparatively better access to infrastructure, the district still reflects many of the national challenges associated with ICT integration in education, including inconsistent resource availability and varying levels of teacher preparedness across schools. Biology teachers in this district operate within a curriculum that increasingly demands the use of technology to support the teaching of complex life science concepts, yet no study has specifically examined their readiness to do so. This gap is significant because Wakiso District, given its demographic size and school density, has the potential to serve as an important reference point for understanding ICT integration challenges in peri-urban Ugandan secondary schools. This study therefore seeks to assess the ICT readiness of Biology teachers in selected secondary schools in Wakiso District, Uganda, focusing on their attitudes towards ICT use, and curriculum support for ICT integration in Biology instruction.

1.2 PROBLEM STATEMENT

Despite the existence of national policy frameworks such as the ICT in Education Policy of 2006 and the Education Digital Agenda Strategy of 2021–2025 that promote the integration of Information and Communication Technology (ICT) in education, the use of digital technologies in classroom teaching remains limited in many Ugandan secondary schools. In particular, Biology teachers in several schools across Wakiso District continue to rely predominantly on conventional instructional approaches such as lecture and chalk-and-talk methods, even in situations where technological resources like computers and projectors are available. The mere availability of ICT infrastructure does not automatically translate into effective classroom integration, as meaningful use of technology requires teachers to possess adequate digital competencies, positive attitudes toward ICT, and institutional support that encourages innovative teaching practices.

Existing evidence from the Ugandan education context indicates that many teachers have negative and cautious attitude toward the use of ICT in teaching biology (Muwanga,et al. 2017). As a result,

the potential of digital technologies to enhance the teaching of complex and abstract biological concepts through simulations, visualizations, and multimedia learning tools remains largely underutilized. This situation may limit opportunities for learners to experience more engaging and conceptually rich Biology instruction that could improve their understanding and interest in the subject.

Although several studies have examined ICT use in education in Uganda, limited locally grounded empirical evidence exists regarding the specific readiness of Biology teachers in Wakiso District to integrate ICT into their instructional practices. This lack of context-specific information makes it difficult for education stakeholders, school administrators, and policymakers to design targeted interventions aimed at strengthening teachers' capacity to effectively utilize ICT in Biology teaching. Furthermore, the demands of the current competency-based curriculum, which requires teachers to apply technology purposefully in ways that promote learner engagement and higher-order thinking, make addressing this gap particularly urgent. Therefore, this study seeks to investigate the readiness of Biology teachers in selected secondary schools in Wakiso District, Uganda, to integrate ICT I;, nto their classroom instruction.

1.3 MAIN OBJECTIVE

To determine the readiness of Biology teachers in selected secondary schools in Wakiso District, Uganda, to integrate Information and Communication Technology (ICT) in the teaching of Biology.

1.4 SPECIFIC OBJECTIVES

To investigate the attitudes of teachers of Biology in selected secondary schools in Wakiso District towards ICT integration in Biology instruction.

To investigate the extent to which biology teachers in secondary schools in Wakiso District, Uganda perceive the Biology curriculum as supporting ICT integration in Biology teaching.

1.5 RESEARCH QUESTION

What are the attitudes of teachers of Biology in secondary schools of Wakiso District towards ICT integration in teaching Biology?

How do teachers of biology in selected secondary schools of Wakiso District, Uganda perceive the extent to which the Biology curriculum support ICT integration in Biology teaching?

1.6 HYPOTHESIS

1. **Null hypothesis:** Biology teachers in selected secondary schools in Wakiso District do not demonstrate a statistically significant positive attitude towards ICT integration in Biology instruction.

Alternative hypothesis: Biology teachers in selected secondary schools in Wakiso District demonstrate a statistically significant positive attitude towards ICT integration in Biology instruction.

2. **Null hypothesis:** There is no significant perception among Biology teachers in secondary schools in Wakiso District that the Biology curriculum supports ICT integration in Biology teaching.

Alternative hypothesis: There is a significant perception among Biology teachers in secondary schools in Wakiso District that the Biology curriculum supports ICT integration in Biology teaching.

1.7 SIGNIFICANCE OF THE STUDY

The findings of this study are expected to provide context-specific evidence that may inform improvements in ICT integration in Biology teaching and contribute to discussions on teachers' professional development, curriculum implementation and ICT-supported pedagogy In Uganda secondary schools.

To Policymakers and Education Authorities, the study will generate evidence-based insights that can inform the review and strengthening of existing ICT integration frameworks such as the Education Digital Agenda Strategy of 2021–2025. By identifying areas in which teacher demonstrate willingness as well as areas in which further support is required, the findings may provide education authorities with context-specific evidence for strengthening ICT integration in Biology teaching.

To School Administrators and Institutional Leaders, the study will highlight the role of institutional support, resource availability, and school-level encouragement in determining the extent to which Biology teachers can meaningfully integrate ICT into their instructional practice. This knowledge can guide school administrators in prioritizing ICT infrastructure investment, creating enabling environments for technology-enhanced teaching, and establishing school-based professional learning communities where teachers can share digital teaching experiences and build collective competence.

To Biology Teachers, the findings may help Biology teachers on their current use of ICT, identify areas requiring further development and consider opportunities for professional learning in biology-specific digital pedagogy. The findings may motivate Biology teachers to seek out professional development opportunities and reflect critically on their own instructional practices in relation to the demands of the competency-based curriculum currently being implemented in Ugandan secondary schools.

To Teacher Educators and Professional Development Designers, the study will provide specific and locally grounded information about the gaps in Biology teachers' digital competencies and attitudes that can be used to design more relevant, context-sensitive, and practically oriented in-service training programs. Rather than offering generic ICT training, professional development providers will be better positioned to tailor their programs to address the precise needs identified among Biology teachers in Wakiso District.

To the Research Community, the study will contribute to the growing body of empirical literature on ICT integration in science education within Sub-Saharan Africa. Given that most existing studies have examined ICT readiness at a general level without subject-specific focus, this study's concentration on Biology teaching in a specific Ugandan district will add valuable context-specific evidence that can serve as a reference point for future comparative studies across other districts, subjects, and education levels in Uganda and beyond

1.8 SCOPE OF THE STUDY

This study was conducted in nine selected secondary schools within Wakiso District, Uganda comprising of 3 government and six private. Wakiso District was chosen because it is one of the most urbanized and densely populated districts in the country, with a high concentration of both government-aided and private secondary schools. In addition, its proximity to Kampala exposes schools to national ICT in education policies and initiatives, making it a relevant context for examining ICT integration in Biology teaching.

The study focused on ICT integration in Biology teaching in secondary schools. Specifically, it examined two key aspects: Biology teachers' perceptions of the extent to which the Biology

curriculum supports ICT integration, and teachers' attitudes towards the integration of ICT in Biology instruction.

The study was conducted during the 2026 academic period running from the month of March to October.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 CONCEPTUAL FRAMEWORK

The theoretical framework of this study is informed by two complementary frameworks: the Technology Acceptance Model (TAM) and the Technological Pedagogical Content Knowledge (TPACK) framework Together, they provide a robust foundation for understanding the factors that influence Biology teachers' readiness to integrate ICT into classroom instruction.

The first model is the Technology Acceptance Model (TAM), originally proposed by Davis (1989). TAM posits that an individual's intention to use technology is primarily determined by two perceptions: perceived usefulness, the belief that using a particular technology will enhance performance and perceived ease of use, the belief that using the technology requires minimal effort. In this study, TAM provides a theoretical lens for interpreting teachers' attitudes towards ICT integration, particularly their perceptions of the usefulness and ease of use of ICT in Biology teaching. Teachers who perceive digital tools as useful for explaining complex biological concepts and as easy to operate are more likely to demonstrate positive attitudes and higher readiness for ICT integration. Conversely, teachers who view ICT as complicated or irrelevant to their instructional practice are less likely to adopt it effectively.

The second model is the Technological Pedagogical Content Knowledge (TPACK) framework, developed by Mishra and Koehler (2006). TPACK extends Shulman's (1986) concept of Pedagogical Content Knowledge by incorporating technological knowledge as a third, equally essential dimension of teacher professional competence. According to TPACK, effective technology integration requires teachers to possess and integrate three knowledge domains: content knowledge (expertise in Biology), pedagogical knowledge (understanding of effective teaching strategies), and technological knowledge (competence in using digital tools). TPACK is particularly relevant to this study because it moves beyond simple access to technology. It focuses on whether teachers have the integrated knowledge needed to use technology meaningfully within the context of Biology instruction.

By combining TAM and TPACK, this framework captures both the motivational and competence-based dimensions of ICT readiness. TAM explains why teachers may or may not adopt technology based on attitudes and perceptions, while TPACK highlights the skills and knowledge required to integrate ICT effectively in teaching TPACK was therefore used primarily as an interpretive framework for understanding teachers' confidence and reported ability to connect technological tools with Biology

content and pedagogy, rather than as a separately measured construct in the study.. Together, these models provide a comprehensive understanding of the factors influencing Biology teachers' readiness to use ICT in Wakiso District secondary schools

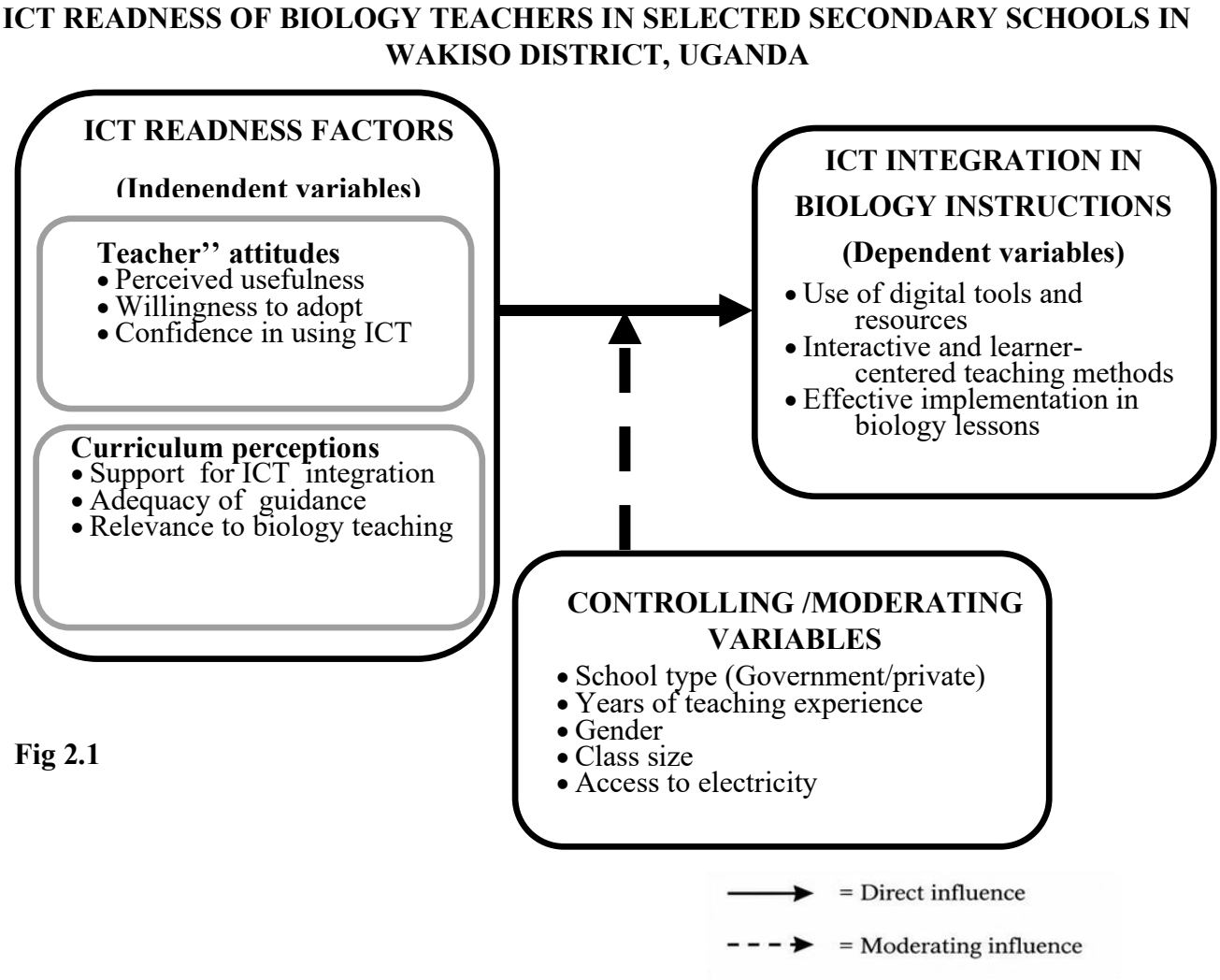


Fig 2.1

In this study, teacher readiness to integrate ICT is conceptualized as a multidimensional construct reflected in teachers' attitudes towards ICT, confidence in using ICT for Biology instruction, willingness to use and learn ICT, and their reported ability to apply ICT in teaching. Teachers' perceptions of curriculum support are treated as a contextual condition that may facilitate or constrain the translation of readiness into classroom practice. Infrastructure, connectivity and student-related factors are recognized as contextual influences but are not treated as primary variables investigated by the study.

Two key variables are proposed to directly influence Biology teachers' readiness to use ICT in the teaching of Biology in secondary schools in Wakiso District. These variables are: teachers' attitudes towards ICT integration and teachers' perception of the Biology curriculum as supporting ICT integration. These

variables represent important dimensions influencing ICT readiness, particularly the motivational and curriculum-related conditions necessary for effective ICT integration in Biology instruction. Specifically, teachers' attitudes towards ICT integration are theoretically informed by the Technology Acceptance Model (TAM), which emphasizes the influence of perceived usefulness and ease of use on technology adoption, while teachers' perceptions of the Biology curriculum as supporting ICT integration provide insight into the extent to which the curriculum framework encourages and facilitates the use of ICT in Biology teaching. Together, these variables provide a theoretically coherent basis for investigating Biology teachers' readiness to use ICT in the teaching of Biology.

In addition to the primary variables, the framework also acknowledges contextual factors that may influence ICT integration, including students' attitudes towards ICT and network connectivity. These factors were not directly measured in the present study and therefore are not treated as primary study variables. They are included to recognize the broader context within which Biology teachers implement ICT-supported instruction

2.2 LITERATURE REVIEW

2.2.1ATTITUDES OF BIOLOGY TEACHERS TOWARDS ICT INTEGRATION IN BIOLOGY INSTRUCTION

The attitudes that teachers hold towards the use of ICT are widely recognized as one of the most powerful factors Teachers' attitudes towards ICT are widely identified as an important factor influencing technology integration in classroom practice that determine whether technology is effectively used in the classroom or not. When teachers hold positive attitudes toward ICT, they are more likely to use it frequently, experiment with different tools, and seek further training to improve their technology-enhanced teaching (Akram et al., 2022).

On the other hand, when teachers are uncertain, fearful, or negative about technology, even the presence of well-equipped computer laboratories and reliable internet connectivity may not translate into meaningful classroom use (Msafiri, Kangwa & Lianyu, 2023). A systematic review of literature on ICT integration in secondary education found that the attitudes and willingness of both teachers and students to adopt and use technology are central to whether ICT integration succeeds or fails in a school environment (Msafiri et al., 2023).

Scholars have therefore consistently argued that investing in changing teacher attitudes through targeted professional development, peer mentoring, and institutional encouragement is just as important as providing the physical tools themselves (Akram et al., 2022).

Research from various parts of the world shows that teacher attitudes are not uniform and tend to be shaped by a range of personal and institutional factors. A study conducted in Bangladesh on biology teachers specifically found that those with more years of teaching experience and higher levels of ICT exposure generally reported more positive attitudes toward using technology in their lessons, and they were more confident in identifying specific ICT tools that would benefit Biology instruction (Farhan, Kazi & Chakraborty, 2024).

A particularly important point raised by scholars is that positive attitudes alone are not sufficient for ICT integration to happen effectively. Teachers must also feel confident in their ability to use specific technology tools; a quality researchers refer to as self-efficacy and they must believe that using ICT will genuinely improve learning outcomes in their specific subject (Molla & Seyoum, 2022).

In Biology teaching, this means that a teacher may generally like technology but still hesitate to use virtual laboratory simulations or cell biology animations in class if they do not feel they understand the tool well enough or if they are unsure how it connects to the specific outcomes they are expected to deliver in their lessons. This link between attitude, confidence, and pedagogical knowledge is central to the TPACK framework, which argues that effective ICT integration happens at the intersection of technological knowledge, pedagogical knowledge, and content knowledge (Koehler & Mishra, 2014).

In Africa, teacher attitudes toward ICT have been studied extensively, and findings consistently show a mixed picture. While many teachers express willingness to use technology, the translation of that willingness into actual classroom practice is often constrained by structural factors such as poor infrastructure, lack of training, and limited administrative support. A study examining the challenges that basic school teachers face in integrating ICT in Ghana found that despite teachers having a strong desire to use technology in their instruction, a lack of confidence during actual implementation, limited ICT training expertise, and negative attitudes particularly among older and less experienced teachers remained significant barriers to effective integration (Quaicoe & Pata, 2024). Notably, the study found that teachers under 35 years of age were more enthusiastic and better prepared to use ICT in their lesson planning and classroom presentations

compared to their older colleagues, pointing to a generational dimension of attitudes toward technology adoption in teaching.

In the East African context, a review of instructional technology use across Tanzania, Kenya, Uganda, Rwanda, and Sudan confirmed that negative attitudes from older or less experienced teachers remained one of the most consistently cited barriers to effective ICT integration (Suliman, Wenlan & Sleiman, 2024). The review also noted that in many of these countries, teachers who had received some form of ICT training reported more positive attitudes and were more likely to attempt using digital tools in their lessons, which reinforces the argument that professional development is key to attitude change. In Kenya, research on the influence of teacher attitudes on ICT implementation found that when school administrators actively supported and encouraged the use of technology, teacher confidence and willingness to integrate ICT in their instruction improved significantly (Bariu & Chun, 2022). In Uganda specifically, a study on ICT integration challenges in National Teachers' Colleges found that while most teacher educators acknowledged the importance of technology in modern teaching, many still held reservations about their own abilities to use it effectively, and these reservations shaped how they modelled and taught ICT-enhanced pedagogy to their student teachers (Nyakito, Amimo & Allida, 2021).

In Uganda, studies specifically focusing on teacher attitudes at the secondary school level have found that while the policy environment increasingly supports ICT use, classroom-level implementation remains limited partly because of attitudinal barriers among teachers. A study examining teacher perceptions on the implementation of the new lower secondary curriculum in Uganda found that many teachers held mixed feelings about using technology in subject teaching, with some expressing enthusiasm but also considerable anxiety about being expected to integrate tools they had not been adequately trained to use (Namubiru, Kisembo & Kasiita, 2024). This anxiety is particularly relevant in subjects like Biology, where the expectation to use ICT for demonstrations, simulations, and presentations is embedded in the new competency-based curriculum, yet many teachers were never specifically trained in Biology-specific digital tools during their pre-service education.

Additionally, a study investigating the challenges that primary school teachers in Uganda face when implementing ICT in STEM subjects in the post-pandemic era found that even among teachers who expressed generally positive attitudes toward technology, actual use in the classroom was limited by a sense of inadequacy specifically, a feeling that they lacked the skills needed to move from basic computer use to meaningful subject-specific ICT integration (Kibirige, 2023).

This distinction between general positive attitudes and subject-specific confidence is a critical consideration for this study, as Biology teachers in Wakiso District may similarly express support for ICT in general terms while struggling to apply it within their specific curriculum contexts.

Taken together, the reviewed studies suggest that positive attitudes are necessary but insufficient for meaningful ICT integration. Teachers may value technology while still experiencing difficulties translating that orientation into practice because of limited subject-specific competence, inadequate support and contextual constraints. This distinction is particularly important for Biology, where effective ICT use often requires teachers to select tools that correspond to specific biological concepts and learning activities.

2.2.2 TEACHERS OF BIOLOGY'S PERCEPTION OF THE BIOLOGY CURRICULUM AS SUPPORTIVE TOWARDS THE INTEGRATION OF ICT IN BIOLOGY TEACHING

Teachers' willingness to integrate Information and Communication Technology (ICT) into classroom instruction is shaped not only by the availability of technological infrastructure but also by how teachers interpret the curriculum they are expected to implement. In secondary education, teachers are more likely to adopt ICT when they perceive the curriculum as explicitly encouraging learner-centred instruction, inquiry-based learning, and the use of diverse instructional resources. Consequently, understanding Biology teachers' perceptions of the Biology curriculum as supporting ICT integration requires engagement with literature on curriculum interpretation, technology integration, Biology pedagogy, and educational reform within developing-country contexts.

Curriculum scholars have long argued that teachers actively interpret curriculum documents rather than merely implement them mechanically (Remillard, 2005). Teachers' instructional decisions are therefore influenced by how they perceive curriculum expectations, priorities, and assessment demands. In the context of ICT integration, this interpretive process becomes particularly important because many curricula do not explicitly prescribe when and how digital technologies should be used in classroom teaching. Instead, teachers infer whether ICT is genuinely valued within the curriculum or whether it remains supplementary to traditional teaching approaches. Ertmer and Ottenbreit-Leftwich (2010) observed that teachers are more likely to integrate technology when they perceive curriculum goals as compatible with learner-centred and interactive pedagogies. Conversely, when curricula are perceived as examination-oriented and heavily focused on content coverage, teachers tend to prioritise direct instruction methods and reduce technology use to peripheral activities.

The extent to which teachers perceive curriculum support for ICT integration is often reflected in several curriculum-related indicators. These include the flexibility of the syllabus, the presence of learner-centred instructional directives, recommendations for practical or inquiry-based learning, alignment between assessment and technology-supported competencies, and the availability of ICT-integrated teaching guidelines (Tondeur et al., 2017). Teachers may also interpret curriculum support through the extent to which curriculum documents encourage research, collaboration, experimentation, and problem-solving activities that can be enhanced through digital tools. Where such indicators are absent or unclear, teachers may conclude that ICT integration is optional rather than pedagogically necessary.

In Biology education, curriculum support for ICT integration is especially significant because many biological concepts are abstract, microscopic, dynamic, and difficult to demonstrate using conventional chalk-and-talk methods alone. Processes such as mitosis, meiosis, genetic inheritance, respiration, ecological interactions, and physiological regulation often require visualisation and simulation to enhance conceptual understanding. Redecker (2017) noted that digital technologies such as animations, virtual laboratories, simulations, digital microscopy, and multimedia presentations significantly improve learners' comprehension of scientific processes that cannot easily be observed directly. Similarly, biology teachers who perceive the curriculum as encouraging practical exploration and conceptual visualisation are more likely to adopt ICT tools during instruction. However, where curriculum documents emphasise theoretical recall and examination preparation without clear guidance on technology-supported pedagogy, teachers may rely predominantly on traditional teaching methods even when ICT resources are available.

Empirical studies in science and Biology education support the argument that curriculum perception strongly influences ICT integration practices. Research conducted in secondary schools in South Africa by Mabila, Gelderblom and Ssemugabi (2020) found that science teachers integrated ICT more frequently when curriculum materials explicitly promoted inquiry-based learning and practical investigations. Teachers reported that topics involving microscopic or dynamic biological processes particularly benefited from simulations and visual technologies. Similarly, a study in Kenya by Kiptalam and Rodrigues (2019) showed that Biology teachers viewed ICT as more relevant in curriculum areas requiring demonstrations, experiments, and visual interpretation than in content areas dominated by factual recall. The study further established that teachers were reluctant to use ICT where national examinations focused primarily on memorisation rather than application of concepts.

The Technological Pedagogical Content Knowledge (TPACK) framework developed by Mishra and Koehler (2006) provides an important theoretical basis for understanding how curriculum perception

influences ICT integration in Biology teaching. The framework argues that effective technology integration occurs when teachers successfully combine technological knowledge, pedagogical knowledge, and subject-content knowledge. Within this framework, curriculum expectations influence how teachers connect these forms of knowledge during instruction. A Biology curriculum that emphasises inquiry, experimentation, competency development, and learner participation provides clearer opportunities for teachers to integrate technological tools meaningfully into lesson delivery. In contrast, a curriculum that offers limited pedagogical guidance regarding technology use may weaken teachers' confidence in identifying appropriate ICT applications for specific Biology topics. Supporting this position, Jiménez Sierra et al. (2023), in a systematic review of secondary school ICT integration studies, concluded that curriculum structure and institutional expectations significantly influence teachers' development and application of TPACK competencies.

Studies from developing-country contexts further demonstrate that teachers' perceptions of curriculum support for ICT integration are influenced by tensions between educational policy reforms and examination-oriented teaching realities. In East Africa, Suliman, Wenlan and Sleiman (2024) reported that teachers were generally more positive towards ICT integration when curriculum reforms explicitly promoted competency-based learning and learner-centred pedagogies. However, the review also found that examination systems across several countries continued to prioritise factual recall, creating uncertainty among teachers regarding the practical importance of ICT in classroom instruction. Similarly, Guma, Mtebe and Mwantimwa (2021) found that Tanzanian science teachers perceived ICT integration largely as a personal initiative because national syllabi offered limited subject-specific guidance on technology-supported teaching. In Nigeria, Dele-Ajayi, Fasae and Okoli (2021) identified a mismatch between government advocacy for digital learning and curriculum implementation practices, noting that many teachers perceived ICT integration as inadequately embedded within subject syllabi and assessment procedures.

Within Uganda, the introduction of the competency-based lower secondary curriculum by the National Curriculum Development Centre sought to promote critical thinking, problem-solving, research skills, creativity, and learner-centred teaching approaches (NCDC, 2020). These competencies are closely associated with ICT-supported pedagogy because digital technologies can facilitate collaboration, inquiry, information access, and interactive learning. However, available evidence suggests that many teachers remain uncertain about how ICT should be integrated within specific subjects, including Biology. Namubiru, Kisembo and Kasiita (2024) found that teachers generally acknowledged government support for ICT integration but reported inadequate subject-specific curriculum guidance on how digital tools

should be incorporated into classroom instruction and assessment. The study further observed that teachers often interpretedz curriculum priorities through examination demands rather than through broader competency-based objectives.

Research focusing on teacher perceptions in Uganda similarly indicates that curriculum alignment plays an important role in shaping ICT adoption. Kiiza and Sangkaworn (2023), drawing on both the TPACK and Unified Theory of Acceptance and Use of Technology (UTAUT) frameworks, found that teachers were more willing to integrate ICT when they perceived institutional policies, curriculum expectations, and assessment systems as supportive of technology-enhanced instruction. Where such alignment appeared weak or ambiguous, teachers frequently reverted to conventional teaching methods despite having access to ICT facilities. These findings suggest that teachers' perceptions of curriculum support are influenced not only by curriculum documents themselves but also by how curriculum implementation is reinforced through institutional practices and assessment structures.

School context further shapes how Biology teachers interpret curriculum support for ICT integration. Teachers working in schools with reliable electricity, internet connectivity, computer laboratories, projectors, and supportive administration are more likely to perceive ICT integration as realistic and curriculum-compatible than teachers operating in resource-constrained environments (Bingimlas, 2009). In Wakiso District, disparities in school infrastructure may therefore influence how teachers interpret the same Biology curriculum. Teachers in better-resourced schools may perceive curriculum directives related to learner-centred teaching and practical learning as achievable through ICT, whereas those in under-resourced schools may interpret such expectations as difficult to implement. Professional development opportunities also influence curriculum perception. Vrasidas and Glass (2005) observed that teachers who receive ICT-related pedagogical training are better able to identify curriculum entry points for technology integration and are more confident in adapting digital tools to subject-specific instruction.

In Uganda, access to ICT-focused professional development remains uneven across schools and districts. Besigomwe and Nabwire (2022) found that many teachers lacked adequate preparation in technology-supported pedagogy despite national efforts to promote digital learning. This limitation affects teachers' ability to interpret curriculum reforms in ICT-oriented ways. Likewise, Akram et al. (2022), in a systematic review of ICT integration barriers in developing countries, identified inadequate training, poor infrastructure, limited technical support, and curriculum ambiguity as the most consistently reported challenges affecting teachers' use of educational technology. These findings suggest that teachers'

perceptions of curriculum support are shaped not only by written curriculum documents but also by the practical conditions under which curriculum implementation occurs.

The reviewed literature demonstrates that ICT integration is influenced by teachers' attitudes, technological and pedagogical competence, professional development, infrastructure, curriculum expectations and assessment systems. However, much of the existing evidence in Uganda has examined ICT integration generally or has focused on broader teacher populations and infrastructural challenges. Limited empirical attention has been given specifically to Biology teachers' perceptions of curriculum support for ICT integration alongside their attitudes towards ICT use. This leaves a contextual and subject-specific gap regarding how Biology teachers in Wakiso District understand the relationship between ICT integration, curriculum expectations and their own readiness to use technology in Biology teaching. The present study addresses this gap by examining teachers' attitudes towards ICT integration and their perceptions of the extent to which the Biology curriculum supports such integration

CHAPTER THREE

METHODOLOGY

3.1 Introduction

This chapter presents the research methodology used in the study. It describes the research design, the philosophical position underpinning the inquiry, the study population, sampling strategies, instrumentation, data collection procedures, pilot study, validity and reliability considerations, ethical safeguards, and the data analysis plan. The methodological choices made in this chapter were directly informed by the study objectives and research questions, which sought to investigate the readiness of Biology teachers in selected secondary schools in Wakiso District, Uganda, to integrate Information and Communication Technology (ICT) in Biology teaching.

3.2 Research Paradigm

This study was anchored in the pragmatist research paradigm. Pragmatism emphasises the practical relevance of knowledge and maintains that research methods should be selected according to the nature of the research problem and the understanding sought rather than strict adherence to a single philosophical tradition (Creswell and Creswell, 2023). The paradigm recognises that both quantitative and qualitative forms of evidence can provide complementary insights into educational phenomena.

Pragmatism was appropriate for this study because the research sought both to measure Biology teachers' attitudes and curriculum perceptions through standardised instruments and to explore the meanings teachers attach to their ICT-related experiences through qualitative inquiry. Within this approach, neither quantitative nor qualitative evidence was privileged; instead, both forms of evidence were treated as complementary and mutually informing. This position aligned with the study's focus on attitude measurement, curriculum perception, and contextualised professional experiences within Ugandan secondary schools.

3.3 Research Design

This study employed a convergent parallel mixed methods design. Quantitative and qualitative data were collected during the same general fieldwork period, analysed separately and brought together during interpretation stage to provide a comprehensive understanding of the research problem (Creswell and

Plano Clark, 2018). The quantitative strand established the prevalence, direction, and statistical significance of Biology teachers' attitudes towards ICT integration and their perceptions of curriculum support for ICT use. The qualitative strand provided deeper insight into the experiences and reasoning underlying teachers' responses.

The convergent parallel mixed methods design was selected because it enables efficient collection of both forms of data within a single fieldwork period, an important consideration given the time and resource limitations of the study. The design also allowed findings from both strands to be compared and integrated, thereby providing a more complete understanding of Biology teachers' ICT readiness than either method could provide independently (Creswell and Creswell, 2023). In addition, the mixed methods approach strengthens the credibility of findings through triangulation, whereby converging evidence from quantitative and qualitative data enhances confidence in the study conclusions.

3.4 Study Area

This study was conducted in Wakiso District, Uganda. Wakiso District is a highly urbanized and densely populated district surrounding Kampala and contains a large number of government-aided and private secondary schools . The district contains a large concentration of secondary schools, including both government-aided and privately owned institutions, and its proximity to Kampala exposes schools to national educational policy initiatives related to ICT integration.

Despite this advantage, Wakiso District also reflects many of the challenges affecting secondary education in Uganda, including uneven distribution of ICT resources, variations in teacher preparedness, and differing levels of institutional support for ICT use. These characteristics make the district an appropriate setting for investigating ICT readiness in Biology teaching.

3.5 Target Population

The target population comprised Biology teachers employed in secondary schools in Wakiso District during the 2026 academic year .Secondary schools in the district serve both Ordinary Level (O-Level) and Advanced Level (A-Level) learners, and Biology is taught across both levels, although with differing levels of content complexity and ICT demands.

According to data from the District Education Office, Wakiso District has many registered secondary schools, and the practicing Biology teachers within these schools constituted the accessible population from which the study sample was drawn.

3.6 Sample and Sampling Procedures

3.6.1 School Selection

Nine secondary schools were purposively selected for this study, comprising three government-aided and six privately owned schools. Purposive sampling was employed to ensure inclusion of schools differing in ownership category, geographical location within the district (urban, peri-urban, and rural), and availability of ICT infrastructure. This variation enabled the study to capture the range of contextual conditions within which Biology teachers operate and develop ICT-related attitudes and perceptions.

3.6.2 Teacher Sampling

Within the selected schools, all available Biology teachers were invited to participate in the quantitative strand of the study. Given the relatively small number of Biology teachers within individual secondary schools, a census approach was considered more methodologically appropriate than probabilistic sub-sampling. This approach maximized participation and minimized the loss of potentially important variation within the population.

Based on estimates from district records, the study anticipated a quantitative sample of approximately 40 Biology teachers across the nine schools. The quantitative sample consisted of 40 Biology teachers. Inferential analysis was limited to tests appropriate to the research questions and the level of measurement of the composite scores, with the results interpreted cautiously given the sample size and non-probability selection of schools.

For the qualitative strand, a purposive sub-sample of seven Biology teachers was selected from the questionnaire respondents using the criterion of maximum variation (Creswell and Poth, 2024). Participants were selected to reflect variation in school type, gender and teaching experience. The total qualitative sample therefore comprised seven participants. four from private schools and three from government-aided schools

3.6.3 Summary of Sample

Participant Category	Sampling Method	Strand	Expected Number
Biology teachers (questionnaire)	Census within selected schools	Quantitative	40
Biology teachers (interview)	Purposive – maximum variation	Qualitative	7
Total			**47**

3.7 Research instruments

Two main research instruments were used to collect data: a structured questionnaire and a semi-structured interview guide.

The questionnaire was used to collect quantitative data from Biology teachers. It consisted of sections covering respondents' background characteristics, attitudes towards ICT integration, confidence and willingness to use ICT, and perceptions of the extent to which the Biology curriculum supports ICT integration. Most of the attitudinal and curriculum-related items were measured using a five-point Likert scale ranging from Strongly Disagree to Strongly Agree.

A semi-structured interview guide was used to collect qualitative data from selected Biology teachers. The interview guide contained open-ended questions that allowed participants to describe their experiences, views and challenges relating to ICT integration in Biology teaching. The semi-structured format provided consistency across interviews while allowing the researcher to ask follow-up questions where clarification or further explanation was required.

The interviews were audio-recorded with participants' consent and subsequently transcribed for qualitative analysis. Participants were identified using codes rather than their names in the transcripts and reporting of findings.

3.8 Pilot Study

A pilot assessment was conducted before the main data collection to establish the feasibility of conducting the study in the selected schools, particularly with regard to the availability of ICT facilities and infrastructure required for ICT-supported teaching. The assessment involved visiting schools and checking whether the schools had basic ICT facilities that could support the integration of ICT into classroom instruction.

The assessment considered the presence and availability of relevant ICT infrastructure and facilities within the schools. Schools that met the basic requirements for ICT-supported instruction were considered suitable for inclusion in the study. This process helped the researcher to identify schools in which the study could be meaningfully conducted and to ensure that the selected schools had the minimum ICT conditions relevant to the research topic. **()**

The researchers formulated an introductory letter introducing them as students from Makerere University before visiting the schools. The letter introduced the researcher to the school authorities and requested permission to conduct the study. The pilot assessment was therefore conducted with the knowledge and permission of the respective school authorities.

3.9 Validity of the Research Instruments

Validity refers to the extent to which a research instrument measures the concepts that it is intended to measure. In this study, content validity was considered by ensuring that the questionnaire and interview guide were developed directly from the study objectives and research questions. The items were designed to cover the major aspects of the study, including teachers' attitudes towards ICT integration and their perceptions of the extent to which the Biology curriculum supports ICT integration.

The research instruments were reviewed by the researcher's supervisor to assess the relevance, clarity and appropriateness of the items to the study objectives. The feedback obtained during the review was used to refine the wording and organization of the instruments before their use in the main study. This process helped to ensure that the instruments adequately represented the concepts investigated in the study.

3.10 Reliability of the Research Instruments

Reliability refers to the consistency of a research instrument in measuring the constructs for which it was designed. In this study, reliability of the questionnaire was assessed using the internal consistency approach. The questionnaire items measuring the same construct were subjected to reliability analysis using IBM SPSS Statistics, and Cronbach's alpha coefficient was used to assess the internal consistency of the items.

The reliability analysis was conducted separately for the main multi-item constructs investigated in the questionnaire. The resulting Cronbach's alpha coefficients were considered alongside the content and conceptual alignment of the items in determining the suitability of the questionnaire for the main study.

Following data collection, internal consistency was computed from the responses of the 40 Biology teachers who completed the questionnaire. The statements in Sections B and C were grouped into scales according to the construct each set was designed to measure. Section B was treated as four attitude subscales: general beliefs about ICT in Biology teaching (items 8 to 12), personal confidence and self-efficacy (items 13 to 17), willingness and motivation to integrate ICT (items 18 to 22) and perceived barriers (items 23 to 26). The four barrier statements are negatively worded and were reverse-coded (6 minus the response) before analysis, so that a higher score on every item indicates a more favourable attitude towards ICT. Section C was treated as two curriculum subscales: curriculum provisions and explicitness of ICT guidance (items 27 to 31) and institutional and structural alignment (items 32 to 36). Item 35, which asks whether the curriculum needs to be updated, was left out of the curriculum scale because agreement with it signals a perceived shortcoming and not support, and because it correlated weakly with the other items in its subscale (corrected item-total correlation = 0.15). Item 37 has four categorical response options and was not included in any scale.

Table 3.1 presents the Cronbach's alpha coefficients. They ranged from 0.67 to 0.91. Five of the six subscales reached the conventional threshold of 0.70. The curriculum provisions subscale (0.67) fell marginally below it, which is not unusual for a scale of five items. The two composite scales on which the hypothesis tests rest were both reliable: 0.82 for the 19-item attitude scale and 0.80 for the nine-item curriculum support scale. All eight scales were therefore retained for analysis.

Table 3.1: Cronbach's alpha coefficients for the questionnaire scales (N = 40)

Scale	Items	No. of items	Cronbach's alpha	Interpretation
General beliefs about ICT	8–12	5	0.775	Acceptable
Confidence and self-efficacy	13–17	5	0.909	Excellent
Willingness and motivation	18–22	5	0.730	Acceptable
Perceived barriers (reverse-coded)	23–26	4	0.710	Acceptable
Attitude composite	**8–26**	**19**	**0.823**	**Good**
Curriculum provisions and ICT guidance	27–31	5	0.669	Marginal
Institutional and structural alignment (item 35 excluded)	32–34, 36	4	0.746	Acceptable
Curriculum support composite	**27–34, 36**	**9**	**0.804**	**Good**

Source: Field data (2026). Interpretation follows conventional guidelines: 0.90 and above excellent; 0.80 to 0.89 good; 0.70 to 0.79 acceptable; 0.60 to 0.69 marginal.

3.11 Data Collection Procedure

Before commencing data collection, the researchers formulated an introductory letter introducing them as students from Makerere University. The letter introduced the researcher to the selected schools and requested permission from the relevant school authorities to conduct the study.

After obtaining permission, the researchers visited the selected schools and administered the questionnaires to eligible Biology teachers. The purpose of the study was explained to the participants, and they were informed that participation was voluntary. Participants were given sufficient time to complete the questionnaires, after which the completed questionnaires were collected by the researchers.

For the qualitative strand, selected Biology teachers participated in semi-structured interviews using the interview guide. With the participants' consent, the interviews were audio-recorded to ensure accurate capture of their responses. The recordings were subsequently transcribed for analysis.

Throughout the data collection process, confidentiality was maintained. Participants' names were not recorded in the research report or qualitative transcripts. Instead, codes such as BT01, BT02, BT03 and BT04 were used to identify interview transcripts and quotations. The names of the participating schools were also not reported in the dissertation in order to protect the identity of the schools and participants.

3.12 Ethical Considerations

Ethical considerations were observed throughout the study. Before data collection, the researchers formulated an introductory letter introducing them as students from Makerere University and presented it to the relevant school authorities to request permission to conduct the study.

Participation in the study was voluntary. The purpose of the research was explained to participants before they completed the questionnaire or participated in an interview. Participants were informed that they could decline to participate or withdraw from the study without penalty.

Confidentiality and anonymity were maintained throughout the research process. Participants' names were not included in the questionnaires, interview transcripts or final research report. Instead, codes were used to identify interview participants and their transcripts. The names of the participating schools were also omitted from the dissertation to reduce the possibility of identifying individual participants or schools.

For the qualitative interviews, audio recording was conducted only with the participants' consent. The recordings and transcripts were treated as research data and were used only for purposes related to the study. In reporting the findings, quotations were attributed to participant codes rather than personal names.

3.13 Data Analysis

Both quantitative and qualitative data were analyzed separately before being brought together during interpretation, consistent with the convergent mixed methods design.

3.13.1 Quantitative Data Analysis

Quantitative data obtained from the questionnaires were coded, entered and analyzed using IBM SPSS Statistics. Descriptive statistics, including frequencies, percentages and means, were used to summarize respondents' background characteristics and responses to the questionnaire items.

For the inferential analysis, composite scores were calculated for the main constructs measured by the questionnaire. A one-sample t-test was used to determine whether the mean scores for teachers' attitudes towards ICT integration and perceptions of curriculum support differed significantly from the neutral midpoint of 3.0 on the five-point Likert scale. The level of statistical significance was set at 0.05.

Composite scores were calculated as the mean of the items in each scale, so that every composite stays on the original one-to-five metric. The attitude composite is the mean of the 19 attitude statements (items 8 to 26), with the four negatively worded statements reverse-coded. The curriculum support composite is the mean of the nine curriculum statements (items 27 to 34 and 36). Composite means were interpreted using the following scale: 3.5 and above indicates a positive attitude or perception, 2.50 to 3.49 a neutral or ambivalent position, and below 2.5 a negative one. Each composite was compared with the neutral midpoint of 3.0 using a two-tailed one-sample t-test with 39 degrees of freedom, and the results are reported as the mean, standard deviation, t, p, mean difference, 95% confidence interval and Cohen's d. Normality of the composite scores was checked with the Shapiro–Wilk test, and the Wilcoxon signed-rank test was used to confirm the t-test decisions.

The quantitative findings were presented using tables, frequencies, percentages and means and were interpreted in relation to the study objectives and research questions.

3.13.2 Qualitative Data Analysis

Qualitative interview data were analyzed using Braun and Clarke's (2022) six-phase reflexive thematic analysis. The interview recordings were transcribed, and the transcripts were examined repeatedly to facilitate familiarization with the data. Initial codes were generated from the data, related codes were grouped into potential themes, and the themes were subsequently reviewed, refined and named.

NVivo was used as a data-management and coding-support tool to organize the seven interview transcripts, manage codes, examine patterns across the data and support the development and organization of themes. Coding was primarily inductive, allowing themes to emerge from participants' accounts, while the

resulting themes were interpreted in relation to the Technology Acceptance Model and the Technological Pedagogical Content Knowledge framework.

Finally, quantitative and qualitative findings were compared and integrated during interpretation to identify areas of convergence, complementarity and divergence.

CHAPTER FOUR

PRESENTATION OF FINDINGS

4.1 Introduction

This chapter presents the findings of the study on the readiness of Biology teachers in selected secondary schools in Wakiso District, Uganda, to integrate ICT into Biology teaching. The findings are organized around the two specific objectives of the study and their corresponding research questions:

Objective One: To investigate the attitudes of teachers of Biology in selected secondary schools in Wakiso District towards ICT integration in Biology instruction.

Research Question One: What are the attitudes of teachers of Biology in secondary schools of Wakiso District towards ICT integration in teaching Biology?

Objective Two: To investigate the extent to which Biology teachers in secondary schools in Wakiso District, Uganda perceive the Biology curriculum as supporting ICT integration in Biology teaching. Research Question Two: How do teachers of Biology in secondary schools of Wakiso District, Uganda perceive the extent to which the Biology curriculum supports ICT integration in Biology teaching?

In line with the convergent parallel mixed methods design described in Chapter Three, quantitative data from questionnaires completed by 40 Biology teachers (analyzed using SPSS) and qualitative data from seven semi-structured interviews (analyzed using Braun and Clarke's six-phase reflexive thematic analysis, with NVivo used to organize and code the transcripts) are reported together under each objective during interpretation to identify areas of convergence, complementarity and divergence. Findings from government-aided and private schools are compared wherever the data allow.

Five-point Likert responses are reported in grouped form. Strongly Agree and Agree are combined and reported as "agree", while Strongly Disagree and Disagree are combined and reported as "disagree". Neutral responses are reported separately. Percentages are calculated out of the 40 questionnaire respondents unless stated otherwise. Interview participants are identified by the codes BT01 to BT07, and the type of school is given alongside quotations. The interview frequencies describe these seven participants only.

4.2 Background Characteristics of Respondents

4.2.1 Questionnaire respondents

Table 4.1 summarizes the background characteristics of the 40 Biology teachers who completed the questionnaire. Male teachers accounted for 26 (65.0%) of the respondents and female teachers for 14 (35.0%). Nearly half of the respondents (19; 47.5%) were aged 20–30 years, 11 (27.5%) were aged 31–40 years, and five (12.5%) each were aged 41–50 years and above 50 years. Most respondents (35; 87.5%) held a Bachelor's degree, while two (5.0%) held a Diploma in Education, one (2.5%) a Postgraduate Diploma in Education, and two (5.0%) a Master's degree.

In terms of experience, 18 teachers (45.0%) had taught Biology for less than five years, eight (20.0%) for 5–10 years, four (10.0%) for 11–15 years, and 10 (25.0%) for more than 15 years. Twenty-two teachers (55.0%) were from government-aided schools and 18 (45.0%) from private schools. Thirty teachers (75.0%) taught both O-level and A-level, while 10 (25.0%) taught O-level only.

With regard to ICT training relevant to teaching, 33 teachers (82.5%) reported some form of training: 14 (35.0%) through pre-service teacher education, 10 (25.0%) through in-service or professional development programmes, and nine (22.5%) through self-taught or informal learning. Seven teachers (17.5%) reported that they had received no formal ICT training.

Table 4.1: Background characteristics of questionnaire respondents (N = 40)

Variable	Category	Frequency	Percent (%)
Gender	Male	26	65.0
	Female	14	35.0
Age group	20–30 years	19	47.5
	31–40 years	11	27.5
	41–50 years	5	12.5
	Above 50 years	5	12.5
Highest academic qualification	Diploma in Education	2	5.0
	Bachelor's Degree	35	87.5
	Postgraduate Diploma in Education	1	2.5
	Master's Degree	2	5.0
Teaching experience in Biology	Less than 5 years	18	45.0
	5–10 years	8	20.0
	11–15 years	4	10.0
	Above 15 years	10	25.0
Type of school	Government-aided	22	55.0
	Private	18	45.0
Level of classes taught	O-level only (S1–S4)	10	25.0
	Both O-level and A-level	30	75.0
Formal ICT training received	Yes, as part of pre-service teacher education	14	35.0
	Yes, through an in-service/professional development programme	10	25.0
	Yes, self-taught or informal learning	9	22.5
	No formal ICT training received	7	17.5

Source: Field data (2026).

4.2.2 Interview participants

Seven Biology teachers took part in the semi-structured interviews: four from private schools (BT01, BT02, BT04 and BT07) and three from government-aided schools (BT03, BT05 and BT06). Their teaching experience ranged from about one year to 30 years. The three government-aided teachers had 15, 19 and 30 years of experience respectively, while the four private school teachers had one year, five years, 12 years and about two to three years respectively. Table 4.2 presents their profiles.

Table 4.2: Profile of interview participants (n = 7)

Code	Type of school	Teaching experience	Levels taught
BT01	Private	1 year	O-level
BT02	Private	5 years	All levels
BT03	Government-aided	15 years	Senior 1–4 (previously S5–S6)
BT04	Private	12 years	Senior 1–4 (previously S5–S6)
BT05	Government-aided	19 years	O and A level (Biology and Chemistry)
BT06	Government-aided	30 years	Senior 1–4 (previously S5–S6)
BT07	Private	Since 2023 (about 2–3 years)	Senior 3–6

Source: Field data (2026). School type for BT03, BT05 and BT06 is recorded as “Government” in the interview records.

4.3 Objective One: Attitudes of Biology Teachers towards ICT Integration

4.3.1 Quantitative findings

Teachers’ responses to the attitude statements are presented under four headings: perceived usefulness of ICT, confidence and competence, willingness and practice, and reservations about ICT use.

Perceived usefulness of ICT in Biology teaching

Table 4.3 shows that most teachers viewed ICT as beneficial. Thirty-seven teachers (92.5%) agreed that ICT enhances the quality of teaching and learning in Biology, two (5.0%) disagreed and one (2.5%) was

neutral. The same number (37; 92.5%) agreed that ICT tools help students understand abstract and complex Biology concepts more easily and that ICT makes lessons more interactive and engaging. Thirty-six teachers (90.0%) agreed that virtual laboratories and simulations are a valuable substitute when physical laboratory resources are unavailable. The statement on making content more relevant to students' everyday lives received the lowest agreement in this group, with 32 teachers (80.0%) agreeing, six (15.0%) neutral and two (5.0%) disagreeing. Mean scores for the five statements ranged from 4.08 to 4.53.

Table 4.3: Perceived usefulness of ICT in Biology teaching

Statement	Agree n (%)	Neutral n (%)	Disagree n (%)	Mean
ICT enhances the quality of teaching and learning in Biology	37 (92.5)	1 (2.5)	2 (5.0)	4.53
ICT tools help students understand abstract and complex Biology concepts more easily	37 (92.5)	1 (2.5)	2 (5.0)	4.53
Using ICT in Biology lessons makes the content more relevant to students' everyday lives	32 (80.0)	6 (15.0)	2 (5.0)	4.08
ICT makes Biology lessons more interactive and engaging for students	37 (92.5)	1 (2.5)	2 (5.0)	4.42
Virtual laboratories and simulations are a valuable substitute when physical lab resources are unavailable	36 (90.0)	1 (2.5)	3 (7.5)	4.47

Source: Field data (2026). Agree = Strongly Agree + Agree; Disagree = Strongly Disagree + Disagree. Mean on a 1–5 scale (5 = Strongly Agree). N = 40.

Confidence and competence in using ICT

As shown in Table 4.4, 31 teachers (77.5%) agreed that they feel confident using ICT tools in their Biology lessons, four (10.0%) were neutral and five (12.5%) disagreed. The same number (31; 77.5%) agreed that they can identify which ICT tools are most appropriate for specific Biology topics. Agreement was lower for the more specific skills: 27 teachers (67.5%) agreed that they are comfortable designing lessons that incorporate ICT-based activities, and 24 (60.0%) agreed that they can troubleshoot minor technical problems, while nine (22.5%) disagreed with the latter. The lowest agreement was recorded for knowledge of Biology-specific digital resources such as simulations, virtual laboratories and online databases: 21 teachers (52.5%) agreed, 12 (30.0%) were neutral and seven (17.5%) disagreed.

Table 4.4: Confidence and competence in using ICT

Statement	Agree n (%)	Neutral n (%)	Disagree n (%)	Mean
I feel confident using ICT tools (e.g., computers, projectors, software) in my Biology lessons	31 (77.5)	4 (10.0)	5 (12.5)	3.95
I am able to identify which ICT tools are most appropriate for specific Biology topics	31 (77.5)	6 (15.0)	3 (7.5)	4.00
I can troubleshoot minor technical problems that arise when using ICT during a lesson	24 (60.0)	7 (17.5)	9 (22.5)	3.50
I am comfortable designing Biology lessons that incorporate ICT-based activities	27 (67.5)	8 (20.0)	5 (12.5)	3.77
I know how to use Biology-specific digital resources (e.g., simulations, virtual labs, online databases)	21 (52.5)	12 (30.0)	7 (17.5)	3.55

Source: Field data (2026). Agree = Strongly Agree + Agree; Disagree = Strongly Disagree + Disagree. Mean on a 1–5 scale (5 = Strongly Agree). N = 40.

Willingness, practice and training needs

Table 4.5 presents responses on willingness to use ICT and on training. Thirty-eight teachers (95.0%) agreed that they are willing to invest additional time to learn how to use ICT tools, and none was neutral. Thirty-four (85.0%) agreed that they actively seek out ICT resources to support Biology instruction, and 31 (77.5%) agreed that they encourage students to use ICT for learning Biology beyond the classroom. Thirty-five teachers (87.5%) agreed that they would use ICT more frequently if they received adequate training and support, and 37 (92.5%) agreed that ICT training should be a mandatory component of professional development for all Biology teachers, with 31 of them (77.5% of all respondents) strongly agreeing.

Table 4.5: Willingness, practice and training needs

Statement	Agree n (%)	Neutral n (%)	Disagree n (%)	Mean
I am willing to invest additional time to learn how to use ICT tools in my teaching	38 (95.0)	0 (0.0)	2 (5.0)	4.47
I actively seek out ICT resources and materials that can support Biology instruction	34 (85.0)	4 (10.0)	2 (5.0)	4.22
I would use ICT more frequently in my lessons if I received adequate training and support	35 (87.5)	4 (10.0)	1 (2.5)	4.38
I encourage my students to use ICT as a tool for learning Biology beyond the classroom	31 (77.5)	6 (15.0)	3 (7.5)	4.10
ICT training should be a mandatory component of professional development for all Biology teachers	37 (92.5)	1 (2.5)	2 (5.0)	4.63

Source: Field data (2026). Agree = Strongly Agree + Agree; Disagree = Strongly Disagree + Disagree. Mean on a 1–5 scale (5 = Strongly Agree). N = 40.

Reservations about ICT use

Table 4.6 presents the negatively worded statements. Twenty-four teachers (60.0%) disagreed that ICT integration is too time-consuming relative to its benefits, while 12 (30.0%) agreed and four (10.0%) were neutral. Thirty-six teachers (90.0%) disagreed with the statement that they do not see the need to use ICT because traditional methods are sufficient, and four (10.0%) agreed. Thirty teachers (75.0%) disagreed that they feel anxious or uncomfortable when expected to use ICT tools, six (15.0%) were neutral and four (10.0%) agreed. On institutional encouragement, 24 teachers (60.0%) disagreed that their school administration does not actively encourage or support ICT use, 10 (25.0%) agreed and six (15.0%) were neutral.

Table 4.6: Reservations about ICT use and institutional encouragement

Statement	Agree n (%)	Neutral n (%)	Disagree n (%)	Mean
ICT integration is too time-consuming relative to the benefits it offers in Biology teaching	12 (30.0)	4 (10.0)	24 (60.0)	2.67
I do not see the need to use ICT since traditional teaching methods are sufficient for Biology	4 (10.0)	0 (0.0)	36 (90.0)	1.88
I feel anxious or uncomfortable when expected to use ICT tools in my lessons	4 (10.0)	6 (15.0)	30 (75.0)	2.05
My school administration does not actively encourage or support ICT use in subject teaching	10 (25.0)	6 (15.0)	24 (60.0)	2.33

Source: Field data (2026). Agree = Strongly Agree + Agree; Disagree = Strongly Disagree + Disagree. Mean on a 1–5 scale (5 = Strongly Agree). N = 40. A lower mean indicates a more favourable position towards ICT.

4.3.2 Qualitative findings

Reflexive thematic analysis of the seven transcripts produced four themes, each with two subthemes (Table 4.7). Themes One to Three relate to Objective One and are presented in this section; Theme Four relates to Objective Two and is presented in Section 4.4.2.

Table 4.7: Themes and subthemes generated from the interviews

Theme	Subthemes
Theme 1: Willing but constrained; the attitude–practice gap	1a: A shared positive orientation towards ICT 1b: Conditional and inconsistent translation of that orientation into practice
Theme 2: Working within what is available; material and institutional conditions	2a: Infrastructure and equipment as a bounding condition on practice 2b: Contextual and pedagogical judgement about when ICT is worth using
Theme 3: Confidence unevenly distributed; skills, training and the advanced-tools gap	3a: A confidence gradient from basic to specialised or emerging tools 3b: A request for practical, sustained, Biology-specific training
Theme 4: Caught between curriculum ideals and examination realities	4a: A perceived mismatch between ICT-supported learning and written examinations 4b: Examination proximity and a shift towards conventional teaching

Source: Field data (2026).

Theme 1: Willing but constrained; the attitude–practice gap

Subtheme 1a: A shared positive orientation. All seven participants (three from government-aided and four from private schools) expressed a positive orientation towards ICT in Biology teaching, and all seven described benefits for student engagement or understanding. Participants most often linked these benefits to visualising processes that learners cannot observe directly.

> "It is not easy to show learners how chromosomes behave during mitosis or how gas exchange takes place in the lungs. A video or animation can make such things clearer." (BT04, private school)

Subtheme 1b: Conditional and inconsistent translation into practice. Reported use varied considerably. BT01 and BT02, both from private schools, reported near-daily and independently prepared ICT use, and BT07 (private) also reported frequent use. At the other end, BT06 (government-aided) relied entirely on colleagues to operate a projector, and BT03 (government-aided) reported low personal use despite a positive view of ICT. Six of the seven participants (BT01 to BT05 and BT07) reported personally operating a projector at least sometimes, six (BT01 to BT05 and BT07) reported personally operating video in lessons, and four (BT01, BT03, BT04 and BT07) reported using a smartphone for lesson content. BT06 described a gap between attitude and ability:

> "My attitude is positive, but my ability is very low... I have not acquired the skills to use it myself." (BT06, government-aided school)

Theme 2: Working within what is available; material and institutional conditions

Subtheme 2a: Infrastructure and equipment. Five of the seven participants (BT03, BT04, BT05, BT06 and BT07) described electricity, classroom sockets, projector availability, internet connectivity or a shortage of gadgets as limiting what they could do, in some cases requiring teachers to share equipment or forgo use altogether. BT01 and BT02 did not raise any infrastructural barrier and described relatively uninterrupted access to a projector and laptop.

> "I would really love to use ICT, at least in every lesson, but the challenge is most schools don't have extensions in classes, I mean sockets in classes. Schools don't have projectors, so I really go limited." (BT07, private school)

Subtheme 2b: Contextual and pedagogical judgement. Six of the seven participants (BT01, BT02, BT03, BT04, BT06 and BT07) said that in some circumstances they preferred traditional methods, depending on

the topic, the time available and the effort of setting up equipment. The question was not addressed in BT05's transcript.

Theme 3: Confidence unevenly distributed; skills, training and the advanced-tools gap

Subtheme 3a: A confidence gradient. Reported confidence ranged from very low to high. BT06 (government-aided) reported "very little confidence, especially with computers and projectors", while BT02 (private) reported high confidence: "I'll be so much confident... I don't find hard time." Six of the seven participants (BT01, BT03, BT04, BT05, BT06 and BT07) reported lower confidence with specialised tools such as simulations, virtual laboratories, digital microscopy and AI tools than with smartphones, projectors and video. BT02 did not raise these tools. Five participants (BT01, BT03, BT04, BT05 and BT06) were aware of such tools but reported limited or no classroom use.

> "I know about these things because I hear other teachers talking about them, but I have never designed a lesson using a virtual laboratory or digital microscope." (BT06, government-aided school)

BT07 (private) was the exception. Alongside confident use of laptops and projectors, BT07 described classroom use of a PhET-type simulation, a virtual microscope and an AI tool for describing specimens, while rating confidence with these specific tools at 5 out of 10. BT05 (government-aided) was the only other participant to mention AI tools.

> "With ICT, we have simulations... we have the virtual microscope. With this, there are like AI tools where you get a specimen... you can now visually expound, increase the magnification, and decrease the magnification." (BT07, private school)

Subtheme 3b: A request for practical, sustained training. Five participants (BT03, BT04, BT05, BT06 and BT07) explicitly asked for practical training, and they described what they wanted in similar terms: sustained, hands-on and Biology-specific support rather than a single workshop. BT01 and BT02 did not request training.

> "It should not just be a workshop where someone talks about ICT for one day. We need someone to sit with us and show us step by step." (BT06, government-aided school)

> "I would really argue that ICT... let there be a program for enhancing that ICT knowledge." (BT07, private school)

4.3.3 Comparison between government-aided and private schools

Table 4.8 compares the interview patterns for the three government-aided and four private school participants. The comparison rests on very small groups and describes these seven participants only.

Table 4.8: Interview patterns on attitudes and practice by type of school

Pattern	Government-aided (n = 3)	Private (n = 4)
Generally positive attitude towards ICT	3 of 3	4 of 4
Perceived benefit for engagement and understanding	3 of 3	4 of 4
Personally operates a projector	2 of 3	4 of 4
Personally operates video in lessons	2 of 3	4 of 4
Uses a smartphone for lesson content	1 of 3	3 of 4
Names infrastructure or equipment barriers	3 of 3	2 of 4
Lower confidence with specialised tools (simulations, virtual laboratories, digital microscopy, AI)	3 of 3	3 of 4
Aware of specialised tools but reports limited or no classroom use	3 of 3	2 of 4
Requests practical, sustained training	3 of 3	2 of 4
Prefers traditional methods in some circumstances	2 of 3	4 of 4

Source: Field data (2026). For preference for traditional methods, BT05 (government-aided) did not address the question. For specialised tools, BT02 (private) did not raise them and BT07 (private) reported active use.

Positive attitudes and perceived benefits were reported by all participants in both groups. Differences appeared in reported practice and conditions. All four private school participants reported personally operating a projector and video, compared with two of the three government-aided participants, and the two participants who reported near-daily independent use (BT01 and BT02) were both from private schools. The only participant who reported active classroom use of a simulation, a virtual microscope and an AI tool (BT07) was also from a private school.

All three government-aided participants named infrastructure or equipment barriers, as did two of the four private school participants (BT04 and BT07); BT01 and BT02, both private, named none. All three government-aided participants reported lower confidence with specialised tools and asked for practical, sustained training, compared with three of four and two of four private school participants respectively.

The lowest reported confidence (BT06) came from a government-aided school, and the highest (BT02, and BT07 for general tools) from private schools. The government-aided participants had 15 to 30 years of teaching experience, whereas the private school participants had between one and 12 years.

4.3.4 Summary of findings on Objective One

Both data sources showed a strongly positive orientation towards ICT. In the questionnaire, 92.5% of teachers agreed that ICT enhances the quality of Biology teaching and learning, and all seven interviewees expressed a positive orientation and described benefits for engagement and understanding. Reservations were uncommon in the questionnaire: 90.0% disagreed that traditional methods are sufficient and 75.0% disagreed that they feel anxious about using ICT.

Confidence showed a similar pattern in both strands. In the questionnaire, 77.5% agreed that they feel confident using ICT tools, but agreement fell to 52.5% for Biology-specific digital resources, where 30.0% were neutral. In the interviews, six of seven participants reported lower confidence with specialised tools than with general tools. Training needs were also reflected in both: 87.5% of questionnaire respondents said they would use ICT more with adequate training and 92.5% agreed that ICT training should be mandatory, while five of seven interviewees asked for practical, sustained training. Infrastructure barriers were named by five of the seven interviewees, and in the questionnaire 25.0% agreed that their school administration does not actively encourage or support ICT use.

4.4 Objective Two: Teachers' Perceptions of Curriculum Support for ICT Integration

4.4.1 Quantitative findings

Explicit mention of ICT and the specificity of guidance

Table 4.9 shows that almost all teachers agreed that the current Biology syllabus explicitly mentions the use of ICT tools in teaching and learning: 39 (97.5%) agreed, one (2.5%) was neutral and none disagreed. Agreement was lower on the specificity of the guidance. Nineteen teachers (47.5%) agreed that the curriculum specifies which digital tools or resources should be used for particular topics, 12 (30.0%) were neutral and nine (22.5%) disagreed. On whether the curriculum provides clear and practical guidelines on integrating ICT into Biology lessons, 16 teachers (40.0%) agreed, 11 (27.5%) were neutral and 13 (32.5%) disagreed. Twenty-five teachers (62.5%) agreed that the syllabus identifies specific topics where ICT tools should be used, with nine (22.5%) disagreeing. Half of the teachers (20; 50.0%) agreed that the curriculum reflects modern technological advancements relevant to Biology education, 13 (32.5%) were neutral and seven (17.5%) disagreed.

Table 4.9: Explicit mention of ICT and specificity of curriculum guidance

Statement	Agree n (%)	Neutral n (%)	Disagree n (%)	Mean
The current Biology syllabus explicitly mentions the use of ICT tools in teaching and learning	39 (97.5)	1 (2.5)	0 (0.0)	4.63
The Biology curriculum specifies which digital tools or resources should be used for particular topics	19 (47.5)	12 (30.0)	9 (22.5)	3.27
The curriculum provides clear and practical guidelines on how to integrate ICT into Biology lessons	16 (40.0)	11 (27.5)	13 (32.5)	3.13
The Biology syllabus identifies specific topics where ICT tools (e.g., simulations, virtual labs) should be used	25 (62.5)	6 (15.0)	9 (22.5)	3.52
The curriculum reflects modern technological advancements relevant to Biology education	20 (50.0)	13 (32.5)	7 (17.5)	3.45

Source: Field data (2026). Agree = Strongly Agree + Agree; Disagree = Strongly Disagree + Disagree. Mean on a 1–5 scale (5 = Strongly Agree). N = 40.

Table 4.10 shows responses to the question on whether specific ICT tools or digital resources are recommended in the syllabus or teaching guide. Twenty-two teachers (55.0%) said they were aware of specific tools or resources mentioned, 14 (35.0%) said ICT is mentioned in general terms but no specific tools are named, and four (10.0%) said the syllabus does not mention specific ICT tools.

Table 4.10: Whether specific ICT tools are recommended in the syllabus or teaching guide

Response	Frequency	Percent (%)
Yes, aware of specific tools or resources mentioned in the syllabus	22	55.0
Somewhat, ICT is mentioned in general terms but no specific tools are named	14	35.0
No, the syllabus does not mention specific ICT tools	4	10.0
Total	40	100.0

Source: Field data (2026).

Flexibility, assessment, resources and infrastructure

Table 4.11 presents the remaining curriculum statements. Thirty teachers (75.0%) agreed that the curriculum gives teachers the professional flexibility to innovate and adapt ICT use in Biology lessons,

four (10.0%) were neutral and six (15.0%) disagreed. Opinion was more divided on assessment: 17 teachers (42.5%) agreed that the school's assessment methods and examinations are aligned with ICT-integrated Biology teaching, nine (22.5%) were neutral and 14 (35.0%) disagreed. Twenty-two teachers (55.0%) agreed that there is a clear link between what the curriculum requires and the ICT resources available in their schools, while nine (22.5%) disagreed. Twenty-eight teachers (70.0%) agreed that the curriculum needs to be updated to better incorporate and reflect ICT use, seven (17.5%) were neutral and five (12.5%) disagreed. Nineteen teachers (47.5%) agreed that the curriculum's ICT requirements are realistic given the infrastructure available in most schools, whereas 14 (35.0%) disagreed and seven (17.5%) were neutral.

Table 4.11: Curriculum flexibility, assessment alignment and resources

Statement	Agree n (%)	Neutral n (%)	Disagree n (%)	Mean
The curriculum provides teachers with the professional flexibility to innovate and adapt ICT use in Biology lessons	30 (75.0)	4 (10.0)	6 (15.0)	3.63
The school's assessment methods and examinations are aligned with ICT-integrated Biology teaching	17 (42.5)	9 (22.5)	14 (35.0)	3.15
There is a clear link between what the Biology curriculum requires and the ICT resources available in my school	22 (55.0)	9 (22.5)	9 (22.5)	3.50
The current Biology curriculum needs to be updated to better incorporate and reflect ICT use	28 (70.0)	7 (17.5)	5 (12.5)	3.77
The curriculum's ICT integration requirements are realistic given the infrastructure available in most schools	19 (47.5)	7 (17.5)	14 (35.0)	3.15

Source: Field data (2026). Agree = Strongly Agree + Agree; Disagree = Strongly Disagree + Disagree. Mean on a 1–5 scale (5 = Strongly Agree). N = 40.

4.4.2 Qualitative findings

Theme 4: Caught between curriculum ideals and examination realities

All seven participants described the Biology curriculum as encouraging ICT use in general terms. Three of them (BT03, BT04 and BT06) added that the curriculum rarely specifies which tool should be used for a given topic.

Subtheme 4a: A perceived mismatch with examinations. Six of the seven participants (BT01 to BT06) described a mismatch between ICT-supported, often collaborative learning and individually written, time-limited examinations.

> "The exam's assessment is very theoretical, whereas the teaching demands a lot of practical work, a lot of ICT integration, which is not reflected in the assessment." (BT01, private school)

BT07 (private) was the one dissenting voice, arguing that any gap reflects teacher practice rather than a structural mismatch. BT07 also proposed that ICT itself be incorporated into assessment, for example by allowing learners who miss an examination to sit it online.

> "I think there is no mismatch, but... it all depends with the teacher." (BT07, private school)

Subtheme 4b: Examination proximity and conventional teaching. Four participants (BT01, BT03, BT04 and BT06) said that conventional methods became more prominent, temporarily or lastingly, as examinations approached.

4.4.3 Comparison between government-aided and private schools

Table 4.12: Interview patterns on curriculum support by type of school

Pattern	Government-aided (n = 3)	Private (n = 4)
Describes the curriculum as encouraging ICT in general terms	3 of 3	4 of 4
Notes that the curriculum does not specify tools for particular topics	2 of 3	1 of 4
Perceives a mismatch between ICT-supported learning and examinations	3 of 3	3 of 4
Reports a shift towards conventional methods as examinations approach	2 of 3	2 of 4

Source: Field data (2026). The private school participant who did not perceive a mismatch was BT07. Tool-level guidance was noted by BT03 and BT06 (government-aided) and BT04 (private). A shift towards conventional methods was reported by BT03 and BT06 (government-aided) and BT01 and BT04 (private).

All seven participants described the curriculum as encouraging ICT in general terms, regardless of school type. The observation that the curriculum does not name tools for particular topics came from two of the three government-aided participants (BT03 and BT06) and one of the four private school participants (BT04). All three government-aided participants perceived a mismatch between ICT-supported learning and examinations, as did three of the four private school participants, the exception being BT07. A shift towards conventional methods as examinations approach was reported by two participants in each group.

4.4.4 Summary of findings on Objective Two

Both data sources showed that the curriculum was seen as encouraging ICT in general, while the tool-level guidance and the alignment with assessment were seen less favourably. In the questionnaire, 97.5% of teachers agreed that the syllabus explicitly mentions ICT, and all seven interviewees described the curriculum as encouraging ICT in general terms. Agreement was lower that the curriculum specifies which tools to use (47.5%) and provides clear and practical guidelines (40.0%, with 32.5% disagreeing), and three interviewees noted that the curriculum rarely specifies tools for particular topics.

On assessment, 42.5% of questionnaire respondents agreed that examinations are aligned with ICT-integrated teaching and 35.0% disagreed, while six of seven interviewees perceived a mismatch and BT07 disagreed. A majority of questionnaire respondents (70.0%) agreed that the curriculum needs to be updated to better reflect ICT use, and 75.0% agreed that it gives teachers the flexibility to innovate and adapt ICT use.

4.5 Summary of the Chapter

This chapter presented the questionnaire responses of 40 Biology teachers and the interview accounts of seven Biology teachers from government-aided and private secondary schools in Wakiso District. On attitudes towards ICT integration, teachers were overwhelmingly positive in both strands, confidence was lower for specialised Biology tools, training was widely requested, and infrastructure barriers were named by five of the seven interviewees. On the curriculum, almost all questionnaire respondents agreed that the syllabus mentions ICT, while agreement was lower on tool-level guidance and on the alignment of assessment with ICT-integrated teaching. In the interviews, the government-aided and private school participants were similar in their positive attitudes and in their views of the curriculum, and differed mainly in reported practice, infrastructure barriers and training requests.

CHAPTER FIVE

DISCUSSION, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

Here, the findings presented in Chapter Four are discussed, conclusions drawn from them and recommendations suggested. The discussion follows the two specific objectives of the study: to investigate the attitudes of Biology teachers in selected secondary schools in Wakiso District towards ICT integration in Biology instruction, and to investigate the extent to which these teachers perceive the Biology curriculum as supporting ICT integration in Biology teaching. Because the study used a parallel mixed method design, the questionnaire and interview findings are read together, and the chapter points out where the two strands agree, where one explains the other, and where they pull in different directions (Creswell & Plano Clark, 2018).

The findings are interpreted against the literature reviewed in Chapter Two and the two frameworks that guided the study, the Technology Acceptance Model (Davis, 1989) and the Technological Pedagogical Content Knowledge framework (Mishra & Koehler, 2006). The chapter ends with conclusions for each objective and for the main objective, recommendations, the limitations of the study, and suggestions for further research. The evidence comes from 40 questionnaire respondents and seven interviewees, so the interpretations are offered with corresponding care, especially the comparisons between government-aided and private schools, which describe the participants in this study and are not claims about all schools in the district.

5.2 Discussion of Findings

5.2.1 Attitudes of Biology Teachers towards ICT Integration (Objective One)

5.2.1.1 A strongly favourable view of ICT, held with practical reservations

The clearest result under Objective One is how consistently favourable the teachers were. In the questionnaire, 92.5% agreed that ICT enhances the quality of teaching and learning in Biology and that it helps students understand abstract and complex concepts (a mean of 4.53 for each statement), and 90.0% regarded virtual laboratories and simulations as a valuable substitute where physical laboratory resources are lacking. All seven interviewees expressed a positive orientation, and most tied it to the same thing: the ability to show learners what cannot be seen directly. BT04 gave the examples of chromosomes during

mitosis and gas exchange in the lungs. Reservations were uncommon. Ninety per cent disagreed that traditional methods are sufficient for Biology and 75.0% disagreed that they feel anxious when expected to use ICT.

These results agree with the Bangladeshi evidence that Biology teachers generally welcome ICT because it makes invisible biological processes observable (Farhan, Kazi & Chakraborty, 2024), and with the wider claim that teachers who hold positive attitudes towards technology tend to use it more and to seek further training (Akram et al., 2022). They also sit comfortably with the pedagogical case made for visualisation tools in Biology (Redecker, 2017; Santos & Prudente, 2022; Reginald, 2023). In terms of the Technology Acceptance Model, perceived usefulness is firmly established among these teachers, with item means between 4.08 and 4.53.

The findings are less consistent with the earlier Ugandan evidence that teachers of Biology hold negative and cautious attitudes towards ICT (Muwanga, Ssentamu & Kimoga, 2017), the evidence on which the problem statement partly relied, or with reports of mixed feelings and considerable anxiety among teachers asked to use tools they had not been trained on (Namubiru, Kisembo & Kasiita, 2024). Several explanations are possible, and the data cannot separate them. Attitudes may have shifted with time, since the earlier study was conducted before the COVID-19 pandemic, which drew attention to the importance of technology in teaching (Olema, 2021). Wakiso District's closeness to Kampala may also expose teachers to more ICT initiatives than teachers in other parts of the country. In addition, self-reported Likert responses are open to social desirability, a limitation acknowledged in Chapter Three, so some respondents may have given answers that sound professionally acceptable. The interviews partly guard against this, because the interviewees' positive views came with specific examples and frank accounts of what they could not do.

The favourable attitude was also not unconditional. Thirty per cent of respondents agreed that ICT integration is too time-consuming relative to its benefits, and the mean of 2.67 for that statement was the least favourable of the four negatively worded items, falling in the neutral band of the interpretation scale. In the interviews, six of the seven participants said they sometimes preferred traditional methods, depending on the topic, the time available and the effort needed to set up equipment. This suggests that the teachers are not simply enthusiastic; they weigh the effort of using ICT against what it adds to a particular lesson. The same trade-off appears in the literature, where time constraints and logistical demands limit the use of simulations in science classrooms (Campos & Benarroch, 2025). It is also consistent with the "ease of use" side of the Technology Acceptance Model, which reminds us that a tool judged useful can still go unused if it is judged troublesome.

5.2.1.2 A confidence gradient from familiar tools to Biology-specific resources

Confidence was high in general but fell as the tasks became more specific to Biology. Agreement stood at 77.5% for feeling confident with ICT tools and for identifying suitable tools for particular topics, dropped to 67.5% for designing ICT-based lessons and to 60.0% for troubleshooting minor technical problems, and was lowest (52.5%, with 30.0% neutral) for knowing how to use Biology-specific digital resources such as simulations, virtual laboratories and online databases. The interviews described the same gradient. Six of the seven participants were more confident with smartphones, projectors and video than with simulations, virtual laboratories, digital microscopy and AI tools, and five knew such tools existed but reported limited or no use of them in class. BT06 put it plainly, saying that these tools were known through colleagues' conversations but that no lesson had ever been designed around them. BT07 was the exception, describing classroom use of a simulation, a virtual microscope and an AI tool for describing specimens.

Read through the TPACK framework, the pattern points to a specific kind of gap. Most teachers appear to have the general technological knowledge needed to run a projector or play a video, but the integrated knowledge that lets them choose, design and teach with a Biology-specific tool is less developed (Mishra & Koehler, 2006). Similar observations have been made elsewhere. Ugandan primary teachers with generally positive attitudes reported difficulty moving from basic computer use to subject-specific integration (Kibirige, 2023); Nigerian Biology teachers reported limited knowledge of subject-specific ICT applications (Ojo & Okunola, 2023); and Tanzanian secondary teachers were found to lack the subject-specific technological knowledge needed to embed ICT in their teaching (Kalinga, 2024). Molla and Seyoum (2022) make the related point that a positive attitude must be matched by self-efficacy with specific tools before it shows up in practice.

The confidence results are somewhat more favourable than those of Olema (2021), who found low ICT readiness and limited confidence and technical competence among teachers in Mayuge District. The difference may reflect the district, the timing of the studies or the composition of the sample, which here was young, with 47.5% of respondents aged 20 to 30 years. Even so, the weaker results for troubleshooting and Biology-specific resources show that the concern raised by Olema has not disappeared. It has narrowed from general competence to specialised competence.

5.2.1.3 Willingness to learn and the demand for a different kind of training

Teachers were ready to learn. Ninety-five per cent said they would invest additional time in learning ICT tools, 87.5% said they would use ICT more often with adequate training and support, and 92.5% agreed that ICT training should be mandatory in professional development for Biology teachers, the highest mean among the attitude statements (4.63). Five of the seven interviewees asked for practical training, and they described it in similar terms: sustained, hands-on and specific to Biology, and not a one-day workshop where someone talks about ICT.

One result needs careful reading. Most respondents (82.5%) reported some form of ICT training, yet the demand for more is very strong. Only 25.0% had been trained through in-service or professional development programmes, while 35.0% had been trained during pre-service education and 22.5% were self-taught or had learned informally. The questionnaire did not measure the quality or content of that training, so it cannot be said why the demand persists, but the interviews suggest an answer: the training teachers have had appears to be general and short, whereas what they ask for is Biology-specific and continuous. This fits the observation that capacity-building in ICT across Sub-Saharan Africa has not consistently translated into classroom practice (Agyei, 2021), and it supports the view that training influences both attitudes and the ability to use tools in subject teaching (Akram et al., 2022; Suliman, Wenlan & Sleiman, 2024b; Vrasidas & Glass, 2005). It also means that the mere existence of training, as counted in Table 4.1, is a weak indicator of readiness.

5.2.1.4 The gap between attitude and practice

The interviews showed that a favourable attitude does not by itself produce classroom use. Reported practice varied widely. BT01 and BT02, both from private schools, described near-daily and independently prepared ICT use, whereas BT06, from a government-aided school, relied entirely on colleagues to operate a projector and BT03 reported low personal use despite a positive view of ICT. BT06 summarised the position: a positive attitude but very low ability. Five of the seven participants also described material constraints, including electricity, classroom sockets, projector availability, internet connectivity and a shortage of gadgets. BT07, for example, said that most schools have no classroom sockets and no projectors, which limited how much ICT could be used.

This is the pattern described in the literature, where attitudes are central to whether integration succeeds (Msafiri, Kangwa & Lianyu, 2023) but effective integration also depends on training and institutional

support (Islam et al., 2024). It also matches reports that computers are rarely used to support active classroom learning even where they are available (Mbabazi, Tusiime & Abiodun, 2022) and that unreliable electricity and connectivity persist despite national investment (Mpumuje, 2024). The finding also refines the problem statement. Reliance on conventional methods among Biology teachers in Wakiso District does not appear to be driven mainly by unfavourable attitudes, as the earlier Ugandan study had suggested; it appears to be driven by uneven skills, uneven access to equipment and the practical effort of using ICT. Wakiso's proximity to the capital does not seem to have removed these constraints, which supports the expectation stated in Chapter One that the district reflects many of the national challenges.

Institutional encouragement gave a more positive picture. Sixty per cent of respondents disagreed that their school administration does not encourage or support ICT use, although 25.0% agreed and 15.0% were neutral. Bariu and Chun (2022) found that administrative support improved teachers' confidence and willingness to integrate ICT, and the generally high willingness observed here may be partly related to that support. The interview accounts, however, show that encouragement alone does not supply sockets, projectors or hands-on training. For a quarter of teachers the encouragement itself is missing.

5.2.1.5 Differences between government-aided and private schools

Positive attitudes and perceived benefits were reported by all participants in both school types. The differences lay in practice and conditions. All three government-aided participants named infrastructure or equipment barriers, reported lower confidence with specialised tools and asked for practical, sustained training, while all four private school participants reported personally operating a projector and video, and the only participant using a simulation, a virtual microscope and an AI tool (BT07) was also from a private school. The two participants who reported near-daily independent use (BT01 and BT02) were likewise both from private schools.

These contrasts should be treated as leads rather than conclusions, for two reasons. The groups are very small, and school type is entangled with teaching experience: the government-aided participants had 15 to 30 years of experience, whereas the private school participants had between one and 12 years. The literature offers competing readings. Farhan et al. (2024) found that Biology teachers with more experience and more ICT exposure held more positive attitudes and were more confident in identifying suitable tools, while Quaicoe and Pata (2024) found that teachers under 35 were more enthusiastic and better prepared to use ICT than older colleagues. The pattern in the present interviews is closer to the second finding, but it cannot be separated from differences in school resources, which Bingimlas (2009) identifies as a major influence on how teachers experience ICT integration. The study did not analyse the

questionnaire responses by school type, so it cannot be said whether the same pattern holds across the 40 respondents. Testing this is left for further research.

5.2.2 Teachers' Perceptions of Curriculum Support for ICT Integration (Objective Two)

5.2.2.1 A curriculum that encourages ICT in principle but guides it thinly

Teachers saw the Biology curriculum as clearly in favour of ICT, but less clear about how ICT should be used. Almost all respondents (97.5%) agreed that the syllabus explicitly mentions ICT, the highest mean in the curriculum section (4.63), and all seven interviewees described the curriculum as encouraging ICT in general terms. Agreement was much lower on the practical detail: 47.5% agreed that the curriculum specifies which digital tools should be used for particular topics, 40.0% that it gives clear and practical guidelines (with 32.5% disagreeing), 62.5% that it identifies topics where ICT should be used and 50.0% that it reflects modern technological advances in Biology. On the direct question, 55.0% knew of specific tools named in the syllabus or teaching guide, 35.0% said ICT is mentioned only in general terms and 10.0% said no tools are named. Three interviewees (BT03, BT04 and BT06) said the curriculum rarely names a tool for a given topic.

In practical terms, teachers read the curriculum as a statement of intent and not as an operational guide. This is the same conclusion reached in Tanzania, where science teachers treated ICT integration as a matter of personal initiative because syllabi gave little subject-specific guidance (Guma, Mtebe & Mwantimwa, 2021), and in Uganda, where teachers acknowledged government support for ICT but reported inadequate subject-specific curriculum guidance on how to use digital tools in teaching and assessment (Namubiru, Kisembo & Kasiita, 2024). It also reflects the point that the presence of ICT-integrated teaching guidelines is one of the indicators by which teachers judge whether a curriculum supports technology (Tondeur, Scherer, Siddiq & Baran, 2017), and the view that teachers interpret curriculum documents actively and do not simply implement them (Remillard, 2005). BT07's remark that any gap depends on the teacher can be read in the same light: where the curriculum leaves the choice of tools open, use depends on individual initiative.

Two findings from the study reinforce each other here. Teachers were least confident about Biology-specific digital resources (Objective One), and the curriculum was seen as rarely naming such resources (Objective Two). A curriculum that does not point to particular tools leaves teachers to find and learn them alone, and it is the teachers with the least confidence and support who are most affected. This is the mechanism that the TPACK framework would predict, in which limited pedagogical guidance on

technology weakens teachers' confidence in identifying suitable ICT applications for specific Biology topics.

5.2.2.2 Assessment as the main point of tension

Assessment produced the sharpest doubts. Only 42.5% of respondents agreed that the school's assessment methods and examinations are aligned with ICT-integrated Biology teaching, while 35.0% disagreed and 22.5% were neutral (a mean of 3.15). In the interviews, six of the seven participants described a mismatch between ICT-supported, often collaborative learning and individually written, time-limited examinations, and four said that conventional methods became more prominent as examinations approached. BT01 described an examination that is very theoretical, whereas teaching calls for practical work and ICT integration that the assessment does not reflect.

The interview evidence was therefore stronger than the questionnaire evidence, which showed a divided opinion and not a clear majority against alignment. One possible reason is that the questionnaire item referred to the school's assessment methods as well as examinations, so some respondents may have been thinking of internal tests, whereas the interviewees spoke mainly about examinations. The small number of interviewees is another consideration. Whichever explanation applies, the two strands agree on the direction: assessment is the least well aligned element of the curriculum environment, and it is the point at which teachers report returning to conventional teaching.

This is a familiar finding. Teachers who see the curriculum as examination-oriented tend to prioritise direct instruction and reduce technology to peripheral activities (Ertmer & Ottenbreit-Leftwich, 2010), examination systems in East Africa have been reported to continue to reward factual recall, leaving teachers unsure of the practical value of ICT (Suliman, Wenlan & Sleiman, 2024a), and Ugandan teachers have been found to interpret curriculum priorities through examination demands and to revert to conventional methods where alignment is weak, even when ICT facilities are available (Kiiza & Sangkaworn, 2023; Namubiru, Kisembo & Kasiita, 2024). Dele-Ajayi, Fasae and Okoli (2021) similarly describe a mismatch between government advocacy for digital learning and the extent to which ICT is embedded in syllabi and assessment. Against this background, the competency-based curriculum's emphasis on critical thinking, collaboration and problem-solving (NCDC, 2020) is difficult to sustain if the examinations that follow do not measure those competencies. BT07 was the one dissenting voice, arguing that there is no structural mismatch and that it depends on the teacher, and proposing that ICT itself be used in assessment, for example by letting learners who miss an examination sit it online. That

suggestion is worth taking seriously, because it points to a way of bringing assessment closer to ICT-supported learning.

5.2.2.3 Flexibility, currency and realism

Teachers saw room to manoeuvre in the curriculum: 75.0% agreed that it gives them the professional flexibility to innovate and adapt ICT use (a mean of 3.63). Flexibility is one of the features teachers use to judge curriculum support (Tondeur et al., 2017), so this is a favourable result. At the same time, 70.0% agreed that the curriculum needs to be updated to incorporate and reflect ICT use better (a mean of 3.77), and views on realism were divided. Only 47.5% agreed that the curriculum's ICT requirements are realistic given the infrastructure in most schools, 35.0% disagreed, and 55.0% saw a clear link between what the curriculum requires and the ICT resources in their own schools.

Taken together, these results suggest that teachers do not experience the curriculum as blocking ICT. What they ask for is more specific guidance, a closer connection to assessment and requirements that match the resources schools actually have. The divided view on realism echoes the infrastructure barriers reported by five of the seven interviewees, and it reflects the observation that teachers in better-resourced schools are more likely to see curriculum expectations as achievable while those in resource-constrained schools find them hard to meet (Bingimlas, 2009). Because the questionnaire data were analysed for the sample as a whole and not by school type, the present study cannot show whether this is happening in Wakiso, and the interview evidence on this point is only indicative.

5.2.2.4 Differences between government-aided and private schools

On curriculum, the two groups were much more alike than they were on practice. All seven participants saw the curriculum as encouraging ICT in general terms, all three government-aided and three of the four private school participants perceived a mismatch with examinations, and two participants in each group reported a shift towards conventional methods as examinations approach. The only visible difference was that two of the three government-aided participants and one of the four private participants noted the absence of tool-level guidance. With such small groups this should not be over-read, but the overall picture suggests that constraints linked to the curriculum and assessment are shared across school types, whereas constraints linked to equipment and skills are felt more unevenly.

5.2.3 Bringing the Two Objectives Together: What the Findings Say about Readiness

The main objective of the study was to determine the readiness of Biology teachers in selected secondary schools in Wakiso District to integrate ICT in the teaching of Biology. Combining the two frameworks, the evidence shows a clear difference between the motivational and the practical dimensions of readiness. On the motivational side, which the Technology Acceptance Model addresses, the teachers are ready: they see ICT as useful, they are willing to invest time in it, and few feel anxious about it. On the competence and enabling side, which TPACK and the curriculum findings address, readiness is partial: confidence drops for Biology-specific tools, guidance on which tools to use is thin, assessment does not clearly reward ICT-supported learning, and many schools lack basic equipment. Attitudes therefore run ahead of practical readiness, which fits the argument in the literature that positive attitudes are necessary but not sufficient (Molla & Seyoum, 2022; Islam et al., 2024).

This also helps to explain the wider concern that policy frameworks such as the Education Digital Agenda Strategy 2021 to 2025 (Ministry of Education and Sports, 2021) have not yet been matched by classroom practice, and that computers in Ugandan schools have been used mainly for administrative purposes (Mukhula, Nabukeera & Nsimbe, 2021). The present study did not measure how often or for what purpose teachers use ICT, so it cannot compare its results directly with that report. The interview accounts of varied and conditional use do, however, point in the same direction.

5.2.4 Interpretation in Relation to the Study Hypotheses

Chapter Three set out how mean scores would be interpreted: 3.5 and above indicates a positive attitude or perception, 2.50 to 3.49 a neutral or ambivalent position, and below 2.5 a negative one. Table 5.1 classifies the questionnaire items against that scale, using the mean scores reported in Chapter Four.

Table 5.1: Questionnaire mean scores classified against the interpretation scale

Group of items	Items	Range of means	Position on the interpretation scale
Attitude statements, positively worded (Tables 4.3 to 4.5)	15	3.50 to 4.63	All 15 items in the positive band (3.5 and above)
Attitude statements, negatively worded (Table 4.6)	4	1.88 to 2.67	Three items below 2.5, which is favorable to ICT; one item (ICT is too time-consuming) at 2.67, in the neutral band
Curriculum support statements (Tables 4.9 and 4.11, excluding the item on the need for updating)	9	3.13 to 4.63	Four items at 3.5 or above; five items in the neutral band (3.13 to 3.45); none below 2.5

Source: Field data (2026). Classification by the researcher using the interpretation scale in Section 3.13.1. The item on whether the curriculum needs to be updated (mean 3.77) is excluded from the last row because agreement with it signals a perceived shortcoming and not support.

On this basis the first alternative hypothesis, that Biology teachers in the selected schools hold a significant positive attitude towards ICT integration in Biology instruction, is supported by the descriptive results, since every positively worded attitude item falls in the positive band and the negatively worded items point the same way. The second alternative hypothesis, that teachers significantly perceive the Biology curriculum as supporting ICT integration, receives only partial support. Explicit mention of ICT (4.63), flexibility (3.63), identification of topics for ICT use (3.52) and the link to school resources (3.50) reach the positive band, but the specificity of tools (3.27), the clarity of practical guidelines (3.13), the reflection of modern technological advances (3.45), the alignment of assessment (3.15) and the realism of requirements (3.15) fall within the neutral band.

To test the hypotheses formally, composite scores were calculated for each construct (Section 3.13.1) and compared with the neutral midpoint of 3.0 using one-sample t-tests. Table 5.2 reports the results for the two composite scores and for the subscales from which they are built.

Table 5.2: One-sample t-tests of composite scores against the neutral midpoint of 3.0 (N = 40)

Scale	M	SD	t (df = 39)	P	Mean diff.	95% CI of diff.	95% CI of mean	d
Perceived usefulness of ICT (items 8–12)	4.41	0.65	13.59	< .001	1.41	[1.20, 1.61]	[4.20, 4.61]	2.15
Confidence and self-efficacy (items 13–17)	3.75	0.91	5.24	< .001	0.75	[0.46, 1.05]	[3.46, 4.05]	0.83
Willingness and motivation (items 18–22)	4.36	0.60	14.27	< .001	1.36	[1.17, 1.55]	[4.17, 4.55]	2.26
Barriers, reverse-coded (items 23–26)	3.77	0.85	5.71	< .001	0.77	[0.50, 1.04]	[3.50, 4.04]	0.90
Attitude composite (items 8–26)	**4.09**	**0.49**	**14.11**	**< .001**	**1.09**	**[0.93, 1.24]**	**[3.93, 4.24]**	**2.23**
Curriculum provisions and ICT guidance (items 27–31)	3.60	0.67	5.64	< .001	0.60	[0.38, 0.82]	[3.38, 3.82]	0.89
Institutional and structural alignment (items 32–34, 36)	3.36	0.89	2.53	.015	0.36	[0.07, 0.64]	[3.07, 3.64]	0.40

Scale	M	SD	t (df = 39)	P	Mean diff.	95% CI of diff.	95% CI of mean	d
Curriculum support composite (items 27–34, 36)	**3.49**	**0.68**	**4.54**	**< .001**	**0.49**	**[0.27, 0.71]**	**[3.27, 3.71]**	**0.72**

Source: Field data (2026). Two-tailed one-sample t-tests against a test value of 3.0. M = mean on the 1–5 scale; mean diff. = M − 3.0; CI of diff. = confidence interval of the mean difference; CI of mean = confidence interval of the mean; d = Cohen's d. Barrier items were reverse-coded and item 35 was excluded from the curriculum scale.

First hypothesis. The attitude composite (α = 0.82) had a mean of 4.09 (SD = 0.49; 95% CI for the mean [3.93, 4.24]), significantly higher than the neutral midpoint, t(39) = 14.11, p < .001, mean difference = 1.09, 95% CI [0.93, 1.24], with a very large effect (d = 2.23). The null hypothesis that Biology teachers do not hold a statistically significant positive attitude towards ICT integration is therefore rejected, and the first alternative hypothesis is supported. The difference was also significant when tested against the 3.5 threshold of the positive band, t(39) = 7.63, p < .001, so the attitude is positive by the interpretation scale as well as above neutral. Every attitude subscale was significantly above 3.0 (p < .001 in each case). The means were highest for perceived usefulness (4.41) and willingness (4.36) and lower for confidence (3.75) and for the reverse-coded barrier items (3.77), which matches the confidence gradient and the reservations discussed in Section 5.2.1.

Second hypothesis. The curriculum support composite (α = 0.80) had a mean of 3.49 (SD = 0.68; 95% CI for the mean [3.27, 3.71]), which was also significantly higher than 3.0, t (39) = 4.54, p < .001, mean difference = 0.49, 95% CI [0.27, 0.71], a medium-to-large effect (d = 0.72). The null hypothesis that teachers do not significantly perceive the curriculum as supporting ICT integration is therefore rejected, and the second alternative hypothesis is supported statistically. The size of the result needs care, however. A mean of 3.49 lies at the very top of the neutral band and cannot be distinguished from the 3.5 threshold of the positive band, t(39) = −0.08, p = .939. Teachers therefore perceive the curriculum as supportive, but only moderately, which agrees with the item-level pattern in Table 5.1, where four items reached the positive band and five stayed in the neutral band. Both curriculum subscales were significantly above 3.0, but institutional and structural alignment (M = 3.36, p = .015) was clearly weaker than curriculum

provisions and ICT guidance ($M = 3.60$, $p < .001$), in line with the concerns about assessment alignment and realism reported in Section 5.2.2.

The composite scores were approximately normally distributed (Shapiro–Wilk $p = .209$ for attitude and $p = .058$ for curriculum support), and the Wilcoxon signed-rank test gave the same decisions for both hypotheses ($p < .001$ in each case), so the conclusions do not depend on the normality assumption. The tests describe the 40 teachers in the nine participating schools. Because the schools were not selected at random, the results should not be generalized to all Biology teachers in Uganda.

5.3 Conclusions

The conclusions below answer each objective and research question directly and are drawn only from the findings reported in Chapter Four.

5.3.1 Objective One: Attitudes of Biology Teachers towards ICT Integration

In answer to Research Question One, Biology teachers in the selected secondary schools in Wakiso District hold strongly positive attitudes towards ICT integration in Biology teaching. They regard ICT as useful for teaching abstract and complex concepts, they are willing to invest time in learning it, and few report anxiety or a belief that traditional methods are sufficient. This orientation was shared by all seven interviewees and was equally present in government-aided and private schools.

The positive attitude, however, is not matched by equal confidence or practice. Teachers are more confident with general tools such as projectors, video and smartphones than with Biology-specific resources such as simulations, virtual laboratories and digital microscopy, and they are widely asking for practical, sustained and Biology-specific training. Reported use is conditional on the availability of equipment, electricity and connectivity, and on the time needed to prepare and set up, and it differs between teachers and, in the interview sample, appears to differ between school types, with government-aided participants reporting more barriers. Teachers' attitudes are therefore favourable, but attitude alone has not been enough to secure consistent ICT use.

5.3.2 Objective Two: Teachers' Perceptions of Curriculum Support for ICT Integration

In answer to Research Question Two, Biology teachers perceive the curriculum as supporting ICT integration in principle but only moderately in practice. They agree almost unanimously that the syllabus mentions ICT and most feel it gives them the flexibility to innovate. They are much less convinced that it

names specific tools, provides clear and practical guidance or is aligned with assessment, and a majority believe that it needs to be updated to reflect ICT use better.

Assessment is the weakest link. Most interviewees perceived a mismatch between ICT-supported learning and written examinations, and a number said they revert to conventional methods as examinations approach, although the questionnaire responses on assessment alignment were divided rather than clearly negative. Perceptions of the curriculum were broadly similar across the two school types. The curriculum is therefore seen as permitting and encouraging ICT use, but not yet as guiding, assessing or resourcing it.

5.3.3 Main Objective: Readiness of Biology Teachers to Integrate ICT

Biology teachers in the selected schools are attitudinally ready but only partly ready in practice. Their motivation and willingness are strong, while their confidence with Biology-specific tools, the tool-level guidance in the curriculum, the alignment of assessment and the availability of basic equipment are not yet strong enough to turn that willingness into consistent classroom integration. Readiness is best described as conditional: it depends on targeted training, clearer curriculum guidance, better-aligned assessment and dependable equipment and power. These conclusions apply to the teachers who took part in the study and should not be generalised to all Biology teachers in Uganda.

5.4 Recommendations

The recommendations follow directly from the findings above. They are grouped by the body best placed to act.

5.4.1 Ministry of Education and Sports and Providers of Teacher Professional Development

Professional development in ICT for Biology teachers should be practical, sustained and specific to Biology. Almost all respondents wanted training to be mandatory (92.5%), 87.5% said they would use ICT more with adequate training, only 52.5% felt they knew how to use Biology-specific digital resources, and five of seven interviewees asked for hands-on support rather than a single workshop. Programmes should therefore run over several sessions with follow-up support in the schools, should let teachers practice with simulations, virtual laboratories and digital microscopy on topics they actually teach, and should include basic troubleshooting, since 22.5% of respondents could not troubleshoot minor technical problems. Because the study found both very confident and very unconfident teachers within the same

district, a mentoring arrangement that pairs confident teachers with colleagues who are less confident, whether within a school or across a cluster of schools, would make good use of expertise that already exists.

5.4.2 National Curriculum Development Centre

The Biology syllabus and teaching guides should say more about how ICT is to be used. Fewer than half of respondents (47.5%) agreed that the curriculum specifies which tools to use for particular topics, only 40.0% found the guidelines clear and practical, and 70.0% agreed that the curriculum needs updating. The Centre should consider adding suggested digital tools and exemplar ICT-supported lessons against specific topics, especially the abstract processes that teachers themselves named as needing visualization, and should provide low-resource alternatives, since only 47.5% found the ICT requirements realistic for the infrastructure in most schools. Guidance of this kind would also reduce the dependence on individual teachers' initiative that came out of the interviews.

5.4.3 Examination and Assessment Authorities

Assessment should be brought closer to the competencies that ICT-supported teaching is meant to develop. Only 42.5% of respondents agreed that assessment is aligned with ICT-integrated teaching, six of seven interviewees perceived a mismatch, and four described a return to conventional methods as examinations approach. Authorities should review how far current examinations reward practical and inquiry-based competencies, and should consider school-based or continuous assessment tasks that involve simulations, digital data or other ICT-supported work. BT07's suggestion that ICT be used in assessment itself, including online sittings where appropriate, deserves consideration in that review.

5.4.4 School Administrators and Proprietors

Schools need to secure the basic conditions for ICT use and to support the teachers who attempt it. Five of the seven interviewees described problems with electricity, sockets, projectors, connectivity or gadgets, and all three government-aided participants named such barriers. School leaders should give priority to reliable power and classroom sockets, to enough projectors and devices, and to a timetable or booking system for shared equipment. Where internet access is unreliable, teachers can be encouraged to download videos and simulations in advance for offline use. Schools should also allow preparation time, since 30.0% of respondents thought ICT integration too time-consuming, and should identify someone who can give technical help. The 25.0% of teachers who felt that their administration does not encourage ICT use suggest that visible and consistent encouragement from school leaders is still needed. Government-aided

schools should be a priority for any external support, given the barriers reported by the government-aided participants.

5.4.5 Teacher Education Institutions

Pre-service programmes should teach ICT within the context of Biology and not only as a general skill. Pre-service education was the largest single source of ICT training among respondents (35.0%), yet confidence with Biology-specific resources remained the weakest area of competence. Institutions should build TPACK-based tasks into Biology methods courses, in which student teachers select, use and evaluate digital tools for particular Biology topics.

5.4.6 Biology Teachers

Teachers can make progress without waiting for external support. They can build on the tools they already use with confidence, such as projectors, video and smartphones, and extend gradually to simulations and virtual laboratories, starting with topics that are hard to demonstrate directly, such as cell division and gas exchange. Sharing lesson resources and experiences with colleagues, through the subject department or a teachers' network, would help to spread the practices of the more confident teachers, and the teachers who already use ICT regularly may be best placed to lead this.

5.5 Limitations of the Study

Several limitations should be kept in mind when reading these findings. The study was confined to selected schools in Wakiso District, and the results may not hold in districts with different infrastructure or resources. The questionnaire drew on 40 respondents and the interviews on seven participants, so the school-type comparisons in particular are descriptive, and in the interviews school type is entangled with teaching experience. The findings rest on self-reported attitudes and perceptions, which may be influenced by social desirability, and the study did not observe classroom practice, so statements about use reflect what teachers said and not what they were seen to do. The questionnaire responses were analyzed for the whole sample and not compared by school type, so the comparisons between government-aided and private schools rest on the interview data alone and are descriptive. Finally, the study captured views at a single point in time, while ICT integration and the competency-based curriculum are still developing. The consistency between the questionnaire and interview findings on most points gives some reassurance, but the limitations remain.

5.6 Suggestions for Further Research

The findings and the limitations above point to several areas for further research.

1. **Classroom observation studies.** The gap between favourable attitudes and varied practice should be examined through observation of lessons and analysis of lesson plans, to establish how often, for what purposes and with what tools Biology teachers actually use ICT.
2. **Larger and broader samples.** A study using probability sampling across more schools and districts, including rural districts, would test whether the patterns found in Wakiso hold elsewhere, and would allow inferential comparison by school type, age, gender and teaching experience. *Such a study should also compare questionnaire responses between government-aided and private schools.*
3. **Separating the effects of school type and experience.** The interview contrast between government-aided and private schools was entangled with years of teaching. A study designed to compare teachers of similar experience across school types would show which factor matters more.
4. **Analysis of curriculum and examination documents.** The present study captured perceptions. A systematic analysis of the Biology syllabus, teaching guides and past examination papers would show how far ICT is actually specified and assessed.
5. **Intervention studies on Biology-specific training.** Evaluating a sustained, TPACK-based training programme for Biology teachers would show whether it improves confidence with specialised tools, classroom practice and learner outcomes.
6. **Perspectives of school leaders and learners.** This study drew only on teachers. The views of head teachers, ICT coordinators and learners, together with the effect of learners' attitudes and network connectivity that the conceptual framework treated as contextual factors, would give a fuller account of the conditions for ICT integration.
7. **Emerging tools.** Only one interviewee reported classroom use of AI tools, and only one other mentioned them. Research is needed on how such tools are entering Biology teaching, what teachers need to use them well and what they mean for assessment.

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APPENDICES

Appendix i: Research permission letter

MAKERERE UNIVERSITY
College of Education and External Studies
Department of Science Education
P.O. Box 7062, Kampala, Uganda

The School Administrator,

_____

_____

(Name of School)

Wakiso District, Uganda.
Dear Sir/Madam,

RE: REQUEST FOR PERMISSION TO CONDUCT RESEARCH IN YOUR SCHOOL

We, the underlisted, are third-year students at Makerere University pursuing a Bachelor of Science with Education degree. We are currently undertaking a research study as part of our academic requirements, titled: "Investigating the Readiness of Teachers of Biology to Use ICT in the Teaching of Biology in Wakiso District of Uganda."

We humbly request your permission to conduct this research in your school. The study will involve administering questionnaires to teachers of Biology. All information collected will be treated with strict confidentiality and used solely for academic purposes.

The research will be conducted at a time convenient to the school and will not interfere with normal teaching and learning activities in second term of academic year 2026. Your cooperation and support will be greatly valued and acknowledged in our final research report.

We look forward to a positive response at your earliest convenience. Please do not hesitate to contact us for any further information or clarification.

Yours faithfully: _____ (on behalf of all members)

Names, Registration numbers and Telephone contacts of Applicants:

1. Mutumba Robert:	23/U/2062	0782574632
2. Kamakune Priscilla:	23/U/0498	0753585084
3. Mukimba Racheal:	23/U/0841	0704173435
4. Kibirige Ibrahim:	23/U/09713/Ps	0702595213
5. Wadribo Nesko:	23/U/1513	0755752091

FOR OFFICIAL USE – SCHOOL ADMINISTRATOR

Permission: ☐ Granted ☐ Not Granted

Name of Administrator: _____
Designation: _____
Signature: _____ Date: _____Official Stamp:

Appendix ii: QUESTIONNAIRE:

MAKERERE UNIVERSITY

School of education of Education and External Studies

RESEARCH QUESTIONNAIRE

Investigating the Readiness of Teachers of Biology to Use ICT in the Teaching of Biology in Wakiso District of Uganda

Dear Respondent,

You are kindly invited to participate in this academic study. This questionnaire is designed to collect data on ICT integration in Biology instruction.

Your honest and candid responses are essential to the success of this research. All information you provide will be treated with strict confidentiality and used solely for academic purposes. Your identity will not be disclosed in any report, publication, or presentation arising from this study.

Completion of this questionnaire is entirely voluntary. Participation implies your consent to take part in this study. This questionnaire should take approximately 15–20 minutes to complete.

Thank you for your time

Section A: Demographic Information

Please tick (✓) the box that best describes you

1. **Gender**

   ☐ Male ☐ Female

2. **Age Group**

   ☐ 20–30 years ☐ 41–50 years

   ☐ 31–40 years ☐ Above 50 years

3. **Highest Academic Qualification**

   ☐ Certificate in Education ☐ Diploma in Education

☐ Bachelor's Degree

☐ Postgraduate Diploma in Education

☐ Master's Degree

☐ PhD / Doctorate

☐ Other (please specify):

_____

4. **Teaching Experience (number of years teaching Biology)**

   ☐ Less than 5 years

   ☐ 5–10 years

   ☐ 11–15 years

   ☐ Above 15 years

Section B: Attitudes towards ICT Integration in Biology Instruction

Using the scale below, please tick (✓) the response that best reflects your personal opinion.

Be as honest as possible — there are no right or wrong answers

Scale: 1 = Strongly Disagree | 2 = Disagree | 3 = Neutral | 4 = Agree | 5 = Strongly Agree

B1: General Beliefs about ICT in Biology Teaching

Statement	**Strongly Disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
8. ICT enhances the quality of teaching and learning in Biology.					
9. ICT tools help students understand abstract and complex Biology concepts more easily.					
10. Using ICT in Biology lessons makes the content more relevant to students' everyday lives.					
11. ICT makes Biology lessons more interactive and engaging for students.					
12. Virtual laboratories and simulations are a valuable substitute when physical lab resources are unavailable.					

2: Personal Confidence and Self-Efficacy with ICT

Statement	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
13. I feel confident using ICT tools (e.g., computers, projectors, software) in my Biology lessons.					
14. I am able to identify which ICT tools are most appropriate for specific Biology topics.					
15. I can troubleshoot minor technical problems that arise when using ICT during a lesson.					
16. I am comfortable designing Biology lessons that incorporate ICT-based activities.					
17. I know how to use Biology-specific digital resources (e.g., simulations, virtual labs, online databases).					

B3: Willingness and Motivation to Integrate ICT

Statement	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
18. I am willing to invest additional time to learn how to use new ICT tools in my teaching.					
19. I actively seek out ICT resources and materials that can support Biology instruction.					

Statement	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
20. I would use ICT more frequently in my lessons if I received adequate training and support.					
21. I encourage my students to use ICT as a tool for learning Biology beyond the classroom.					
22. ICT training should be a mandatory component of professional development for all Biology teachers.					

B4: Perceived Barriers and Challenges

Note: The following statements are negatively worded. Please respond honestly about your actual experience.

Statement	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
23. ICT integration is too time-consuming relative to the benefits it offers in Biology teaching.					
24. I do not see the need to use ICT since traditional teaching methods are sufficient for Biology.					
25. I feel anxious or uncomfortable when expected to use ICT tools in my lessons.					

Statement	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
26. My school administration does not actively encourage or support ICT use in subject teaching.					

Section C: Perceptions of Biology Curriculum as supporting ICT Integration

Please indicate your level of agreement with each statement below

Scale: 1 = Strongly Disagree | 2 = Disagree | 3 = Neutral | 4 = Agree | 5 = Strongly Agree

C1: Curriculum Provisions and Explicitness of ICT Guidance

Statement	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
27. The current Biology syllabus explicitly mentions the use of ICT tools in teaching and learning.					
28. The Biology curriculum specifies which digital tools or resources should be used for particular topics.					
29. The curriculum provides clear and practical guidelines on how to integrate ICT into Biology lessons.					
30. The Biology syllabus identifies specific topics where ICT tools (e.g., simulations, virtual labs) should be used.					
31. The curriculum reflects modern technological advancements relevant to Biology education.					

C3: Institutional and Structural Alignment

Statement	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
32. The curriculum provides teachers with the professional flexibility to innovate and adapt ICT use in Biology lessons.					
33. The school's assessment methods and examinations are aligned with ICT-integrated Biology teaching.					
34. There is a clear link between what the Biology curriculum requires and the ICT resources available in my school.					
35. The current Biology curriculum needs to be updated to better incorporate and reflect ICT use.					
36. The curriculum's ICT integration requirements are realistic given the infrastructure available in most schools.					

37. **Are specific ICT tools or digital resources explicitly recommended in your Biology syllabus or teaching guide?**

☐ Yes — I am aware of specific tools/resources mentioned in the syllabus

☐ Some-what — ICT is mentioned in general terms but no specific tools are named

☐ No — the syllabus does not mention specific ICT tools

☐ I am not sure

Thank you very much for completing this questionnaire.

Your contribution is greatly appreciated and will directly support efforts to improve Biology education through ICT in Uganda.

Appendix iii: SEMI-STRUCTURED INTERVIEW GUIDE FOR BIOLOGY TEACHERS

MAKERERE UNIVERSITY SCHOOL OF EDUCATION AND EXTERNAL STUDIES

SEMI-STRUCTURED INTERVIEW GUIDE FOR BIOLOGY TEACHERS

Research Title:

Investigating the Readiness of Teachers of Biology to Use ICT in the Teaching of Biology in Wakiso District of Uganda.

INTRODUCTION TO THE RESPONDENT

Dear respondent,

Thank you for agreeing to participate in this interview. The purpose of this interview is to obtain your views and experiences regarding the use of Information and Communication Technology (ICT) in the teaching of Biology.

The information you provide will be treated confidentially and used strictly for academic purposes. Your name will not appear in the research report; instead, a pseudonym or code will be used. Your participation is voluntary, and you are free to decline to answer any question or withdraw from the interview at any time without penalty.

With your permission, the interview will be audio-recorded to ensure that your responses are captured accurately. The interview is expected to take approximately 30 minutes.

Consent

1. Do you consent to participate in this interview?

2. Do you consent to the interview being audio-recorded?

Thank you.

SECTION A: BACKGROUND AND EXPERIENCE WITH ICT

1. Could you briefly describe your experience of using ICT in teaching Biology?

Possible probes:

- How long have you been teaching Biology?
- Which levels do you currently teach?
- What ICT tools or digital resources have you used in teaching Biology?
- How often do you use ICT in your Biology lessons?

SECTION B: TEACHERS' ATTITUDES AND READINESS TOWARDS ICT INTEGRATION

2. What is your take or opinion on the use of ICT in teaching Biology, and how has this view been shaped by your experience?

Possible probes:

- What benefits or concerns have shaped your attitude towards using ICT in Biology?
- Has your attitude towards ICT changed over time - for example, after using it for a particular Biology topic - and what influenced the change?
- Are there circumstances in which you would prefer traditional teaching methods over ICT? Why?

3. How confident do you feel about selecting and using ICT to teach Biology, especially for abstract or difficult-to-visualize topics such as mitosis, photosynthesis or genetics?

Possible probes:

- How confident are you in selecting and designing an ICT-supported lesson for a specific Biology topic, using tools such as simulations, virtual laboratories or digital microscopy?
- How confident are you using general ICT tools such as computers, smartphones or projectors, and how do you handle minor technical problems?
- Are there particular ICT tools or Biology topics where you feel more or less confident? Why?

4. In your experience, how does ICT affect the teaching and learning of Biology?

Possible probes:

- Does ICT help students understand abstract or complex Biology concepts? How?
- Does it influence student engagement, participation or interaction?
- How does ICT support practical work, visualization, simulations or experiments?
- Does ICT make Biology more relevant to students' everyday lives?

SECTION C: TEACHERS' PERCEPTIONS OF THE BIOLOGY CURRICULUM AND ICT INTEGRATION

5. How well does the Biology curriculum or syllabus support and guide the use of ICT in teaching Biology?

Possible probes:

- Does the syllabus explicitly encourage ICT use and recommend particular tools or resources for specific Biology topics?
- Does the curriculum support competency-based learning through ICT?
- How much flexibility does the curriculum give teachers to decide when and how to use ICT?

6. How well do assessment and examination requirements support ICT-integrated Biology teaching?

Possible probes:

- How do school assessments or national examinations encourage to use ICT?
- Do the skills emphasized in assessments align with those developed through ICT-supported learning, or is there a mismatch?
- How does this relationship between curriculum expectations and examinations affect the way you teach Biology?

SECTION D: CLOSING

7. Is there anything else about your attitudes towards ICT or your perception of how the Biology curriculum supports ICT integration that you think is important for this study?

Thank you

End of interview.