THE INFLUENCE OF INFORMATION COMMUNICATION TECHNOLOGY (ICT) ON STUDENTS' CLASSROOM PARTICIPATION IN LEARNING BIOLOGY IN GOVENRMENT-AIDED SECONDARY SCHOOLS

CASE STUDY: KIMAANYA-KABONERA DIVISION, MASAKA CITY

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DEDICATION

I dedicate this academic piece of work to my family members and course mates, for their continued support up to this level. For the classmates who completed before me, you have been an inspiration to me and I believe that, this work is possible and one day I shall also graduate just like you did. For the family members you have endured the division of family resources.

ACKNOWLEDGEMENTS

Research is not a one-day activity. It involves a series of steps and procedure from the location of a researchable problem up to defense. During this research processes, numerous persons have been instrumental and without their assistance, guidance and time, this study would have been a fiasco. For this reason, I profoundly take this opportunity to appreciate my wife Nakalawa Flavia and children, Nalutaaya Catherine, Ssembatya Ivanovic, Ssenkungu Timothy, Nambatya Christine, Namuganga Mary Immaculate and Muwanguzi Augustine for the moral support they rendered to me. My course mates whom i consulted constantly are also appreciated. My dear respondents, thank you for sparing your valuable time and responded to all question items. I also thank my late father Mr. Lutaaya Yozefanti for encouraging me and supporting to pay school fees painfully throughout my entire education by growing coffee which I have been selling to raise the university tuition and other fees. I'm so grateful for his enduring and tireless support without your effort; this would not have been possible. On the same note, I thank my brothers and sisters for the support. I also thank the authors of textbooks and materials I have read to support this piece of work. In addition to the above, Dr. O'dama Kayi Modest you are greatly appreciated for the academic guidance. Thank you very much.

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LIST OF ACRONYMS

CEO	:	City Education Officer
COVID–19	:	Corona Virus Disease 2019
CVI	:	Content Validity Index
E-Learning	:	Electronic Learning
ECLAC	:	Economic Commission for Latin America & Caribbean
EFA	:	Education for All
et-al	:	Latin words meaning and others
EU	:	European Union
ICT	:	Information Communication Technology
MoES	:	Ministry of Education and Sports
NCDC	:	National Curriculum Development Centre
NCLB	:	No Child Left Behind
OECD	:	Organization for Economic Cooperation and Development
SPSS	:	Statistical Package for Social Scientists
TAM	:	Technology Acceptance Model
UACE	:	Uganda Advanced Certificate of Education
UCE	:	Uganda Certificate of Education
UK	:	United Kingdom
UMU	:	Uganda Martyrs University
UNESCO	:	United Nations Educational Scientific and Cultural Organization
USA	:	United States of America
USE	:	Universal Secondary Education
WB	:	World Bank

TABLETS: Is a wireless, portable personal computer with a touch screen interface

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ABSTRACT

The study examined the influence of Information Communication Technology (ICT) on Students' Classroom Participation in Learning biology in Government-Aided Secondary Schools in Kimaanya–Kabonera division, Masaka City. The study was guided by the following specific objectives: To assess the influence of the internet usage on students' classroom participation in learning biology in government aided secondary schools in Kimaanya–Kabonera division. To analyze the influence of computer usage on students' classroom participation in learning biology in government aided secondary schools in Kimaanya–Kabonera Division. To establish the influence of tablets usage on students' participation in learning Biology in government aided secondary schools in Kimaanya–Kabonera division. To evaluate the influence of smartphones usage on students' participation in learning biology in government aided secondary schools in Kimaanya–Kabonera division. Constructivist Theory, which was advanced by Jean Piaget (1896–1980), informed this study. During the study, the researcher used a descriptive survey design. The study was conducted in three (3) government aided secondary schools. The samples included 322 S3 and S4 students and 16 teachers of biology. The researcher used questionnaire forms and interview guides to collect the data. The findings are: 91.3% of the teacher-respondents agree that internet use enhances students' classroom participation in biology lessons (M=4.34; SD=0.66). Secondly, 98% (M=3.24; SD=1.76) of the teachers agree that computer use promotes students' classroom participation in biology lessons in the surveyed schools. However, 25% of the students disagree because they believe that schools do not have enough computers for students and students do not use the available computers for typing their notes and other assigned activities. Thirdly, 62.6% (M=2.80; SD=2.20) of teachers agree that students use tablets to increase their participation in biology learning lessons. This shows a low agreement among teachers. The interview result also indicates that students concur with teachers on this finding. The reasons both teachers and students attribute to this are: lack of access or affordability and school policy. Lastly, 100% of teachers and students agree that smartphones ease the teaching – learning process by enabling students to research biology content on their own; smartphones motivate learners (37.5%); and smartphones help students to understand contents taught in biology (18.75%). It is concluded that the use of ICT tools can help teachers of biology to enhance their teaching and students' learning in biology lessons, but both teachers and learners have to access and know how to use these ICT tools to realize their pedagogical potential in teaching and learning biology. The

Ministry of ICT and Ministry of Education and Sports should provide wireless and free internet services to all government-aided secondary schools to harness the pedagogical potential of ICT tools to enhance students' classroom participation in biology lessons. The Ministry of Education and Sports should train all secondary school teachers in ICT to increase the use of ICT resources, thereby, increasing students' classroom participation in biology lessons. The Ministry of Education and Sports should procure and supply secondary schools with functional computers, internet, tablets and smartphones to increase students' participation biology lessons.

CHAPTER ONE

GENERAL INTRODUCTION

1.0. Introduction

The study examined the influence of Information Communication Technology (ICT) on Students' Classroom Participation in Learning Biology in Government Aided Secondary Schools in Kimaanya – Kabonera Divisions, Masaka City. The advancement of ICT has changed the way people share information in all sectors including education. In schools, ICT is commonly used and has been known by different names, that is; online learning, (E-learning, blended learning among other names (Pima et-al, 2017; Popova & Gabre, 2017; Ghavifekr & Rosdy, 2015). The integration of ICT in the teaching – learning process assists teachers of biology to better their teaching methods and enhances students' level of classroom participation. This chapter mainly focused on background to the study, research questions, scope of the study, significance of the study, justification of the study and conceptual framework.

1.1. Back ground to the study

History of the influence of ICT on learning biology

Information and Communication Technology (ICT) has gone through innovation and has transformed society and the World has become a global village. ICT has changed peoples' lives (UNESCO, 2003, 2002). ICT prepares students for the current digital era and teachers are seen as catalysts and key players in using ICT during the teaching – learning processes. ICT provides a dynamic and proactive teaching – learning environment which enhances students' level of classroom participation (Becker, 2007; Oblinger, 2004). The use of ICT in education has been a priority in most developed countries in the world in the last three decades.

In countries such as United Kingdom (UK), schools have embedded the use of ICT in the teaching and learning Processes (Organization for Economic Cooperation and Development–OECD, 2004; UNESCO, 2003, 2002). The rapid growth of the global economy and the information based society has pressurized education systems around the world to use ICT to teach the knowledge and skills needed to transform communities in the 21st Century (World Bank, 2004).

In 1994, President Bill Clinton signed The Goal 2000: Educate America ACT, Leadership in Technology called upon policy makers in the USA Education Department to create strategies which were aimed at involving technology into all educational programs (Goals, 2000; Educate America Act, 1994). Spears (2012) observed that the Educate America Act of 1994 acknowledged the use of ICT to be a driving force to increase students' level of participation in the teaching-learning process. In Latin America, the Economic Commission for Latin America and the Caribbean (ECLAC) in conjunction with European Union (EU) in 2010 implemented the project called Alliance for the Information Society 2 – Inclusive Policy Dialogue and Exchange of Experiences. The project was aimed at using ICT in all sectors of the economy.

The World Bank developed strategies to help all countries in Latin America to take advantage of the opportunities brought about by ICT and create an impact in teacher training, distance learning, digital literacy, assessment and increasing students' classroom participation (Achimugu & Afolabi, 2018; Ashley, 2016). It should be noted, however, the use of ICT in the teaching – learning process is greatly influenced by teachers' level of proficiency, the willingness of the school administrators to provide ICT gadgets and the availability of power supply. The virtual learning – environments are seen to have potential in providing opportunities for active learning more especially where individualized learning is more needed for instance during school holidays and when the world was put on lockdown during COVID 19.

In Malaysia, the Ministry of Education launched a comprehensive review of the education system 2011. During the review, one of the fundamental recommendations was:

Ensuring that there is integration and implementation of ICT for self-guided learning in the country (Young, 2017; Zhang, 2017).

In line with Education for All (EFA), the Malaysian government embarked on a heavy investment in Education aimed at improving and upgrading the systems to become fully operational in utilizing ICT in the teaching – learning processes. The project which was mentioned on the 7th shift required scaling up quality learning in Malaysia by providing free internet and virtual learning environment (Malaysian–Ministry of Education, 2012). However, it has to be noted that the use of ICT in Malaysian schools has had many hurdles and one of them is that the minority approximately 20% of the teachers have little technical know-how when it comes to the use of ICT gadgets and this affects the students" classroom participation (Rosnaini & Mohid, 2010). The level of ICT knowledge among teachers is one of the key factors for Malaysian society to make successful adoption of ICT in its education.

On the contrary, many developing countries in Africa are living in a world of technological deficiency, that is, lack of knowledge to access knowledge via the internet (OECD, 2006). To date, many teachers in secondary schools in East Africa use handwritten note to teach what is extracted from text books and use face-to-face pedagogical approaches to deliver the contents to Students. This mode of teaching substantiates that there is technological deficiency in the teaching – learning process thereby hindering students‟ level of classroom participation (Tarimo & Kavishe, 2017). The use of ICT in the teaching and learning processes in secondary schools is still in its infancy in many East African countries. Many urban schools in East Africa have adopted ICT as a means of imparting knowledge and skills required by the students but many rural based schools are still using the traditional approaches of teaching and this has greatly affected students level of classroom participation (UNESCO, 2002). In Rwanda, the government in 2008 launched the one laptop per child (OLPC) project and over 5000 laptops were distributed to primary schools in three districts. The overall purpose of OLPC was to equip every child in primary with ICT skills. In 2007, ICT was officially introduced as one of the compulsory subjects in the secondary curriculum and students had to spend at least 2 hours per week learning ICT skills (Iradukunda, 2015).

Uganda started embracing ICT as part of its economic development strategy of its economic development strategy when the first mobile phone service company (Celtel) came onto the Uganda Scene in 1994. He cost of owning and maintaining a mobile phone was too high and very few Ugandans by that time could afford (Asaba, 2017).

Since then, the ICT sector in has grown and there is a fully fledged Ministry of ICT. Uganda has the world's youngest population estimated over 78% below 30 years and internet users are estimated to be over 6.5 million people (Opira, 2016; MoES, 2010). The Ministry of Information and Communication was established in June 2006 and given the mandate of providing strategies and technical leadership in ICT. The use of ICT has grown rapidly in the last two decades and many Ugandans are using smartphones, iPods, laptops and many are using social media platforms like WhatsApp (Kayiwa, 2017).

During the lockdown due to corona virus the ministries of ICT and Education promoted E-learning. Also media houses like television stations and radio stations were used to teach students. However, this mode of teaching only favored students from high socio–economic status families and those from low socio- economic status lagged behind (UNEB, 2021).

1.1.2. Theoretical perspective

The study was guided by the Constructivist Learning Theory. This theory was advanced by Jean Piaget (1896–1980). This theory assumes that children learn through communication with others (Fontana, 2015; Farrant, 2007). Piaget posits that learning takes place by learners completing tasks for which support is initially required. This support may come from teachers, parents, fellow learners or by use of ICT gadgets. Piaget asserts that student–centered methods of teaching increase students' level of classroom participation. Learning takes place as students practice. Students do not learn well if the teacher happens to teach the abstract things (Douglas, 2016; Mann and Tall, 2016). In the essence of the study, the use of the Constructivist Learning Theory is justified on the following grounds:

- During the formal operational stage, students are able to apply logic to abstract thought and as a result, students can learn to apply ICT knowledge in solving academic problems.
- Second, Learning Environment teachers' role ceases to be of imparting knowledge but to act as a catalyst during the teaching – learning process.

The above two ground makes this theory relevant to the study logical thinking and guided learning enhances students' level of classroom participation (Farrant, 2007; Atkinson, 2000; Good & Brophy, 2002; Child, 2006). Unlike the teacher – centered approach of teaching where the teacher is the custodian of knowledge, the Constructivist Learning Theory advocates for active participation of the students. It is against this background that the researcher deemed this theory relevant in examining ICT and students' level of classroom participation in studying biology in secondary schools.

In addition to the above theory, the study is guided by the connectivism learning theory. This theory was put forward by Siemens G (2008). According to Siemens, modern day learning occurs through a network of connections. In this, individuals share their interests, knowledge, perspectives, expertise and opinions in online and virtual learning environment. In addition to the above, Siemens argues that connectivism is a learning theory comprised of nodes to connect hundreds of networks to facilitate synchronous and asynchronous learning. These connections provide individuals with direct access to reliable information from millions of sources to duplicate and share with in their social networks and delete, critique, and discard inaccurate, irrelevant and unreliable information. This theory is found to be so useful to this study because it advocates for social interactions among learners with in their classrooms. With this, learners can share, communicate and store information with the support of ICT Tools like computers, tablets and smartphones. It is against this background that the theory is justified for use in this study.

The study is further guided by the discovery learning theory by Jerome Brunner (1960). Brunner's theory argues for active participation of learners in gathering scientific knowledge. The theory encourages teachers to create experiences that facilitate construction of knowledge. Biology being a science subject, the researcher finds it worth for use in this study. This is because it combines aspects like students' interaction, sharing, creating and disseminating scientific knowledge which all much possible with the support ICT tools. Through the process of student interaction, participation is enhanced which stimulates critical thinking and problem solving generic skills among learners.

1.1.3. Conceptual perspective

Students' classroom participation in learning biology refers to the energy and effort students exert during the teaching–learning processes. It can be observed in a number of aspects like cognitive, affective and behavioral participations (Fontana, 2015; Biggs, 2009; Becker, 2007). Cognitive participation relates to deep learning strategies, self-regulation and understanding; affective participation relates to positive reactions to the learning environment, that is, schoolmates or classmates and teachers whereas behavior participation relates to participation, persistence and positive conduct (Ngoungouou, 2017; Mtebe and Raphael, 2017; Ngugi & Kinzi, 2017). Students' level of participation in biology can be expressed in terms of observable and measurable indicators through cognitive, affective and behavioral actions or reactions. It has to be noted that students' level of classroom participation during the teaching and learning of biology does not occur in vacuum, but there are a number of facilitating factors (Pima & Mtui, 2017; Popova & Fabre, 2017).

ICT is believed to increase students' level of participation when they show the following characteristics; critical thinking, reflection, desire to do well, positive interaction with their fellow students and teachers, classroom participation and involvement. The study focused on how ICT enhancement influences students' participation in biology lessons. (Kisanjala et- al 2017)
ICT has been described to refer to the field work and study that includes use of technologies such as computers, software, peripherals and connections to the internet that is intended to fulfill information processing and communication (Zepre et–al, 2010). According to Young (2017) and Vougt (2016), utilization of ICT refers to the intentional use of networked ICTs such as computers and internet in the teaching– learning process.

1.1.4. Contextual perspective

In Uganda, the ordinary level and Advanced level curricula have ICT as one of the examinable subjects. The rationale of including ICT on the curricula was to enable all students to become computer literate. The Ministries of Education and ICT embarked on a nationwide campaign to distribute computers to all government aided secondary schools (MoES, 2017; 2015, 2010). As stated in the National Curriculum for Lower Secondary and in the Advanced level Curriculum the aims and objectives of teaching ICT to both levels of secondary education are to: help students to develop cognitive affective and manipulative skills in their application; enhance students' classroom participation among others (NCDC, 2019, 2015, 2010). Secondary school teachers need to apply appropriate teaching approaches and methods which are suitable to enhance students' classroom participation particularly in biology. Students will not only be able to acquire in-depth knowledge in biology but also be able to understand how they can generate more knowledge using ICT tools during the learning process (MoES, 2022, NCDC, 2019).

All government aided secondary schools were supplied with computers and this depended on the students' enrollment and infrastructure where these ICT gadgets were to be housed. The variation in number of computers supplied by the Ministries of Education and ICT makes the current study on ICT and students' classroom participation in Biology and government aided secondary schools in Kimaanya – Kabonera Division in Masaka City very pertinent. Secondly, even in secondary schools where infrastructure and reasonable number of computers exist; it remains unclear whether there is adequate students' classroom participation as a result of ICT. This background showed that there is need to ascertain the correlation between ICT and students' classroom participation in the teaching and learning of biology in government aided secondary schools in Kimaanya–Kabonera Division–Masaka City

1.2. Statement of the problem

Students' participation has remained central in any teaching – learning studies by scholars (Asabere, Togo and Ampandu (2017). ICT provides an opportunity for secondary schools to harness and computers to support the teaching – learning process in biology in government aided secondary schools (Kayiwa,2016). Biology is one of the compulsory subjects at ordinary level and it is optional at advanced level. Despite the importance of science related subjects such as biology, students' participation in learning biology is poor, hence students' academic performance has consistently remained poor over the years particularly in Masaka City (Report by Masaka City Education Officer, 2021). This because of low usage of internet, lack of enough computers, absence of tablets and smart phones among teachers and students, and lack basic computer skill among teachers of biology. The cause of the concern is although the Central region of Uganda has continued to perform fairly well in biology in UCE and UACE results (UNEB, 2021). Schools in Masaka City particularly in Kimaanya – Kabonera Division are not performing well in sciences at both levels. Numerous teaching methods and approaches have been applied by teachers of biology with an aim to boost students' participation and performance in biology (Kayiwa, 2016; Kisanjara, 2017).

It is against this background that the researcher is decided to carry out an exhaustive study to ascertain the influence of ICT on students' participation in the teaching and learning of Biology in secondary schools in Kimaanya–Kabonera Division with a focus on government aided secondary schools as units of analysis.

1.3 Objectives of the study

1.3.2. Major objective

To assess the influence of ICT on students' classroom participation in learning Biology in Government aided secondary schools in Kimaanya–Kabonera Division in Masaka City.

1.3.1. Specific objectives

1) To assess the influence of the internet usage in teaching and learning on students' classroom participation in learning biology in government aided secondary schools in Kimaanya–Kabonera Division.
2) To analyze the influence of computer usage in teaching and learning on students' classroom participation in learning biology in government aided secondary schools in Kimaanya–Kabonera Division.

3) To establish the influence of tablets usage in teaching and learning on students' participation in learning biology in government aided secondary schools in Kimaanya–Kabonera Division.
4) To evaluate the influence of smartphones usage in teaching and learning on students' participation in learning biology in government aided secondary schools in Kimaanya–Kabonera Division.

Constructivism theory of learning advocates for supported learning through gathering experiences. The ICT tools such as internet, computers, tablets and smartphones are all supporting materials. They enable learners to create experiences that facilitate construction of knowledge. Consequently, knowledgeable students become more active participants in their learning and likely to perform better academically.

1.4. Research questions

1. How does the use of internet in teaching and learning influence students' classroom participation in learning biology in government aided secondary schools in Kimaanya–Kabonera Division?
2. How does the use of computers influence students' participation in learning Biology in government aided secondary schools in Kimaanya–Kabonera Division?
3. How does the use of tablets influence students' classroom participation in learning Biology in government aided secondary schools in Kimaanya–Kabonera Division?
4. How does the use of smartphones influence students' classroom participation in learning biology in government aided secondary schools in Kimaanya–Kabonera Division?

1.5 Scope of the study

1.5.1 Content Scope

The study focused on "The influence of Information Communication Technology (ICT) on students' classroom participation in Learning biology in Government aided secondary schools." In particular, the content of the study focused on how internet, computers, tablets and smartphones influence students' participation in learning biology in government aided secondary schools in Kimaanya– Kabonera, Masaka City.

1.5.2 Geographical Scope

The study was conducted in government aided secondary schools found in Kimaanya–Kabonera

Division in Masaka City. Masaka city is located in the central region of Uganda approximately 130km from Uganda's Capital City Kampala along Masaka – Mbarara road.

The coordinates of Masaka city are latitude O^{0} 18 27.60 N and Longitude 31^{0} 42 28.10E. Masaka city is bordered by Kalungu district in the North, Lwengo district in the South, Kyotera district in South East and Masaka district in the East and Bukomansimbi district in the West.

1.5.3 Time Scope

The study considered data available for a period of ten years (2013– 2023). It was during this period that the Ministry of Education and sports and that of ICT massively supplied ICT gadgets to government aided secondary schools in Masaka city and also students' performance in biology has been poor (MoES, 2017: 2015: 2010). The campaign was aimed at enabling students participate in the learning–teaching processes and to equip them with ICT skills. The integration of ICT catalyzes the teaching and learning of biology (Asabere et-al., 2017).

1.6 Justification of the study

Previous studies by scholars like Kisanjara et-al (2017) and Dudency (2014) mainly concentrated on academic performance and teachers' job performance. So this study mainly intended to look at how ICT usage in teaching and learning influences students' participation in biology. In the long run, active students' participation resulted into better students' academic performance. Secondly, the study was justified on the ground that students who studied biology using ICT acquired more skills and got more prepared in managing the resources around them in a more productive way. Lastly but not least, this study is pertinent at this time because it is one of the requirements which must be fulfilled before any student is awarded a Master's Degree of Uganda Martyrs University

1.7 Significance of the study

It is hoped that the study is going to be useful in the following ways:

The findings of the study are going to bridge epistemological gaps in literature and will act as a point of reference to future scholars and researchers in the fields of education and ICT. The new knowledge that has been found out as stated in the conclusion in chapter five shall enable future scholars to refer to it.

Teachers of biology in secondary schools are going to find the findings useful since it may help them to better their pedagogical skills and approaches during the teaching – learning processes by integrating ICT. It is expected that teachers integrate ICT in teaching and learning of biology in

secondary schools.

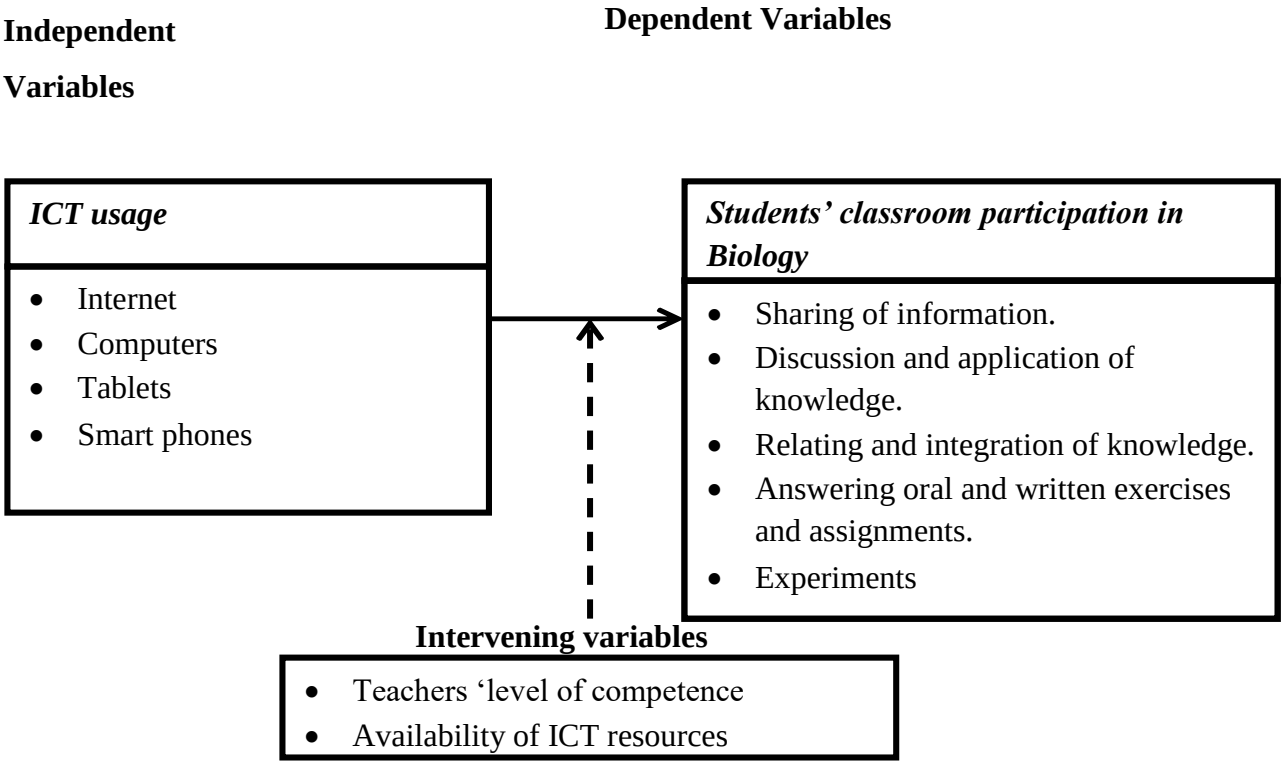
ICT has the potential to enhance the teaching and learning processes in secondary schools by preparing students to acquire skills, knowledge, attitudes and competencies which may enable them to compete in the global village hence making them relevant in the job market.

The findings of the study will be useful to the policy makers in the Ministries of Education and ICT. The findings will be used in the formulation of policies, strategies and intervention to address related challenges in Uganda.

Lastly but not least, the study will provide relevant body of knowledge to curriculum developers at the National Curriculum Development Centre (NCDC) as regard to the benefits of ICT as a teaching method. In planning and preparing what students should learn, NCDC benefits from this study by integrating ICT as a teaching aid in the teaching and learning of biology and other subjects.

1.8 Conceptual framework

According to Vyhmeister (2011) and Miles and Hurbman (2012), a conceptual framework is a research tool required to aid a researcher in developing awareness and understanding of the major variables under study. The conceptual framework in figure 1.1belowwas used to conceptualize ICT and its influence on students' participation in Biology in government aided secondary schools in Kimaanya– Kabonera Division, Masaka City.



Source: Adapted from Student – Learning outcomes by Ashley (2016) and modified by the Researcher (2024)

***Figure 1.1*: Conceptual frame work indicating ICT and its influence on students' participation in biology lessons**

In the above delineated figure 1.1, ICT tools like internet, computers, tablets, smart phones and projectors are aspects of the Independent Variables (IV) and students' participation the Dependent Variable (DV). The figure clearly illustrates that the ICT influences students' participation during learning of biology in government aided secondary schools in Kimaanya–Kabonera Division, Masaka City. The participation of students was considered in terms of active involvement during the teaching and learning of biology lessons. On the other hand, the intervening variables have the potential of influencing the Dependent variables (DV) either positively or negatively.

The explanation of the dependent variable was in line with students' involvement in biology lesson by listening attentively to the teacher, responding to verbal instructions and taking part in practical lessons through experiments, sharing of information amongst themselves, relating and integration of ICT knowledge in biology as well as doing both oral and written exercises and assignment using ICT gadgets available at school.

The intervening variables were controlled by the researcher by selecting equal number of respondents from each of the sampled schools. That is the number of questionnaires distributed to each school were the same. The researcher divided the sample size of 304 by three. This gave a result of about 101 questionnaires per school for students to respond too. This controlled bias, since some schools had a bigger number of students than others in s.3 and s.4 classes that were sampled.

To keep the conditions uniform for all the groups, the respondents were approached at 2:00PM. This controlled bias on time of the day, since some of the respondents were day scholars. It was expected that at this time all students were in school.

About teachers' level of competence, the researcher approached each of the sixteen teachers separately and requested them to fill the questionnaire separately. All the sixteen biology teachers were served with questionnaires irrespective of their age, gender, teaching experience. This enabled the researcher to control the influence of teachers' level of competence which could be resulting from their age, working experience on ICT usage and students' participation in learning biology.

About availability of ICT resources, the researcher used the single blind technique. In this technique the researcher did not disclose the intention of the outcomes of the study to respondents. This enabled the researcher to obtain as much information as needed about ICT resources. This could not have been possible because some teachers would not want to expose the weaknesses of their schools and about themselves, especially regarding the level of education and working experience.

CHAPTER TWO

LITERATURE REVIEW

2.0 Introduction

In this chapter, a review of related literature is done. The review covered the theoretical review, internet and students' classroom participation, computers and students' classroom participation, tablets and projectors and students' classroom participation. This was done in accordance with the objectives of the study. This chapter examines pertinent gaps in the existing literature and conclusions arising out of the literature review.

2.1 Theoretical framework

This study was guided by three theories, that is, Discovery Learning Theory by Bruner (1960), Constructivism Theory by Jean Piaget et al (1896 – 1980) and Connectivism learning theory by. Jerome Bruner (1960) developed the concept of Discovery Learning. He argued that students should not be presented with the subject matter in its formal form but are required to organize it themselves (Farrant2007; Fontana, 2015) requiring them to discover for themselves relationships that exist among items of information. This theory is appropriate for the current study because during biology lessons, ICT eases the practical part of it. The teaching of biology is more practical than theoretical.

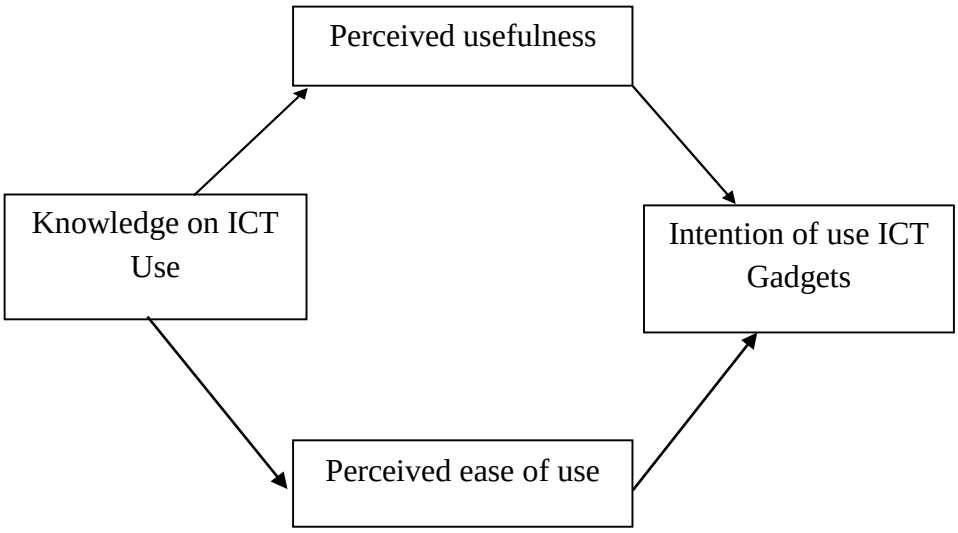
Bruner's theory is probably clearest when illustrated with practical examples in biology (Mcleod, 2023.). Bruner argues that students should discern for themselves the structure of subject content discovering the links and relationships between different facts, concepts and theories rather than the teacher of biology simply teaching them. The students can use ICT tools to research and discover for themselves thereby increasing their classroom participation (Baddeley, 2014. Fontana,2015. Ashley,2016; Child, 2006). Both Bruner and Vygotsky emphasize the students' school environment more than Piaget did. Both agree that students should play an active role in the teaching – learning processes (Tezei, 2019; Popova & Fabre,2017). In fact, the discovery learning theory is an active hand on style of learning. In this theory, Bruner emphasizes that students should be "learning by doing". With this learning, students use ICT tools to enhance their participation in the lesson instead of passively receiving knowledge. I.C. T tools enable students to interact with their environment especially if powered by internet to explore and manipulate objects, wrestling with questions and controversies or performing experiments. They are encouraged to think, ask questions, hypothesize, speculate, cooperate and collaborate with others. Using internet powered computers; they develop confidence in problem solving and feel

comfortable using knowledge they already have instead of students being empty vessels for a teacher to fill with knowledge that may be able to apply to the current subject at hand. In this theory, teachers are encouraged to focus on the process, not just grade a written paper at the end of experience. Therefore, constructivism and discovery learning theories have been found important for this study because they both advocate for active involvement of learning rather than passive consumption of knowledge. Such supported learning is possible with the use of ICT tools, which can be manipulated to facilitate learners generate new knowledge.

Bruner and Piaget agree that for learning to take place, students should actively participate. The teaching of biology using ICT gadgets calls for active involvement of all students (Fontana, 2015). The major theme in the theoretical framework of Bruner is that learning is an active process in which students constructs new ideas and concepts based upon their current/past knowledge in biology. Bruner's constructivist theory is a general framework for instruction based up the study of cognition. Much of the theory is linked to the child's development research.

Jean piaget asserts that the learning environment should be rich in physical experiences, involvement is the key to intellectual development. This can all be possible in presence of ICT tools like computers and internet for students to explore an entire world from their learning room. This will ultimately lead to increased participation in the classroom since students will have prior knowledge about what is to be taught. Therefore, the use of internet, computers, tablets and smartphones can be used by students to discover and prepare for the following lesson.

The Bruner's theory on discovery learning encompasses the idea of learning as an active process where by those learning are active participants and able to form new ideas based on what their current knowledge is as well as their past knowledge is in biology. For this reason, therefore, teachers of biology should use ICT resources focusing on encouraging, motivating and aiding the teaching–learning processes. The communication between the teacher and the learner is key and fundamental. During the teaching – learning process, the teacher acts as a facilitator (Fontana, 2015).



Source: Adapted from TAM model by Davis (2003), modified by the researcher (2024)

***Figure 2.1*: TAM Model**

The above TAM model explains how knowledge on ICT use by students will affect their perceived usefulness and perceived ease to use ICT and the intention to use ICT gadget. In this case, the intention will be to boost students' classroom participation in the teaching –learning of biology. This theory (TAM) guided the researcher in understanding ICT and students' classroom participation. The Constructivist Learning Environment and TAM shifts the role of the biology teacher from being the sole source of knowledge during the teaching –learning process to facilitating learning (The teacher acts as a facilitator or catalyst). Two theories, that is, TAM and Constructivist Learning Theory will be used because they complement each other thereby making biology lessons student – centered. It will be against this background, that the researchers will use these theories to ascertain the influence of ICT on students' classroom participation in biology among S3 and S4 students in government aided secondary schools in Kimaanya–Kabonera Division, Masaka City.

ICT-enhanced biology education

ICT-enhanced biology education draws from the constructivist learning theory, which posits that students learn best when actively involved in constructing their own knowledge (Piaget, 1970). In the context of ICT, technologies like interactive simulations, virtual labs, and multimedia presentations enable students to visualize complex biological processes that are difficult to grasp through traditional teaching methods alone. This approach aligns with Vygotsky's social constructivist theory, which emphasizes the role of collaboration and interaction in learning

(Vygotsky, 1978). ICT tools, such as collaborative platforms and discussion forums, facilitate peer learning and enable students to participate more actively in biology lessons.

Influential factors

The influence of ICT on classroom participation is shaped by several factors, including students' digital literacy, access to technological resources, and the teaching environment. The Technology Acceptance Model (TAM), developed by Davis (1989), provides a framework for understanding how students perceive and engage with ICT tools in education. According to TAM, students' perceived usefulness and ease of use of ICT tools directly influence their participation and willingness to engage in ICT-mediated learning activities. Students with higher levels of digital proficiency tend to participate more actively in biology classrooms where ICT is utilized, as they are more comfortable navigating the technological tools and resources provided.

Socioeconomic factors also play a critical role in influencing ICT integration. The digital divide, particularly in low-income or rural areas, affects students' ability to access ICT-enhanced education. The inequality in access to devices, internet connectivity, and digital tools remains a significant barrier to the effective implementation of ICT in biology education (Selwyn, 2016).

Advantages and challenges

The advantages of ICT in enhancing student participation in biology classrooms are rooted in its ability to make learning more engaging, interactive, and tailored to individual learning styles. Multimedia elements such as videos, animations, and interactive quizzes help demystify abstract biological concepts, making them more accessible to students (Mayer, 2009). Additionally, ICT tools provide students with opportunities for personalized learning through adaptive technologies, which adjust the content and difficulty based on the student's progress.

However, the integration of ICT in biology education is not without challenges. One key challenge is the potential for distractions. The accessibility of non-educational content on devices may divert students' attention away from the lesson (Crompton, 2017). Additionally, teachers often lack the necessary training or confidence to fully integrate ICT tools into their biology lessons, which can limit the effectiveness of these technologies (Ertmer & Ottenbreit-Leftwich, 2019). The theoretical framework of Technological Pedagogical Content Knowledge (TPACK), introduced by Mishra and Koehler (2006), highlights the importance of teachers possessing a deep understanding of how to combine ICT with pedagogical strategies and subject knowledge to maximize learning outcomes.

Research methodologies

Research into the influence of ICT on student participation in biology classrooms primarily employs both qualitative and quantitative methodologies. Theoretical frameworks like Activity Theory, which views learning as a socially mediated process, are frequently used to analyze how ICT tools support student interactions and participation in the classroom (Engeström, 1987). Studies that adopt a mixed-methods approach often provide a more holistic view of the effectiveness of ICT, blending observational data with measurable outcomes, such as improved student performance or engagement levels (Creswell, 2014).

Quantitative research typically relies on surveys, tests, and analytics from learning management systems to measure the extent of student engagement and participation in ICT-enhanced biology lessons. On the other hand, qualitative approaches involve in-depth interviews, classroom observations, and focus groups to explore students' perceptions of ICT tools and their influence on classroom dynamics.

Biology education contexts

The application of ICT in biology education varies across different educational contexts. In developed countries, well-resourced schools have access to advanced ICT infrastructure, enabling the use of virtual labs, data modeling software, and real-time collaboration tools in biology classrooms. In contrast, under-resourced schools, particularly in developing countries, face challenges in accessing the necessary technologies and infrastructure to support ICT-enhanced education (Ilochonwu, 2022).

Cultural factors also influence how ICT is integrated into biology education. In some cultures, where teacher-centred approaches dominate, the use of ICT may not be fully embraced, as it requires a shift towards more student-centered learning environments (Selwyn, 2016). On the other hand, educational systems that promote inquiry-based learning are more likely to integrate ICT tools that support student exploration and experimentation in biology education.

Teacher-centered aspects

Teachers play a pivotal role in determining the extent to which ICT influences student participation in biology. The TPACK model underscores the importance of teacher preparedness in combining technology with pedagogy and content to create effective biology lessons (Mishra & Koehler, 2006). Teachers who are proficient in using ICT tools can create interactive and engaging lessons that encourage students to participate actively in learning.

However, a lack of professional development and ongoing training hinders many teachers from

effectively integrating ICT into their lessons (Ertmer & Ottenbreit-Leftwich, 2019). As a result, the success of ICT-enhanced biology education often depends on the availability of support systems and professional learning opportunities for teachers to improve their technological and pedagogical skills.

Assessment and evaluation

ICT tools have transformed the assessment and evaluation of students' participation in biology classrooms. Digital tools such as online quizzes, interactive assignments, and peer-assessment platforms allow for real-time feedback, enabling students to track their progress and participation levels (Schmid & Petko, 2019). Formative assessments using ICT provide teachers with instant data on student performance, allowing them to adjust their teaching strategies to better support student learning.

Moreover, learning analytics can help educators assess students' engagement by tracking their interactions with digital content. However, there are challenges in evaluating student participation through ICT, as not all forms of participation (e.g., passive observation or quiet reflection) are easily captured through digital platforms (Crompton, 2017). Therefore, assessment tools must be carefully designed to ensure they measure not only cognitive participation but also emotional and social engagement in biology learning.

Emerging trends and future directions

The future of ICT-enhanced biology education is shaped by emerging trends such as artificial intelligence (AI), augmented reality (AR), and gamification. AI-powered platforms can provide personalized learning experiences, while AR can bring complex biological processes to life by allowing students to visualize and interact with 3D models of cells, ecosystems, and organisms (Dede, 2014). Gamification, through the use of game-like elements in learning, can further increase student motivation and participation in biology by making learning more enjoyable (Gikas & Grant, 2013).

Looking ahead, the integration of ICT into biology education will likely become more seamless, with increasing reliance on cloud-based platforms, real-time collaboration tools, and data analytics to foster more active student participation. However, there remains a need for more research on how these emerging technologies can be equitably implemented across diverse educational contexts.

2.2 How the use of internet in teaching and learning influenced Students' classroom participation in learning biology?

Studies carried out in UK by impacts (2000) on students' attainment revealed that there is a positive effect on students' participation, behavior, motivation, communication and school retention when teachers used ICT in teaching and learning processes. This is most often linked to a shift in the attitude of students and greater involvement in the learning activities.

The teaching – learning process when computers are used seem to be more interactive (Student – centered) (Mtebe & Raphael, 2017; Pima et-al, 2016). There have been a number of studies that revealed that the utilization of computers greatly affects students' classroom participation. Ngugiand Kinzi (2017) conducted a study in secondary schools found in Naivasha sub-county– Kenya and found out that the utilization of computers in the teaching – learning processes greatly facilitated the acquisition and retention of knowledge by the students. They also found out that ICT utilization in secondary schools was limited by: lack of enough computers and lack of skills by some secondary school teachers.

Schools in the western world invested a lot in ICT infrastructure such as computers over the last twenty years and teachers utilize ICT gadgets to enhance students' level of participation through e-learning (UNESCO, 2011, 2002, and 2003). However, in developing countries, technical difficulties like inadequate power supply and less competent teachers in ICT seem to frustrate both students and teachers. Many teachers do not use computers because of less ICT proficiency skills they possess. The technical problems have become a major barrier in the utilization of ICT in the teaching –learning process (Tarimo & Kavishe, 2017; Kisanjara, Tossy, Sife & Msanjili, 2017). With the development of e – learning in the 21st century, education teaching pedagogies have changed rapidly and during the COVID 19 lockdown, many counties in the world used ICT mode of teaching (Hawkins, 2020).

From the above literature, it can be noted that the use of ICT in education requires presence of resources like infrastructure (computer laboratories), money for maintenance, hardware, software package data as well as competent teachers with a positive attitude towards the use of ICT during the teaching–learning process (Barrera & Linden, 2019; Ashley, 2016). Ngoungouo (2017) notes some of the ICT devices for educational use such as laptops, desktop computers, calculators, telephones, data storage devices, printers, cameras, overhead projectors, interactive white boards, web technologies and other peripheral devices. All these devices are vital for the use of ICT in teaching in secondary schools. Many secondary schools now regard the use of ICT and the

mastering of its basic concepts as part of the core of teaching and learning processes of education (UNESCO, 2002).

In this study (ICT and students' classroom participation), students' participation looks at the effort students exert during the teaching –learning processes.

The teacher during the teaching and learning of biology acts as an instructor or catalyst through interaction with ICT tools in relation to their academic participation and application of the acquired skills, knowledge, attitudes and values by the students offering biology (Popora & Fabre, 2017; Spears, 2017; Chaameve, 2010).

The use of ICT creates a powerful learning environment and it transforms the learning of biology in secondary schools in which students deal with knowledge in an active, self-directed and constructive way especially when computers are used. This study therefore, ought to seek the influence of ICT on students' classroom participation particularly in biology. It has been proved that the use of computers in the teaching – learning process has a lot of benefits as far as students' interaction and enhancement is concerned (Hernes, 2016; Mann & Tall, 2016; Dudeney, 2014).

However, Gao, Wang, Wong & Choy (2017), suggested that the integration of ICT into the teaching of Biology depends on the individual teacher's competence and confidence. Research finding showed that lack of teachers' confidence and competence prevents teachers from using ICT gadgets and this hinders students' level of classroom participation (Tezei, 2019; Grabe & Grabe, 2017; UNESCO, 2005). A study by Kerry (2010), for instance, indicated that many teachers have a negative attitude towards the use of ICT gadgets because many schools in developing countries have not heavily invested in the education sector. Pima et-al (2016) found out that many secondary school teachers have low proficiency towards the use of computers in the teaching – learning process because the student – computer ratio is not matching. In many schools in East Africa one computer connected to internet can be used by more than 100 (one hundred) students and this hinders students' classroom participation (Iradukunda, 2015). Many schools have internet which is on and off.

The availability of computers with internet in secondary schools could help students in exploiting enormous possibilities for acquiring knowledge for learning purposes and could increase learning through increased students' classroom participation (Farrant, 2007; Fontana, 2015). Adebayo (2019) asserts that the increased availability of ICT in secondary schools is useful for students with Special Needs Education (SNE) since ICT use allows teachers to prepare suitable tasks for SNE students which cater for the individual differences in an inclusive setting. However, scholars like

Cox and Marshall (2019) believed that allowing students to overuse computers may distract them from focusing on the tasks at hand and instead watch films or pornography and other unrelated materials.

Internet-based learning strategies

Internet-based learning strategies have become integral to modern education, providing new ways to deliver content and enhance student engagement. According to Sun and Chen (2020), these strategies include using educational platforms, online videos, interactive simulations, and quizzes, which allow students to learn at their own pace and reinforce their understanding of complex topics in biology. The flexibility of online learning enables students to access resources beyond the classroom, promoting independent learning and inquiry-based education (Anderson & Dron, 2017). Interactive elements like online discussion forums and virtual labs have also been effective in fostering collaboration among students, thus improving their participation and engagement.

Factors influencing student participation

Several factors influence student participation in internet-based biology learning. Teacher involvement is a significant determinant, as educators who incorporate internet tools effectively can motivate students to participate more actively (Yeh et al., 2019). Moreover, student access to technology, internet connectivity, and digital literacy also play crucial roles. Low et al. (2021) found that students with better access to internet resources and devices are more likely to engage in classroom discussions and activities. Additionally, students' interest in biology, personal learning styles, and attitudes toward technology can influence their level of participation (Wang et al., 2020).

Benefits and challenges

Internet-based learning offers numerous benefits, including enhanced accessibility to educational resources, flexibility in learning schedules, and improved engagement through multimedia content (Al-Samarraie et al., 2018). For biology, in particular, online resources like virtual dissections, simulations of biological processes, and interactive diagrams have improved students' conceptual understanding (Wu et al., 2018). However, challenges such as unequal access to technology, distractions from non-educational online content, and lack of

direct interaction with teachers can hinder student participation (Hew et al., 2018). Furthermore, the digital divide between urban and rural students can exacerbate educational inequalities, limiting the effectiveness of internet-based learning in less privileged regions (Cerna et al., 2020).

Empirical studies

Several empirical studies have explored how internet-based learning influences student participation in biology. Yeh et al. (2019) examined the impact of flipped classrooms, where students accessed lectures online and engaged in discussions during class. The study found that students who used online resources before attending class participated more actively in classroom discussions. Similarly, Wu et al. (2018) conducted a study using virtual labs for teaching biology, which significantly increased students' engagement, as they could experiment with complex biological processes in a controlled digital environment. These studies suggest that internet-based learning strategies can lead to increased participation and better learning outcomes when properly integrated into the curriculum.

Regional and cultural contexts

The use of internet-based learning varies across regions and cultural contexts. In developed countries, students tend to have better access to internet infrastructure and technology, resulting in higher participation levels in internet-based learning environments (Low et al., 2021). However, in developing regions, such as Sub-Saharan Africa and parts of Southeast Asia, limited access to technology, poor internet connectivity, and lack of digital literacy can pose significant barriers to effective participation (Cerna et al., 2020). Cultural factors, such as attitudes toward technology in education and teacher-centered vs. student-centered learning traditions, can also affect how internet-based learning is perceived and adopted (Bates et al., 2020). Despite these challenges, initiatives to improve digital infrastructure and internet access in these regions have shown promise in bridging the gap in educational participation.

Emerging trends and technologies

Recent technological advancements continue to shape internet-based learning in biology. Artificial intelligence (AI), virtual reality (VR), and gamification are emerging trends that are

transforming how students engage with educational content (Zawacki-Richter et al., 2019). AI-powered learning platforms can personalize learning experiences based on student performance, while VR offers immersive environments for exploring biological concepts in 3D. According to Veletsianos (2020), gamification—using game design elements in learning—has also been shown to increase student motivation and participation, particularly in challenging subjects like biology. These technologies hold the potential to further enhance classroom participation by making learning more interactive and enjoyable.

2.3 How the use of computers in teaching and learning influenced students' classroom participation in learning biology?

Several scholars carried out studies on the utilization of computers and the studies revealed that school administrators should ensure that computers are used by students for academic purposes instead of resorting to online chatting (Asabere, Togo and Ampandu, 2017). Applications such as spread sheet, database or word processing should be utilized for educational purposes as well as searching for useful information via web browsing. However, studies reveal that some teachers are reluctant to use ICT especially computers in the teaching of biology. The effective integration of applied science into classroom practices poses a challenge to teachers include lack of appropriate skills fear of ICT elements and physical challenges such as power (Achimugu & Afolabi, 2018). From a large scale study in lowa, Ravitz, Mergendoller and Rush (2002), as cited by Cox and Marshall (2019), reported a positive association between student achievement and computer proficiency and home computer use, that is, students with higher levels of computer use and proficiency with computers tended to have higher levels of classroom participation and performance.

On a much smaller scale in the United Kingdom (UK), Ghavifekr and Rosdy (2015) also reported a positive association between using computers at home and students' classroom participation in Mathematics tests. However, it is hard to incorporate adequate controls for other factors that might influence students' concentration and participation in class (Winglinsky, 1998, United States Department of Education, 2002). The OECD (2005) reported on an analysis of data from PISA (2003) and suggested that there was an association of computer use at home and confidence in the use of computers in Mathematics performance. However, some of the relationships were non-linear, with moderate use being associated with better performance than the highest levels of computer use.

It is not possible in these analyses to be sure whether the home computer use and confidence in computer ability are reflections of other abilities that also influence Mathematics test performance. In the ever growing body of ICT literature and learning it seems that the ways in which and the extent to which students engage with learning biology tasks is crucial. In general, the evidence suggests that the use of computers enables richer, more engaging learning environments to be developed (Winglinsky, 1998). However, it is also evident that the use of computers does not always result in greater emotional participation with learning.

There is too much variation among students and the nature of learning tasks to expect conclusion that can be applied uniformly regardless of context like variation in socio – economic conditions or statuses where students are coming from. Fontana (2015) and Farrant (2007) contend that students' classroom participation is more likely to be strengthened when the teacher – student relationships are strong.

Teachers of biology are more likely to employ and be successful using ICT when they are confident if they have the skills to use it. Ongoing professional development is crucial to ensure that teachers have the requisite technology knowledge and skills that can actually foster student participation (Spears, 2017).

By giving feedback in the form of asking questions, students are encouraged to reflect more deeply (Good & Brophy,2002). Teachers of biology provide on-going encouragement to students to contact their teachers proactively when needed has also been found to be particularly effective. In addition, as ICT becomes more pervasive, computer based equipment is integrated into every aspect of schools' classroom participation (Kayiwa, 2016; MoES, 2010). A number of scholars like Mtebe & Raphael (2017), Biggs (2009) and Becker (2007) assert that the use of computers in teaching and learning can help students to become more knowledgeable. Recent trends towards cognitive approach on teacher – student integration suggest that the learning process can be enhanced through the use of ICT. For effective use of computers in instruction, the pedagogical practices used by teachers should change from teaching to instructing and from teacher – centered learning to student – centered learning if students' classroom participation is to be enhanced and sustained during the teaching and learning of biology in government aided secondary schools. Oblinger (2004) observed that the use of ICT in the teaching – learning process enhances students' motivation, participation and performance compared to the traditional chalkboard classroom instruction.

ICT allows for greater differentiation in secondary schools especially with educational programmes aimed at catering for individual student's needs. In other words, ICT provide teachers with an opportunity to provide a variety of learning tasks within the same classroom for the benefit of individual students' e – learning. However, e-learning is not free from criticisms. The ICT based instruction induces reallocations, substituting alternative, possibly more effective forms of instruction. Given a constant overall instruction time, this may decrease student performance.

This is caused by destruction particularly at home where internet access could be a source of destruction because of that rooms or online games, reducing the time spent in doing homework or learning (Mann & Tall, 2016). It has to be noted, however, the extent to which students engage with virtual learning environment may depend on the quality of the ICT gadgets, the interaction with the students, and the design and interactivity of the ICT gadgets. Provision of regular, personalized, clear and constructive feedback by the teachers to individual students can greatly enhance participation. Students' use of ICT not only depends on the availability opportunities, but also on the type of activity that the new technologies are supporting in the school environment.

Learning models in biology, for example, can lead to the development of cognitive related skills (Fontana, 2015; Child, 2006; Good & Brophy, 2002). Opportunities to use ICT means giving students a chance to freely interact with ICT gadgets which depends on factors like the number of internet enabled computers available, classroom enrollment, teacher's level of proficiency and students' level of motivation and interest (Atkinson, 2000; Farrant, 2007). Results of Cox and Marshall's study (2007) indicated that teachers not only need traditional – centered approach but also modern pedagogies. In addition, teachers' readiness and skills in using ICT are playing an essential role in the use of ICT in education.

Teachers need sufficient ICT skills to implement the technology and to have high confidence level to use it in a classroom setting. Besides, teachers of biology require insight into the pedagogical role in ICT in order to use it meaningfully in the instruction process (Barrera et-al, 2019). However, it should be noted that, the teaching of biology is much of hands-on-approach, so the use of ICT is of paramount importance in enhancing students' participation.

Computer-based learning strategies

Computer-based learning strategies, including simulations, virtual labs, and interactive software, have enhanced students' participation in biology education. According to Pérez-López and Contero (2021), digital simulations of biological processes allow students to interact with complex biological systems that would otherwise be difficult to observe in a traditional classroom. These technologies foster active learning, enabling students to experiment and visualize phenomena such as cell division, genetics, and ecosystems. The integration of computer-based assessments and real-time feedback also motivates students to participate more consistently, leading to a deeper understanding of biology topics (Schmid et al., 2020).

Additionally, adaptive learning platforms have been shown to personalize learning, catering to students' individual needs, thereby increasing their engagement. For example, Morris and Lim (2020) found that students who used interactive, computer-based tutorials demonstrated higher participation rates and a greater grasp of complex topics compared to those who learned through traditional methods. These platforms provide tailored content and self-paced learning, which can significantly improve student participation in the classroom.

Specific biology topics and age groups

Different biology topics and age groups show varying levels of engagement when exposed to computer-based learning. In secondary and tertiary education, students studying complex subjects like molecular biology, human anatomy, and ecology benefit significantly from computer-based learning tools (Park et al., 2021). These tools break down difficult concepts into more manageable, visually engaging simulations. For younger students, interactive games and animations are more suitable for fostering participation. According to Lee et al. (2020), using gamified biology lessons increases participation in younger learners by making abstract concepts tangible and engaging.

Moreover, computer-based learning allows for scaffolded learning in biology, where students are guided through progressively complex tasks, helping them build knowledge incrementally. This method is particularly effective in topics such as genetics and evolutionary biology, where understanding requires the integration of multiple levels of biological organization (Park et al., 2021).

Teacher-centered factors

The role of the teacher remains critical in maximizing the impact of computer-based learning. Teacher proficiency in integrating technology into the curriculum significantly influences student participation. Hattie and Donoghue (2020) emphasize that teachers who receive adequate training in using computer-based tools can more effectively facilitate classroom engagement. In biology, teachers must bridge the gap between traditional teaching methods and new technology by embedding computer-based activities that complement hands-on learning. The effective use of computer simulations and virtual dissections, for instance, allows teachers to demonstrate biological phenomena that are otherwise difficult to visualize (Schmid et al., 2020).

Moreover, teacher attitudes toward technology influence how they incorporate computer-based learning tools. According to Lim et al. (2020), teachers who view technology as an enhancement to traditional pedagogy are more likely to adopt computer-based strategies that increase student participation. However, a lack of teacher confidence in using digital tools can lead to reduced engagement and ineffective classroom integration.

Contextual and sociocultural factors

Contextual and sociocultural factors, such as students' access to technology, classroom environment, and socioeconomic background, affect how computer-based learning impacts participation. In technologically advanced regions, students often have greater access to computers, leading to more frequent use of digital tools and higher engagement in learning (Howard et al., 2021). However, in less privileged regions or schools with limited technological resources, participation may be hindered by a lack of access to necessary devices and infrastructure (Nawi et al., 2021).

Cultural attitudes toward technology also play a role in shaping the effectiveness of computer-based learning. In some societies, traditional teaching methods are preferred, and there may be resistance to integrating computers into the classroom (Bates et al., 2020). Conversely, in regions that embrace educational technology, students often exhibit higher levels of participation and motivation in using computer-based tools to learn biology.

Emerging trends and future directions

Emerging trends in educational technology, such as artificial intelligence (AI), virtual reality (VR), and augmented reality (AR), are expanding the possibilities of computer-based learning in biology. AI-powered platforms that offer personalized feedback and adaptive learning pathways have been shown to increase participation by catering to individual student needs (Zawacki-Richter et al., 2019). Additionally, VR and AR are transforming biology classrooms by allowing students to explore 3D models of biological structures, providing immersive learning experiences that engage students at deeper levels (Veletsianos, 2020).

Looking ahead, the integration of AI and machine learning algorithms into educational software is expected to further improve classroom participation by providing data-driven insights into student learning behaviors and preferences (Pérez-López & Contero, 2021). As these technologies become more accessible, they are likely to play a critical role in shaping the future of biology education, enabling more personalized, engaging, and interactive learning environments.

2.4 How the use of tablets in teaching and learning influenced and students'? classroom participation in learning biology.

The utilization of tablets in the teaching – learning process has been noted to have a remarkable effect on the entire secondary education in Uganda (MoES, 2019, 2014, 2010). Science related subjects are compulsory at ordinary level. These subjects are practical in nature and the integration of ICT in the teaching of biology is likely to enhance students' classroom participation. Enhanced student participation through using ICT can lead to a number of short term and long term academic and social outcomes (NCDC, 2019, 2010). In school and classroom settings, teachers of biology and head teachers are attempting to find the best way to harness ICT technology to support their teaching and students' classroom participation.

However, accomplishments that are convincingly the result of the direct causal impact of ICT use are not always easily identifiable (Voogt & Pelgrum, 2015; Douglas, 2016; UNESCO, 2005).

However, it should be noted that, tablets are unlikely to be the only variable influencing students' classroom level of participation in biology. According to this theory, an optimal learning experience will occur when a students' skills are sufficiently challenged by the task being administered by the teacher (Asabere et-al, 2017; Pimaet–al, 2016). In the case of ICT, the

challenge may stem from the need to navigate and assimilate a wide range of complex biology content and from the opportunity to interact directly with the specimen rather than from the tablet itself. Fontana (2015) asserted that the potential of virtual learning environments to transcend the limitations of time, space, resources like power supply can hinder or promote students' classroom participation in biology.

The extent to which students engage with virtual learning may depend on the quality of the instructional message the teacher is able to offer during the teaching – learning processes (Farrant, 2007; Hawkins, 2020; Young, 2017; Lynch, 2014).

According to Oblinger (2004) and UNESCO (2003), it was observed that games and simulations are potentially powerful in learning and a school can adopt them to enhance students' level of participation. The interactive nature of involvement and the availability of ICT facilities in a particular school greatly matters. Zhang (2017) and Young (2017) asserted that educational games or simulations operate by engaging the students and capturing the attention of those students. The enhanced participation in co-curricular activities can be transferred to the classroom situation there by enabling student to become active through cooperation with their classmates.

Pima & Mtui (2017) assert that the use of games, influence learning through enhanced motivation by increasing student control and feedback. Becker (2007) and Hamidi, Meshkat, Rezaee and Jafari (2018) contends that technologies used in computer games, improve students' attention span, inspire new interests and a result improve participation, learning and performance. It should be noted that tablets can be misused. Instead of students using them for academic purposes, they may use them for other things which can divert their attention. ICT faces some challenges such as inadequate supply of facilities and in experienced teachers in some schools.

The impact of technology on education

Technological advancements, particularly mobile devices like tablets, have increasingly influenced the dynamics of classroom learning. According to Sung, Chang, and Liu (2016), technology in education enhances engagement by facilitating interactive learning environments. Tablets offer immediate access to multimedia resources, allowing students to explore scientific content interactively. These devices encourage active learning and enable more individualized instruction, which can foster greater student participation, particularly in subjects like biology where hands-on and visual learning are crucial (Dolan, 2016).

Tablet-based learning strategies

Tablet-based learning in biology often involves the use of digital textbooks, interactive apps, and multimedia resources that support interactive and inquiry-based learning. In a study by Akpan and Strayer (2020), students using tablets for biology lessons demonstrated higher engagement levels as they could interact with digital simulations of biological processes, such as photosynthesis or cell division, thereby making abstract concepts more tangible. Gamification tools available on tablets also encourage students to participate actively in biology learning by transforming classroom activities into interactive challenges (Bano et al., 2018).

In addition, the portability of tablets allows for mobile learning, enabling students to continue their biology lessons outside of the classroom. This mobility enhances their engagement by making learning more flexible and accessible (West, 2015). Tablets also provide students with instant feedback through quizzes and assessments, which has been shown to boost participation as students are motivated to improve based on real-time results (Davis et al., 2017).

The role of teachers in tablet-based learning

Teachers play a crucial role in determining the success of tablet-based learning. According to Ifenthaler and Schweinbenz (2016), teachers who are adept at incorporating tablets into their lessons can foster higher levels of classroom participation. The effectiveness of tablet-based learning depends on how well teachers integrate the devices into biology curricula, utilizing interactive apps and simulations to supplement traditional teaching methods.

Teacher training is key to ensuring the success of tablet integration. Teachers must be comfortable with the technology and understand how to align tablet-based activities with learning objectives (Ertmer & Ottenbreit-Leftwich, 2019). Studies show that teachers who receive adequate training and support for using tablets report higher levels of student engagement, as they can more effectively create a participatory classroom environment (Zou et al., 2021).

The impact of tablets on student learning outcomes

Tablet-based learning has been linked to improved student learning outcomes in biology. Research by Hwang and Wu (2018) indicates that students who use tablets for biology education show enhanced retention of knowledge, particularly when learning about complex biological concepts like ecosystems, human anatomy, and cellular processes. The interactive nature of tablets allows students to explore these concepts through visuals, simulations, and interactive quizzes, which can lead to deeper comprehension and longer-lasting retention of information.

Furthermore, in a study by Clark and Luckin (2013), students reported feeling more motivated to participate in biology lessons when using tablets, as the technology made learning more enjoyable and less monotonous. This motivation is crucial in improving learning outcomes, as increased participation generally correlates with better academic performance.

Case studies and best practices

Several case studies highlight the benefits of tablet-based learning in biology classrooms. For instance, a study conducted in a U.S. high school biology classroom by Liu, Scordino, and Geurtz (2020) revealed that tablet use significantly enhanced student engagement and participation. Students were able to collaborate on group projects using tablets, which fostered peer interaction and collaborative learning—an essential element of biology education.

Another case study from South Korea found that the introduction of tablets in biology classes led to improved problem-solving skills among students. The interactive nature of the devices enabled students to work through biological scenarios in a hands-on manner, thereby improving both participation and comprehension (Kim & Park, 2021).

The Ugandan context

In Uganda, the use of tablets in education has seen increased adoption in recent years, particularly in urban schools where technological infrastructure is more developed. The Ministry of Education and Sports has promoted tablet-based learning as part of its strategy to

enhance digital literacy and improve classroom participation (Nsubuga & Male, 2020). However, challenges remain, particularly in rural areas where access to technology is limited.

A study by Muwanga-Zake (2017) found that the introduction of tablets in Ugandan classrooms significantly increased student participation in science subjects, including biology. Students reported feeling more engaged when they could access digital resources and interactive applications that complemented their biology lessons. However, the study also noted that the success of tablet-based learning depends on adequate teacher training and access to reliable internet, which remains a barrier in many parts of Uganda.

In the Ugandan context, it is essential to address infrastructure challenges, such as access to electricity and internet connectivity, to maximize the impact of tablets on student participation. Additionally, culturally relevant digital content should be developed to align with the Ugandan biology curriculum, ensuring that students are learning material that is relevant to their local environment and experiences (Nabushawo et al., 2019).

The influence of smartphones usage in teaching and learning on students' participation in learning biology

Smartphone-based learning tools and resources

Smartphone-based learning tools have transformed biology education by providing students with access to a wide array of resources. Applications like *Khan Academy*, *BioInteractive*, and other educational platforms offer multimedia content, such as videos, quizzes, and interactive simulations, that enable students to learn biological concepts in an engaging manner (Wong, 2020). Moreover, smartphones allow students to access real-time data, collaborate with peers through social media, and use scientific apps like *Phyphox* and *iNaturalist* for data collection and analysis in fieldwork.

While these tools are beneficial for content delivery and reinforcement, some studies, like those by Zhang and Chen (2021), point out that the effectiveness of these tools depends on their alignment with the curriculum and the ability of students to critically engage with the material. Although the use of smartphones expands the learning ecosystem, educators must ensure that the chosen resources align with educational standards to avoid superficial learning experiences.

Pedagogical approaches

The integration of smartphones into teaching biology has led to shifts in pedagogical approaches. Smartphone-supported teaching promotes constructivist learning environments where students actively participate in their learning processes rather than passively receiving information (Kukulska-Hulme & Traxler, 2019). For example, mobile-assisted inquiry-based learning (MAIL), which utilizes smartphones for scientific investigations and problem-solving activities, encourages students to explore biological phenomena hands-on, fostering deeper understanding and engagement (Sung, Chang, & Liu, 2016).

Flipped classrooms are another pedagogical approach enhanced by smartphone usage. In this model, students access pre-recorded lectures or reading materials on their smartphones outside of class, while in-class time is devoted to interactive activities such as group discussions, experiments, or problem-solving tasks (Lai et al., 2021). This approach has been shown to increase student participation and collaboration in biology classrooms by allowing students to engage more deeply with the content during class hours.

Student engagement and learning outcomes

Studies indicate that smartphones have a positive impact on student engagement and participation in biology learning. Students using smartphones are more likely to collaborate with their peers, engage in active learning tasks, and participate in classroom discussions (Hashemi, Azizinezhad, & Farokhi, 2020). The mobility of smartphones allows students to take their learning beyond the classroom, engaging with content while on field trips or during their personal time, thus fostering continuous learning.

In terms of learning outcomes, smartphone usage can enhance students' understanding of complex biological concepts through the use of animations and simulations that make abstract ideas more tangible. A study by Crompton, Burke, and Gregory (2017) found that biology students using smartphones to visualize cell structures or ecological systems reported better comprehension compared to those relying solely on textbooks.

However, there are concerns that the educational benefits of smartphones may be limited by distractions. While smartphones can offer useful educational apps, they also provide access to social media, games, and other non-educational content, which may detract from student

engagement. Thus, educators must create strategies to mitigate distractions while capitalizing on the educational potential of smartphones (Sung et al., 2016).

Challenges and barriers

Despite the growing use of smartphones in education, several challenges and barriers limit their effective implementation in biology classrooms. One major issue is unequal access to smartphones among students. In low-income settings or under-resourced schools, not all students may have personal smartphones or reliable internet access, leading to disparities in participation and learning opportunities (Ilochonwu & Iheanachor, 2022).

Additionally, the use of smartphones in classrooms often faces resistance from educators who are concerned about disruptions and the potential for off-task behavior. Teachers may lack the skills or confidence to integrate smartphones into their teaching effectively, especially if they have not received sufficient training on using mobile technology for pedagogical purposes (Gupta & Nath, 2020). This resistance is often coupled with concerns over academic integrity, as students may use smartphones to cheat during assessments or plagiarize assignments.

The cost of data and internet connectivity is another barrier, particularly in regions where infrastructure for wireless communication is underdeveloped. Without reliable and affordable access to the internet, the use of smartphones as a learning tool can be inconsistent and impractical, limiting their usefulness in the classroom (Munyofu, 2021).

Teacher professional development

The successful integration of smartphones into biology teaching relies heavily on teacher professional development. Teachers must be trained not only in how to use smartphone technology but also in how to adapt their instructional strategies to maximize its educational potential. Professional development programs should focus on equipping teachers with the skills to design effective learning activities that utilize smartphones and mobile applications (Ertmer & Ottenbreit-Leftwich, 2019).

Moreover, teachers need to understand how to manage potential distractions and set clear expectations for smartphone use in the classroom. This includes teaching students about digital literacy and responsible smartphone use to ensure that these devices are used for educational purposes rather than entertainment (Hwang, 2020). Professional development initiatives should

also address teachers' attitudes toward mobile learning, as those who perceive smartphones as disruptive rather than beneficial may be less inclined to adopt them in their teaching.

2.5 Knowledge, methodological and contextual gaps emerging from the literature review

The entire literature reviewed showed knowledge, methodological and contextual gaps in the previous studies. The main gaps from he reviewed literature included the fact that earlier studies by Ngoungouou (2017), Mtebe et – al (2017) and Kisanjara et al. (2017) used case studies and their studies were mainly quantitative in nature but the current study, the researcher intends to use qualitative paradigm. The researcher intended to use mixed methods which according to Mugenda and Mugenda (2019), the use of both qualitative and quantitative approaches enriched each other. Earlier studies used Expectancy theory, Expanded Goal Setting Theory and Curriculum Theory by Raph and Tyler. The current studies used constructivist Learning Theory by Piaget and Jerome Bruner's Constructivism Theory. These two theories bridged gaps contextually.

Whereas the traditional teaching methods were appropriate for the old curriculum, that was knowledge based, where learners could be presented with knowledge and crammed it, they are no longer useful in the new competence based curriculum because in the new curriculum, teachers are only facilitators of learning but passively passing on information. The current research seeks to explore the new modern teaching methods where learners are actively involved in their learning journey.

The previous scholars assumed that students had expectations of what they are supposed to learn. However, the current study emphasizes that learners should construct knowledge from their experiences as they interact with the world with support from ICT tools such as the internet, computers, tabs and smartphones.

The previous scholars employed case studies research which is only appropriate for small populations and which require long time to analyze data. However, the current study employs a mixed methods approach to cover large population size of schools that were sampled.

In addition to the above, the previous studies focused on quantitative studies which focus on numbers thus overlooking broader themes and relationships. However, the current study used both quantitative and qualitative methods to cover important themes from respondents. For example, the use of focus group discussion method to cover qualitative data from students' quotes.

Knowledge gaps

While the use of technology in education, specifically in biology, has shown promise in improving student participation, there remains a gap in understanding the long-term cognitive and psychological effects on students. Most studies, such as those by Hwang and Wu (2018) and Akpan and Strayer (2020), primarily focus on short-term engagement or immediate academic performance outcomes. Little is known about how sustained use of tablets or computers impacts students' deep understanding of biological concepts or their attitudes toward science as a career. The emotional and motivational aspects of students' engagement with biology through these technologies remain underexplored, leaving a gap in how technology can be leveraged to foster long-term interest in the sciences.

Moreover, knowledge about the differential effects of technology on diverse groups of students, such as those with special learning needs or students in underprivileged communities, is scarce. Existing research typically assumes that technology benefits all students equally, but studies like those of West (2015) show that access and usage disparities can lead to uneven educational outcomes. Hence, more nuanced studies focusing on how technology affects different demographics are necessary to close this knowledge gap.

Methodological gaps

Several methodological gaps are evident in the current literature. Most studies, including those by Liu, Scordino, and Geurtz (2020), use quantitative methods such as surveys or performance assessments to measure student engagement or participation. While these methods provide valuable data, they often lack depth in capturing the experiential and qualitative aspects of learning. Qualitative methodologies, such as interviews and case studies that focus on students' experiences and perceptions of technology use, are underutilized in research.

Additionally, many studies are cross-sectional in nature, examining the effects of technology at a single point in time rather than longitudinally (Kim & Park, 2021). This limits the ability to assess long-term trends in student engagement and participation, as well as the sustained impacts of tablet and computer use. Further research that employs longitudinal designs would provide a more comprehensive understanding of how technology influences learning over time.

Contextual gaps

Research on the use of technology in biology education has primarily been conducted in well-resourced environments with access to reliable internet and up-to-date devices. This creates a significant contextual gap when applying these findings to settings with limited resources, such as

rural schools or schools in developing countries. For instance, studies like those of Nabushawo, Namusoke, and Ssekabira (2019) acknowledge the potential for digital learning in Uganda but also highlight the infrastructural and logistical challenges faced in such contexts.

Many studies fail to account for the contextual realities of low-tech environments where internet access or even basic electricity might be intermittent. Therefore, future research should address how technological interventions can be adapted or designed to work within these constraints, ensuring that digital learning strategies are inclusive and effective across different contexts.

Geographical gaps

A geographical gap exists in the body of research, as much of the literature originates from high-income countries like the United States, South Korea, and parts of Europe (Bano et al., 2018; Kim & Park, 2021). Studies from developing nations, particularly in Africa and Latin America, are limited. This imbalance in geographical focus presents a gap in understanding how cultural, economic, and educational systems in other regions interact with technology in the biology classroom.

In the Ugandan context, while studies such as those by Muwanga-Zake (2017) have explored tablet use, the findings are specific to urban settings where infrastructure is more robust. There is a lack of research focusing on rural or underserved regions, where both the availability and use of technology in education are significantly different. Thus, future studies should strive to balance the geographic distribution of research to gain a more global understanding of how digital tools influence biology education.

Theoretical gaps

There is a notable theoretical gap in the frameworks used to study the impact of technology on student participation. Many studies adopt a technological determinism perspective, assuming that technology alone drives engagement (Dolan, 2016). However, this overlooks the complex interplay between students, teachers, curricula, and the broader educational environment. Few studies employ theoretical frameworks such as constructivist learning theory or socio-cultural theory to better understand how technology is integrated into the learning process.

For instance, a constructivist perspective would examine how students actively construct knowledge through interactions with technology, rather than passively consuming information. Similarly, a socio-cultural approach could provide insights into how the cultural and social context of students affects their engagement with technology. Future research would benefit from integrating these or other theoretical perspectives to provide a more holistic understanding of how

technology impacts learning in biology.

Practical gaps

Practical gaps in the literature highlight the lack of actionable guidelines for educators and policymakers. While studies, such as those by Ertmer and Ottenbreit-Leftwich (2019), emphasize the need for teacher training in technology integration, there is a lack of clear, evidence-based strategies on how to effectively implement digital tools in biology classrooms. Much of the research is exploratory, identifying benefits and challenges but failing to translate these findings into practical solutions that can be readily adopted by schools, particularly in resource-limited settings (Ifenthaler & Schweinbenz, 2016).

For example, while studies highlight the importance of teacher training in ensuring the success of tablet or computer use (Zou et al., 2021), there is little discussion on the specific training approaches or models that work best in different contexts. Furthermore, guidelines for selecting appropriate apps, software, or digital content for biology learning are generally absent, leaving educators with limited direction on how to choose and implement these tools effectively.

2.6 Conclusions

ICT integration in education generally implies technology–based teaching and learning process that closely relates to the use of e-learning in secondary schools. Students' familiarity with the use of ICT gadgets help students to learn better within technology – based environment which enhances students' classroom environment specifically in biology which is one of the practical subjects taught at O' and A' levels of the lower and upper secondary school. From the literature reviewed, it is apparently clear that students benefit from ICT integration where they are not bounded to the limited supply of textbooks and other resources, instead of hands-on-tasks in ICT based course designed to help them to stimulate their understanding about biology (Voogt & Pelgram, 2015; Kessel et – al, 2015). ICT is perceived as a catalyst in teaching styles, learning approaches and self-regulated learning particularly in the study of biology in secondary schools. ICT enhances students' ability to acquire knowledge, skills, abilities, values and attitudes in biology. The literature showed that the utilization of ICT by teachers in the teaching and learning of biology is depending on teacher's level of competence, availability of ICT gadgets and student's level of readiness to use the gadgets.

Researchers like Iradukunda and Chaama conducted studies on the influence of ICT on students' performance in secondary schools in 2015 and 2010 respectively and in their respective studies. They found out that there is a positive correlation between ICT and students' participation and performance. It was found out that there is little research which has been conducted to ascertain the influence of ICT and students' classroom participation particularly in biology in government aided secondary schools. Thus, information on these attributes, that is, ICT and students' classroom participation in learning of biology, the latter is the dependent on the former. Throughout the reviewed literature, it was concluded that utilization of ICT gadgets in the teaching-learning process enhances student's participation, concentration, and performance. Literature showed that teaching has become more complex especially when there is insufficient use of ICT by both teachers and students .because it limits the rate of research by two parties.

CHAPTER THREE
METHODOLOGY

3.0 Introduction

This chapter discusses the methods and the methodologies that were employed during the study. It is divided into the following sections: Research design, area of study and population, sample size and sampling techniques, data collection methods and instruments, quality control methods, data analysis techniques, ethical considerations, expected limitations and delimitations.

3.1 Research design

The researcher used descriptive survey design. This design is appropriate for the study because it enabled the researcher to collect detailed qualitative data on ICT and students' participation in Biology lessons. Secondly, this design was appropriate because it describes the existing phenomena and bridges the epistemological gaps (Leedy, 2016; Mamdan, 2010). This design helped the researcher to solicit quantitative and qualitative data on internet, computers, smartphones and tablets and how they influence students' participation in biology. Questionnaire forms, focus group discussion guide and documentary review guide were appropriately used in eliciting data from the respondents. The researcher employed qualitative and quantitative techniques in the collection and analysis of data. The collection of qualitative and quantitative data enabled the researcher to calculate the mean, standard deviation. These were used to compare and analyze data. This enabled the researcher to study how the data collected relates to each research objective by comparing the means and standard deviations about each item on the questionnaire. The qualitative data collected enabled the researcher to study how the students' responses on the usage of ICT tools relate with students' classroom participation in learning biology.

Another justification for using this design was that researchers like Adebayo (2019) and Chaame (2010) there studies were successful in their studies they conducted using same design.

In addition to the above, the descriptive survey research design was suitable for this study because there was a need the describe how learning occurs with the traditional teaching methods. This is then used to improve and describe how it should occur with new and modern technologies with the help of ICT tools. With these descriptions it would then be much possible and easier to assess the influence of ICT tools like internet, computers, tablets and smartphones on classroom participation.

3.2 Study population

The study was carried out in government aided secondary schools in Kimaanya–Kabonera Division, Masaka city. The division has five government aided secondary schools. The participants in the study were teachers of biology and students were selected from Senior 3 and Senior 4. The respondents were required to elicit data on ICT and students' classroom participation in biology.

3.3 Sample size and sampling techniques

A sample is a small proportion of the population the researcher selects to take part in the study (Leedy, 2016; Kisilu & Tromp, 2016). And sampling is a systematic procedure the researcher undertakes to select the participants in the study. The teachers of biology were purposively selected because they teach biology. The researcher assumed that they are the ones with the required data for the successful completion of the study, and the students were selected using Krejcie and Morgan (1970) table for Sample Size Estimation as cited by Mugenda and Mugenda (2009) by using purposive sampling technique. The Krejcie and Morgan (1970) sample size estimation table provides an easy way of determining the sample size by looking at the population and considering the estimation ranges which are already prescribed. Krejcie and Morgan (1970) table enabled the researcher not to be biased, and it gave an equal opportunity for people to participate in the study. The students were purposively selected using the Krejcie and Morgan (1970) sample size estimation table, teachers of biology and the head teachers were purposively selected because they were hoped to provide more valid and authentic data on the variables which were under study. Since the population of the government aided secondary schools were few, the researcher decided to include all of them in the study. This was intended to provide sufficient statistical inference (Miles et-al, 2012). The table eliminates bias and provides good representation. This is because the table gives the sample size from a given population to be selected. So the researcher's involvement in the choice of the sample size is limited and this reduces bias and gives a good representation number.

Table 3.1: The table below shows the categories of the targeted study population, population size of the categories, sample sizes to be used in the study and the techniques used to select the sample sizes

Categories of study population.	Population size	Sample size	Sampling techniques
S3 & S4 students	2,000	322	Krejcie & Morgan (1970)
Teachers of biology	16	16	Purposive sampling
Government-aided secondary schools	03	03	Purposive sampling

Source: Masaka City Education Office (2023) and the Researcher (2024)

Table 3.3 above shows that Kimaanya–Kabonera Division–Masaka City has three government aided secondary schools and 16 teachers of biology and 2000 students in S3and S4. The schools and teachers were purposively selected whereas students were selected using the Krejcie and Morgan (1970) sample size estimation table in appendix (E).

3.4 Data collection methods and instruments.

Data was collected using the following instruments

3.4.1 Questionnaire method

The researcher used questionnaire method to collect primary data from the teachers of Biology from the three government aided secondary schools in Kimaanya–Kabonera Division, Masaka City. The instrument was preferred because it provided future reference. Secondly, teachers of Biology can easily read comprehend and this helped the researcher to elicit the required data within relatively a short period of time (Kisilu & Tromp, 2016; Mamdani, 2010). The researcher sent soft copies to the teachers' email addresses. The teachers' questionnaires had five sections (A, B, C, D, E and F) which included: Demographic characteristics of the respondents (teachers), Internet and students' classroom participation in learning biology, tablets and students' classroom participation in learning biology and smartphones and students' classroom participation in learning Biology.

The questionnaire elicited data on the major variables of the study. The questionnaire form/tool had close-ended likert scaled and open-ended questions and statements. The questionnaire form had a five-point likert scale ranging from:

5 = Strongly Agree (SA)

4 = Agree (A)

3 = Undecided (UD)

2 = Disagree (D)

1 = Strongly Disagree (SD)

3.4.2 Focus group discussion method

The researcher conducted face-to-face oral discussions particularly S3 and S4 students. During the focus group discussions students in groups between 5 and 10 were engaged in these discussions. The rationale behind the use of this method and Focus Group Discussion guide tool was that it eased collection of data from a sizeable sample. Secondly, the interjections from the students in each group added meaning. The respondents 'body language also helped the researcher to generate more data on ICT and students' classroom participation in the teaching and learning of biology and government aided secondary schools in Kimaanya – Kabonera Division, Masaka city. The focus group discussions guide was designed in accordance with the objectives of the study.

3.4.3 Documentary review method

The researcher reviewed related literature on ICT and students' participation. The researcher designed a documentary review guide containing all relevant key documents on the study topic and variables. The rationale behind documentary review was to help the researcher to avoid duplication and to bridge gaps in the existing epistemology (Miles & Hurbman, 2012; Mamdan, 2010). The researcher reviewed documents from Uganda National Examination Board about results in government aided secondary schools in Kimaanya-Kabonera division, Masaka city, Ministry of Education and sports (MOES, 2020, 2019, 2018, 2015, 2010) and reports from the City Education Officer.

3.5 Content Validity Index

3.5.1 Validity of instruments

According to Amin (2005) and Enon (1998), validity refers to how well or consistent a test measures what it is purported to measure. The researcher used the Content Validity Index (CVI) to ensure the research instrument yielded valid results which can be generalized. The views and

opinions of the research supervisor were taken into consideration in reviewing the questionnaire items to suit the intended research variables and topic. The researcher engaged three experts in the fields of ICT, Biology and Education Administration and Management to evaluate the items in the tools for relevance to the topic and the specific research objectives. The researcher kept on redesigning the items in the tools basing on the advice of the supervisor and the three experts. This enabled the researcher to calculate the Content Validity Index using the formula below:

$$CVI = \frac{\text{Number of items judged relevant}}{\text{Total number of question items in the tool}}$$

Mamdan (2010) contends that items with validity coefficients to at least 0.70 are accepted as valid and reliable in research projects, the results for each variable were presented in table 3.5.

The researcher engaged a team of three experts who were requested to judge the items for relevance and clarity. The experts studied each item on the questionnaire and gave scores on a likert scale to check for relevance and clarity. For relevance the experts scored whether the items were highly relevant, somewhat relevant or not relevant at all. For clarity, the researcher scored for very clear, clear but need minor revision, item need some revision and not clear.

The scores from each item were tabulated to find out how many experts were in agreement with the items. The scores are then used to calculate the content validity index where the number of experts in agreement is divided by the total number of experts. The results ranged from 1 to 0.3. In this study all the three experts were in agreement about the relevance and clarity of the items in the questionnaire which gave a content validity index of 1.0. which is well above 0.7. According to Mamdan (2010), the items were all judged relevant.

Table 3.5: Content Validity Index

Items	Number of items
Internet	06
Computer	06
Tablets	06
Smartphones	08
Total items on variables	28

Question items on demographic characteristics were five (5). The total number of items in the questionnaire form were 33 (28+5). Thus, the CVI=28/33=0.84

Therefore, the instrument was reliable and valid. Tools are considered relevant because the CVI was above 0.7. According to Wangusa, if the CVI is greater than 0.70 (CVI>0.70), the instrument is considered valid.

3.5.2 Testing reliability of the instruments that were used in this study

Reliability is the degree to which a research instrument is stable and consistent in producing reliable or dependable results (Hessler, 2014; Best et-al, 2006). The research instruments were tried several times but still produced the expected results. The researcher piloted the study at Kako Senior Secondary School in Nyendo - Mukungwe Division, Masaka city. This is because Kako is in another Division. And the researcher never wanted to pilot the study in the area of study to control bias. The findings from the pilot study were analyzed and interpreted using the Statistical Package for Social Scientists (SPSS). According to Vyhmeister (2011), when test and retest correlations are established, the results are likely to be more reliable. The scores from the test and retest (Cronbach's Alpha Coefficient) are in Table 3.2

Table3.2: Cronbach's alpha coefficients

Variable	Number of items	Alpha
Internet and students participation in biology	11	0.68
Computers and students participation in biology	06	0.80
Tablets and students participation in biology	06	0.80
Smartphones and students participation in biology	08	0.88
Average Coefficient	31	0.79

The internal consistence was measured using split half reliability using Cronbach's alpha above in table 3.2. According to Leedy (2016), if the alpha value is above 0.7, then the instrument is considered. Most of the alpha values were above 0.7. So the instruments were reliable and yielded authentic and valid results which can be generalized to a wider population. Cronibach's alpha coefficient was used to measure internal consistency or reliability of a set of survey items. It helped the researcher to determine whether the collected items from the respondents produced similar results every time it was used and enabled the researcher to quantify the level of agreement on a

likert scale.

3.6 Research procedure

The researcher presented a concept note to the Dean and after its approval, the researcher got an introductory letter from the Dean Faculty of Post Graduate Studies of Uganda Martyrs University. This letter was used to seek for permission from the Masaka City Education Officer (CEO). It was used to seek for permission and consent from head teachers as well as teachers of biology from three government aided secondary schools to be sampled. The researcher tried to brief the accessible population concerning the intentions of the study. Thereafter, the researcher made appointment when to solicit data from the participants. Participants were met from their respective schools. After collection of data, the researcher embarked on sorting, analysis and interpretation of findings and finally a dissertation was written.

3.7 Data analysis

Data from the field were compiled, sorted, edited and coded. All this was done to guarantee quality, accuracy and completeness. Qualitative data were analyzed thematically and the themes were derived from the four specific research objectives of the study. Descriptive statistics approach was used to analyze quantitative data where by the researcher evaluated derived frequencies, percentages, means and standard deviations. The researcher used SPSS version 22.0 to aid quantitative data analysis. A file was prepared to accept data from the questionnaire form in form of codes for the different categories of responses that were expected from the respondents.

3.8 Measurement of variables

The independent variable and the dependent variable were measured using a likert scale of five points, that is, strongly agree=5, Agree=4, undecided=3, Disagree=2 and strongly disagree =1. The choice of this measurement was due to the fact that each point on the scale carried a numerical value or score which was used to measure the respondents' perception, attitude, opinion, or view on ICT and students' level of participation in biology lessons in government aided secondary schools in Kimaanya-Kabonera Division in Masaka city. According to Miles and Herbman (2012), the likert scale is used to measure respondents' perception as regards the major variables. The responses were interpreted using the likert mean range scale as shown in the table 3.2. In nominal measurements of the major variables, that is, ICT and students' classroom participation in biology lessons. Numbers were assigned for purposes of comparing the variables which were being measured. The interval scales of measurement were used to elicit data from the targeted respondents.

Table 3.2: Measurement of variables and interpretation

Description	Mean Range	Scale	Interpretation
Strongly Agree	4.20-5.00	5	Very high agreement
Agree	3.40-4.19	4	High agreement
Undecided	2.60-3.39	3	Neutral
Disagree	1.80-2.59	2	Low agreement
Strongly Disagree	1.00-1.79	1	Very Low agreement

Source: Adapted from qualitative data analysis by Miles and Hurban (2012)

3.9 Ethical considerations

The researcher got an authorization letter from Uganda Martyrs University before conducting the study. The authorization letter was used to seek for permission from Masaka City Education Officer and from the head teachers. Consent from the participants was sought verbally from both the teachers of biology and from the students. The head teachers of the three schools authorized the researcher to conduct the study in their schools. The names and identity of the participants was kept anonymous and the information collected was treated with the utmost confidentiality. The participants were given a consent form. This helped the participants to feel free and voluntarily responded to the question items. The researcher briefed the respondents that the information provided was confidential and voluntary. The researcher was introduced to students by the director of studies. There after questionnaires were distributed to all students in class. The researcher informed those participants willing to take part in the study to fill the forms while those not willing to return the forms. Some few students returned unfilled forms. After some time, the researcher collected the forms. The researcher thanked all the participants and non-participants and left at once. The researcher acted honestly, fairly, respectfully and participation in the study was on voluntary basis. Finally, the researcher desisted from any form of plagiarism by acknowledging authors and citing all works under secondary source.

3.10 Limitations

The researcher encountered both theoretical and methodological limitations like failure for some students to read and interpret some technical terms in the questionnaire. The researcher had to intervene to interpret these technical terms. This could have affected the independence of the respondents. To overcome this, the researcher had to give these learners some reasonable time for them to analyze and interpret these technical terms.

In addition to the above, some students were copying from others. In one school, students thought that it was an examination. To overcome this limitation, the researcher used focus group discussion method where students were interviewed verbally. This was done in order to arrive at an appropriate conclusion.

The theories do not directly inform us whether increased participation automatically lead to greater academic achievement. In this, the researcher had to first study the data collected and relate participation to academic achievement. To overcome this limitations, the researcher used the triangulation technique. In this method the researcher used three theories, that is connectivism, discovery learning theory and constructivist learning theory. All the three theories advocated for learning by doing. The learner is presented with experiences from which to construct knowledge. The researcher also used also used three methods of data collection, that is questionnaire method, interview method and documentary review method. The data sources were also triangulated in that the researcher obtained data from students of senior three, teachers of biology and Masaka city education office.

Delimitations

The study was delimited to examining ICT and students' participation in biology in government aided secondary schools in Kimaanya–Kabonera Division in Masaka City. Only S.3 and S.4 students were considered for the study, their teachers of biology, deputies and head teachers took part in the study. Data was elicited on ICT gadgets, that is, computers, tablets, smart phones, internet and how they influence students' participation in the teaching and learning of biology.

CHAPTER FOUR

DATA ANALYSIS AND PRESENTATION, AND DISCUSSION OF FINDINGS

4.0 Introduction

This chapter focuses on response rate, demographic information of respondents, internet and students' classroom participation, computers and students' classroom participation, tablets and students' classroom participation and smartphones and students' classroom participation. The findings of the study are presented, analyzed and interpreted basing on the objectives of the study.

4.1 Response rate

The different categories of respondents had varied response rates. All teachers of biology who were targeted and finally sampled took part in the study whereas students who were sampled were 322 but three hundred four participated in the interviews which were held in (3) three government aided secondary schools found in Kimaanya–Kabonera Division, Masaka City.

Table 4.1: show the number of respondents who participated in the study

Categories of respondents	**Sample size**	**Number of respondents who participated in the study.**	**Percentage participation**
Teachers of biology	16	16	100.0
S.3 and S.4 students	322	304	94.6
Total	**338**	**320**	

The table 4.1 above clearly shows that teachers' response rate was 100% and the response rate for students was 94.4%. Out of 322 students who were expected to participate in the study only 304 were able to participate in interviews. All the three sampled schools were both day and boarding schools. And most of the students who did not take part in oral interviews were mainly day scholars. The overall response rate was 94.6% ($^{320/338}\times100$). The response of 94.6% is adequate to generalize the findings of the study on ICT and students' classroom participation during the teaching and learning of biology. Students who did not turn up for interviews were only 18 (5.5%). According to Amin (2005), a response rate above 70% is quite enough to draw inferences and generalize findings to the target population.

4.2 Socio-characteristics of the respondents

4.2.1 Teachers of biology socio characteristics

The researcher elicited background information from all teachers of biology who took part in the study as summarized in Table 4.2.1 below.

Table 4.2.1: The table below shows socio-characteristics of the teachers of biology who took part in the study

Variables	Categories	Frequency	Percentage
	Male	10	62.5
	Female	6	37.5
	Total	16	100.0
Age bracket	20–29years	03	18.75
	30–39years	05	31.25
	40–49years	06	37.5
	50 years and above	02	12.2
	Total	16	100.0
Work experience	0-9years	02	12.5
	10-19years	08	50.0
	20-29years	03	18.75
	30 years and above	03	18.75
	Total	16	100.0
Marital status	Married	12	75.0
	Single	03	18.75
	Separated	01	6.25
	Total	16	100.0
Highest academic qualifications	Diploma in Education	05	31.25
	Graduate Teacher	07	43.75
	Post Graduate Diploma	03	18.75
	Master's Degree	01	6.25
	Total	16	100.0

Table 4.2.1 above show that most (62.5%) of the respondents were male and females constituted

of 37.5%. Therefore, the conclusions of the study can be confidently inferred upon each of the two sexes. The rationale of including both female and male teachers of biology with a view of getting a balanced view on ICT and students' participation in learning of biology in Government aided secondary schools. Table 4.2.1 also shows that most of the respondents hard worked for more than ten years and only two (2) had a work experience of 0–10 years represented by12.5%.

To establish the ages of teachers of biology, they were asked to indicate the range in which their ages fall. The results in figure 4.2.1 indicate that 37.5% of the teachers were between 40–49 years. 30–39 years were 31.25%, 20 – 29 years were 18.75% and only 12.5% were 50 years and above. The results implied that the ages of teachers of biology differed significantly. The variation in age among teachers of biology might have influenced teachers' usage of ICT in the teaching of biology (Barrera et-al, 2019) pointed out that the youngest group of teachers is more likely to integrate ICT in the teaching–learning process than those who are fifty (50) years and above since young teachers are more flexible and creative. Data in Table 4.2.1 above also pointed out that the majority (43.75%) of the teachers of biology were graduates, followed by Diploma holders in secondary education (31.25%), post graduate diploma holders in education were 3 (18.75%) and Master's degree holders were the minority (6.25%). It was obvious that most teachers are having some ICT skills. Globalization has put ICT at the forefront and teachers' exposure to ICT and adaptation eases the teaching – learning processes (Ashley, 2016; Hernes, 2016; Ghavifeker & Rosdy, 2015).

4.2.2 The socio- economic-characteristics of the students

This category of respondents were students drawn from S.3 and S.4. The table below gives the summaries of students' age brackets and the classes where they were drawn.

Table 4.2.2: below shows the socio- economic characteristics of the students who took part in the study.

Variables	Categories	Frequency	Percentage
Age	12–15years	11	3.61
	16–19years	250	82.23
	20 years and above	43	14.14
	Total	304	100.0
Class	Senior three (S.3)	152	50.0
	Senior four (S.4)	152	50.0
	Total	304	100.0

The results in Table 4.2.2 revealed that the majority of the students (82.2%) were between 16 and 19 years and those above 20 years were 14.14% and those between 12 and15 years were only 3.61%. The findings showed that each class was represented by 50% respectively. The young people are more interested in using the ICT and this helps them to carry out research there by easing the teaching and learning of biology in secondary schools.

4.3 How Internet use in teaching and learning influences students' classroom participation in learning biology

Research Question i): How does the use of internet influence students' classroom participation in learning biology in government aided secondary schools in Kimaanya–Kabonera Division?

4.3.1 Responses from teachers of biology on how use of internet in teaching and learning influences students' participation in learning biology.

The responses from teachers of biology had varying levels of agreement or disagreement on the use of internet and students' classroom participation in biology lesson as indicated in table 4.3.1 the responses from the teachers of biology ranged on a likert scale from 1 to 5. The respondents' responses varied considerably as shown in the table below.

Table 4.3.1: shows how Internet use in teaching and learning influences students' classroom participation in learning biology

Statement	Level of agreement	Frequency	Percentage
Students use the internet to search for biology content	Strongly Agree(SA)	09	56.25
	Agree(A)	06	37.5
	Undecided(UD)	01	6.25
	Disagree(D)	00	00
	Strongly Disagree	00	00
	Total	16	100.0
	Mean	4.50	
	Standard deviation	0.50	

Teachers use the internet in the teaching– learning process	Strongly Agree(SA)	08	50.0
	Agree(A)	08	50.0
	Undecided(UD)	00	00
	Disagree(D)	00	00
	Strongly Disagree	00	00
	Total	16	100.0
	Mean	4.50	
	Standard deviation	0.50	
Teachers search biology content from the internet	Strongly Agree(SA)	08	50.0
	Agree(A)	07	43.75
	Undecided(UD)	00	00
	Disagree(D)	00	00
	Strongly Disagree	01	6.25
	Total	16	100.0
	Mean	4.31	
	Standard deviation	0.69	
ICT enhances students' participation in biology	Strongly Agree(SA)	07	43.75
	Agree(A)	09	56.25
	Undecided(UD)	00	00
	Disagree(D)	00	00
	Strongly Disagree	00	00
	Total	16	100.0
	Mean	4.44	
	Standard deviation	0.56	
All teachers of biology use the internet to teach biology	Strongly Agree(SA)	07	43.75
	Agree(A)	04	25.0
	Undecided(UD)	03	18.75
	Disagree(D)	01	6.25
	Strongly Disagree	01	6.25
	Total	16	100.0
	Mean	3.94	
	Standard deviation	1.06	

The results presented in table 4:3:1 above revealed that the majority of the respondents (93.7% = 56.2 + 37.5) from the sampled schools, agreed that students use internet to search for biology content. (Mean 4.5, Standard deviation 0.5). However, all respondents (100%), agreed that, teachers of biology use ICT particularly the internet (mean 4.5, Standard deviation 0.5). Furthermore, the results in table 4:3:1 above showed that students' classroom participation in biology was assessed and it was found out that ICT enhances students' classroom concentration and participation in the teaching-learning process (Mean 4.38, Standard deviation 0.62). This affirms that all teachers of biology who participated in the study have a positive perception on the use of the internet in enhancing the teaching and learning of biology and do strongly believe that the use of the internet greatly promotes students' classroom participation. The findings also revealed that some teachers of biology do not frequently use the internet to search for the content (18.75 + 6.25 + 6.25 = 31.25%). This percentage (31.25%) seems to be big, and it may be the teachers who do not frequently use the internet because they are not competent in using ICT or they lack ICT gadgets.

The overall mean and standard deviation are: (M=4.34; SD=0.66). This shows that 91.3% of the teacher respondents agree that internet use enhances students' classroom participation in biology lessons.

Teachers of biology who took part in the study observed that ICT is part and parcel of the teaching – learning process. The finding revealed that the use of ICT particularly the use of the internet increases students' participation in biology. The findings showed students who usually go to the computer laboratory and use the internet to search for the content in biology are always active in class and tend to perform better than those who rarely go there.

In summary of the above, the data collected about internet and students' participation in learning biology showed that there is lack of continuous supply of internet in schools due to lack of funds to subscribe for it on time. Therefore, teachers and students were using it at a less extent during classroom lessons because it is always on and off. This therefore reduced students' classroom participation in learning biology.

Table 4.3.3: shows how students responded about the ICT devices teachers of biology use in teaching biology.

ICT devices used by teachers of biology in teaching biology lessons	Frequency of students	Percentage out of total number of students
Smartphones	101	33.2
Computers	76	25.0
Internet	67	22.0
Tablets	52	17.1
Projectors	08	2.6
Total	304	100.0

Table 4.3.3 above clearly shows that the majority (33.2%) observed that most teachers of Biology use smartphones to search for content, 25% of the teachers use computers, 22 use internet, 17.1% use tablets whereas the least 2.6% of teachers of biology use projectors during the teaching–learning processes.

The key informants particularly students of biology were interviewed to find out whether they use ICT resources (gadgets) in the learning of biology in their respective schools and the profound explanations are given in the two quotations below:

> "In my school students' are not allowed to come to school with mobile phones. The most ICT gadgets used is computers but Computers are not enough in the computer laboratory and the Internet is always on and off. This limits the use of ICT resources.

During the face to face oral interviews, the researcher observed that of all the sampled schools none had enough ICT resources. Out of the three sampled secondary schools which were selected to participate in the study, only one school had a projector. One of the schools had more than 800 students in S.3 and S.4 but only 40 computers were available in the computer laboratory. This gives the computer – student ratio at 1:20. This implied that twenty students were using one computer. The scarcity of ICT resources limits students' exposure to Information Communication Technology. The above response confirms that the commonly used ICT gadgets in the sampled

schools, was the computer. The inadequacy of computers and other ICT gadgets in government aided secondary schools in Masaka city seem to hinder the utilization of ICT technologies. As indicated in the foregoing citation, one of the respondents (students) observed;

"In my class, less than a quarter of the students know how to use the tablets."

The above two citations from students clearly show that the use of ICT resources and internet in the surveyed secondary schools influences students' classroom participation in biology lesson, but the influence is low (minimal) due to challenges such as: students are not allowed to use smartphones in class; computers are not enough; network/internet is on-and off; and some students do not know how to use the ICT gadgets.

Students' elicited responses were in agreement with studies conducted by Hawkins (2020), Ngounguou (2017), Mtebe and Raphael (2017) and Kisanjara et-al (2017) in their studies, they reiterated that the integration of ICT in teaching-learning process enhances students' participation and engagement. They also observed that lack of enough skilled teachers in ICT and the financial ability of the schools to provide internet services may hinder active learning and the level of students' engagement. Tarino and Kavishe (2017) observed that adequate time must be allocated for teachers and students to develop explore and be able to integrate ICT in teaching-learning process in secondary schools. Students little knowledge on how to use tablets affects their rate of participation and worse still, very few schools or teachers have tablets.

Therefore, although schools had computer laboratories, it was found out that, the laboratories did not have enough computers. This further reduced students' classroom participation because not all of them could search for biology content in time prior to the biology lessons.

4.4 How the use of computers in teaching and learning influences students' classroom? participation in learning biology.

Research Question ii): How does the use of computers influence students' participation in learning Biology in government aided secondary schools in Kimaanya–Kabonera Division?

Table 4.4.1: show how teachers of biology responded on how computers influence students' classroom participation in learning biology.

Variable measured	Statement which teachers responded to	Level of agreement by the teachers of biology who took part in the study.						No. of Teachers	Mean	Standard Deviation
		SA	A	UD	D	SD				
Computers and students' classroom participation in Biology lessons	Basic computer literacy enhances Students' classroom participation	10	06	00	00	00	16	4.63	0.37	
	The use of ICT enhances the teaching of Biology.	08	08	00	00	00	16	4.50	0.50	
	My school has enough computers for the Students	00	00	00	07	09	16	1.43	3.57	
	Students use computers to type set notes and do assigned activities in Biology.	01	03	01	07	04	16	1.75	3.25	
	Computers enhance students' Participation and teachers are able to give feedback.	06	05		03	01	01	16	3.87	1.13

The results show that basic computer knowledge enhances students' classroom participation in biology lessons. In regard to teachers' responses on computer literacy and students' classroom participation in biology lessons, all teachers of biology agreed (10+6 =16 =100%);

(Mean=4.63) this implies that for teachers of biology who have embraced computer literacy in teaching and learning process, students actively participate in lessons. However, it should be noted that many schools have insufficient computers and this limits students' level of classroom participation, thus giving a low mean 1.43, Standard Deviation 3.57. The results implied that resources be directed to incorporate the use of ICT applications in the teaching-learning process in order to enhance students' classroom participation.

In table 4.4.1 above, the results indicate that basic computer literacy enhances students' participation in biology lessons. The participants (teachers) were sixteen (16). 62.5%+35.5% (98%) of the teacher respondents agreed. The results imply that basic computer literacy enhances students' participation in the teaching-learning process of biology lessons. The overall mean and standard deviation for teachers' responses are: (*M*=3.24 and *SD*=1.76), which indicate that 98% of the teachers agree that computer use promotes students' classroom participation in biology lessons in the surveyed schools. However, 25% of the students disagree because they believe that schools do not have enough computers for students and students do not use the available computers for typing their notes and other assigned activities.

The findings of the study also confirm earlier findings by Mann and Tall (2016) and Miller and Clark (2016) who found that many students in the developing world study computers theoretically and have little hands on experience. Tezei (2019) and Spears (2017) also found out that lack of time and ICT resources hinders the successful integration of ICT into the curriculum. The findings of the study were in agreement with Tezei and Spears' findings. The results indicated that students with computer knowledge are able to make slides about biology and this increases their readiness to learn. Popova and Fabre (2017) and Pima, Odetayo, Iqbal and Sedoyeka (2016) observed that computers can increase students' participation in the teaching – learning process but many teachers feel that computers are misused by students. Instead of using them for educational purpose, they use them to play games and watch pornography. However, Pimaet-al (2016) demonstrated that computer use by students has a positive impact on teaching and learning only when ICT resources are used effectively and appropriately. The findings showed that computers enable students to accomplish their assignment more quickly, thereby enhancing students' participation.

The results therefore show that, some biology teachers lack basic computer skills, this limited the use of computers in teaching of biology. In addition to the above, schools do not have enough computers for students to type set their notes, search for biology content. This greatly reduced students' classroom participation in learning biology.

4.5 How tablet use in teaching and learning influences students' classroom participation in learning biology lessons

Research Question iii): How does the use of tablets influence students' classroom participation in learning Biology in government aided secondary schools in Kimaanya–Kabonera Division?

4.5.1 Teachers' responses

Table 4.5.1.1: sow how teachers of biology responded on tablets and students' classroom participation in learning biology

Statement to which teachers responded	**Level of agreement to statement**	**Frequency of teachers**	**Percentage agreement**
The school computer laboratory has enough tablets for students.	Strongly Agree(SA)	00	00
	Agree(A)	00	00
	Undecided(UD)	00	00
	Disagree(D)	04	25.0
	Strongly Disagree	12	75.0
	Total	16	100.0
	Mean	1.38	
	Standard Deviation	3.62	
Tablets increase students' participation in biology lessons	Strongly Agree(SA)	05	31.25
	Agree(A)	05	31.25
	Undecided(UD)	03	18.75
	Disagree(D)	01	6.25
	Strongly Disagree	02	12.5
	Total	16	100.0
	Mean	3.25	
	Standard Deviation	1.75	

Students use tablets to make biology notes	Strongly Agree(SA)	00	00
	Agree(A)	00	00
	Undecided(UD)	00	00
	Disagree(D)	09	56.25
	Strongly Disagree	07	37.5
	Total	16	100.0
	Mean	1.56	
	Standard Deviation	3.44	
Tablets increase students collaboration in class	Strongly Agree(SA)	08	50.0
	Agree(A)	03	18.75
	Undecided(UD)	01	6.25
	Disagree(D)	03	18.75
	Strongly Disagree	01	6.25
	Total	16	100.0
	Mean	3.88	
	Standard Deviation	1.12	
Tablets increase teacher – student relationship and integration.	Strongly Agree(SA)	02	12.5
	Agree(A)	12	75.0
	Undecided(UD)	01	6.25
	Disagree(D)	01	6.25
	Strongly Disagree	00	00
	Total	16	100.0
	Mean	39.4	
	Standard Deviation	1.06	

The results presented in table 4:5:2, revealed that, the average mean ranged between 1.375 to 3.8, and the standard deviation ranged between 0.6 to 3.6. Signifying that there's low use of tablets by teachers and students during the teaching and learning of biology lessons, and this limits students' classroom participation. The overall mean and standard deviation are: (*M*=2.80; *SD*=2.20) and

which indicates low agreement among teachers (62.6%) that students use tablets to increase their participation in biology learning lessons.

Students' responses

Key informants (S.3 and S.4 students) gave a wide range of responses on tablets and students' classroom participation in biology lessons. One of the students in a school coded, C' revealed:

> "I have never seen a tablet and I don't know how it works but I have heard from my fellow students particularly in S.4 saying it is `used to search for academic content."

Another key informant from the school which was coded observed:

> At our school, there is only one teacher I have seen using a Tablet in one of the lesson of English language. I don't know how it is operated. In the computer laboratory we have a few Computers and getting access to them is not easy because at times, the computer laboratory is closed. Whenever it is open, students scramble for the few available computers.

In the two citations above, it is evident that tablets in secondary schools are mainly used by a few teachers who can afford to buy them on their own. None of the sampled schools had tablets in their laboratories. Herein, both teachers and students have similar responses on lack of access to and use of tablets in learning biology. They both believe that the reasons for the low students' use of tablets to boost their participation in learning biology include: lack of access or affordability and school policy. It is also noted that if schools had tablets, they would increase students' participation in the teaching – learning processes. These findings also confirm previous findings of Ashley (2016); Chavifekr & Rosdy (2016); Fontana (2015) and Farrant (2007) who found out that abstract teaching and learning with irrelevant resources hinders students' participation in the teaching – learning process and facilitates cramming which in the long run kills creativity and innovativeness. The findings of Achimugu and Afolabi (2018) and Albirini (2018) are also similar to the views of both teachers and students. In 2006, the OECD (Organization for Economic Cooperation and Development) observed that many countries in Africa were living in a world of technological deficiency, and many teachers have a negative attitude towards the integration of ICT resources in the teaching – learning process. Many teachers are still using hand-written notes extracted from textbooks and entirely depend on face-to-face pedagogical approaches and methods to deliver the content. This can be substantiated by the outbreak of COVID – 19, when schools were closed in Uganda very few teachers continued to teach using e–learning approach and this was attributed to lack of ICT resources, lack of enough skills in ICT by both teachers and students and lack of money to buy data (MoES, 2021). These findings confirm earlier findings by Winglinsky (1998) who

found out that lack of tablets in many schools affected students' achievement in mathematics. The teachers of biology noted that if schools had enough tablets for the students this would increase their participation and the absence of tablets compel teachers to use teacher – centered approach of teaching because students efforts to research for themselves are limited. According to the researcher, the teacher knew the importance of having tablets at school. The findings of the study coincided with earlier findings by scholars like Hamidi, Meshkat, Rezaee and Jafari (2018) and Kessel (2015) who observed that ICT resources can support various types of interactions in the school learning environment: learner – content, learner – learner, learner –teacher and learner interface. These types of interactions make learning more enjoyable (Good and Brophy, 2002). The available tablets in almost all surveys, government aided schools in the division were in a ratio of one tablet to two hundred students. This inadequacy of tablets hinders students' active involvement in the teaching-learning process.

In summary of the above, the results showed that few teachers use tablets in teaching biology whereas students do not use them at all. This is because tablets are expensive for teachers and students are not allowed to come to school with tablets. This reduced students' classroom participation in learning biology. This is because students lack tablets which they could use to search, store and even share biology content. Also teachers could use the tablets to collaborate with other teachers, share marking guides and even lesson notes.

4.6 How use of smartphones influences students' classroom participation in learning biology

How does the use of smartphones influence students' classroom participation in learning biology in government aided secondary schools in Kimaanya–Kabonera Division?

4.6.1 Teachers' responses on how smart phones influence students' classroom participation learning in biology

The findings from teachers of Biology showed that if students are well guided on how to use smartphones productively, they can influence and enhance students' level of participation and interaction in the teaching–learning process. Teachers revealed that though the use of smartphones are prohibited but most of the students are day scholars and whenever they go back home, they use their parents 'phones to search for the required biological content. The table below summarizes teachers' responses on the merits and demerits of using smartphones to increase students' participation in the teaching and learning of biology.

Table 4.6.2 shows how teachers' biology responded on the merits and demerits of using smartphones in biology lessons

Merits /demerits	**Response that teachers of biology**	**Frequency of teacher who agreed to the statement**	**Percentage agreement**
Merits of smartphone use in teaching and learning	Eases the teaching– learning process by enabling students to research on their own.	07	43.7
	Motivates students to learn.	06	37.5
	They help teachers to teach abstract things there by making it real.	03	18.75
	Total	16	100.0
Demerits of using smartphones in teaching and learning	Smart phones are expensive	08	50.0
	Students are not allowed to come to school with smartphones.	03	18.75
	They can be misused by the students	03	18.75
	Distracts class attention	02	12.5
	Total	16	100.0

Source: Researcher, 2024

Table 4.6.2 above show that the majority (43.7%) of the teachers observed that smartphones ease the teaching – learning process by enabling students to research biology content on their own. Other respondents revealed that smartphones motivate learners (37.5%) and help students to understand some content which would be too abstract (18.75%). The results imply that teaching and learning goes beyond teachers' ability to deliver content and disseminate information without the adequate students' participation. This is in agreement with Ajayi's observations (2018). Ajayi asserted that, learning takes place when the teacher integrates ICT in the teaching–learning process and encourages learners to actively participate in the lessons. These findings rhyme well with those of Choi and Tang (2019), Cox and Marshall (2010) who observed that adequate supply of ICT resources eases teacher's preparation and assists the students to participate in the teaching–learning process.

Students' responses on the merits and demerits of smart phones use in teaching and learning biology.

The findings revealed that students are not allowed to come with smartphones at school and this can be evidenced by some of the profound citations from S.4 students from a school which was coded A.

The students observed:

> "It is stated clearly in our school rules and regulations that phones are prohibited."

Another key informant observed:

> "We are not allowed to come to school with phones. I only use the smart phone search for biology content when i go back home using my mother's phone."

The findings imply that all schools do not allow students come to school with phones. This prohibition limits the use of ICT resources in the teaching – learning process. Even if smart phones were allowed, children from low socio-economic status families cannot afford to buy them.

Key informants (students) elicited merits and demerits of using smart phones in biology lessons. The salient citations are given below:

One of the students from the school coded A, observed;

> "A smartphone can help a student to make her/his personal research and be able to read ahead of the teacher. Smartphones are expensive and many students cannot afford them and data is also expensive."

The above quotations imply that students know the advantages and limitations of using smartphone in learning of biology. In the view of the key informants interviewed, it is high time schools allowed students to use smartphones by putting in place a mechanism to regulate their usage. Although this issue is still highly contested but I think customized phones and tablets can be made without a provision for the sim cards. Furthermore, phones and tablets could be kept in a specific room at school where students can access them periodically. In the meantime, government and school heads should install more computers connected to internet. Government should install free wireless internet or subsidize it so that it is manageable by schools. The foregoing responses confirm that smart phones have limitations like students may be exposed to pornography and there

is a cost attached like buying data which can limit usage. The use of smartphones by students in schools may create antisocial behaviors among the learners hence becoming a disservice to the teaching-learning process.

The researcher also requested students to suggest ways how ICT can be integrated in the teaching and learning of Biology in secondary schools. Students gave a wide range of interventions and suggestion. Some of the outstanding responses are given in the three citations:

> "The MoES and school administration should allow students to come to school with smartphones because tablets and computers are expensive and not easy to maintain."

> "The ministry of education should install free and wireless Internet in all government aided schools."

> "More periods of ICT should be put on the teaching timetable to enable students get more hands-on experience and the Computer laboratory should be open from Monday to Saturday to enable students to use it in shifts since computers and other ICT tools are not enough."

The above citations were given by students and they were in line of overcoming the demerits and challenges facing teachers and students who use ICT resources in the teaching– learning process. The recommendations by the students are in agreement with suggestions by earlier scholars like Ngugi and Kinzi (2017), Popova et-al (2017), Pima et-al (2016) and Voogt (2016) who found out that students and teachers have challenges to access internet due to poor connectivity, scarcity of computers in schools and lack of regular maintenance of school tools or gadgets. Mfaune (2019) reported that the Tanzania government through the Ministry of Education came up with ICT policy for Basic Education (BE) and started to encourage parents and teachers to start utilizing mobile phones among other ICT resources in order to enhance the quality of education in Tanzania. Even if the students are allowed to use smartphones in secondary schools, many students in government aided secondary schools come from families with low incomes and allowing students to have them; can affect students' retention level as well as school completion. The qualitative data showed that students are not allowed to come to school with phones. This correlates well with the quantitave data which showed that teachers mainly use smart phones for teaching biology even though data is a challenge. The quantitative data also showed that students were not allowed to come to school with phones. This consequently reduced students' classroom participation in learning biology.

In summary of the above, schools do not have continuous supply of internet to power the smartphones, data is expensive for teachers, smartphones are expensive for teachers and students are not allowed to have phones at school. This reduces students' classroom participation in learning biology because they cannot search, share and communicate biology information.

4:8 Practical implications of the research findings

4:8:1 The findings on internet use in teaching and learning influences students' classroom participation in learning biology

The results implied that teaching and learning is about teacher-student interaction. The ultimate goal of this interaction is to boost student participation in the teaching-learning process. In spite the fact that all schools were using internet for academic purposes, the research indicated that many schools couldn't afford to access internet all the time because at-times schools lack funds to subscribe for the internet. This issue of not having internet in some schools due to lack of funds to subscribe can be overcome by the ministry of education and sports providing free internet to all government aided secondary schools in the country. The results implied that government aided secondary schools in Kimaanya- Kabonera division have not fully adopted the use of internet in teaching and learning of biology. This is due to lack of regular internet and infrastructure and the costs involved in maintenance, procurement and subscription.

4:8:2 The findings on how computer use in teaching and learning influences students' classroom participation in learning biology

The findings on computers and students' classroom participation in biology lessons showed that the computer- student ratio in school coded A, B and C varied considerably, that is school A 1:30, B 1:25 and school C 1:40. The results showed that all the sampled schools had insufficient computers. Inadequate supply of computers in government aided secondary schools in Kimaanya-Kabonera division limits students' participation during the teaching –learning process in biology lessons, so the ministry of education and sports and that of ICT should supply more computers to all schools in order to reduce the computer-student ratio. To at least, 1:10. This will in the long run increase the students' classroom participation in biology lessons in government aided secondary in Kimaanya-Kabonera division in Masaka city.

4:8:3 The findings on how the use of tablets and smartphones influence students' classroom participation in learning biology

The findings revealed that government aided schools in Kimaanya-Kabonera division in Masaka city; do not allow students to come to schools with smartphones. Such restrictions limit the use of smartphones to search for biology content. Those who use smartphones to search for biology content, borrow them from their teachers. It was also revealed that the tablet-student ratio stood to 1:80. The findings implied that the tablets and smartphones are the least used among ICT gadgets used in teaching and learning of biology. The school administration should put up rules and regulations on how to use smartphones in secondary schools with the aim of increasing students' classroom participation in biology lessons.

CHAPTER FIVE

CONCLUSIONS AND RECOMMENDATIONS

5.0 Introduction

This chapter is divided into sections: conclusions, recommendations and suggested areas for further research. For clarity purposes, conclusions and recommendations are presented in accordance with the specific research objectives of the study.

5.0 Conclusions

5.0.1 Concussion on how internet influences students' classroom participation in biology

The use of internet in teaching of biology brings the context which may seem to be abstract nearer to the students, for example, teachers can use it to play animated biology videos for students in class to enhance their understanding of difficult concepts.

It can also be concluded that the use of internet can help teachers of biology to enhance their teaching and students' participation in learning in biology lessons, but both teachers and learners have to access and know how to use these ICT tools to realize their pedagogical potential in teaching and learning biology for example, students get information directly from the internet, search engines like Google and share it in class with colleagues, and teachers of biology to use platforms like SKYPE which can enable them to hold video conferencing with other teachers' in other schools, but such an investment needs a lot of finances.

5.0.2 Conclusion on how computers use in teaching and learning influence students' classroom participation in learning biology

The findings of the study show that schools have a deficiency when it comes to the availability of ICT resources. Therefore, computers are not enough for students in the surveyed government-aided secondary schools in Kimaanya –Kabonera division. This means that students have to scramble for the few available computers. Because of their large numbers, some may not get an opportunity to use the computers to search for biology content prior to the following lesson. This in turn would reduce their classroom participation in learning biology.

5.1.3 Conclusion on how tablets use in teaching and learning influence students' classroom participation in learning biology

It was found out that tablets are very expensive to buy, most in all schools, no school possessed tablets and teachers who use them to teach, use their personal tablets. It can be concluded that tablets can increase students' classroom participation in biology lessons, but they are expensive for students and teachers to buy, and no government-aided secondary schools in Kimaanya-Kabonera has them. This means that students use of tablets to search, collaborate, make and store notes is much limited. This in turn reduces their classroom participation in learning biology because they lack prior knowledge about what is to taught in the following lesson.

5.1.4 Conclusion on how smartphones influence students' classroom participation in learning biology

The findings revealed that in secondary schools, teachers use smartphones to search for biology contents, but according to school policy, students are restricted in using them. Though smartphones enhance students' participation in biology lessons, their use and potential in learning biology is realized due to restricting school policy in the surveyed government-aided secondary schools in Kimaanya-Kabonera division.

Even though with their purported use, students' classroom participation is low because they are expensive for biology teachers and students are not allowed to have them in school. This greatly reduces their use in classrooms which in turn reduces students' classroom participation in learning biology. This is because without smart phones students may not easily search for biology content since computers are few in schools sampled.

5.2 Recommendations

5.2.1 Recommendation on how Internet use in teaching and learning influence students' classroom participation in learning biology.

To school administrators

It is recommended that government-aided secondary schools should install free and wireless unlimited internet subscribe for it to enable students and teachers to access it for learning biology.

The government of Uganda, through the Ministry of Education and Sports and ICT, should exempt government-aided secondary schools in Uganda from monthly subscriptions to the service providers like UTL, MTN and Airtel since these services are expensive for most teachers and

students.

The findings also revealed that some teachers have a negative attitude towards the use of ICT and the internet, and this was attributed to lack of sufficient ICT skills. So teachers who are less skilled in ICT should get refresher courses on how to use ICT tools, especially in basic computer applications like Microsoft office package like word, excel and power point. The government through ministry of education and sports and school heads through their ICT departments should be in charge of the refresher courses for teachers. School heads should provide incentives to their ICT teachers to teach other teachers these ICT packages.

5.2.2 Recommendations on how computers use in teaching and learning influences students' classroom participation in learning biology

Students should be equipped with computer literacy skills, for example, Microsoft applications such as word, excel and power point to help them address the problem of lack exposure to the use of computers in teaching and learning biology in the surveyed government-aided secondary schools in Kimaanya- Kabonera division.

Teachers should be given on-the-job training on how to use computer packages like Microsoft word, excel and power point., and integrate ICT in teaching-learning biology so that they become efficient in using computers.

Policies in this area should be revised by the Ministry of Education and Sports to support teachers and students in accessing and using ICT tools such as computers in preparing schemes of work, lessons plans and lesson notes.

School head teachers should mobilize funds from parents-teachers' associations (PTA) and from board of governors (BOGs) to set up infrastructure for ICT so that teachers can be motivated to integrate ICT in the teaching-learning process.

The findings of the study revealed that in all the sampled schools, it was found out that the student–computer ratio was between 1:20 or 1:30. With such a ratio, students do not get enough hands on experience. It is recommended that the government should support government-aided secondary schools to stock computer laboratories with more computers in order to reduce the student–computer ratio to at least 1:10.

Parents from families of high socio–economic status should buy laptops and encourage their

children to use them while at home. This kind of approach will enable students to put in practice what they learn at school especially during holidays.

5.2.3 Recommendatios on how tablets influence students' classroom participation in learning biology

It may be hard for schools to have enough tablets for teachers and students because school ICT resource demands are enormous. So teachers should endeavor to buy their own laptops and tablets and use them in class.

The Ministry of Education and Sports and the Board of Governors of government-aided secondary schools should mobilize parents to contribute some fee towards the procurement of tablets such that each class has at least one tablet.

5.2.4 Recommendations how on smartphones use in teaching and learning influences students' classroom participation in learning biology to schools

The findings revealed that a smartphone is much cheaper and easy to maintain. Therefore, government-aided secondary schools all over Uganda should allow students who can afford to have smartphones at school, to buy them and keep them with school administration so that the school administration regulates how these phones are used in class so as not to distract students during the teaching and learning process. Although this issue is highly contested, the researcher suggests that students should be allowed to come to school with phones which they should keep in a specified room with in school. The room should be supervised by school librarians who will ensure that students access them after classes for a few hours like from 5:00pm to 6: oopm daily. This is similar to the way students access the computer laboratories after classes under the supervision of the library attendant. This practice was found in all the three secondary schools that were sampled. The researcher suggests that during these hours of contact with phones, teachers give tasks which students can respond to using the searches with their phones.

Parents whose children study in government-aided schools should buy smartphones for their children and buy data for them, but they should regulate how these phones are used so that students do not use them for searching unwanted materials instead of using them for academic purposes while at home.

5.3 Suggested areas for further research

It was recommended that future researchers should study;

- Factors affecting the use of ICT in secondary schools.
- The impact of ICT on students' academic performance.

- ICT and teachers' preparedness to teach using the competence-based curriculum in lower secondary.

The above studies may help to generate knowledge on the role of ICT in the education sector. The findings of the study will help in bridging knowledge gaps in the existing literature in ICT and education.

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APPENDICES

Appendix A: Introductory letter from Faculty of Education–Uganda Martyrs University

Uganda Martyrs University

making a difference

The Faculty of Education

Date: 20/07/2023

Re: PERMISSION LETTER TO CONDUCT FIELD RESEARCH

Dear Sir/madam,

Greetings from Uganda Martyrs University.

The Faculty of Education is delighted to introduce SSENKUNGU RAPHAEL, Registration number 2017-M312-30015, a student pursuing a Master of Education degree of Uganda Martyrs university.

S/he is undertaking a field research to fulfill one of the requirements leading to the award of a Master of Education degree of Uganda Martyrs University.

His/her research topic is: INFORMATION COMMUNICATION TECHNOLOGY (ICT) AND STUDENTS' CLASSROOM PARTICIPATION IN LEARNING BIOLOGY IN GOVENRMENT AIDED SECONDARY SCHOOLS IN KIMAANYA – KABONERA DIVISION, MASAKA CITY

We request that you offer him/her the necessary assistance in order to complete this research project. For further inquiry on this matter, please contact me at 0772-366156 or email: aodele@umu.ac.ug.

Thank you for your support and cooperation.

Sincerely,

AOdele

Dr. Anne Odele

Head of Postgraduate Department

Faculty of Education

Uganda Martyrs University P.O. Box 5498 - Kampala - Uganda
Tel: (+256)038-410611 Fax: (+256) 038-410100 Email: umu@umu.ac.ug

Appendix B: Consent Form

Uganda Martyrs University

P.O. Box 5498, Kampala.

Dear Respondent,

You have been identified to take part in a study to examine:

"ICT and Students' Classroom Participation in Learning Biology in Government Aided Secondary Schools in Kimaanya–Kabonera, Masaka City."

It is believed that you will provide relevant data which will enable the researcher to compile an academic dissertation. The findings of the study will only be used for academic purposes and enable the researcher to obtain Master's Degree in Educational Management and Administration from Uganda Martyrs University.
The researcher will keep the information you will provide with high degree of confidentiality and participation in the study will be on voluntary basis.

Thank you for your cooperation Yours faithfully,

.....

SSENKUNGU RAPHAEL

RESEARCHER

ACCEPTANCE CLAUSE ☐

Tick where applicable

I will be able to participate in the study ☐

I will not be able to participate in the study ☐

Name:_____

Contact:_____

Email address: _____

Date and time to collect the questionnaire:

Date: Time:

Appendix C: Questionnaire Form for Teachers of Biology

I am a Master's student at the Faculty of Education at Uganda Martyrs University. As part of study program, am required to undertake a study on:

"ICT and Students' Classroom Participation in Learning Biology in Government Aided Secondary Schools in Kimaanya–Kabonera, Masaka City."

Your school has been selected to get involved in the study and you have been identified since you are a teacher of biology and you're believed to have information required for the successful completion of the research project. This is therefore, to humbly request you to respond by filling the questionnaire attached overleaf.

Thank you for your cooperation.
Yours faithfully,
SSENKUNGU RAPHAEL
RESEARCHER

SECTIONA:

Demographic characteristics about respondents. Tick appropriately where applicable ☐

1. What is your gender?

(a) Male ☐ (b) Female ☐

2. Indicate your age bracket:

(a) 20–29years ☐ (b) 30–39 years ☐

(c) 40–49years ☐ (d) 50 years and above ☐

3. Work experience:

(a) 0-9years ☐ (b) 10-19years ☐

(c) 20-29years ☐ (d) 30 years and above ☐

4. Marital Status:

(a) Married ☐ (b) Single ☐

(c) Separated ☐ (d) Windowed ☐

(e) Any other?

Specify……..

5. Highest level of academic qualifications:

(a) Diploma in Secondary Education ☐

(b) Graduate teacher ☐

(c) Post Graduate Diploma in Education. ☐

(d) Master's in Education ☐

SECTION B:

Internet and Students' Classroom Participation in Biology

6. Please show your level of agreement or disagreement to the following likert scale statement:

5 = Strongly Agree (SA)

4 = Agree (A)

3 = Undecided (UD)

2 = Disagree(D)

1 = Strongly Disagree (SD)

Statement	**Level of Agreement**				
	SA5	**A4**	**UD3**	**D2**	**SD1**
Students use Internet to search for biology content					
Teachers use internet in the teaching–learning process.					
Teachers get biology Content from the Internet.					
ICT enhances students' classroom participation in biology.					
All teachers of biology use the internet to teach biology.					

7. How does the internet influence students' participation in biology classes?

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SECTIONC:

Computers and Students' Classroom Participation in Biology

8. Please show your level of agreement or disagreement to the following likert scale statement: 5 = Strongly Agree(SA)

4 = Agree (A)

3 = Undecided (UD) 2=Disagree(D)

1 = Strongly Disagree (SD)

Statement	**Level of Agreement**				
	SA 5	**A 4**	**UD 3**	**D 2**	**SD 1**
Basic computer literacy enhances students' classroom participation In biology.					
The use of ICT enhances the teaching of biology.					
My school has enough computers for the students.					
Students use computers to type set notes and do assigned activities in biology.					
Computers enhance students' participation and help teachers to Give feedback in biology.					

9. How does the use of computers influence students' participation in biology?

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……
……
……

SECTIOND:

Tablets and Students' Classroom Participation in biology

10. Please show your level of agreement or disagreement to the following statements:5 =Strongly Agree(SA)

4=Agree (A)

3 = Undecided (UD) 2=Disagree(D)

1 =Strongly Disagree(SD)

Statement	**Level of Agreement**				
	SA 5	**A 4**	**UD 3**	**D 2**	**SD 1**
The school computer laboratory has enough functional tablets for Students.					
Tablets increase students' classroom participation in biology.					
Students use tablets to make biology notes.					
Tablets increase students' collaboration in biology lessons.					
Tablets increase teacher–student classroom interaction in Biology Lessons.					

11. How do tablets influence the students 'classroom participation in biology lessons?

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SECTION E:

Smartphones and Students' Classroom Participation in biology

12. How do smartphones influence students' participation in biology lessons?

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13. What are:

a) Merits of using smartphones in biology lessons?

b) Demerits of using smartphones in Biology lessons?

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14. Are the students allowed to come to school with smart phones?

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……

15. Are the students able to use smartphones during the learning of biology?

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……

……

……

16. Please show your level of agreement or disagreement to the following likert scale statement: 5 = Strongly Agree(SA)

4 = Agree (A)

3 = Undecided (UD) 2=Disagree (D)

1 = Strongly Disagree (SD)

Statement	**Level of Agreement**				
	SA 5	**A 4**	**UD 3**	**D 2**	**SD 1**
All students have smartphones					
Students are allowed to come with smartphones to schools.					
Smartphones increase students' participation in biology lessons.					
Smartphones are used by teachers.					

END

Thank you very much for your cooperation.

Appendix D: Focus group discussion guide for s.3 and s.4 students

1) Do you have ICT Department in your school?
2) Which of the following ICT resources do teachers of biology use in teaching?
a) Internet
b) Computers
c) Tablets
d) Smartphones
3) Are the learners of biology use ICT resources in learning biology?
4) What are the:
a) Merits of using ICT resources in learning biology?
b) Demerits of using ICT resources in learning biology?
5) What is the influence of ICT resources on students' participation in learning biology?
6) In your own opinion, what are the challenges affecting students" level of using ICT gadgets at school.
7) Suggest ways of increasing students" access to ICT gadgets in the teaching – learning process particularly in biology.
8) How do the following ICTs (Internet, Computers, Tablets and Smartphones) influence students' participation in learning biology in government aided secondary schools in Kimaanya–Kabonera division?
9) What is your perception on the use of ICT gadgets in the learning of biology?
10) How the use of ICT can be enhanced in the teaching of biology in secondary schools?

End

Thank you very much

Appendix E: Documentary Review Guide

The researcher reviewed the following documents:

1) Uganda National Examinations Board Results in the government aided secondary schools between 2013– 2022 found in Kimaanya – Kabonera Division, Masaka City.
2) Reports from ministry of Education and sports on the Integration of ICT in the teaching –learning process from the Ministry of Education and sports.

3) Report from the city Education Officer

Appendix F: Krejcie and Morgan (1970) Sample Size Estimation Table

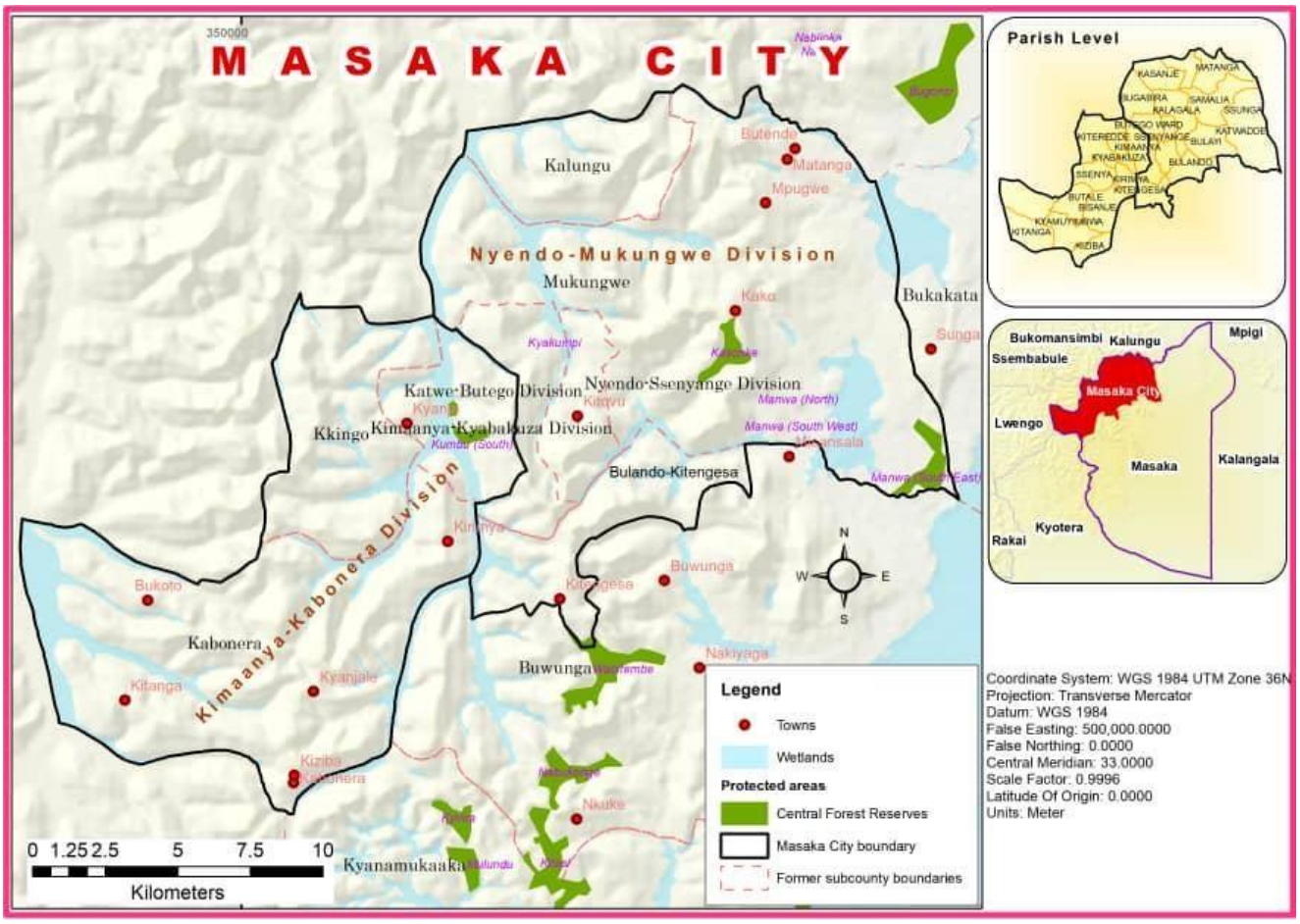
Table for Determining Sample Size for a Given Population

N	S	N	S	N	S	N	S	N	S
10	10	100	80	280	162	800	260	2800	338
15	14	110	86	290	165	850	265	3000	341
20	19	120	92	300	169	900	269	3500	246
25	24	130	97	320	175	950	274	4000	351
30	28	140	103	340	181	1000	278	4500	351
35	32	150	108	360	186	1100	285	5000	357
40	36	160	113	380	181	1200	291	6000	361
45	40	180	118	400	196	1300	297	7000	364
50	44	190	123	420	201	1400	302	8000	367
55	48	200	127	440	205	1500	306	9000	368
60	52	210	132	460	210	1600	310	10000	373
65	56	220	136	480	214	1700	313	15000	375
70	59	230	140	500	217	1800	317	20000	377
75	63	240	144	550	225	1900	320	30000	379
80	66	250	148	600	234	2000	322	40000	380
85	70	260	152	650	242	2200	327	50000	381
90	73	270	155	700	248	2400	331	75000	382
95	76	270	159	750	256	2600	335	100000	384

Note: "N" is population size
"S" is sample size.

Source: Krejcie & Morgan (1970)

Appendix G: Map of Masaka City showing Kimaanya Kabonera Division



Appendix H: Observation Checklist

Unit of observation	**Comment(s)**
ICT infrastructure in place: Computer laboratory ICT infrastructure at the learning center	
Biology laboratory	
Access to ICT infrastructure: Access by teachers Access by students	
Technical support: Availability of ICT personnel Availability of internet	
Use of ICT, teachers and students' participation in biology lessons	

Appendix I: Cronbach's Alpha Coefficient

Any value above 0.6 is considered highly reliable and acceptable index.

N = number of items

c = average variances between item pairs

v = average variance

$$\alpha = \frac{K}{(k-1)\, y(s^2y - \sum si^2)}$$

k = Number of items

$\sum s^2$ = Sum of variances

s^2y = Variance of the total

Source: Derived from Kyambogo University: Education Research Module PS/2/22010

Appendix J: Pre–test data collection tool/CVI Computation

The research tools, that is questionnaire form and the interview guide both have twenty-seven (27) question items. The CVI is computed using the formula below:

$$CVI = \frac{\text{Number of items judged relevant}}{\text{Total number of question items in the tool}}$$

$CVI = {}^{28}/_{30}$

$CVI = 0.84$

Therefore, the tools were considered relevant because the CVI is above 0.7.

Appendix K: Plagiarism test page

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