UNIVERSITY OF CAPE COAST

INFLUENCE OF INFORMATION AND COMMUNICATION TECHNOLOGY CAPABILITIES IN STUDENT ACHIEVEMENT IN WEST GONJA MUNICIPAL

SEIDU IBRAIMAH

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INFLUENCE OF INFORMATION AND COMMUNICATION TECHNOLOGY CAPABILITIES IN SENIOR HIGH SCHOOL STUDENT ACHIEVEMENT IN WEST GONJA MUNICIPAL

BY

SEIDU IBRAIMAH

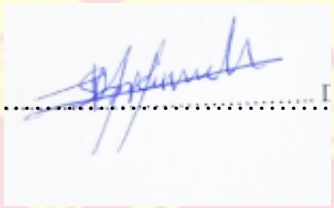
Thesis submitted to the Institute for Educational Planning and Administration, University of Cape Coast, in partial fulfilment of the requirements for the award of Master of Philosophy degree in Administration in High Education

2023

DECLARATION

Candidate's Declaration

I hereby declare that this thesis is the result of my own original research and that no part of it has been presented for another degree in this university or elsewhere.



Candidate's Signature ……..…….. Date …….

Name: Seidu Ibraimah

Supervisor's Declaration

We hereby declare that the preparation and presentation of the thesis were supervised in accordance with the guidelines on supervision of thesis laid down by the University of Cape Coast.

Principal Supervisor's Signature…… Date ……

Name: Dr. Samuel Tieku Gyansah

ABSTRACT

The research investigated the influence of Information and Communication Technology (ICT) capabilities on student achievement in the West Gonja Municipal. The study identified ICT capabilities as the affordances offered by ICTs in education that students identify and use to meet their learning needs and improve knowledge retention and conceptual understanding of specific domains, which include computational capabilities, graphing capabilities, engagement capabilities, and motivation capabilities. The study is mainly a quasi-experimental research with quantitative research approach. A sample of 120 participants was taken from three Senior High Schools in West Gonja Municipal using the stratified random sampling technique. The study utilized diagnostics tests and a survey questionnaire to collect data, which were analysed with the aid of Python 3.8. At the most global level, the study found that student test scores improved after the treatment was implemented which means each of the ICT capabilities impacted student test scores positively. The study also found that of the four different ICT capabilities, computational ICT capabilities had the most influence on student performance. In line with the findings, the study recommends for Information and Communication Technology to be fully integrated into the SHSs curriculum. The study further recommends that the integration should focus on building the capabilities of SHS students regarding the use of ICT in their educational activities rather than simply providing ICT tools.

KEY WORDS

Information Communication Technology

ICT Capabilities • Graphing Capabilities

Computational Capabilities

Student Achievement·

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DEDICATION

To my wife, children and my entire family.

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LIST OF ACRONYMS

Acronym		Meaning
ICT	-	Information and Communication Technology
AR	-	Augmented Reality
PBL	-	Project Based Learning
WGM	-	West Gonja Municipal
SR	-	Savannah Region
GES	-	Ghana Education Service
IM	-	Multiple Intelligence
MD	-	Mechanics Dynamics
EPT	-	Educational Productivity Theory
DCM	-	Dynamic Capabilities Model
PFA	-	Production Function Approach
CC	-	Computational Capabilities
GC	-	Graphing Capabilities
EC	-	Engagement Capabilities
MC	-	Motivation Capabilities
ESP	-	Education Strategic Plan

CHAPTER ONE

INTRODUCTION

Background to the Study

Information, communication and other technologies are driving a new revolution in various fields and professions including medicine, agriculture, record keeping and education. This revolution is transforming the structures, strategies, employment patterns, policies, and social practices around the world. Tassos (2018), in a study, notes that the ubiquitous presence and utility of ICTs further strengthen the case that ICTs would drive even more significant implications on our very survival. Today, there is widespread awareness that these fast-pace advances in ICTs and their ubiquity around the world are leading further developments in the global knowledge society and enormous empirical evidence in support that all spheres of human life and our general wellbeing run on Information and Communication Technologies (ICTs).

Joseph and Joey (2021) believe that ICT forms the foundation of every major industrial and organizational activity, from services to manufacturing to logistics. In the field of education, ICT provides universal access, equity, quality delivery of teaching and learning, and enhances effective educational management (Paola-Marcela, 2020). The rise of digital schools and platforms is the child of advances in ICTs and their subsequent applications in the educational arena. Because our society has become increasingly dependent on these technologies from our Electric Grid, Water and other utility systems to healthcare, communication, and transport systems, Bart and Danielle (2018) hold the view

that there is an increasing need to facilitate a new generation of experts with wider and better interactive arrangements and ICT provides the means to its achievement. For this reason, great efforts have been and are still being made at various levels of societies and sectors to integrate and derive the most benefits offered by ICTs (Paola-Marcela, 2020). In many circles, information and communication technology (ICT) has been seen as an important part of strategies to deliver basic education to the low-skilled, the poorly qualified and the hard to reach.

It is evident and verified worldwide that investments in ICT integration efforts have increased exponentially over the last few decades (World Bank, 2018). The astronomical rise in global investments in ICTs responds to the conventional wisdom that ICT integration engenders tremendous improvements to performance. Fan (2017) notes that prudent deployment and management of ICTs and their afforded capabilities can significantly enhance performance and value. Fan (2017) cautions however that ICTs have unique characteristics and affordances to record, store, and process data and information and so integration of ICT should be done within proper contextual settings. More importantly, Sohni (2020) notes, ICT evolves at a fast-pace and so integration must keep pace with eminent changing trends and needs as they evolve (Sohni, 2020).

In Ghana, the ICT industry plays a various key roles and interests in different ICT-led solutions as well as infrastructure have risen lately (Waliu, 2021). This is evidenced by the huge investments being made in the industry that have led to the industry growing from from merely US $ 35 million in 2013 to $1 billion in 2022

(International Trade Administration, 2023). Today, the role that ICTs play in the country's broader economic success are enormous. The Oxford Business Group (2022) views the ICT industry to be among the fastest-growing industries in Ghana.

In the field of education, the unique characteristics and feature of ICT afford actions and new revolutions in teaching and learning that consequently benefits learning (Maria, Antonio & Maria, 2019). ICT integration in education is gathering pace with developments in the 'Internet of Things', virtual teaching and learning platforms, 3D Printing, cloud technologies, Augmented Reality(AR), smartboards, digital textbooks, Project Based Learning (PBL) techniques, and learning simulations set to unleash major transformational change in the educational systems of countries across the globe (Connect4Change Education Ghana Alliance, 2016).

ICT is integral to Ghana's education policy. Borne out of the increasingly important role of ICT to socio-economic growth and development, successive governments in Ghana have prioritized ICT integration in education from the Ghana ICT for Accelerated Development in 2003, 2006, 2009 and the ICT in Education Policy in 2015 (Ghana Education Service, 2018). The overall purpose of these ICT-led educational reforms were intended to develop the desire and competences in pupils to use ICTs, equip pre-tertiary learners with ICT capabilities, infuse ICT into education management, and transform teacher development and tertiary education through technology-based training (Ministry of Education, 2018). The Education Strategic Plan (ESP) 2018 – 2030 details

these integration objectives and provides further prospects and challenges with ICT integration at various levels of the country's educational system. The integration was also intended to influences student achievements and enhance the quality of school management systems. Another important reason advanced for digital educational technologies is premised on a number of research findings in the advanced world that suggest that academic achievement of students amplified where students possess sufficient knowledge and appropriate capabilities of ICTs (Lange, 2019). In other words, good knowledge of ICTs has a strong positive impact on student academic achievements especially in computational and demonstrative subjects such as mathematics, physics, chemistry, and other sciences (Adel & Mounir, 2018). ICTs are also believed to enhance the quality and effectiveness of the learning process and this is shown by the huge investments that are being made to equip schools with ICT (Lange, 2019).

Despite its relevance and the resources and efforts expended in pursuing ICTs, its integration in basic and secondary education comes with a lot of controversies regarding the ultimate influence ICTs may have on students. Michael's (2020) critique of "ICT integration in education" highlights two key perspectives to ICT in educational policy: the scope and models of integration and outcomes (net impacts-ethical and moral protocols in the use of ICT) if ICT integration. The integration model perspective looks at ICT and education policy integration at two levels: access and capability (Michael, 2020). At the access level, ICT tools and other digital technologies including both hardware and software are made readily available and accessible to students. The One Laptop Per Child Policy

(OLPCP) is an example of the access-based ICT integration where focus is given to accessibility to hardware and software.

The capabilities perspective focuses on engaging students to develop Information and Communication Technology (ICT) capability as they learn to use ICT effectively and appropriately to access, create and communicate information and ideas, solve problems and work collaboratively in all learning areas at school and in their lives beyond school. ICT capability involves students learning to make the most of the digital technologies available to them, adapting to new ways of doing things as technologies evolve and limiting the risks to themselves and others in a digital environment.

Waliu (2021) explains that the aspect of ICT integration in education that has received the most discussion is the ultimate net impact of ICT use among students. A fraction of the public advances several rational for the need to include ICT in basic and secondary level education and critics raise legitimate concerns over the tremendous risk associated with open access to information that may be harmful to students. Research studies have shown conflicting results and this study intends to investigate how ICT capabilities drives student educational achievement (Rafal, 2014; Shakeel, 2019; Halilic, 2020).

Waliu (2021) contends that the ICT integration in education in Ghana has focused mainly on improving access to ICT tools such as mobile phones and computers, internet access, and other digital technologies with little to no attention to building the capabilities in handling such ICT tools. The National Communications Authority (2020) found that less than 5% of Ghanaians aged 5

years and above possess basic ICT capabilities beyond copying of files and documents. In its recommendations, the National Communications Authority (2020) advised that with the ubiquity of ICT tools, the focus of educational policy as it relates to ICT integration should be directed towards building the capacities and capabilities relevant to handle the various ICT tools.

In a nutshell, ICT integration in education is a topical and important issue and there is real need for an authoritative research to unearth the impact of ICTs on education. This is not necessarily borne out of the increasing global investments in the provision and building the capacities of students and teachers in ICTs but because it is extremely important to examine the influence of ICT capabilities on student achievement.

Statement of the Problem

Information and Communication Technologies (ICTs) have infused into almost all aspects of our living and their continuous advancements necessitates new forms of practices and policies in education. Today, ICT integration in educational settings is a worldwide expectation and new trends in human life, such as the emergence of COVID – 19, place enormous importance to ICTs (Phungsu, 2020). Consequently, ICT integration in education is a global phenomenon and ICTs form an integral component of the educational policies of many countries across the world. In Ghana, ICT integration in education remains a controversial issue because of the wide-ranging and complex implications it has especially on students in second cycle institutions (Loana, 2020). These

controversies have led many to question net impact of ICT on student achievement.

On the one hand, advocates of ICT integration in basic and secondary education (such as Opoku, 2016; Lucia & Pino, 2017) opine that ICT offers many benefits (such as improved knowledge retention, enhanced collaboration and student engagement) and engenders a new wave of revolution in educational spheres. At the other extreme end, critical voices against the use of ICT education usually raise concerns that ICT integration in education has the potential to create serious difficulties, putting a spotlight on the failures of ICT. These critical voices such as Joseph *et al.*,(2021) argue the benefits of increased engagement and access to online resources offered by ICTs are being offset by the students' continuing engagement in misapplication of ICT tools that tend to reduce study or learning engagement hours per day and discourage creative knowledge work.

A large number of studies have been conducted along the same research issue in Ghana as well as in other parts of Africa. A greater portion of these studies have focused mainly on the effects of ICT Tools on student achievement (Tajudeen, 2020). Other researchers such as Francis (2015) also focused on influence of specific ICT tools such as calculators on student achievement. This study differs from these studies on a number of issues.

First and foremost, this study focuses on the capabilities derived from ICT that afford specific actions attributable only in basic or secondary educational settings. The study considers those essential ICT capabilities required by students

in the context of the study (secondary school setting). This study also differs from the others in respect of the study area.

This study investigates the influence of Information and Communication Technology (ICT) capabilities on the academic achievement of students in Senior High Schools in West Gonja Municipal.

Purpose of the Study

The study investigated the influence of ICT capabilities on student achievement in Senior High School in the West Gonja Municipal in the Savannah Region.

Research Questions

The research pursues these questions:

1. What is the influence of ICT computational capabilities on student achievement in West Gonja Municipal?
2. What is the influence of ICT graphing capabilities on student performance in West Gonja Municipal?
3. What is the influence of ICT engagement capabilities on student achievement in West Gonja Municipal?
4. What is the influence of ICT motivation capabilities on student achievement in West Gonja Municipal?

Hypotheses

These hypotheses were investigated.

H1: There is a significant correlation between ICT computational capabilities and student achievement in West Gonja Municipal.

H2: There is a significant correlation between ICT graphing capabilities and student achievement in West Gonja Municipal.

H3: There is a significant correlation between ICT engagement capabilities and student achievement in West Gonja Municipal.

H4: There is a significant correlation between ICT motivation capabilities and student achievement in West Gonja Municipal.

Significance of the Study

The research is relevant to many users including education policy makers, government and its sister agencies, students, parents, and researchers. To the education policy makers, government and its sister agencies, the findings of this research will provide relevant information that will be valuable to the crafting of superior regulation and policies that are efficient to address prevailing challenges associated with the use of ICTs. Students will also find the results of the study useful especially in relation to ways and ethical values to be observed when using ICT tools. Parents will also gain an appreciative understanding of the need to encourage and support their wards on the best way to use ICT. This research further adds to current literature on the topic of the study and maybe referenced by future researchers or forms the basis for the conduct of future studies.

Delimitations

The study examined the influence of ICT capabilities on the performance of students in Senior High Schools in West Gonja Municipal. The study focused on four (4) ICT capabilities described by Marcelino (2020). In addition, student performance is broad and may include performance test scores, post-education employment, and personal development, among others. This study considers student performance to mean performance in test scores. Therefore, the ICT capabilities that were considered in the study are computational capabilities, graphing capabilities, motivation capabilities, and engagement capabilities.

Limitations

The study had a number of limitations. The research is descriptive in nature and its context is limited to students in West Gonja Municipal. Therefore, the application of results will also be limited to the study area. Another important limitation of the study is time and resources. The entire design and administration of the questionnaire is generally time consuming and resource intensive. Nonetheless, efforts were made to ensure that these limitations did not have an influencing impact on the results of the study.

Definition of Terms

Student Engagement

The energy and effort that students employ within their learning community, observable via any number of behavioral, cognitive or affective indicators across a continuum.

Information and Communication Technology

This refers to the technology (including the hardware, software, others) used to collect, process, store and communicate or transfer data and information.

ICT Capability

The ability of a student to identify and use ICT to meet learning needs and improve knowledge retention and conceptual understanding of specific domain such as mathematics, chemistry, and physics, among others. In other words, it is the ability to strategically use Information and Communication Technologies for educational purposes and to drive and support educational outcomes.

Motivation Capabilities

The capacity of ICT skills to keep a student focused and interested towards studies and other relevant academic activities. This constitutes the ability of ICTs to drive a student's persistence, willingness, interest, pride, curiosity or desire to engagement in a certain positive behaviour in order to enhance his or her academic achievement. Curiosity is an important condition for learning and it plays a significant role in learners, students are better at learning information they are curious about. Curiosity has been shown to have a significant impact on students' achievement. Willingness is a key behaviour that helps students to get on in learning ICT, being open to or seeking out new experiences, skills and information that improve their abilities.

Engagement Capabilities

The ICT skills to afford students the ability to engage with other students and teachers with the purpose of sharing academic-related information and data

intended to improve the students understanding of concepts and domains relevant to achieving better academic outcomes. Engagement capabilities help produce information literate students in such a manner as to help them determine information need, where to find it, how to evaluate information sources and how to use information.

Computational Capabilities

ICTs provide effective algorithms and computation simulation tools that help to equip students with effective and efficient techniques to performance computations in mathematics, business, physics, and other numerical courses. Computational capabilities of ICTs are the affordances that ICTs offer to enhancing students' ability to solve computational problems effectively and efficiently.

Graphing Capabilities

Data visualization is embedded in a number of ICT suites that help to improve student conceptual understanding of graphing through the use of data visualizations simulation software and data analytical tools such as Microsoft Excel. ICTs afford students to opportunity to understanding conceptual issues of graphing and provide a platform for solving graphing problems especially in mathematics and physics.

ICT Investment

ICT investment is defined as the acquisition of equipment and computer software that is used for more than one year. ICT has three components:

information technology equipment (computers and related hardware); communications equipment; and software.

Organisation of the Study

The study consists of five (5) chapters. The first chapter introduces the study. It discusses the background to the study, problem statement, and the aim of the study. The chapter also outlines the research objectives, research question or hypotheses, and the relevance of the study. Finally, the chapter states the delimitations and limitations, offers the definitions relevant terms used in the study and explains how the study is organized.

The second chapter provides a review of related literature about ICT Capabilities, student achievement and the relationships between them. The chapter covers the theoretical review that provides theoretical framework and model for the study, the empirical review of variables as identified in the study, and the concepts that underline the study.

Chapter three offers the research methods used to conduct the research. The fourth chapter provides results of data analysis and discusses them. It organizes the results in the order of research questions or hypothesis. Finally, the fifth chapter provides an overview of the entire research work by providing summary and conclusions. The chapter identifies the research findings and offers recommendations to address any issues found in the research.

CHAPTER TWO

LITERATURE REVIEW

Introduction

This chapter presents a review of extant literature on ICT Capabilities, student achievement and the relationship between them. The chapter explores the theoretical foundations underpinning the ICT capabilities and student achievement. It also presents a review of concepts relevant to understanding the relationship and possible influences of ICT capabilities on student achievement. In addition, the chapter presents an empirical review of variables to explore the possible predictable influences of ICT capabilities on student achievement.

An Overview of Student Achievement and ICTs in Education

This section provides a background to the core concepts that are under study in this research. These include the concept of student achievement and ICT in education.

Concept of Student Achievement

The importance of student achievement cannot be overemphasized as it represents the ultimate bottom line of any educational system across the globe. According to the Institute of International Educational Programmes (2018), the ultimate goal of every instructional strategy, curriculum or educational initiative and reform is to achieve greater achievement of students. As such, student achievement and academic performance in general is an international concern (Institute of International Educational Programmes, 2018). Globally and Ghana in particular, improvements in student achievement has been found to correlate

positively with the quality of human resource the quality of education and investment on educational and human resources and general economic wellbeing. Lydia (2016) considers student achievement on merit as an important input factor that delivers superior economic returns on all investments in education. Therefore, without doubt academic performance presently is a major issue among students, teachers, parents, school administrators, and the community at large (Lawrence, 2018). Researchers have made several attempts to unravel the complexities surrounding academic performance (Lawrence, 2018). For example, psychology researchers have put forward a lot of reasons why disparities in achievement among young people exist (Lawrence, 2014).

Today, the issue of student achievement is topic one in Ghana (Francis, 2014). With the passage of time, these debates have centered on the conceptual issues regarding the definition, what should be included and excluded, drivers of educational performance and more important, how to improve the performance of students in specific areas of study.

Defining Student Achievement

According to Allingham (2018), achievement is a broad term with different perspectives and theoretical underpinnings. Therefore, Passos *et al* (2020) explains, the discussion of the concept of student achievement should necessarily begin with an undistorted, all-inclusive definition of the term student achievement. Avis (2016) explains that though student achievement is widely researched and well documented in literature, there is no consensus on its definition. According to Avis (2016), largely independent studies conducted in the

area have defined the concept with each emphasizing on different variables. Armstrong (2014) explains that student achievement has been viewed in relation to two major concepts including functional intelligence and emotional intelligence. For instance, Jason and Chazan (2009) hold the view that a student is said to perform or achieve well when he/she achieves high test scores or desirable student outcomes in examinations. This definition emphasizes on the functional intelligence. Ikenna (2016) also explains that students perform academically when they acquire the knowledge, skills, and attitudes that will prepare them to lead happy and successful lives. This definition draws concepts from the functional and emotional views. For the purpose of this research, the definition by Jason and Chazan (2009) was adopted since it is usually more difficult to measure emotional intelligence.

Theories of Student Achievement

Governments, policy makers and educators have long been seeking ways of improving students' academic performance and obtaining desirable students outcomes in both pre-tertiary and tertiary educational institutions. Over the years, the issues of student achievement and student academic performance have been the center of focus of a number of research efforts around the world (Graham, 2014). This has led to the development and adoption of a myriad of theories that seek to present alternative views to the nature and otherwise of academic performance (Tomei, 2008). Graham (2014) explains that different theories on student achievement have emerged, adopted, and applied over the years in attempt to assess the effects of different items on student achievement. Armstrong (2016)

noted that the theories emphasize on different variables that measure student achievement and hence, the inconsistencies in research findings.

The review shows that some of the popular theories of academic performance are Multiple Intelligence (IM) Theory which emphasizes that the student has different types of intelligence including linguistic, musical, logical-mathematical, and spatial Intelligences. The theory thrives on the premise that to attain desirable academic performance, the teaching and learning process requires the use a variety of techniques, methods, tools, and strategies to explore and foster those intelligences of the student. Incidentally, the theory argues that academic performance is based associated with his abilities in mental operations (Graham, 2014).

Another important theory is the Mechanics Dynamics (MD) Theory which emphasizes on the use of technology to enhance student academic performance (Graham, 2014). Bibir (2010) explains that the theory views academic performance through the development of skills that facilitate the development of knowledge about a domain.

Finally, the Vygotsky and the Zone of Proximal Development Theory, which combines the MI Theory and MD Theory, describes the span between what a learner can do independently and what he or she is capable of accomplishing with more expert assistance (Gebhard, 2001). The theory emphasizes the fusion of technology and mental capabilities to enhancing academic performance and so teaching and learning experiences should take full advantage of the interactions between technology and mental capacities. According to Graham (2014), the main

thrust of this theory is that technology enhancements should be intentionally integrated into guided learning opportunities that offer technology-assisted situations in which students are supported in the construction of relevant understanding within an authentic context.

Academic Performance is widely researched and extensively documented but there is no unified definition of the term due to its multidisciplinary nature (Avis, 2004). The largely independent studies conducted in the area have defined the concept with each emphasizing on different variables. According to Armstrong (2013), research shows that the concept of academic performance has been viewed in relation to two major concepts including functional intelligence and emotional intelligence. For instance, Jason and Chazan (2009) hold the view the view that a student is said to perform academically well when he achieves high test scores or desirable student outcomes in examinations emphasizing on the functional intelligence. Ikenna (2016) also explains that students perform academically when they acquire the knowledge, skills, and attitudes that will prepare them to lead happy and successful lives. This definition draws concepts from the functional and emotional views. For the purpose of this research, the definition by Jason and Chazan (2009) was adopted.

Student achievement is a very important variable pursued by any educational policy, school, educationists, parents and students alike. Gaps in the academic performance of students across various levels of education have and continue to be a major concern. According to Bibir (2010), students come from a wide range of social, economic, and cultural backgrounds. As such, they have

different life experiences, different educational opportunities, expectations, needs, and varied academic potential (Fraser and Kalen, 2003). These factors affect students' academic performance differently.

Bibir (2010) identified macro and micro determinants of achievement. The micro determinants include school attendance, study hours per day, home environment, and the availability of learning materials. The macro factors also include the teaching environment, the quality of teachers, and availability of teaching materials, among others.

ICT in Education

The rapid development of ICTs in education, several educational technologies have been wildly used in teaching and learning processes (Leona, 2021). In many different contexts, the applications of ICTs in education mainly focused on introducing novel tools to support teaching, learning, and management (Waliu, 2021). For example, in the UK and many other advance nations, teachers and other educators may assess their own pedagogical digital competences and find various possibilities to upgrade them. Furthermore, in Second Cycle Institutions, ICTs are being used in the teaching and learning processes in informatics labs, libraries with access to internet enabled computers, classrooms, and other places where teaching and learning takes place. Today, the use of diagnostics assessment systems is on the rise because of the affordance that the various ICTs offer to the scientific community (Leona, 2017).

Historical Background of ICTs Integration in Education

Information communication technology (ICT) tools such as radio, television, and, recently, computers with an Internet connection, have been gainfully employed over time in the educational sector to enhance teaching and learning. ICTs also include communication and computing equipment or materials that enhance and support all forms of teaching and learning activities in schools. Historically, the use of ICTs in education dates back to the 1950s through the launch of Skinner's Programmed Logic for Automatic Teaching Operations (PLATO) which served as an important aid for student self-learning (Tassos, 2018). Many researchers consider the introduction of PLATO as the Wave of ICTs in education (Edgar, 2015). The second wave, according to Edgar (2015), was the penetration of personal computers, which student can use to demonstrate their skills and creativity.

Michael (2021) in a critique "Personal Computers: Tutors in an intelligent learning environment" emphasizes that the proliferation of personal computers and other handheld digital devices have driven a wave of innovations in educational technologies and ICT-led intelligent platforms that hitherto were considered impossible to achieve. The formation of the United Nations Educational, Scientific and Cultural Organization (UNESCO), an organization known widely as a promoter of ICT in education and championing its contributions in enhancing learning and providing new skill sets for students, further climaxed the relevance of ICTs integration in schools and educational systems.

The history of ICTs in education in Ghana follows a similar trend with its major antecedents being radical reforms in educational policies and practices in 2007. Since then, several other reforms and policies have been implemented by successive governments to beef up the growth of ICTs across all levels of the country's educational system. In spite the challenges, efforts and the investments in ICTs especially in education are yielding positive results (National Communication Authority, 2020).

ICT Integration in Education in Ghana

Over the last couple of decades efforts have been gathered and directed towards the development and integration of ICTs in the educational sector. According to Basri and Feras (2018), the emphasis on ICTs has been in response to the increasing relevance of these technologies in transforming world economies that deliver accelerated socio-economic development and their major influences on human evolution. In Ghana, successive governments has claimed high levels of commitment to the development, integration and use of ICTs at all sectors including the educational sector. The emphases placed on ICTs are captured in the Ghana Poverty Reduction Strategy Papers I and II, the Education Strategic Plan 2003 – 2015, the ICT in "*Education Policy 2008"* and "*ICT in Education Policy 2015*", among others.

Today, ICT has become an important source of innovation and improvement in learning outcomes at all levels of education in Ghana and there are efforts towards renewing and upgrading teaching models that explore the possibilities of technologies associated with new teaching and learning tools (Lange, 2019). The

future of ICT integration will focus on promoting the deep integration of information technology and education, creating a wise learning environment, building large educational resources, improving the information literacy of teachers and students, transforming the mode of talent cultivation, educational service, and educational governance from the integrated application to the innovative development (Ministry of Education, 2020).

Waliu (2021) however observed that the process of applying ICT in education should also consider addressing the lack of ICT skills and the unwillingness to apply intelligent ICT tools in education. Waliu (2021) cites the National Communication Authority (2020) as admitting that less than 5% of Pre-Tertiary students possess the basic ICT capabilities that are relevant to their self-learning in Ghana. This was also identified as a major obstacle to the full integration of ICTs in the various educational policies in Ghana (National Communication Authority, 2020).

In this regard, despite its overwhelming relevance the creationof an intelligent educational environment, the opportunities and affordances of ICTs in education is largely underutilized. Yhough many have put forward new demands on teachers and students' abilities to apply ICT to solve related problems, teachers and students' abilities of using ICT are limited in Ghana. The Ghanaian teachers' attitudes towards the use of ICT in education are less positive, with only 54% of them believing in ICT's role of creating better learning results for students (National Communication Authority, 2020).

Therefore, more and more schools are equipped with educational media such as computers, notebooks, video booths, LCD televisions, projectors, multimedia central control systems, touch-in-one computers, , tablets, mobile terminals, and smart blackboards. Educational media are becoming more and more diverse. Educational media tend to be intellectualized and intelligent. Its interactive and data storage and analysis functions are becoming more and more powerful. Traditional classrooms and laboratories are being replaced by intelligent subject classrooms, which are more and more conducive for learners to acquire diversified, personalized, intelligent, and situational learning experience. The rapid development of intelligent classroom, campus, and education will create a convenient, comfortable, and efficient intelligent learning environment for learners.

The Ghanaian government attaches great importance to the popularization of information and communication technology education and has formulated appropriate policies, reforms, and standards to equip pupils and students at various levels of the country's educational system with skills that are relevant to today's global environment (Ministry of Education, 2020). At present, Information and Communication Technology courses are generally offered in primary and secondary schools, and basic courses of computer application in universities are generally offered in colleges and universities. The capacities of teachers in the understanding of the concepts and use of Information and Communication Technology application has been improved through a number of targeted projects and capacity building programs. Ministry of Education through

the Ghana Education Service and other sister agencies actively promotes the training of teachers' information technology application ability. Teachers' information literacy has been greatly improved, and information-supported teaching has gradually become the norm. Computer and information literacy skills form the core to teaching training in all the universities in Ghana.

The development of new technologies such as educational robots, educational data, artificial intelligence, internet of things, learning analysis technology, and blockchain technology has brought new opportunities for the future development of educational technologies in Ghana. Future educational technologies are expected to focus on promoting the deep integration of information technology and education, creating a wise learning environment, building large educational resources, improving the information literacy of teachers and students, transforming the mode of talent cultivation, educational service, and educational governance from the integrated application to the innovative development. This will stimulate further reforms of education system that focuses integration, innovation, and development that enhances integration effect of technology and education, and cultivate innovative talents with global awareness and global vision (Waliu, 2021).

With regards to its impact on education, Loana (2017) holds the opinion that ICTs enhances the cardinal principles of education for all by expanding access to remote and the less privileged, improves on quality delivery through practical simulations and demonstrations and ensures proper educational administration and management. The review emphasizes that there are huge differences in the

understanding of the importance and urgency of implementing the strategies and policies of ICTs in the Ghanaian education system. While emphasis have been placed on improving accessing to ICT tools and platforms, little has been done to enhance the skills and competences of teachers and students to handle such tools and platforms (Lange, 2019).

Challenges of ICT Integration in Education in Ghana

Despite the efforts and resources expended by governments and other Civil Society Organizations (CSOs) and individuals, several challenges thwart the success of ICTs integration in education in Ghana. These challenges range from personal, to the community, cultural, infrastructural, policies, inadequate training, or absolutely lack of training. According to Waliu (2021), a number of empirical enquiries and several other studies conducted on Information and Communication Technology in Ghanaian schools have adumbrated identical challenges facing ICT integration in Ghana: Cost, perceptions and attitudes, willingness, lack of strategic vision, the lack of ICT capabilities and skills, and the lack of comprehensive policies that support interventions.

The review points out that almost all studies strongly identify ICT as an inevitable tool that ought to be integrated into schools from elementary through tertiary levels (Jabari, 2021). This dichotomy is interesting because by reviewing the infrastructural conditions of some schools across Ghana, it is almost impossible to invest in the kind of ICT that scholars, policymakers, and international agencies recommend. Waliu (2021) explains that while it is commendable to utilize the ICTs of the 21st Century, proponents and influencers

should be cautious not to generalize this mandate to every school and every technology. To Waliu (2021), the nuances and unintended consequences of educational technologies such as ChatGPT are enormous and policymakers need to review these nuances inherent in their respective contexts in the considerations for ICTs integration in education.

Concept of Motivation

Toure-Tillery and Fishback (2014) define motivation as the force that enables action towards achieving a stated goal. As a concept, motivation has been the subject of numerous studies and scientific inquiry across fields and industries (Grant, 2018). While it has been studied extensively, motivation as a psychological construct cannot be observed or measure or recorded directly and so studying it has raised a number of concerns and issues such as how to measure it. According to Toure-Tillery and Fishback (2014), determining how to measure motivation starts with an undistorted and clear understanding of what type of motivation one intends to measure. Phillips (2015) asserts that motivation has different dimensions including outcome-focused and process-focused dimensions. Outcome-focused dimension relates to the motivation to complete a goal whiles the process-focused dimension relates to the motivation to attend to elements that relate to the process of goal pursuit.

In experimental settings, motivation can be measured by the degree to which goal-related concepts are accessible in memory and so the greater the motivation to pursue or achieve a goal, the more likely the individual are to remember, notice or recognize the concepts, objects, or persons related to that

goal. Phillips (2015) outlines a number of measures of motivation including cognitive and affective and behavioral measures of motivation. Proponents of the behavioral measures assert that motivation enables goal-oriented behavior which can then be use to capture the strength of motivation by measuring the extent to which one's actions are consistent with a focal goal. For instance, motivation enables a student to direct his or her actions towards achieving better academic outcomes which lead to a goal-congruent behavior. Measures such as choice, speed, performance, or persistence exerted in the course of goal pursuit capture the goal congruence of behavior and can thus assess the strength of one's motivation to pursue the goal.

Theoretical Framework

The theoretical framework used in this study were Walberg's Educational Productivity Theory, Dynamic Capabilities Model, Mechanics Dynamics Theory, and Zone of Proximal Development Theory. These theories were relevant to properly contextualize student achievement, ICT capabilities and how the latter is influenced by the former.

Gardner's Multiple Intelligences Theory

Howard Gardner propose the "multiple intelligence theory" in 1983. In his book "Frames of Mind", Gardner (1983) broadens the definition of intelligence and outlines several distinct types of intellectual capabilities. The Multiple Intelligence Theory challenged the traditional view of the existence of only one single type of intelligence. The central position of Gardner's Theory of Multiple Intelligences is that human intelligence can be differentiated into eight modalities

(Marenus, 2020). This theory emphasizes that the student has different types of intelligence including linguistic, musical, logical-mathematical, and spatial Intelligences (Armstrong, 2016).

Graham and Nathan (2019) explains that the theory of Multiple Intelligence thrives on the premise that to attain desirable academic performance, the teaching and learning process must utilize a variety of techniques, methods, tools, and strategies to explore and foster those multiple intelligences of the student. Eschewing previously narrow, preconceived notions of learning capabilities the idea behind the theory of multiple intelligences is that students learn in a variety of different ways. Marenus (2020) explains that the multiple intelligences theory describes the different ways students learn and acquire information. These multiple intelligences range from the use of words, numbers, pictures and music, to the importance of social interactions, introspection, physical movement and being in tune with nature. Accordingly, an understanding of which type(s) of intelligence a student may possess can help teachers adjust learning styles, and suggest certain career paths for learners.

Zone of Proximal Development Theory

The Zone of Proximal Development Theory combines the MI Theory and Mechanic Dynamics Theory as the premise to its foundational underpinning. The theory describes the span between what a learner can do independently and what he or she is capable of accomplishing with more expert assistance (Gebhard, 2001). The ZPD refers to the learner's ability to successfully complete tasks with the assistance of more capable other people, and for this reason it is often

discussed in relation to assisted or scaffolded learning. The creation of ZPDs involves assistance with the cognitive structuring of learning tasks and sensitivity to the learner's current capabilities. The theory also emphasizes the fusion of technology and mental capabilities to enhancing academic achievement. According to Marenus (2020), the theory also notes that teaching and learning experiences should take full advantage of the interactions between technology and mental capabilities. The thrust of this theory is that technology enhancements should be intentionally integrated into guided learning opportunities that offer technology-assisted situations in which students are supported in the construction of relevant understanding within an authentic context (Institute of International Educational Programmes, 2018).

Walberg's Educational Productivity Theory

The Educational Productivity Theory is an empirically tested theory of educational learning influences based on an extensive review of several thousands of studies across the world (Stephen & Diperna, 2016). The Walberg's Educational Productivity Theory outlines three groups of nine factors student academic performance. Aptitude (ability, development, and motivation); instruction (amount and quality of time spent in school); environment (home, classroom, and peers – amount and quality of time spent on studies outside school). The model explains that the main factors that determine how well a child performs academically included the child's level of motivation (extrinsic or intrinsic) to excel academically, the amount and quality of time spent in school, and the amount and quality of time spent on studies outside school.

Joseph *et al.* (2021) demonstrated the importance of the domains of motivational orientations, self-regulated learning strategies, and educational technologies in facilitating student achievement. The study further asserts that students who became more self-aware and confident regarding their learning abilities, who were more motivated, who set learning goals, and who were organized in their approach to work (self- regulated learning) performed better in school. According Joseph's *et al* (2021) research attempted to link educational technology, social, emotional, and academic factors to student achievement and found a sufficiently strong connection amongst them. Today, a central challenge for researchers, educators, and policymakers is to strengthen this connection through targeted, ICT-driven educational policy reforms that focus on both technology ubiquity and capacity building.

The theory further presupposes that classroom learning is a multiplicative, diminishing-returns function of four essential factors: student ability and motivation, and quality and quantity of instruction the social psychological environment of the classroom, education-stimulating conditions in the home and peer group, and exposure to educational technology Each of the essential factors appears to be necessary but insufficient by itself for classroom learning; that is, all four of these factors appear required at least at minimum level (Haertel et al., 1983).

Mechanics Dynamics Theory

Mechanics Dynamics (MD) Theory emphasizes on the use of technology to enhance students learning outcomes (Greswill, 2011). Armstrong (2008) explains that the theory views student achievement through the development of skills that facilitate and enhances knowledge about a specific domain and area of study. It identified technology and the use of digital devices as important to enhancing student capability, moral and desire to develop new skills and knowledge that facilitate achievement in different areas of study including mathematics, physics, and recently, languages. Riley, Beard and Strain (2011) explain that the use of assistive technology is the heart and main takeaway of the Mechanic Dynamics Theory but that assistive technology goes beyond making a classroom become more alive to increasing, maintaining and enhancing, on a consistent basis, the function capabilities of its users including students with special needs. In their argument, Graham *et al* (2019) observed that common applications of the theory of Mechanic Dynamics relate mainly to the assessing the effects of assistive technologies such as computers, calculators and other mobile devices in promoting positive student performance results.

Marcelino (2020) took the debate further in his article "Emerging Technologies in Educational Productivity" that the theory of mechanic dynamics prevails over other theoretical positions and that the definition of assistive technologies as emphasized by the theory does not end on the technological devices per se. according to Marcelino (2020), technology by themselves do not

impart any influence until the necessary competences to handle such devices are taught, understood and mastered.

Production Function Approach

In simple terms, the Production Function Approach model is an economic theory used to study the relationship between a dependent variable and an independent variable or variables (Hanushek, 2020). Gordon (2017) explains that the Production Function Approach Model helps to measures the maximum quantity of an output (in this study, student achievement) that can be produced using various combinations of inputs. The Production Function Approach model is widely used and has one of the highest successes in terms of its applications across several domains (Hanushek, 2020). It is basically about the transformation of input into output of goods and services. The PFA has been used to model how determinants of academic performance influence academic performance. Thus, in the context of this study, student achievement (SA) is treated as the output (dependent variable) and computational capabilities(CC), graphic capabilities(GC), engagement capabilities (EC), and motivation capabilities(MC) are treated as independent variables as shown in in equation 1.

$$SA = f(CC, GC, EC, MC) \text{---------- (1)}$$

The model in (1) above identifies student achievement as a function of computational ICT capabilities, Graphing ICT capabilities, Engagement ICT capabilities and Motivation capabilities of ICTs. The formula proposes that actual student achievement is the result of effective ICT capabilities in computation,

graphing, engagement, and motivation. This does not attempt to offset the possible role of other factors including psychological and environmental ones. Instead, it attempts to represent student achievement within the context and understanding of the various ICT constructs agreed on in the study.

Further, the function suggests that there are four major prerequisites for student achievement in today's smart and intelligent educational environment:

- A student must possess relevant ICT capabilities that enhance the conceptual understanding of computation and graphing
- A student must possess relevant ICT skills that enables a student to effectively identify an information need, locate the needed information, evaluate it and use it to achieve the ultimate goal of a student
- A student must possess the skills in ICT that make learning fun and so drives up the student's interest and desires to strive towards improve knowledge acquisition and retention.

Conceptual Review

This study relied on a framework to describe the relationship between ICT capabilities and student achievement. The independent variables are computational capabilities, graphing capabilities, engagement capabilities and motivation capabilities that influence student achievement, the dependent variable. The review of extant literature suggests that the influence of ICT capabilities on student achievement could follow the model as shown on Figure 1.

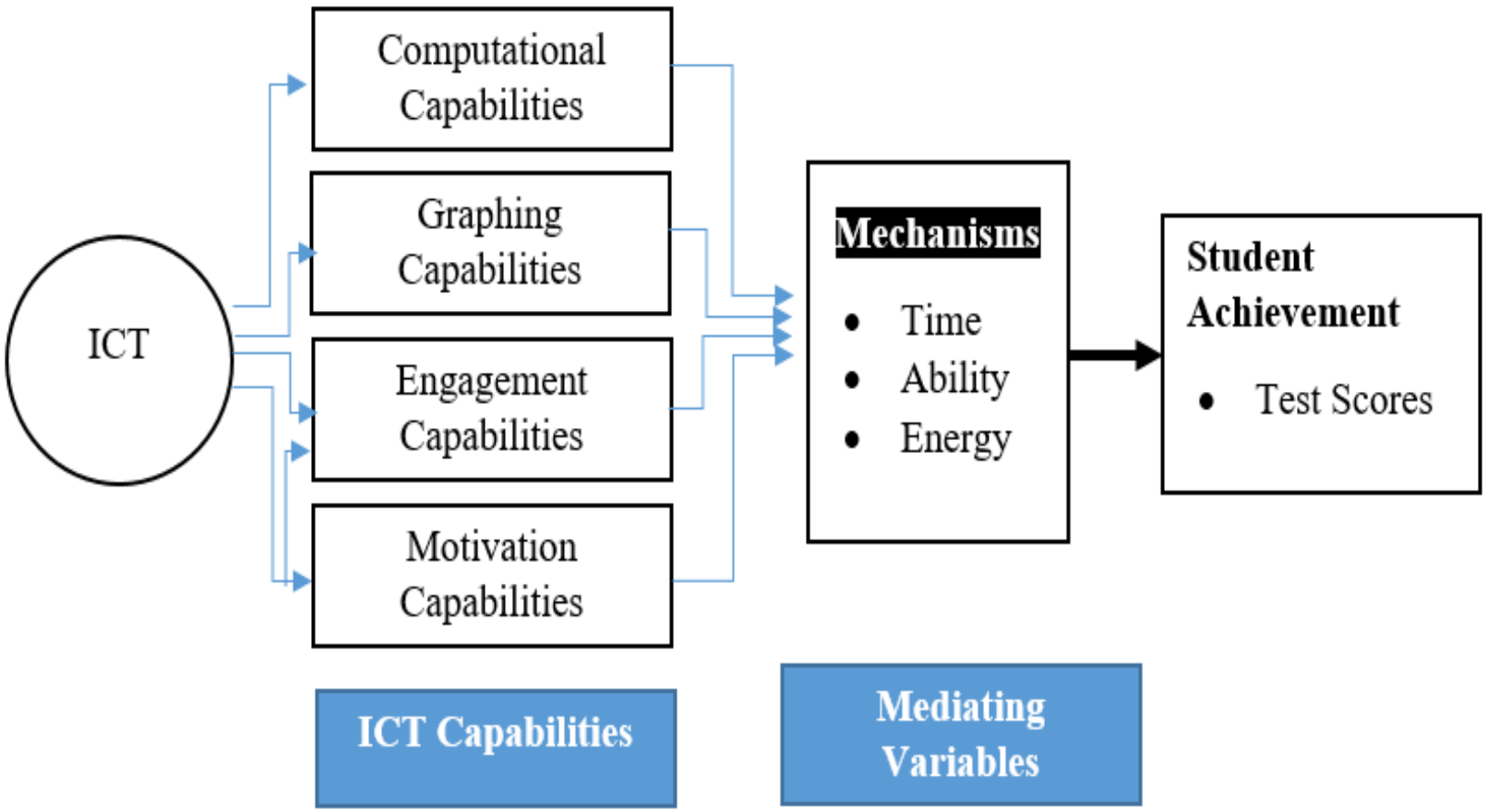

FIGURE 1: CONCEPTUAL FRAMEWORK

Figure 1 show the conceptual framework which seeks to explore the mechanisms by which ICT capabilities influence student achievement (dependent variable). The figure suggests that computation capabilities, graphing capabilities, engagement capabilities, and motivation capabilities lead to enhance student ability, time and energy expended in sound learning activities. This leads to improvements in test scores and hence, student achievement.

This model attempts to provide a comprehensive theory of motivation and proposes that actual achievement and competence are the results of a motivated, skillful, and biologically capable person interacting within a responsive environment.

Empirical Review of Variables

This sections deals with literature about ICT capabilities. Based on Tassos (2018), there are several approaches to describing ICTs and their introduction in education. Marcelino (2020) identifies three sides to contextualizing ICTs in education including the technologies, pedagogical approach and the capabilities. Marcelino (2020) emphasizes that ICTs as they pertain to education are best described by their capabilities and the level of influence on key drivers of student achievement including computation, engagement, motivation, and graphing. In this study, the focus is on these four components.

Engagement Capabilities

Student engagement has increasingly been designated as critical to quality teaching and learning by educators, researchers and policy makers (Marenus, 2020). From a spanning perspective, student engagement measures the degree of curiosity, attention, interest, optimism and passion that students exhibit when

learning or being taught. Student engagement's influence on students goes beyond curiosity in teaching and learning (Marcelino, 2020). Student engagement is an important motivation factor that drives the number of hours per day students spend on self-study. Students' overall engagement in studies is a significant determinant of academic outcomes and a key factor in determining the success of educational interventions and policies (Noor, 2019). According to Ashvin and McVitty (2015) student engagement is fundamental to improvement their learning outcomes.

According to Marenus (2020), ICTs pay a critical role in improving the levels of student engagement in studies. Candy (2020) observed that the effective use of digital learning tools by students can increase student engagement in studies, build essential skills, and facilitate personalized learning. Lacinta (2018) identifies three dimensions to student engagement including behavioral, cognitive, and emotional. Lacinta (2018) noted that an examination of the determinants of student engagement should focus more on those variables that move or influence these three aspects of student engagement.

Bailey (2015) also observed that its nature and the evidence that student engagement efforts aim to enhance the time and energy spent on educational sound activities identify student engagement identified as a critical driver of student leaning outcomes and by extension, student achievement. The review of extant literature such as Edgar (2015), Marenus (2020), and Femi (2021) suggests that the levels of student engagement in digital-support learning environments is much higher. Students display much higher levels of eagerness, dedication, time,

and energies in digitally supported learning environments (National Survey of Student Engagement, 2015).

In summary, engagement capabilities have been recognized to as an important function of ICTs that can significant improve the time and energies expended by students on sound learning activities.

Graphing Capabilities

Graphing forms an important aspect of a number of subjects taught in Senior High School including mathematics, physics, and economics among others. According to Okeoma (2018), graphs are used to display information in a manner that makes it easier for understanding. Lydia (2016) notes that in mathematics and other sciences, graphs are constructed to enhance clarity on the relationship between variables. In learning physics, mathematics, economics, and other sciences, students have to deal with graphs in many situations (Pospiesh, 2019). In a recent study, Marenus (2020) emphasized that graphing is a critical competence to develop by students since graphing items constitute a significant proportion of examination. Leandre (2019) also indicates that interpretation and construction of graphs has been fundamental to explaining and understanding some concepts better. But there is evidence of serious difficulties of students in reading, understanding and constructing graphs (Marenus, 2020).

Graphing skills have been used to enhance the understanding of functions and concepts in different subject areas in education. Boucher (2021) explains that learning outcomes in graphing items in mathematics and physics have been found to improve student outcomes. Abubakari (2015) in a study on the effects of

calculators on student performance in mathematics found that graphing items form a significant proportion of mathematics examination and performance in those items have been found to contribute to achievement.

Modern ICT tools have been found to drive graphing capabilities among students. According to Boucher (2021) digital graphing tools have been instrumental in building the capabilities of students in the interpretation and construction of graphs at various levels education.

Computational Capabilities

Computational skills are a key driver to student academic achievement in most of the subjects in second cycle institutions. In a typical mathematics or science examination, computational items constitute over forty percent of examination questions. Abubakari (2015) found that student achievement in computational items can enhance student achievement in test scores. Computational skills are the foundation of science and technology and efforts to imbibe in students the abilities to perform computational exercise have been an interest of great concerns (Marenus, 2020). Access to ICT tools have had significant influence in the development of computation skills and capabilities among students. The introduction of ICT tools for mathematical computations is in response to the need to develop such skills using digital technologies (Noor, 2019).

Motivation Capabilities

Motivation is the key to students' increased ability to learn and promote academic achievement. Phillips (2015) found that student motivation to sound learning activities are critical to achievement in the learning object. Christiana (2012) suggests that student motivation, along with their sense of efficacy, are malleable and are likely to influence engagement. Christiana (2012) explains further that motivation of students is very important for better output in the academic pursuit. Phillips (2015) found positive correlation between motivation and student achievement. There is significant relationship between school environment and structure and students' motivation. According to Tassos (2018), there is overwhelming proof that students are more eager to learn due to the presence of some form of ICT tools such as a laptop.

Chapter Summary

The chapter reviewed extant literature on ICT capabilities, student achievement and the interlinkages between them. The chapter covered the theoretical, empirical and conceptual reviews.

CHAPTER THREE

RESEARCH METHODS

Research Design

Research design could be described as a blueprint that underlines how data is collected, measured and analyzed in a study (Kothari, 2009). Vinayak and Mousami (2019) for instance, describe the research design as a plan that covers the type of study, *"data collection methods"*, and sampling techniques. This study used the experimental design with a quantitative research approach. The quantitative design handled the quantitative data from the survey questionnaire. In this regard, the experimental design is most appropriate in situations where a researcher seeks to evaluate the effectiveness or otherwise of an intervention without necessarily adhering to randomization. The purpose here is to establish the cause-and-effect relationship between an intervention and student test outcomes.

In the pretest-posttest quasi-experimental design, the researcher used the three groups pretest-posttest strategy. The purpose was to measure the achievement of the sample participants in a general examination consisting of physics, mathematics, economics (Appendix A). That is an examination (R) is given to the groups (A, B, and C) without any special capabilities in ICT usage (Q_o). A treatment (X) is applied to groups A and B, building ICT capabilities and the same examination (R) is administered again. The scores are then recorded (Q_1) and compared against the scores in the first examination. This is summarized in Figure 2.

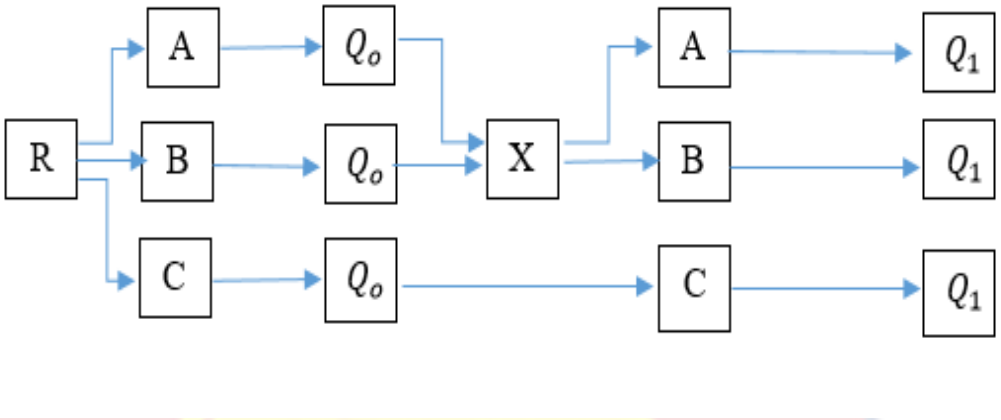

Figure 2: Pretest-Posttest Comparison Group Design

In addition to the pretest and posttest diagnostics tests, the research also measured the level of motivation in the two states under consideration. To study focused more on the process-focused dimensions of motivation with specific considerations to the behavioral measures. According to the behavioral construct, motivation enables a goal-oriented behavior which is evident through action. Therefore, the researcher focused on the speed or test completion time, performance, and choice to measure the level of motivation of students in ICTs. In the experiments, the researcher measured student adherence to use of ICTs to solve quantitative questions. This was to assist the researcher to draw conclusion on student preparedness and choice to rely on ICTs to achieve their goals.

In the context of this study with specific reference to motivation capabilities of ICTs, the research looked into two issues: the extent to which ICTs lead encourages students' participation in learning activities (such as ICTs effect on self-studies and time spend on them) and ICTs direct effects on examination outcomes (such examination completion time). The researcher relied more on the

behavioral measures to determine the extent of motivation capabilities of ICTs and their ultimate influence on student achievement. The measures of speed, performance and choice were used. This is a line with Phillips (2015) assertions that motivation can manifest in terms of the time it takes an individual (student) to act in pursuit of a goal (achieve better outcomes). This may include how long an individual engages in processes that lead to goal achievement or how fast a student completes an examination task. Motivation also manifests itself in terms of the level of performance exhibited at a goal-related task or activity that is considered integral to achieving the goal. For instance, in the study, the research measure the effects of ICTs on the effectiveness of students' self-learning such as information search, simulations and understanding of basic concepts using AI algorithms. Another aspect of performance used in the study was the extent of persistence shown by students in the pursuit of better study outcomes such as the amount of time spent on studies.

Population

Population describes a collection of people, animals, or objects of interest by a study defined within geographical, political or natural arenas (Shirley, Stanley & Daniel, 2011). In this research, the target population includes all students of Damongo Senior High School, Ndewura Jakpa Senior Technical School and Saint Anne's' Girls Senior High School. Records from management of the schools show that the population for the study is 3530. The breakdowns are provided in Table 1.

Table 1: Population Distribution

Name of School	Total Population	No. on campus
Damongo Senior High	2105	1151
Ndewura Jakpa SHS	1340	720
St. Anne's Girls SHS	85	85
TOTAL	3530	1956

Source: Field Survey (2021)

Sampling Procedures

The survey involved a sample of 120 students. This number was determined based on guidelines of Sekaran (1992). According to Sekaran (1992), the sample size for most research studies should be between 30 and 500. The guidelines further suggest that in multivariate analysis, the sample size should be at least 10 folds the number of variables in the study. Taking this into consideration, this study consists of four (4) independent variables and one (1) dependent variable totaling five. Moving further, the result of 50 (10*5) is 50, which is less that the 120 targeted, thus satisfying the guideline.

The study adopted stratified random sample of the probabilistic sampling methods to populate the sample. The reason was to ensure that all the subgroups (SHSs) within the population were fairy represented. To achieve, each of the SHSs was allotted a sample target based on the ratio of the number of students on the campus of each school to the target population as shown in Table 2. Further, students were drawn from each stratum randomly to form the sample.

The study used this technique because it ensures the representativeness of the 3 SHSs in West Gonja District.

Table 2: Sampling Procedures

Name of School	Target Population (No. on campus)	Weight	Sample
Damongo Senior High	1151	0.5884	71
Ndewura Jakpa SHS	720	0.3681	44
St. Anne's Girls SHS	85	0.0435	5
TOTAL	1956	1.0000	120

Source: Field Work (2021)

Data Collection Instrument

The research utilized a multiple data collection instruments including the diagnostic tests and a questionnaire. The diagnostics test paper is a general examination that was used to assess student achievement. The results from both the pre-test and post-test scores were used to assess whether or not there was a significant difference in student achievement before and after treatment was administered. This enabled the researcher to conclude whether or not, ICT capabilities had any influence on student achievement. A questionnaire was also administered to investigate the effectiveness of ICT capabilities on student engagement and motivation to studies.

Reliability Analysis

The researcher conducted a reliability test to ascertain the internal consistencies of datasets of the independent variables using the Cronbach's Alpha on 10% of the sample target. The Cronbach's Alpha is very effective in assessing a data collection instrument and helps to evaluate the quality of the tool at the design and pre-deployment phases. It is also appropriate for measuring the internal consistence among tool items

Cronbach's alpha can be written as a function of the number of test items and the average inter-correlation among the items. Mathematically, the Cronbach's Alpha is given as:

$$CA\ (\alpha) = \frac{N\bar{c}}{\bar{v} + (N-1)\bar{c}}$$

Where N is the number of items in the tool, $\bar{c}$ is the average inter-item covariance, and $\bar{v}$ is the average variance. From the formula one can see that Cronbach's Alpha increases if the number of items under consideration increases and vice versa. It can also be noted that if the average inter-item correlation is low, alpha will also be low and if it is high, alpha will be high.

The Cronbach's value ranges from 0 to 1 with 0 indicating no correlation between items and 1 indicating a perfect correlation. Vinayak and Mousami (2019) explain that analysts use an alpha of 0.7 as the benchmark value for Cronbach's value. At this level and higher, the items are sufficiently consistent to indicate the measure is reliable. Typically, values near 0.7 are minimally acceptable but not ideal.

In this study, the research conducted an internal consistency or reliability test using the Cronbach's Alpha method. Table 3 provides a summary of the results of the reliability test.

Table 3: Results of Reliability Analysis (Cronbach's Alpha)

Reliability Statistic	No. of Items	Cronbach Alpha Value
Computational Capabilities	5	0.764
Graphing Capabilities	3	0.706
Engagement Capabilities	5	0.702
Motivation Capabilities	3	0.792

Source: Field Survey (2021)

From Table 3, the results show a strong consistency and reliability among the items in the various sections of the survey questionnaire and the diagnostic tests sheets. This means that the questions in each section of the questionnaire are material, relevant and interrelated. The minimum Cronbach's Alpha value was 0.702.

Instrument Response Rate

The study involved One Hundred Twenty (120) students from three (3) SHSs in the West Gonja Municipal. The survey was successful as all distributed questionnaires and diagnostics tests were returned, showing a 100% response rate. Table 4 provides a summary of the results of analysis.

Table 4: Instrument Response Rate

School	Number Distributed	Number Returned	Response Rate (Percent, %)
Damongo SHS	71	71	100
Ndewura Jakpa SHS	44	44	100
St. Anne's Girls SHS	5	5	100
Total	120	120	

Source: Field Survey (2021)

Data Collection Procedure

The main data used in the study were collected from primary sources with the aid of a diagnostics test and structured questionnaire. Both qualitative and quantitative data were collected. The procedure used to collect data was categorized into four (4) stages. The first stage involved the acquisition of relevant permissions from both the University of Cape Coast and management of the three SHSs. Creswell (2007) emphasizes the importance of gaining the necessary permissions before entering a site for data collection purposes. An introductory letter was taken from UCC and presented to headmasters of the schools who granted the permission to engage their students.

Dwuring the second stage, the researcher met with all participants and explained the purpose of the exercise. At the meeting, the researcher also took the opportunity to brief participants on matters relating to venue and other modalities that will govern the behavior and conduct of participants. At the third stage,

students were handed ICT tools including laptops and tablets and the pre-test was administered on all three groups.

During the fourth stage, the treatment was administered to all the groups but group C. This took 12 days and on the 13th day, the posttest diagnostics test was also administered on all groups. The researcher then took the opportunity to administer the questionnaire.

Data Processing and Analysis

Data from the diagnostic tests and the questionnaire were edited, missing and inappropriate responses were addressed before data was entered into Microsoft Excel 2019 and saved as a CSV file. For purposes of analysis, data was loaded into SPSS. The analysis involved both descriptive and inferential analysis including regression and analysis of variance, among others. The results of the analysis are then arranged in tables organized in a manner that aids easy explanation and discussions.

Quantitative analysis

The study employed descriptive statistics and statistical inference techniques to analyze the qualitative data. For descriptive analysis, the study used statistics such as mean, median, and standard deviation. The research also involved the conduct of multivariate analysis to avail the influence of ICT capabilities on student achievement. This was necessary in examining the relationship between the dependent and independent variables. The multivariate model treats student achievement as the dependent variable (y) and computational capabilities, graphing capabilities, engagement capabilities and motivation capabilities as the

independent variables. The regression function of the multivariate model is given as follows:

$$y = \beta_0 + \beta_1 CC + \beta_2 GC + \beta_3 EC + \beta_4 MC + \varepsilon$$

y = student achievement (difference in test scores)

$\beta_0, \beta_1, \beta_2, \beta_3, \beta_4$ are regression coefficients

$CC -$ Computational Capabilities

$GC -$ Graphing Capabilities

$EC -$ Engagement Capabilities

$MC -$ Motivation Capabilities

$\varepsilon -$ Error or Stochastic Term

The study measures the variables using a 5-point Likert scale 0 – 4 as shown in Table 5.

Table 5: Variable Definition and Scale

Variable:	Definition	Measurement (Scale)
Y	Student Achievement	Likert Scale 0 – 4
CC	Computational Capabilities	Likert Scale 0 – 4
GC	Graphing Capabilities	Likert Scale 0 – 4
EC	Engagement Capabilities	Likert Scale 0 – 4
MC	Motivation Capabilities	Likert Scale 0 – 4

Source: Field Survey (2021)

Chapter Summary

The chapter discussed the methods, materials and tools used in the conduct of the study. The research design adopted was the descriptive design with pre-test post-test control group. The target population was mainly students from Damongo SHS, Ndewura Jakpa SHS and St. Anne's Girls SHS. The study involved 120 participants from whom data was generated with the aid of diagnostics tests and a questionnaire. Data was analysed with the aid of Microsoft Excel 2019 and Stata.

CHAPTER FOUR

RESULTS AND DISCUSSIONS

Introduction

The study investigated the influence of ICT capabilities on student achievement in SHSs in the West Gonja Municipal. The study identified ICT capabilities to include Computation ICT Capabilities, Graphing ICT Capabilities, Engagement ICT Capabilities and Motivation ICT Capabilities. The study involved 120 students from three selected schools and using a pre-test posts-test diagnostics tests and a survey questionnaire, the researcher collected data about the influence of different ICT capabilities on student achievement. The chapter covers the background information of participants, analysis of test results, descriptive analysis, and overall regression analysis. The study sought to examine the influence of ICT capabilities on student achievement in Senior High Schools in the West Gonja Municipal.

Background of Respondents

The background characteristics of a respondent such as the sex, age, level of education and the number of years of experience are relevant in assessing the value of the responses he or she gives. To understand the structure of the gender of participants in this study, this section covers analysis of the background characteristics of the participants involved in this study, the research required participants to indicate their gender and the programme of study. Table 6 provides a summary of the results of analysis of responses provided by participants.

Table 6: Background of Respondents

Main Factor	Level Factor	Frequency	Percent
Gender	Female	50	41.67
	Male	70	58.33
	Total	120	100.00
Programme of Study	Business	50	41.67
	Science	30	25.00
	Agric	20	16.67
	Technical	5	4.17
	Home Econ	5	4.17
	Arts	10	8.33
	Total	120	100.00

Source: Field Survey (2021)

In respect of gender, the results show that majority of the participants (58.33%) were male and 41.67% were female. In addition, 41.67% of the students who took part in the study offered Business, 25% of them offered General Science, 16.67% agricultural science, 4.17% offered Home Economics and Technical and 8.33% offered General Arts.

Analysis of Performance on Diagnostic Tests

This section was dedicated to the analysis of the pre-test/post-test diagnostics test scores. The results of analysis done on the scores that were obtained by both the experimental and control groups are presented here. The analysis is done to ascertain the average scores obtained by each group in the pre-test and post-test

examinations in order to make a comparative analysis of scores obtained. The section also presents results of an association test on scores obtained by each student in both examinations.

Analysis of Pre-Test Scores

Pre-test diagnostic tests were administered to both the experimental and control groups. The purpose was to ascertain the test scores of students without any special ICT capabilities. The test consisted of five (5) question covering 3 computational items and 2 graphing items. All questions carried an equal mark of 1.

Table 7 provides a summary of results obtained from analyzing the overall scores of students obtained in the pre-test diagnostic test.

Table 7: Overall Performance in Pre-Test Diagnostics Test

Main Factor	Level Factor (Marks)	Frequency	Percentage
Overall Score	0 - Mark	26	21.67
	1 - Mark	22	18.33
	2 - Marks	62	51.67
	3 - Marks	10	8.33
	4 -Marks	0	0.00
	5 - Marks	0	0.00
	Total	120	100

Source: Field Survey (2021)

The results show that majority of the participants (51.67%) scored 2 marks in the pre-test, 18.33% scored one (1) mark and 8.33% scored three (3) marks. 21.67% of the students scored zero (0) in the pre-test diagnostics test. This shows that more than two-thirds of the students failed the pre-test diagnostics paper.

The research further analyzed the scores in the pre-test diagnostics test to ascertain the performance of students in relation to computational and graphing items and Table 8 provides a summary of the results obtained.

Table 8: Results of Pre-Test Scores

Main Factor	Level Factor (Marks)	Frequency	Percentage
Computational Items	0 - Mark	30	25.00
	1 - Mark	64	53.33
	2 - Marks	26	21.67
	3 - Marks	0	0.00
	Total	120	100.00
Graphing Items	0 - Mark	60	50.00
	1 - Mark	60	50.00
	2 - Marks	0	0.00
	Total	120	100.00

Source: Field Survey (2021)

The results as given in Table 8 show that in respect of the computational items as it pertains to the diagnostic test, 25% of the students obtained 0 marks, 53.33% of them obtained 1 mark and 21.67% of them obtained 2 marks. No student obtained up to the total of 3 marks allotted for that section. Further, the average obtained by the student on the computational section of the test was 0.97 out of 3 marks with a standard deviation of 0.69. The results confirm the poor knowledge of computation (arithmetic) among students as found by past studies such as Habib (2015), Sekesai (2016) and Bridget (2018).

The second part of the diagnostic test contained two (2) graphing questions and the results of analysis of the scores obtained by students show that out of the maximum of 2 marks, 50% of the students scored zero (0) mark and another 50% scored 1 mark. The mean score was 0.5 (of 2) with a standard deviation of 0.504.

The research also analyzed the performance of test scores obtained in the pre-test diagnostics paper based on the groups and provided in Table 9. In the pre-test paper, the analysis shown in Table 9 show that least mark obtained by the experimental group was 0% obtained by 20% of the students and the maximum score was 60% obtained by 13% of the students. In respect of the control group, the least mark obtained was 0% (23% of students) and 60% (by 3% of the students).

Table 9: Performance in Pre-Test based on Groups

Main Factor	Level Factor	Frequency	Percent
Experimental Group	0 - Mark	12	20
	1 - Mark	12	20
	2 - Marks	28	47
	3 - Marks	8	13
	4 -Marks	0	0
	5 - Marks	0	0
	Total	60	100
Control Group	0 - Mark	14	23
	1 - Mark	10	17
	2 - Marks	34	57
	3 - Marks	2	3
	4 -Marks	0	0
	5 - Marks	0	0
	Total	60	100

Source: Field Survey (2021)

Analysis of Post-Test Scores

The post-test diagnostic test was also administered to both the experimental and control groups and the results from analyzing the scores are discussed in this section. Table 10 provides a summary of the overall performance.

Table 10: Overall Performance in Post-Test Diagnostic Test

Main Factor	Level Factor	Frequency	Percent, %
Post-Test Score	0 - Marks	0	0
	1 - Mark	18	15
	2 - Marks	40	33
	3 - Marks	42	35
	4 - Marks	20	17
	5 - Marks	0	0
	Total	120	100.00

Source: Field Survey (2021)

The research also analyzed the overall performance in post-test diagnostics to understand the performance in graphing and computational items. Table 11 provides a summary of the results obtained from the analysis. From Table 11, analysis of scores obtained by participants in the post-test diagnostics examination. The analysis was done subject to the different categories of questions in the test: graphing and computational items.

Table 11: Performance in Post-Test Computational and Graphing Items

Main Factor	Level Factor	Frequency	Percent, %
Performance in Computational Items	0 - Marks	4	3
	1 - Mark	38	32
	2 - Marks	60	50
	3 - Marks	18	15
	Total	120	100
Performance in Graphing Items	0 - Marks	32	27
	1 - Mark	84	70
	2 - Marks	4	3
	Total	120	100

Source: Field Survey (2021)

From Table 11, the results on performance in computational items show that exactly 50% of the students scored 2 – marks out of 3 – marks, 32% scored 1 out of 3 – mark and 3% did not score any mark. 15% of the students who sat for the paper scored 3 out of 3 – marks representing a 100% pass. In total, more than 60% of students passed in the computational items. In relation to graphing items, the results show that 70% of the students scored 1 out of 2 – marks, 3% scored 2 out of 2 – marks and 27% score zero, 0 – marks.

To disaggregate the performance of the control and experimental groups, the research performed an analysis of the score obtained by participants in the separate grouping. The results show that higher increase in the performance of the

experimental group compared with the margin increase in the performance of the control group. Table 12 provides a summary of the results.

Table 12: Performance in Post-Test Diagnostics Test Based on Group Type

Main Factor	Level Factor	Frequency	Percent, %
Experimental Group's Performance in Post-Test	0 - Marks	0	0
	1 - Mark	2	3
	2 - Marks	10	17
	3 - Marks	28	47
	4 - Marks	20	33
	5 - Marks	0	0
	Total	60	100
Control Group's Performance in Post-Test	0 - Marks	0	0
	1 - Mark	16	27
	2 - Marks	30	50
	3 - Marks	14	23
	4 - Marks	0	0
	5 - Marks	0	0
	Total	60	100

Source: Field Survey (2021)

From Table 12, 47% of students in the experimental group obtained 60% (3 marks), 33% obtained 80%, 17% obtained 40%, and 3% of the students obtained 20%. For the control group, half of the students in the group obtained 40%, 27% of them obtained 20%, and 23% of the students obtained 60% of the marks.

The research also conducted a comparative analysis of average scores of each group in the pretest and posttest diagnostics examination. The results show that the average score of the control group was 1.40 in the pretest and 1.97 in the post test. This shows an improvement of 40.71% of students test scores over the pretest scores. With regards to the experimental group, the analyses show that average scores were 1.53 and 3.10 in the pretest and posttest scores respectively. The results indicate a 102.61% improvement of students' achievement in the post-test diagnostics test over the pretest scores of the same group. This could be the result of the treatment administered to prop up student achievement.

Figure 3 shows a side by side comparison of the average scores of the control and experimental groups in both tests. As indicated on Figure 3, the average score of the experimental group more improved significantly whiles the score of the control only improved marginally. Therefore, it may be appropriate to infer that there is a seemingly clear influence on student test scores by the treatment (ICT capabilities).

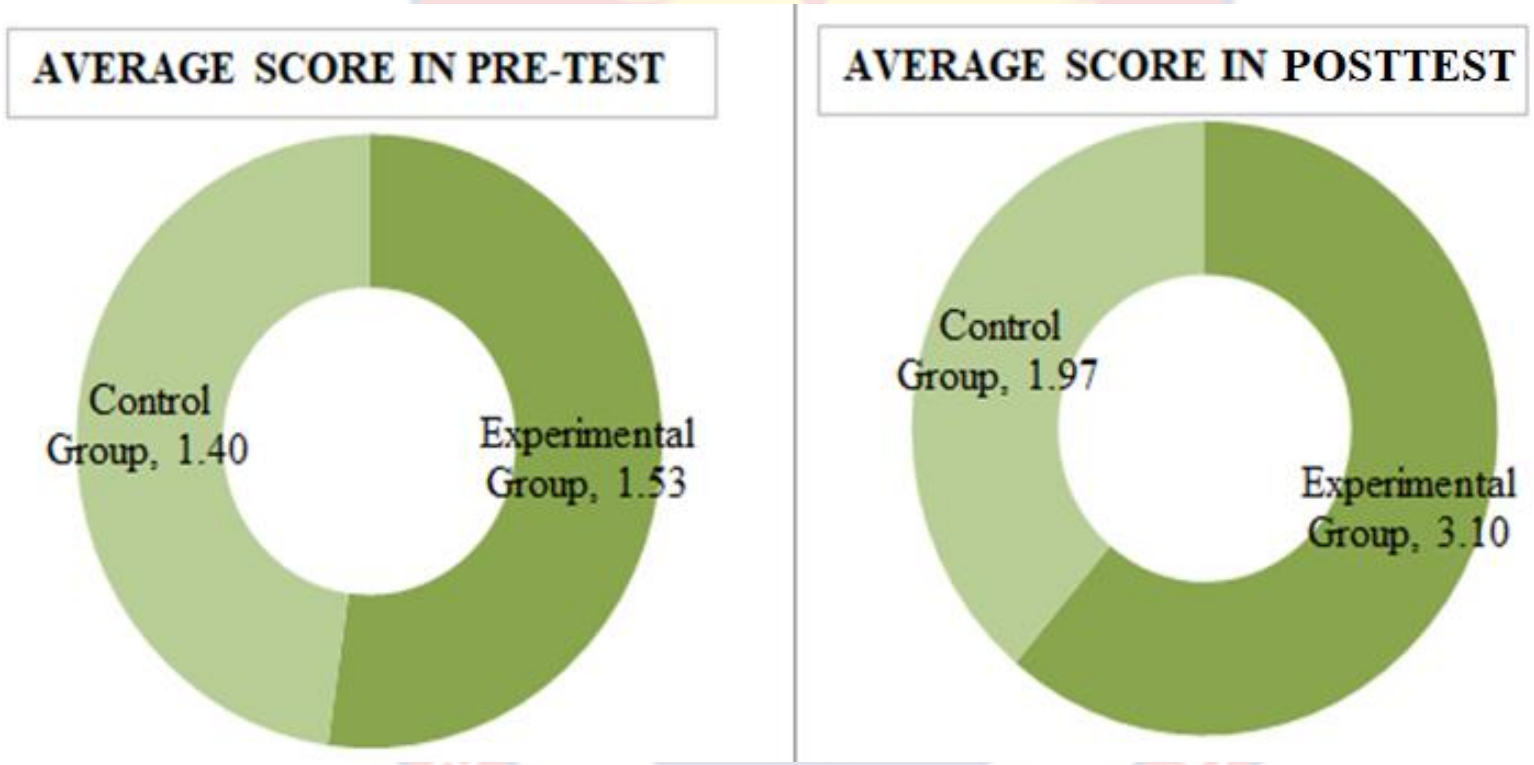

Figure 3: Comparison of Average Scores in Pre-Test and Post-Test for Experimental and Control Groups

Test of Association in Test Scores

The researcher performed a test of association per overall performance in pre-test and post-test, performance in computational and graphing items, and per control and experimental groups. In general, the analysis show improvement in test scores in the post-test examination over scores in the pre-test examination for both the control and experimental groups. The results also show that for the control group, the maximum difference in scores for the post-test and pre-test diagnostic examinations was 1 mark. This means that on average, student test scores improved between 25 and 50%. In the experimental group however, the results show that students test scores improved between 75 and 100%. This means that on average, the improvements in test scores in the experimental group is much higher than that in the control group.

Test of Association in Pre-Test-Post-Test Test Scores

The association test of the overall performance in pre-test results and post-test results was conducted using a line graph. Figure 4 provides a summary of the results. Consider the comparison of the test scores between the experimental and control groups as depicted on Figure 4. The results obtained by the experimental group is much higher that obtained by the control group. Now, the results show that student achievement in post-test improved marginally over the pre-test scores in the control group indicating that ICT capabilities are not the only variable capable of driving student achievement.

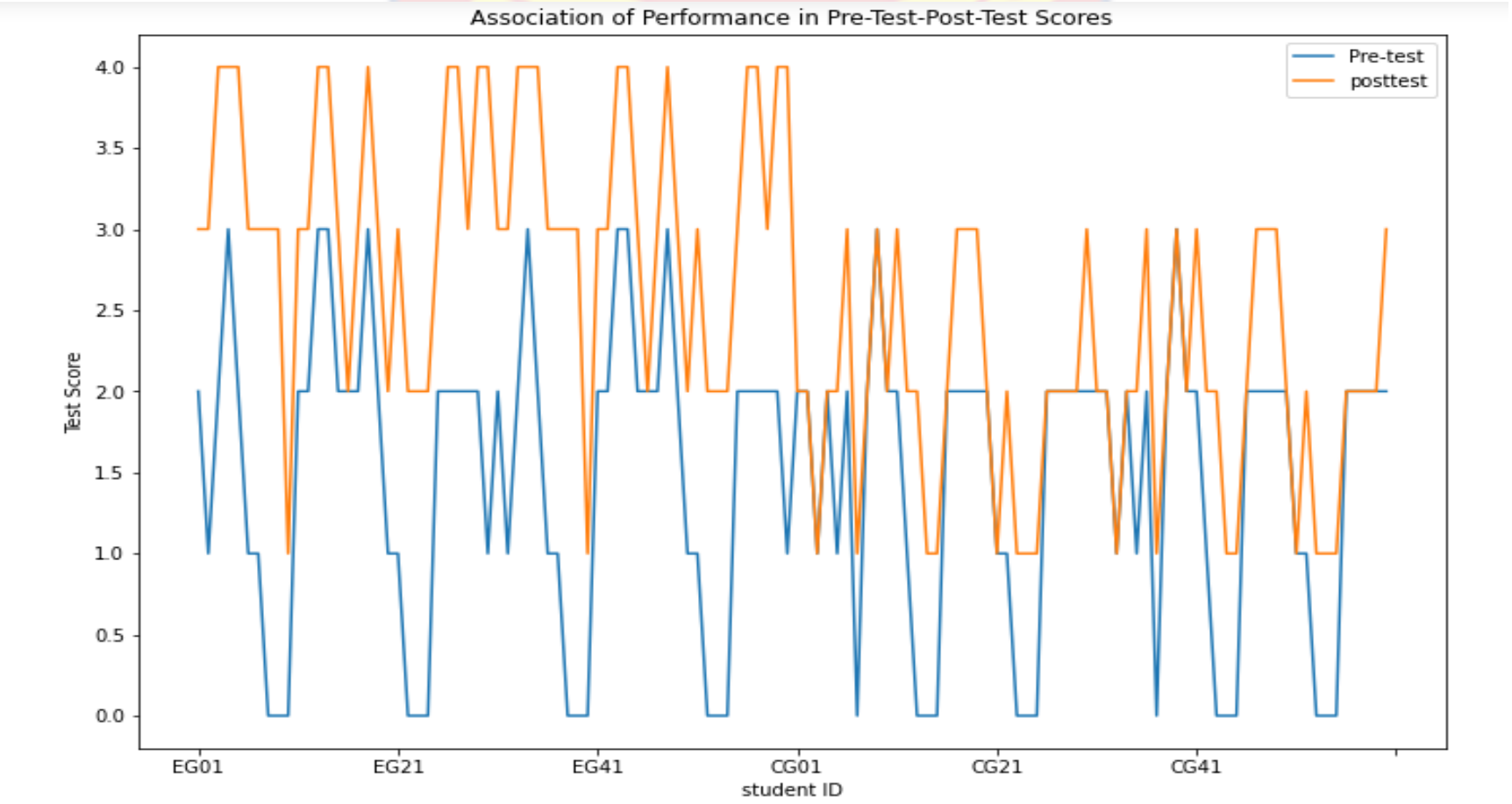

Figure 4: Line graph of comparing overall performance in pre-test and post-test results

From Figure 4, the blue line represents results obtained by students in the pre-test diagnostics paper and the yellow line, scores obtained in the post-test diagnostics paper. It shows the score of each student in the pre-test and post-test results for all 120 students. The post-test scores (yellow line) lies above the pre-test scores (blue line) for a majority of the data points. This signifies a superior performance in the post-test scores over the pretest scores for the data points where yellow line lies on top. From Figure 4 it is further noticed that the posttest scores of the experimental group is largely much greater than same of the control group.

Test of Association of Performance in Computational and Graphing Items

To understand the source of the improvement in the scores in post-test diagnostics paper, the researcher performed an association test of scores in computational items. The association test involves comparing the test scores of student in pretest and posttest scores in line graph format. The results are plotted on a graph in Figure 4. From Figure 5, scores in computational items in the post-test diagnostics paper showed an appreciation from the scores in computational items in the pre-test computational items. From Figure 4, there is really substantial improvement in the scores obtained by the experimental group compared with those in the control group

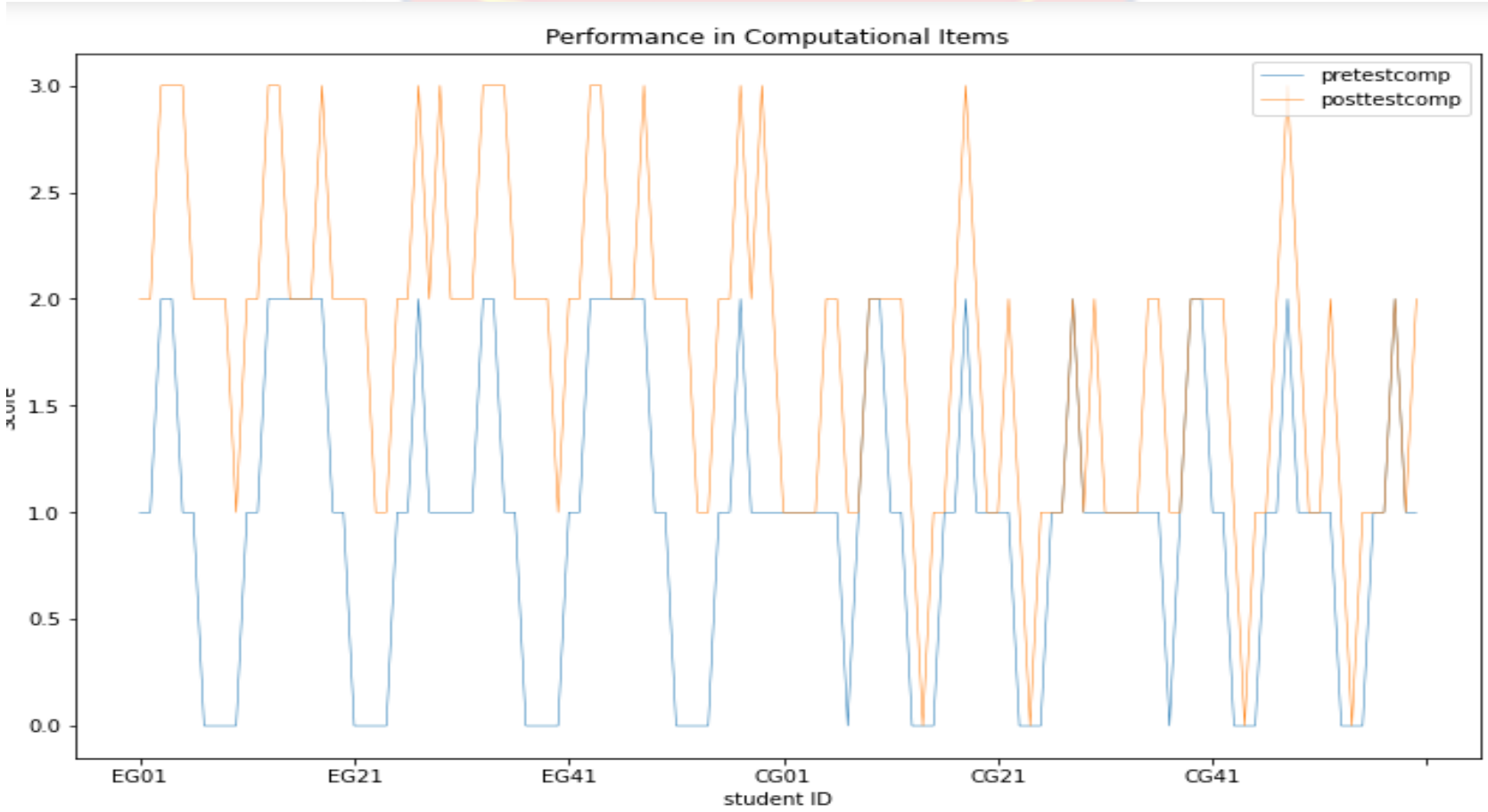

Figure 5: Line graph of comparing performance in computational items

From Figure 5, scores in computational items in the post-test diagnostics paper showed an appreciation from the scores in computational items in the pre-test computational items. From Figure 4, there is really substantial improvement in the scores obtained by the experimental group compared with those in the control group.

A test of association was between scores of graphing items obtained in both the pre-test and post-test papers by each student were also performed. A summary of the results are shown in Figure 6.

As observable on Figure 6, that for most of students, the marks obtained in graphing items for both the pre-test and post-test diagnostics papers were relatively the same for the control group. This means that there were no improvements in the test scores obtained by the students in the control group. However, with regards to the experimental group, the results as depicted Figure 6 indicate significant differences among a few data pointes in the pre-test/post-test scores.

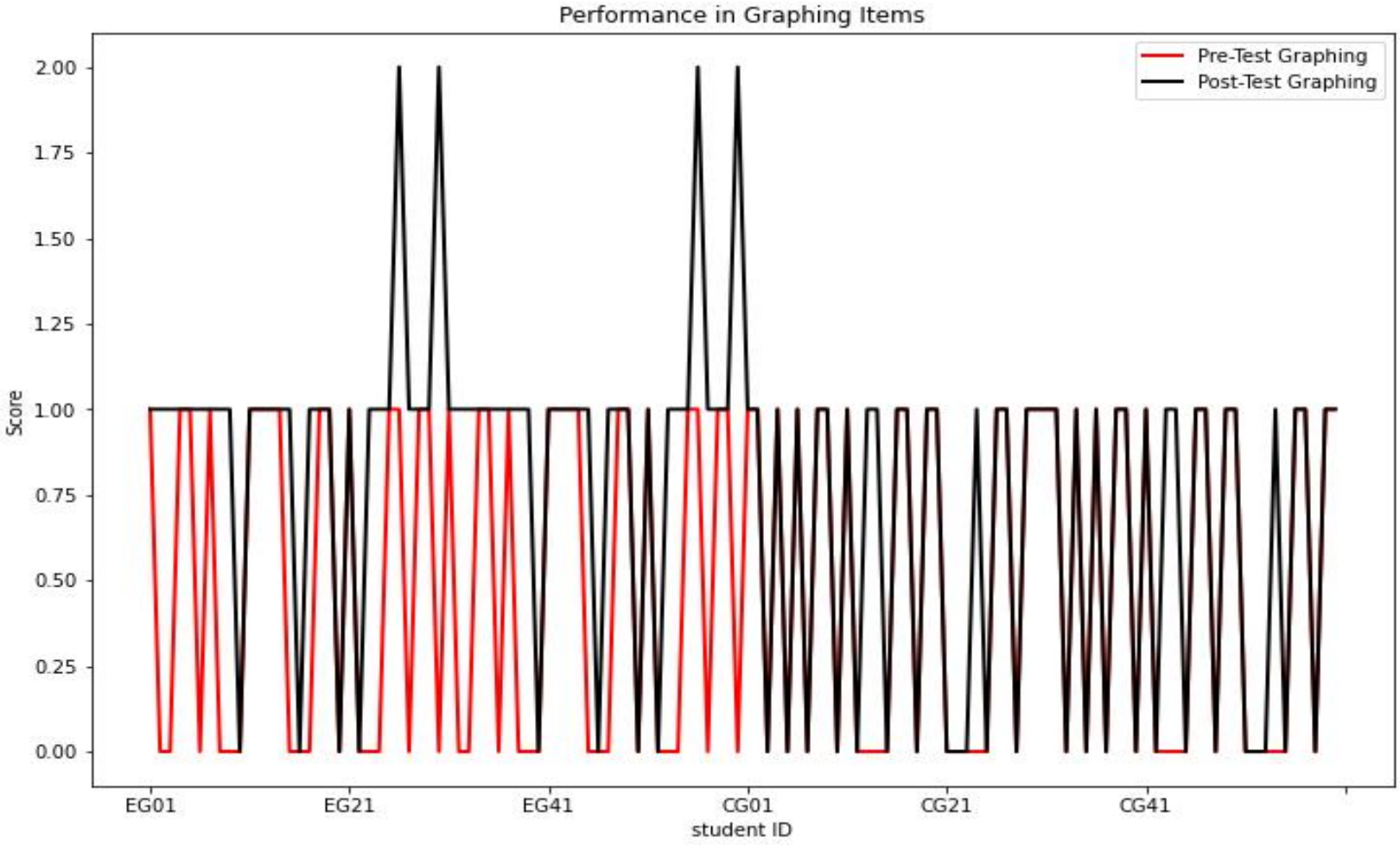

Figure 6: Line graph of comparing performance in computational items

The results indicate that for four (4) data points (students in experimental group), the results in post-test scores were much higher than the pre-test scores. For each of the data points, the analysis shows that post-test scores increased by 100 percentage points representing a significant improvement of performance over pre-test scores.

In summary, the results show that graphing capabilities drove significant improvements in student test scores in graphing items as demonstrated by the improvements in scores by the experimental group.

Test of Association of Performance in Experimental and Control Groups

A test of association between test scores obtained in the pre-test and post-test diagnostics among the various groups, thus the experimental and control groups, was performed. From Figure 7, it can be observed that test scores obtained in the post-test diagnostic examination by the experimental group were significantly higher than the pre-test scores for most of the data points. This means that on average, the scores in post-tests by the group showed significant improvement over the scores in obtained in the pre-test diagnostics paper. Figure 7 provides a summary of the results.

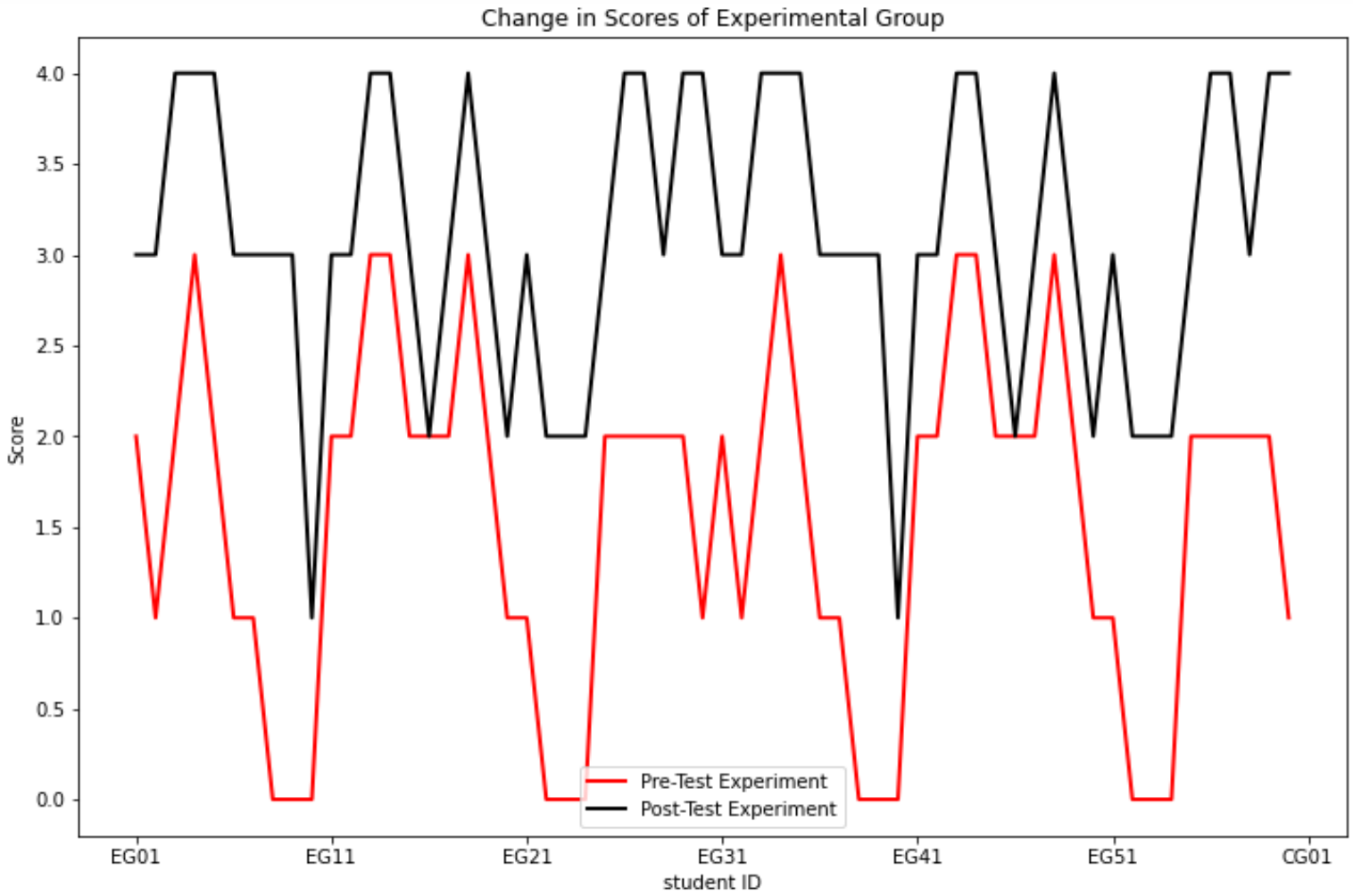

Figure 7: Line graph of overall performance by Control Group

From the graph, the highest score obtained in the pre-test paper by the experimental group was 3 – marks (60%) by 13% of the students. For the scores in post-test, the highest score was 80% obtained by 17% of the students. Obviously, there is a significant difference in the scores in post-test and pre-test papers. The difference is scores of the experimental group in the pre-test diagnostic test and the post-test diagnostic test indicates that there is a positive effect of the administered treatment on student test scores. The results also indicate, by extension, that ICTs have a positive influence on student academic outcomes as observed in Godswill (2011).

These observations are further explained from Figure 7 above. Figure 7 shows that at any given data point on the graph, the post-test score lies above its corresponding pre-test score. This means that post-test results on average are higher that its corresponding pre-test score for each data point. Ordinarily, this reflects and represents an improvement over pre-test scores.

Test of association between pre-test and post-test scores as obtained by the control group also showed some marginal improvements. The marginal improvements in post-test scores over pre-test scores for the control group could be explained by the presence of other mediating factors such as student study time and prior exposure to examination questions. Nonetheless, there was clearly a much larger improvement observed in the experimental group that the control which presupposes a possible influence of the treatment.

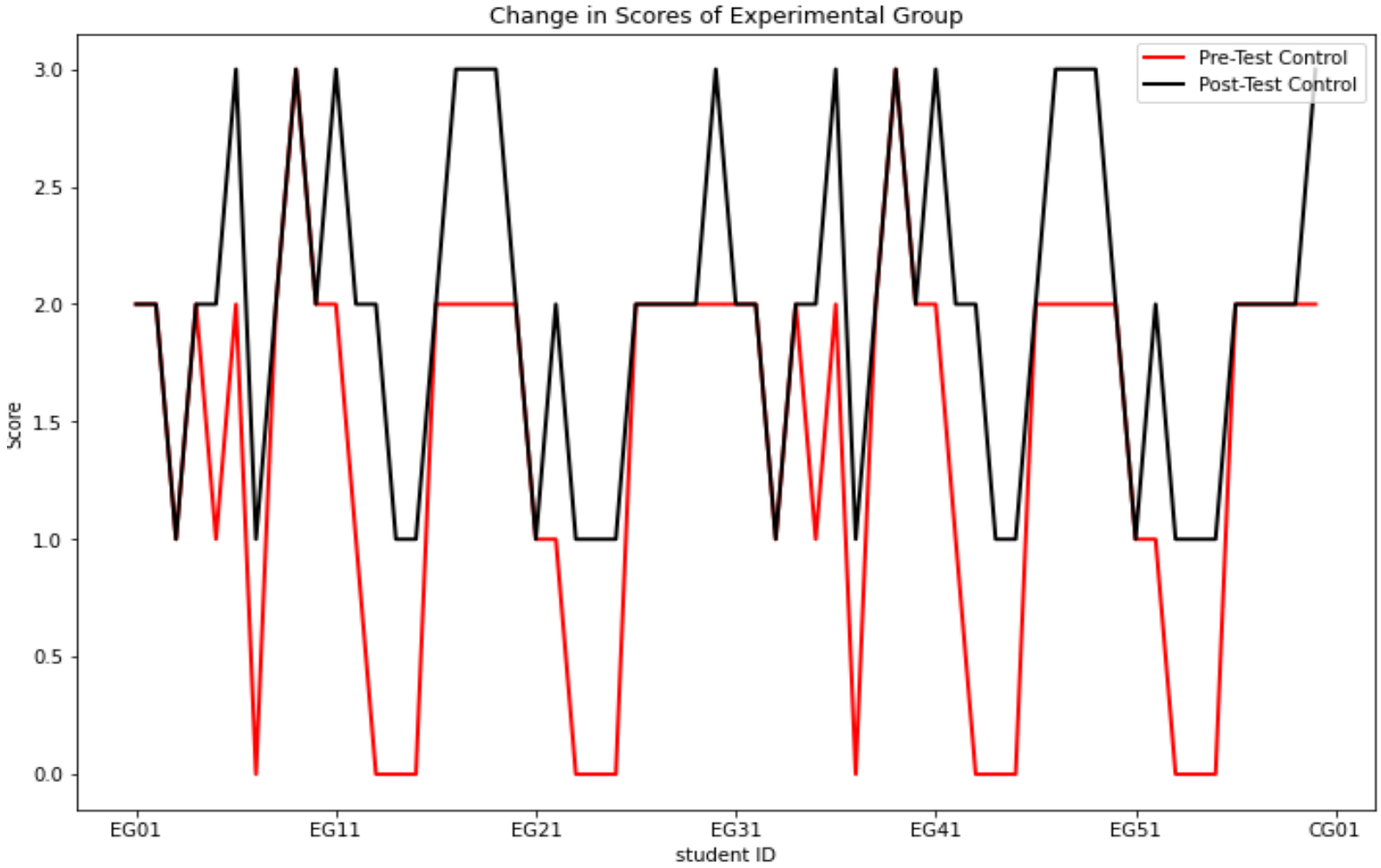

Figure 8: Line Graph of Overall Performance of the Control Group

From Figure 8 above, the black line represents the line plot of scores obtained by students in the post-test diagnostics paper and the red line represents that of pre-test scores. It is observed that the test scores obtained in both diagnostics papers remained relatively the same but at some given data points, the post-test data points lie above their counterpart pre-test data points. This shows improvement in performance of some students driven by other factors other than ICT capabilities such as prior encounter with the same set of questions.

Descriptive Analysis

This section analyzes the data collected with the aid of the survey questionnaire that was administered to participants. The results are presented with the aid of statistics including *percentages*, *mean* and *standard deviation*.

Influence of Computational Capabilities on Student Achievement

Participants were probed on their opinions about the influence of computational ICT capabilities on their test scores emphasizing on three (3) factors of computational capabilities. Specifically, the students were asked to respond by indicating on a scale of 0 – 4, the level of influence capabilities in arithmetic operations and processes, digital logic system and understanding of computational activities on their achievement. The mean response value to the statements and their respective standard deviations provided in Table 13.

Table 13: Influence of Computation Capabilities

	Mean	Std
Arithmetic operations and processes	3.5	0.6
Digital logic system	3.3	0.6
Understanding of Computational activities	3.5	0.5

Source: Field Survey (2021)

From Table 13, with respect to the capabilities in arithmetic operations and processes, the mean response value was 3.5 and a standard deviation of 0.6. The results mean that on average, the participants hold the view that to a very large extent, computation ICT capabilities significantly influence student achievement. This outcome corroborates the position of Robberts (2018) who found that the use of electronic devices improved student achievement in computation items and by extension, student achievement.

With respect to digital logic systems, the results in Table 13 show a mean value of 3.3 at a standard deviation of 0.6. This means that ICT capabilities in digital logic influence student achievement to a very large extent. This position also confirms the findings of previous academic works including Sean *et al* (2018) who found that competences in digital logic may influence student achievement in logic and conceptual items in a test.

The results also show that in respect of the understanding of computational activities, the participants hold the view that to a very large extent, the factor influenced student achievement in SHSs in West Gonja Municipal. This is back with a mean response value of 3.5 at a standard deviation score of 0.5.

Influence of Graphing Capabilities on Student Achievement

The study also measured the influence of graphing ICT capabilities on student achievement. To achieve this, participants were asked about extent to which data visualization processes, understanding graphical data representation and the conceptual understanding and attitude toward graphing influenced student test scores in graphing items including algebra, linear equations and inequalities, among others. Table 14 gives the statistics.

Table 14: Influence of Graphing Capabilities

Graphing Capabilities Factor	Mean	std dev
Data visualization processes	3.25	0.77
Understanding of graphic data representation	3.31	0.79
Conceptual understanding and attitude towards graphing	3.25	0.68

Source: Field Survey (2021)

Results of participant's analysis show that in respect of data visualization techniques and processes, the mean response provided by participants was 3.25 at a standard deviation of 0.77. This result implies that participants, to a very large extent held the view that graphing capabilities influenced their test scores and student achievement by extension. In addition, as it pertains to the extent to which competences in graphical data representation influences student achievement, the results show that the mean response was 3.3 with a standard deviation of 0.79. The results mean that participants believed that to a large extent, an understanding of graphical data representation influenced test scores.

Finally, participants were also probed to indicate the extent to which the conceptual understanding and general attitude towards graphing influenced their test scores, the results show a mean response of 3.25 and a standard deviation of 0.68. These statistics indicate that participants believed to a very large extent that understanding and attitude toward graphing influenced their test scores, especially in graphing items.

In summary, all the three (3) graphing capabilities factors were believed to influence achievement, to a very large extent. These findings are in concordance with the position adopted by the Australian Council for Educational Research (2020) in its report on the National Partnership Agreement on Digital Educational Revolution (NPADER) in which the council points to increased scores in student achievement due to the introduction of graphing calculators and other computer devices in the educational curriculum.

Influence of Engagement Capabilities on Student Achievement

The research also sought to examine the influence of engagement ICT capabilities on student achievement. To achieve this, the research sought responses from participants on the influence of active learning activities outside school, immediate feedback, and proficiency in using digital learning environment. The results show average mean values greater than 3 for all the engagement capabilities factors. Table 15 provides the summary of the results.

Table 15: Influence of Engagement Capabilities

Engagement Capabilities Factor	mean	std dev
Active learning activities outside school	3.50	0.63
Immediate feedback on studies	3.50	0.63
Digital Learning Environment (digital games)	3.63	0.50

Source: Field Survey (2021)

From Table 15, the mean response on the influence of learning activities outside school on student achievement was 3.5 and standard deviation 0.63, the mean for immediate feedback on studies was 3.5 and standard deviation of 0.63 and for influence of digital learning environment or digital games on student achievement, the mean response was 3.63 with a standard deviation of 0.50. The results mean that participants are of the view that each of the descriptor variables to a very large extent influenced student performance. These findings are in synch with the positions adopted in previous studies including the Australian Council for Educational Research (2020) who found that ICTs boost student engagement and student Engagement Capabilities in the use of digital platforms such as digital games, web-conferencing (Microsoft Meeting, Zoom, Telegram) and Google classroom influence their test score (achievement). the findings also corroborate the positions of Don (2021) who found that gamification of learning, educational or learning videos and personalized activities in a digital learning environment all enhance student cognitive, behavioural and emotional engagement and by extension, better achievement in test scores.

Influence of Motivation Capabilities on Student Achievement

The study also assessed the influence of Motivation ICT capabilities on student achievement. In this respect, participants were asked to respond to three statements by indicating the extent to which ICT motivation capabilities including critical thinking competences, optimism to progress in studies and effectiveness of studies.

Table 16: Influence of Motivation Capabilities

Motivation Capabilities Factor	mean	std dev
Critical thinking	3.31	0.79
ICTs drive your ability and optimism to progress in your studies	3.25	0.93
Effectiveness of studies	3.06	0.77

Source: Field Survey (2021)

From Table 16, all the motivation capabilities factors has a mean responses greater 3.0. This indicates that participants believe that to a large extent, each of the factors influence students achievement in the West Gonja Municipal. Specifically, the mean value for the influence of critical thinking, optimism to progress in studies and effectiveness of studies were 3.31, 3.25, and 3.06 respectively. The findings corroborate the positions of previous academic works such as Victorian Government's Department of Education and Training (2019), Socrates (2020) and Marcelino (2021) who found a positive relationship ICT motivation on student achievement.

Regression Model

The study also conducted regression analysis to verify the connection between each of the descriptors and student achievement in SHSs in the West Gonja Municipal and also to disaggregate the impact of each of the categories of ICT capabilities on student achievement. To achieve this, the research conducted preliminary analysis using correlation methods to ascertain the nature of the relationship among the studied variables (Multiple Regression). To understand the combined impact of the independent variables and determine the marginal impact of each of the independent variables on student test scores, the researcher conducted a regression analysis of the overall regression model as presented in equation (1).

Analysis of the coefficients of the model was conducted and Table 17 provides a summary of the results of analysis done.

Table 17: Coefficients of Overall Regression Model

Model	Coefficient (β)	Std. Error	t.	Sign
(Constant)	0.38	0.084	2.025	0.39
Computational Capabilities	0.39	0.015	3.84	0.000
Graphing Capabilities	0.41	0.018	2.76	0.000
Engagement Capabilities	0.52	0.084	3.62	0.000
Motivation Capabilities	0.68	0.017	3.21	0.000

Source: Field Survey (2021)

The results shown from the table above indicate that the coefficients of the regression model are far apart from 0. With the levels of significant (p-value) of 0.39 for $\widehat{\beta_0}$ (0.38), 0.000 for $\widehat{\beta_1}$(0.39), 0.006 for $\widehat{\beta_2}$(0.41), 0.000 for $\widehat{\beta_3}$(0.52)and 0.000 for $\widehat{\beta_4}$(0.68). The values indicate that the coefficients of the regression model are significant.

$$\hat{y} = \widehat{\beta_0} + \widehat{\beta_1}CC + \widehat{\beta_2}GC + \widehat{\beta_3}EC + \widehat{\beta_4}MC + \hat{\varepsilon}$$

Therefore,

Student Achievement $(\hat{y}) = 0.38 + 0.39CC + 0.41GC + 0.52EC + 0.68MC$

In addition, the results of the multiple regression analysis also show a strong connection or relationship between ICT capabilities and Student Achievement. The results suggest that 99.5% of the changes in student achievement is attributed to the collection change in computational, graphing, motivation, engagement capabilities by a unit. The results are shown in Table 18.

Table 18: Model Summary of Overall Regression

Model	R	R Square	Adjusted R Square	Std. Error
1	0.911	0.830	0.778	0.139

Std. Error – Standard Error (Estimate)

The findings from the table above show that Adjusted R Square is 0.803 indicating that 80.3% variation in student performance can be explained by a unit joint variation in the model constructs. This indicates a strong and positive relationship between the model predictors and student achievement of SHSs in the West Gonja Municipality.

The results of ANOVA on the multiple regression model indicate the adequacy of the model and a strong positive relationship among computational, graphing, motivational, and engagement capabilities and student achievement in Senior High Schools in the West Gonja Municipal. Table 19 provides a summary of the results of ANOVA.

Table 19: ANOVA Results of Overall Model

	df	*SS*	*MS*	*F*	*Significance F*
Regression	4	2.14038	0.535095	15.90913	6.28E-05
Residual	115	0.437248	0.033634		
Total	119	2.577628			

Source: Field Survey (2021)

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

Introduction

This chapter provides the key findings of the study and conclusions made from them. The chapter also discusses the recommendations put forward as possible ways to addressing the findings. In summary, the chapter covers the findings, conclusions and recommendations.

Key findings

The study investigated the influence of ICT capabilities on student achievement in Senior High Schools in West Gonja Municipal. The study identified ICT capabilities as the affordances offered by ICT in education and the ability of a student to identify and use those affordances to meet learning needs and improve knowledge retention and conceptual understanding of specific domains. Based on the review of contemporary academic works in the area, especially Tassos (2018) and Marcelino (2020), the study identified four (4) ICT capabilities: Computational Capabilities, Graphing Capabilities (Tassos, 2018), Engagement Capabilities, and Motivation Capabilities (Marcelino, 2020). The research adopted the descriptive research design with quantitative approach. A sample of 120 students from three SHSs in West Gonja was used and data was collected with the aid of diagnostics tests and a survey questionnaire. The findings include:

Based on the analysis of the overall performance of students in both the pre-test and post-test paper, it was found that the average performance of students in the

post-test paper was higher than the average performance in the pre-test paper. The results also show that average performance of the experimental group improved significant from the pre-test to the post-test while that for the controlled group was marginally the same. The results also show a significant increase in student scores in computational items in the experimental group with less observable improvement in scores by the control group. Participants also indicated that the implementation of the treatment in respect of improving the computation capabilities using ICT enhanced their understanding and by extension scores in computation items in the post-test diagnostics paper. In summary, average score in computational items improved in the post-test compared with the pre-test for the experimental group.

The study also measured the changes in student scores in graphing items for both the experimental and control groups in both pre-test and post-test diagnostics tests. The results show that average scores in graphing items marginally improved in the post-test diagnostic test among the experimental group compared to the same in the control group. The study also found graphing capabilities had a marginal influence on student test scores especially graphing items.

The study measured the influence of engagement capabilities on student achievement in specific reference to specific objective 3. The study found that engagement capabilities of ICTs have a strong and positive influence on student achievement in Senior High Schools in the West Gonja Municipal. The study identified engagement capabilities of ICT (digital engagement capabilities) in education as the affordance ICTs afford students to interact with teachers,

supervisors, and their colleagues through digital (virtual) platforms and channels for educational purposes. Evidenced from the test scores in post-test examination and the responses provided by the participants how ICT Engagement Capabilities including digital engagement and other virtual engagement channels influence student engagement, the study found that engagement capabilities have a strong influence on student achievement. This position confirms the position of previous studies including Tassos (2019) and Marcelina(2020) who found that digital engagement channels open numerous opportunities to students for quick feedback and enhance student access to information resources that positively influence their achievement. The study also confirms the position of Bart and Danielle (2019) who identified those virtual channels including webinars, live chatting and messaging, and virtual classrooms, among others to be effective measures to improving student knowledge and performance.

The study also examined the influence of motivation capabilities of Information and Communication Technologies on student achievement in SHSs in the West Gonja Municipal. Motivation capabilities of ICT are identified as the affordance of ICTs offer students that inspire vigilance, competence, and purposeful educational activities. Based on the analysis of the test scores and the responses provided by participants to the questionnaire, the study found that motivation capabilities of Information and Communication Technologies have a strong and positive influence on student achievement. This finding corroborated the position of Tassos (2018), Bart *et al* (2018), and Marcelino (2020) who studied the effects of information technologies on student performance. Tassos (2018), for instance,

found that ICT tools serve as critical motivation for students at all levels especially in less advanced countries where a person's ability to access and use a computer (for example) is exemplified with superior talents. Marcelino (2020) also found that among college students, access to and the use of computers enhances the levels of concentration, attention, and moral to understand educational concepts and by extension, further performance.

Conclusions

Based on the results from the analysis and the findings made, the study makes the following conclusions.

Based on the findings and results of analysis done on student scores and responses, the conclusion that could be drawn from the findings is to the effect that computational capabilities in ICTs significantly drives the achievement of students in Senior High Schools in the West Gonja Municipal. The study found a strong connection between computational capabilities variables and student achievement of students in SHSs in the West Gonja Municipal. Based on these, it could be concluded that if computational capabilities of ICTs are enhanced among students in SHSs, their performance (achievement) could improve significantly.

On graphing capabilities of ICTs, it is concluded that there graphing capabilities to influence student achievement in SHs in the West Gonja Municipal. The study showed that all descriptor variables of graphing capabilities had a strong and positive influence on student test scores in the post-test diagnostics examination. The study further showed enhanced capabilities in graphing using ICT tools could lead to significant improvement in students' conceptual understanding of

graphing and hence, improve scores in graphing items in examinations. The study concludes that graphing capabilities of ICTs significantly influence student achievement in SHSs in the West Gonja Municipal.

Digital engagement capabilities have been found to be critical affordances offered by ICTs especially, amidst the COVID – 19 pandemic. In respect of engagement capabilities of ICTs, the study concluded that engagement capabilities factors do significantly influence student scores. The study found that engagement capabilities factors significantly influenced student scores in the post-test paper. The study found that active learning activities outside schools, and immediate learning feedback are suitable affordances offered by digital engagement platforms (channels) that enhance student achievement. On this basis therefore, the study concludes that engagement capabilities of ICTs positively and strongly influence student achievement in SHS in the West Gonja Municipal.

On motivation capabilities, the study concludes that motivation capabilities of ICTs do influence student test scores and by extension, achievement. The study found that all motivation capabilities factors had statistically significant influences on student achievement in graphing, computational and conceptual items. The study further noticed that curiosity, attention, ability and the effectiveness of studies are the main mediating variables that connected motivation capabilities and student achievement. The study concluded that motivation capabilities strongly and positively influence student achievement in SHSs in the West Gonja Municipal.

Recommendations

Subject to the findings and the conclusions, the study established that computational, graphing, engagement and motivation capabilities of ICTs strongly and positively influence student achievement in SHSs in the West Gonja Municipal. The study further established that in terms of ranking, computational capabilities of ICTs influence student achievement the most followed by graphing, motivational and engagement capabilities. On these bases the study makes the following recommendations.

The study recommends that the government, Ministry of Education and stakeholders in the educational sectors should work towards fully integrating ICTs in the SHS curriculum. The study further recommends that the focus of the integration should go beyond access of ICTs to include pragmatic steps that should focus on building the capabilities of students in the use of these ICT tools. With the globe drifting slowly towards digital transformation, efforts towards integrating ICTs into all levels of education should focus on building the capabilities rather than the access.

In addition, the study recommends that the integration of ICTs should be done in a hierarchical order subject to the findings that the different ICT capabilities have different levels of influence on student achievement. Any framework adopted for integrating ICTs should focus first of all on computational capabilities, followed by graphing then motivation and finally, engagement capabilities. This will enable students to build the appropriate and necessary ICT capabilities that are tailored towards enhancing student achievement.

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Appendices

Appendix A: SURVEY QUESTIONNAIRE

I am a final year Master's student of the University of Cape Coast, currently conducting a research on the "INFLUENCE OF ICT CAPABILITIES ON STUDENT ACHIEVEMENT IN SHSs IN THE WEST GONJA MUNICIPAL". I would like you to assist me by completing this questionnaire.

BACKGROUND INFORMATION

School [ ] DASS [ ] NDESCO [ ] SAGISS

Gender[ ] Female [ ] Male

Student No. ……..

INFLUENCE OF COMPUTATIONAL CAPABILITIES OF ICTs ON STUDENT ACHIEVEMENT

Please indicate by choosing from the alternative options, the extent to which computational ICT capabilities influenced your achievement (0 – Not At All, 1- Small Extent, 2 – Moderate Extent, 3 – Large Extent, 4 – Very Large Extent)

COMPUTATIONAL VARIABLES	0	1	2	3	4
Arithmetic operations and processes	[ ]	[ ]	[ ]	[ ]	[ ]
Digital logic system	[ ]	[ ]	[ ]	[ ]	[ ]
Understanding of Computational activities	[ ]	[ ]	[ ]	[ ]	[ ]

INFLUENCE OF GRAPHING CAPABILITIES OF ICTs ON STUDENT ACHIEVEMENT

Please indicate by choosing from the alternative options, the influence of ICT Engagement Capabilities on the following variables (0 – Not At All, 1-Small Extent, 2 – Moderate Extent, 3 – Large Extent, 4 – Very Large Extent)

STUDENT GRAPHING VARIABLES	0	1	2	3	4
Data visualization processes	[ ]	[ ]	[ ]	[ ]	[ ]
Understanding of graphic data representation	[ ]	[ ]	[ ]	[ ]	[ ]
Conceptual understanding and attitude towards graphing	[ ]	[ ]	[ ]	[ ]	[ ]

INFLUENCE OF ENGAGEMENT CAPABILITIES OF ICTs ON STUDENT ACHIEVEMENT

Please indicate by choosing from the alternative options, the influence of ICT Engagement Capabilities on the following variables (0 – Very Low, 1-Low, 2 – Neutral, 3 – High, 4 – Very High)

STUDENT ENGAGEMENT VARIABLES	0	1	2	3	4
Active learning activities outside school	[ ]	[ ]	[ ]	[ ]	[ ]
Immediate feedback on studies	[ ]	[ ]	[ ]	[ ]	[ ]
Make learning fun	[ ]	[ ]	[ ]	[ ]	[ ]

INFLUENCE OF MOTIVATION CAPABILITIES OF ICTs ON STUDENT ACHIEVEMENT

Please respond to the following statement about the influence of Motional capabilities on your academic performance. Note, 0 – Strongly Disagree, 1 – Disagree, 2 – Neutral, 3 – Agree, 4 – Strongly Agree.

STATEMENT	0	1	2	3	4
ICTs enhance your attention, curiosity and passion for studies	[ ]	[ ]	[ ]	[ ]	[ ]
ICTs drive your ability and optimism to progress in your studies	[ ]	[ ]	[ ]	[ ]	[ ]
ICTs enhance the effectiveness of your studies	[ ]	[ ]	[ ]	[ ]	[ ]