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ASSESSING THE IMPACT OF MULTIMEDIA TOOLS IN TEACHING AND LEARNING OF ICT IN SCHOOLS IN THE MAMPONG MUNICIPALITY, ASHANTI REGION

BIE ANSOBIE BILIGUO

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BIE ANSOBIE BILIGUO

A dissertation in the Department of Information Technology Education, Faculty of Mathematics and Science, submitted to the School of Graduate Studies in Partial fulfilment of the requirements for the ward of the degree of Master of Science (Information Technology Education) in the Akenten Appiah-Menka University of Skills Training and Entrepreneurial Development.

JULY, 2022

DECLARATION

STUDENT DECLARATION

I, BIE ANSOBIE BILIGUO, declare that this dissertation, with the exception of quotations and references contained in published works which have all been identified and duly acknowledged, is entirely my own original work, and it has not been submitted, either in part or in whole, for another degree elsewhere.

Signature……..

Date…….

SUPERVISOR'S DECLARATION

I hereby declare that the preparation and presentation of this work was supervised in accordance with guidelines for supervision of dissertation as laid down by the Akenten Appiah-Menka University of Skills Training and Entrepreneurial Development, Kumasi.

Dr. Francis Ohene Boateng (Principal Supervisor)

Signature……

Date……

DEDICATION

In memory of my late father, Biliguo Tungbani (Born: circ. 1929; Passed on: 29th February, 2008) for his toils and sacrifices to ensure my education. He was ~~–~~guide by my side rather than sage on the stage."

To my children in waiting; and my students who stand in their stead.

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LIST OF ABBREVIATIONS

ADDIE	Analyses, Design, Development, Implementation and Evaluation
BBC	BlackBoard Computing
BECE	Basic Education Certificate Examination
CAT	Computer-aided Teaching
CDROM	Compact Disc Read Only Memory
CLT	Cognitive Load Theory
CTMML	Cognitive Theory of Multimedia Learning
DCT	Dual Coding Theory
ECL	Extrinsic Cognitive Load
GES	Ghana Education Service
GCL	Germaine Cognitive Load
GPRS	Ghana Poverty Reduction Strategy
IBM	International Business Machine
ICL	Intrinsic Cognitive Loads
ICT	Information and Communications Technology
MAT	Multimedia-aided Teaching

MBI	MarkerBoard ICT
NaCCA	National Council for Curriculum and Assessment
RLG	Roland Links Ghana
SDG	Sustainable Development Goals
SHS	Senior High School
SPSS	Statistical Package for Social Scientists
WAEC	West African Examination Council
WASSCE	West Africa Senior School Certificate Examination

ABSTRACT

The study compares the impact of multimedia-aided teaching (MAT) and the traditional method of teaching Information and Communications Technology at Senior High Schools in Mampong Municipal. Two schools identical in intellectual competencies, based on WASSCE performance, and availability of computing facilities were sampled for the study. The random sampling yielded a total of two hundred and ten students comprising 80 science and 130 art students. In terms of gender, the sample size for the study comprised 54% males and 46% females. The study used experimental design to verify causal claims. The experimental group (Amaniampong SHS) was taken through a lesson using multimedia tools whereas the control group (St. Joseph Seminary SHS) was taken through traditional mode of instructional delivery (via marker board). The impact on performance was measured through pre-test and post-test instruments. Again students' perception survey on their interest levels in both types of classroom was conducted. Students in multimedia classrooms had more positive perceptions of instructors' instructional methods than students in traditional classroom. Interest levels for both approaches were statistically significant (with average of 3.5 for traditional approach, and 3.9 for that of multimedia, out of a possible 5). This was confirmed through the researcher's observations in the classrooms. Whereas both approaches improved learning, the comparative differences in change in knowledge for both groups was not statistically significant (p-value = 0.10). There were some gains, however, in favour of multimedia. The research therefore called for a policy shift in the adoption of multimedia tools at the Senior High level to complement traditional mode of instructional delivery. The schools and teachers should also be equipped with the requisite infrastructure and skills enough to deliver lessons using multimedia technologies.

CHAPTER ONE

INTRODUCTION

1.0 Introduction

This chapter comprises preliminary issues on the research project. It spells out the background of study, profile of study area, statement of problem, purpose of the study, research question, hypothesis, significance of the study, limitations of the study, delimitation, and definition of terms as well as organisation of study.

1.1 Background of Study

Multimedia is the field concerned with the computer-controlled integration of text, graphics, drawings, still and moving images(video), animation, audio, and any other media where every type of information can be represented, stored, transmitted and processed digitally (Pavithra, Aathilingam, & Prakash, 2018). The author's many years of teaching ICT has brought to light certain inherent challenges in its delivery and integration with other disciplines.

The US Department of Education (Malcalm, 2012) notes that: "The challenges for modern education systems call for the learning of new technologies to create engaging and learning materials for both educators and learners."

The UN Sustainable development goal (SDG) 4 seeks to "ensure inclusive and equitable quality education and promote live-long learning opportunities for all" (UN, n.d). These SDGs are well-aligned with Africa's Agenda 2063 and Ghana's Agenda 2030 (Ghana, 2019).

Several studies have been carried out on multimedia in different localities and in different subject areas (Banji et al, 2020; Kumar et al, 2020; Deku et al, 2017). There have been mixed results (Zhang, 2002; Kareem, 2018). But the impact of multimedia has not been experimented in Mampong municipality.

The European Commission pointed out that there is alarming decline in the attitude of students towards science and recommended that improvements in science education should be brought through new forms of pedagogies and approaches (Shah & Khan, 2015). The new approaches through multimedia instruction are thought to affect student's performance and interest (Shah & Khan, 2015; Kareem, 2018).

Moreover, other authors disagree. Students' perception of multimedia classroom has been studied at East Tennesee State University (Zhang, 2002). He found no difference in perception of achievement by students in multimedia classrooms compared to traditional classrooms. He further recommended a future study in a larger and more diverse population.

Perception and use of multimedia in pre-service teacher education has been carried out in Australia (Tennent, 2003). The author reported that teachers had a positive attitude towards embracing multimedia whereas the impact of interactive multimedia in physics has been examined in Sweden (Fedulov, 2003). Fidulov is of the view that interactive multimedia moderately improves learning. This view is somewhat corroborated by Onah et al (2020), in their paper on Computer Assisted Instruction in physics and mathematics. Onah et al (2021) reported a similar finding with Mathematics in Mampong but at the colleges of education level. This research seeks to know to what extent this impact is statistically significant in teaching ICT in Mampong municipality.

Shah et al (2020) studied the impact of multimedia-aided teaching on academic achievement at the elementary level in Pakistan. He concluded multimedia had significant effect on academic performance. Goundar (2011) rather reviewed the impact of using mobile devices in education in China (Goundar, 2011). Using document analyses of related work, he reported ground breaking teaching and learning technologies with added mobility advantage. Furthermore, Kumar & Jamil (2016) studied enhanced learning using motion graphics in higher education in Saudi Arabia. Their studies showed a higher retention for students who walked info graphic video in class than lecture-based sessions. Kabooha and Elyas (2018) consigned theirs to the effect of YouTube in multimedia instruction for vocabulary learning among Saudi females studying English as a foreign language in Saudi Arabia. The selection of appropriate content was thought to beneficial.

A Kenya-based project study of using technology in teaching in Sub Saharan Africa , showed positive gains in reading skills for both boys and girls (Abrami, et al., 2020). Chigona(2013) studied multimedia use in storytelling in South Africa. Participant perceived technological skills as one of the most important factors for their stories. Digital story-telling further created shared understanding. Kareem (2018) examined the impact of multimedia on learning outcomes in Biology in Nigeria. His survey concluded multimedia has a positive impact on students learning outcomes. Multimedia lessons are more effective and provide better comprehension for students (Kareem, 2018).

In Ghana, a study conducted by Deku et al (2017) reported mixed results in English language acquisition among varying components of the subject whereas Ayittey (2015) conducted multimedia instructions in Biology, both in the Central Region. Several authors treated the phenomenon in basic schools and elsewhere in different countries.

Their work also consigned itself to performance and made no mention on interest or attitude of students towards studying a subject using multimedia tools (Deku, 2017; Ayittey, 2015). Again, this research seeks to know the narrative in Mampong by testing the theory of causal claims.

In 2003, Ghana formulated its first ICT in education policy. This has since received successive reviews (Banji, Okyere, & Dogbe, 2020). However formal study of ICT at the pre-tertiary level begun later in 2007. Banji et al (2020) further reported, the government as part of the ~~–~~one laptop per child policy" distributed laptops to pupils and students through RLG Communications. Since the implementation of Information and Communications Technology (ICT) in the pre-tertiary curriculum in 2007, teaching the subject has not being without challenges.

The Covid 19 era with its attendant lockdown had a tremendous impact on the mode of learning. It imposed untold limitation on face to face sessions as learning took the medium of television for basic schools, and computers, zoom platform and other learning management systems for the universities.

While ICT is supposed to be integrated into other subject areas, ICT itself is still taught at pre-tertiary levels on the marker and black boards. The world has meanwhile become a global village due to the influence of ICT on society. To catch up with modern trends of development, we cannot but have to employ ICT tools in the production process as well as the delivery of services.

A few years ago, video of a Ghanaian teacher went viral after drawing the entire Microsoft Word application window on the blackboard. Through NasDaily Facebook page, a page dedicated to one minute long videos, the phenomenon of Richard Gerafusco was made known to the world. When this got to the attention of the software

giant, Microsoft itself donated twenty seven computers and accessories to the rural school. Undoubtedly, multimedia tools now take precedence and preference over the use of the blackboard as that rural school now uses projector for instructional delivery. This scenario represents the generality of the Ghanaian situation and its consequence on students' performance and interest in the subject. Just as there was a shift from blackboard to marker board, it may once again be necessary to transition from marker board to multimedia presentation, if not entirely.

With regards to Mampong municipal not such research has been carried out. Asare and Agyemang's(2020) research focused on mouse skills development at the basic school level whereas Nyarko(2021) tackled multimedia-aided learning in mathematics education at the Colleges of Education. With some modest gains in supply of ICT infrastructure the researcher wishes to test the preparedness of ICT in the integration derive.

1.1.1 Profile of the Study area

The study setting is within the Mampong Municipality, with the Senior High Schools Amaniampong SHS (Experimental group) and St. Joseph Seminary SHS (Control group). Mampong Municipality is one of the nine municipal assemblies in Ashanti Region. Mampong, the Municipal capital is 57 km from Kumasi, and it is a very important town in the Ashanti Region (Mampong Municipal Assembly, 2010). The 2010 Population projection for Mampong was 88,051 (Ghana Population and Housing Census, 2000).

Mampong Municipality has eighty-five (85) primary schools, fifty eight (58) Junior High Schools, four (4) senior high schools and one vocational school. There are also two teacher training colleges, a mid-wifery training school and a university. Despite the

numerous educational facilities in the municipality, the standard of education is not encouraging due to poverty (Mampong Municipal Assembly, 2010).

Established in 1963, Amaniampong Senior High School (Great AMASS) is a mixed, public school. It has boarding facilities for both boys and girls. As of the 2020/21 academic year, Great AMASS had a total population of three thousand and seventy two students (3,072) made of one thousand six hundred and sixty three boys (1663) and one thousand four hundred and nine (1409) girls representing 54% and 46% respectively. This participated in the research as the experimental group.

The other counterpart for the research project, St. Joseph Seminary Senior High School (St. Joss), is also a mixed, public facility established in 1968.. St. Joss has a total population of two thousand six hundred and thirteen (2, 613) with boys one thousand four hundred and forty nine (1449) representing 55% and girls one thousand one hundred and sixty four (1164) representing 45% of the total population. This participated in the project as the control group.

Both schools deemed of equal strength in terms of academic performance (as reflective in WASSCE performance) and similar characteristics offer the following programmes.

- General Art
- Business
- Home Economics
- Visual Art
- General Science
- Agricultural Science

However, the connecting line for this research is Information and Communications Technology (Core) pursued for the first two years of the senior high school as provided for by the curriculum.

1.2 Statement of Problem

The pre-tertiary education space mainly uses chalkboard and marker board in delivering instructions (Deku, 2017). Students' performance in Information and Communications Technology (ICT), delivered using these conventional methods, has been abysmal over the years. Significantly, the Chief Examiner's Report (CER) which assesses students' performance in ICT at Basic Education Certificate Examination (BECE) level affirms this (BECE, 2017; BECE, 2019). This has been partly blamed on the mode of delivery. Students transition to the Senior High Schools (SHSs) with these challenges (WASSCE, 2018).

Multimedia tools could be used to teach any subject content (Deku et al, 2017; Ayittey, 2015). As Khan et al (2016) puts it, multimedia tools are very effective to teach students a wide range of disciplines. Undoubtedly, employing multimedia tools in lesson delivery is a step towards the development of these practical skills that is expected to counter this trend.

Investigations have shown conflicting outcomes in the use of multimedia tools in pedagogical instruction. For instance, Deku et al (2017) studied its applications in English language, whereas Ayittey (2015) conducted a study in multimedia instruction in Biology, both in the Central Region. Deku's aggregations were mixed in terms of learning outcomes whereas Ayittey agreed it improved instruction. Zhang(2002) rather gave a contrary view, deeming the phenomenon as statistically insignificant.

Multimedia has not particularly being investigated in terms of both student performance and interest taking the subject ICT itself and Mampong municipality into perspective. Shah and Khan (2015) considered the issue of attitude rather in a foreign clime, showing declining attitude in the sciences calling for new modes of pedagogical instruction.

Personal classroom observation has shown that students get disinterested in ICT lessons that do not use multimedia tools or practical demonstration. ―Let‘s go to the lab", sleeping and noise making are all signs of disinterest in traditional methods of delivering instruction.

Moreover, students and teachers are not taught to use multimedia. Whilst resource constraints are manifest, tutors have strong desire to participate in the integrating ICT into other disciplines (Nyarko et al, 2021). Luckily, with the new curriculum (NaCCA, 2019) being enrolled, teachers have been given laptops that will enable them deliver lessons using multimedia tools. ICT teachers must lead in this drive to integrate with other discipline.

Explaining certain concepts verbally cause them to draw their imaginations in ―abstract space" in a bid to comprehend when it could be made easier with multimedia tools or demonstration. As Kareem (2018) puts it, the multisensory nature of multimedia makes it stimulate multiple senses at a time. This increases student‘s interest. When students interest increases, understanding is enhanced with a corresponding tendency for improvement in academic achievement and attitude (Kareem, 2018).

This research seeks among other things to either confirm or disconfirm the significance of multimedia tools in instructional delivery amidst varying opinions. It would possibly call for a policy push so as to make ICT play its rightful place in education.

1.3 Purpose of the Study

The main objective of this research is to study the impact of multimedia tools on teaching and learning in terms of students‘ performance and interest. The research seeks among other things to encourage teachers of all disciplines to consider incorporating multimedia tools in their instructions.

To achieve this overall objective, the following specific objectives which are linked to the research question were defined for this dissertation.

1. To determine the impact of the use of multimedia tools in teaching and learning of ICT on interest and performance of students
2. To determine the impact of traditional teaching approach on interest and performance of students

1.4 Research Question

The study was driven by the quest to obtain answers to the following critical questions.

1. What effect does the use of multimedia tools in teaching and learning of ICT have on students‘ interest and performance?
2. What is the impact of the use of traditional approaches in teaching and learning of ICT on students‘ interest and performance?

1.5 Hypotheses

To enable the investigation, these null hypotheses are thus formulated.

H01: There is no significant difference in the interest of students taught (a given topic) using multimedia tools and other traditional mode of delivery.

H02: There is no significant difference in the performance of students in instructions delivered via multimedia tools or traditional methods.

H03: There is no significant difference in terms of gender in relation to performance using multimedia tools and traditional methods of instruction

1.6 Significance of the study

The research contributes to knowledge by highlighting the impact of multimedia in pedagogical instruction against the backdrop of traditional methods (marker board, blackboard). When I went to St. Joseph SHS and the Rector/Headmaster asked me to state my project topic and I did. He replied, ―Then the choice of school is wrong. We do not use it (multimedia) in teaching here. It is done at the universities". I said, yes. I will use it and measure its impact on performance and students interest in its participation by establishing evidence.

Multimedia methods seem to develop interest and understanding of students especially on topics that employ great deal of multimedia elements (Khan & Bhashani, 2020). In a single bundle, it also seeks to assist students finish up with their syllabus and prepare them for the new method of instruction in fields not restricted to education alone.

Much of the first year in SHS is devoted to theory. Practice begins at the tail end of the first year and runs through the second where the ICT Core subject ends according to the curriculum. Due to the lack of resources, access to the ICT laboratory and practice is often reserved for second years. This denies the first year's access to effective technology driven instruction.

Most often the syllabus is not exhausted, and presentation application which is at the very end is often invariably neglected. Encouraging multimedia aided teaching will kill two birds with one stone. It would enable the students learn the presentation requirement of the curriculum without necessarily being taught. It will develop interest of students and enhance their understanding.

It would also equip them with the requisite background for coping with tertiary education, and integrating it into specific fields of learning. Multimedia is the basis for teaching at higher level where the student embraces after high school education. It would therefore to be appropriate to equip students with these skills early enough in their educational development to get used to the phenomenon as a modern paradigm shift.

A good foundation through holistic training is necessary for embodying more complex phenomena. No doubt, the foundation knowledge is essential for imbibing the higher concepts. The study would also help to develop positive interest of students towards science in general and ICT in particular.

This research will as well provide useful information to academics, managers and educational practitioners to adopt best strategies which could go a long way to kill two birds with one stone. Future scholars could also investigate this backdrop to either confirm or disconfirm the findings with another locality.

Policy makers in particular could implement the recommendations to bring a transformation in the pre-tertiary education through government commitment to uplift the standards of education. Being a research breaking ground will draw policy makers to consider the integration of ICT into other subject disciplines at the basic level and more so to use multimedia in every instructional delivery just as in the tertiary institutions. Just as ICT started at the tertiary level and gradually crept to the basic and secondary, it is the researcher‘s hope that multimedia aided teaching would soon get integrated into every subject discipline with presentations done using multimedia tools so as to advance teaching and learning. The baseline remains to arouse students‘ interest and enhance their performance.

1.7 Limitation of the Study

It is often costly to deal with total populations especially taking the two populous schools into consideration. However, according to several studies, a 10% sample is representative of a total population for a research study (Creswell & Creswell, 2018). The research limited itself to such a choice with a strong conviction of dealing with a homogenous population with equal strengths and concerns.

The time of the research project coincided with the academic calendar where normal instructions with the academic calendar were taking place. The researcher did not want to disrupt or interfere with the routine academic work of schools by consigning most of these sessions to the night prep hours. It also limited the duration of interaction. Particularly, the nature of the academic calendar prolonged the research especially in the control group as we had to break during holidays.

More so, the study discounted old technologies like epidiascope or newer technologies such as intelligent/smart boards due to the author's knowledge of the prevailing circumstances in the two schools.

The study was carried out on science and art students only being necessitated by the random sample. It is not certain whether a generalisation could be drawn on students of other disciplines such as business, agriculture, visual art, etc. which are also studied in these schools. It also borders on perception and human assessment s and self-reported data (Zhang, 2002) and student-teacher assessment (e.g. instructor behaviour).

The Covid 19 also provided another limitation on the number of students that could be engaged at the various computer laboratories for the treatment and responses.

1.8 Delimitation

The research period in its entirety spans June 2021 to January, 2022. However, previous gathering of information through proposal writing and literature review preceded the actual experiments much earlier. This length of time was partly necessitated by disruption in the academic calendar rather than the volume of instruction delivered or contact hours used.

The area of research is Mampong Municipal, one of the forty three (43) districts in Ashanti Region. It considers two senior high schools in the municipality: Amaniampong SHS for the experimental and St. Joseph Minor Seminary SHS as the control group for the study. The Kofiase Adventist Senior High Technical School is only considered for a pilot study. The study considered the second year (both Gold &Green track) students for Great AMASS and their counterparts (both Gold & Green) in St. Joseph present in school for the 2020/2021 academic year.

1.9 Definition of Terms

Attitude: A disposition to respond positively or negatively to a given situation

Conventional method of teaching: Traditional mode of marker board/blackboard teaching

Double track: The system where two streams are accommodated at SHS

Gold track: Second stream at the SHS level

Green track: The first stream of SHS level

Instructional technology: is the application of scientific knowledge and learning to the particular tasks of teaching and learning

Interest:	Feeling of curiosity or concern about something that makes the attention turn toward it.
Learning theories:	Principles for knowledge acquisition, retaining and recall of information
Multimedia tools:	Devices used in multimedia presentations(Laptops, TV, CDROMs, etc)
Multimedia:	A combination of text, sound, pictures, videos that stimulate multiple senses.
NaCCA	National Council for Curriculum Assessment
Performance:	Academic achievement of a student measured on a given topic
Policy:	What government plans to do or not to do
SPSS:	Software for analysing quantitative research data

1.10 Organisation of Study

Organisation of Study provides a cursory overview of each topic or sub aspect. Chapter one, typically on introduction to the project, espouses the Research Problem providing the grounded justification for carrying out the research. The objectives of the research, chiefly developing interest and enhancing performance in teaching and learning, follows. I next state the research question and reframe it as baseline hypothesis in relation to the objectives stated earlier. The relevance of the study is justified in connection with the research problem. The various factors defining the boundaries of the research are spelt out.

Chapter two, literature review, presents a broad overview of the topic, giving a brief account of evolution of instructional design theories, then the emergence of multimedia and the intercourse of the two as modern requirement for enhancing teaching and learning.

The methodology next discusses the ways by which the research is carried out. It spells out the research design, sampling techniques among others.

Chapter four encompasses results and discussions where the data analyses is actually carried out using Excel and SPSS software and presented in a number of attractive formats for both graphical impression and literary reading. The fifth chapter draws a conclusion based on the results thus analysed and presented. It also offers recommendations for implementing multimedia policies and technologies or even for carrying out future research work.

CHAPTER TWO

LITERATURE REVIEW

2.0 Introduction

An essential part of literature review involves determining which theories should be used to explore the research questions (Creswell & Creswell, 2018). I will also review existing policies and the underlying empirical and conceptual frameworks for governing traditional and multimedia-aided instructions. Moreover, literature review seeks to examine the state of research in a given area with a view to establishing the gap that one's own study would fill.

2.1 Theoretical Framework of the Study

This segment examines basic learning theories, multimedia theories, as well as instructional design theories and related literature. These theories are intertwined and every successful lesson makes a good combination of a number of them. However the theories that chiefly relate to this study on multimedia are the dual coding theory, cognitive load theory, cognitive theory of multimedia as well as Liard's sensory theory. These theories are hinged on the premise that deeper learning occurs from words and pictures than words alone (Robinson, 2004).

2.1.1 Learning Theories

Learning theories are a set of principles that explain how best a student can acquire, retain and recall new information (Stevens-Fulbrook, 2019). Behaviourism, cognitivism, and constructivism are the three broad learning theories most often used in the creation of instructional environments (Kumar & Jamil, 2016).

The educator has to incorporate various teaching and learning strategies to develop the interest of the students and enhance deep learning of the subject. The three theories differ in how learning is defined, which subsequently leads to different roles of the learners, and dictates what different teaching methods and assessment strategies are to be carried out (Khalil & Elkhider, 2016). A good knowledge of the trio would enable one understand well the multimedia theories espoused in this study.

Behaviourism is based on the idea that knowledge is independent and on the exterior of the learner. In the behaviourist mind, the learner is a blank slate (*tabula rasa*) that should be provided with the information to be learnt. Skinner refined the law of effect, stating that those behaviours that are reinforced are strengthened and those not reinforced tend to dissipate. This is positive reinforcement from classroom management perspective, and has been reckoned a popular element of behaviourism (Picciano, 2011).

Constructivism is based on the premise that we construct learning new ideas based on our own prior knowledge and experiences. Learning, therefore, is unique to the individual learner. Students adapt their models of understanding either by reflecting on prior theories or resolving misconceptions. Constructivism embodies some aspect of cognitivism, requiring minimal guidance on the learner (Dick, Carey, & Carey, 2015).

Humanism, closely related to constructivism, was spearheaded by Carl Roger and Abraham Maslow. Maslow‘s theory operates on the premise that students‘ progress through a set of sequential needs from physiological to self-actualisation. As they move up through the levels, they feel more comfortable in their learning environment and have the confidence to push further. There is therefore the need for teachers to feel empathetic with and build good rapport with students in meeting their needs (Picciano,

2011). Teachers can create classroom environment that can help students get closer to self-actualisation by provision of safe and comfortable environment, conducive to learning (Stevens-Fulbrook, 2019).

Connectivism focuses on the idea that people learn and grow when they form connections with their interests, roles and obligations in their life.

Cognitive learning theory looks at the way people think. Mental processes are an important part in understanding how we learn. As Carey & Carey (2018) puts it, cognition is a learning theory in which learning is viewed as active mental processing to store new knowledge in memory and retrieve knowledge from memory.

The cognitive theory recognises that learning can be influenced by both internal and external elements. According to Piaget, the child goes through four stages of cognitive development: sensorimotor, preoperational, concrete operational and formal operational, spanning birth to adulthood. With the sensory motor stage (from birth up to two years), the child learns basic schema and object permanence. In the preoperational (2 to 7 years), s/he continues to form more schemas and think symbolically. Concrete operational (7-11 years) is when the child begins to work out things in the head rather than physical. He also begins to appreciate the principle of conservation. The formal operational stage (11 years to adulthood), is where abstract thought and logic develop (Stevens-Fulbrook, 2019).

Piaget‘s work on cognition has given rise to some brilliant work from people like John Sweller who developed the fantastic load theory and Flavell‘s work on metacognision (Picciano, 2011).

The **information processing model** is the dominant theory in cognitive psychology (Khalil & Elkhider, 2016). It includes three types of memory (sensory, working and long term memory) that interact to encode information. Khalil and Elkhider (2016) further detailed, all information perceived by sensory memory will pass to working memory when the learner pays attention to it. Materials must be processed in the working memory to reflect our consciousness and learning. The limitation of working memory is considered critical when designing instruction.

Students use two types of rehearsal when processing information in the working memory: maintenance and elaborative rehearsal. The former also known as rote memorisation, occurs when the learner goes through the learning materials many times without thinking. The latter provides an avenue to organise the information to reach a meaningful form. So while rote memorisation works for short term memory retention, elaborative rehearsal is an active learning process that transfers information to the long-term memory. Unlike working memory, long term memory is unlimited in capacity and stores information permanently in organised schemas. The ultimate goal is to facilitate the process of elaboration for better encoding of content to be learnt. This phenomenon is elaborated in more detail later.

Aside these learning theories, we have adult learning theories. These are concerned with helping adults learn and do self-directed learning. Here the learner takes active part in the learning experience and directs the selection of teaching methods that promote experiential learning.

2.1.1.1 *Bloom's Domains of Learning*

In 1956 Benjamin Bloom, an American educational psychologist first proposed three domains of learning: cognitive, affective and psychomotor. The cognitive domain (Bloom's taxonomy) focuses on the idea that objectives that are related to cognition

could be broken down into subdivisions and ranked in order of cognitive difficulty. The subdivisions are knowledge, understanding, application, analyses, synthesis, and evaluation, in increasing levels of cognitive difficulty.

The cognitive domain has to do with mental skills; the affective domain is concerned with feelings whereas the psychomotor domain is consigned to reflex actions, interpretive movements and discreet physical functions. Blooms theories apply to both educational and business settings (Dick, Carey, & Carey, 2015).

2.1.1.2 Gagne's 5 Conditions of Learning

Gagne (1965) was concerned with basic subordinate skills required for the learner to start up an instruction (Dick, Carey, & Carey, 2015). Gagne was an American educational psychologist. His five conditions of learning are fused with Bloom's domains as follows.

- Verbal instruction (cognitive domain)
- Intellectual skills (cognitive domain)
- Cognitive strategies (cognitive domain)
- Attitudes (affective domain)
- Motor Skills (psychomotor domain)

To achieve these five conditions of learning, Gagne believed that learning would take place when students' progress through **nine levels of learning** which are included in every teaching session (Dick, Carey, & Carey, 2015; Khalil & Elkhider, 2016). Gagne's idea was that the nine levels of learning activate the five conditions of learning and thus learning will be achieved. These levels provide a framework that teachers often use to plan lessons and topics (Picciano, 2011). The nine levels of instructions are given below.

1. Gain attention
2. Inform students of the objective
3. Stimulate recall of prior learning
4. Present the content
5. Provide learning guidance
6. Elicit performance (Practice)
7. Provide feedback
8. Assess performance
9. Enhance retention and transfer to the job (Dick, Carey, & Carey, 2015; Khalil & Elkhider, 2016).

The combination of two or more of these theories can be used to plan lessons and instructions. Research has also shown that an integrated learning approach is far more effective than teaching isolated bits of information. Proper instructional design methods augment PowerPoint (multimedia) presentation by subject matter experts conveying disciplinary knowledge to novice students (Khalil & Elkhider, 2016).

These theories, however, were developed at a time where learning was not imparted chiefly through technology, at least not as it is today. Since the emergence of computing technology and multimedia, instructional design has taken a new dimension. Permit me to invoke a famous Chinese saying: I hear and I forget, I see and I remember, I do and I understand.

This action research is undertaken in educational environments seeking to collaborate with students in order to find solutions to everyday problems encountered in the classroom that hamper the progress of learning.

2.2 History of Instructional Design

This aspect examines the various theoretical aspects as related to both multimedia and instructional design. The two phenomena are extremely difficult if not impossible to separate, theoretically, at least. Instructional design (ID) refers to the systematic and professional planning and implementation of education or training (Schott & Norbert, 2012). Alternatively, instructional design is a process by which learning products and experiences are designed, developed and delivered. An instructional analysis is a set of procedures that, when applied to an instructional goal, identifies the relevant steps for performing a goal and the subordinate skills required for a student to achieve the goal.

Not so many years ago, instruction was typically created by professors or trainers who simply developed and delivered lectures based on their research, experience, and expertise. Since the early 1970s, instructional emphasis has shifted dramatically from expert lectures to interactive instruction. This instruction focuses on the main purposes for and anticipated outcomes of learning, the nature of the environment where acquired knowledge and skills would be used, and the particular characteristics of the learners in relation to the discipline and environment (Dick, Carey, & Carey, 2015). Dick et al further indicated that the elegance of a generic systematic instructional design process is its inherent ability to remain current by accommodating emerging technologies, theories, discoveries, or procedures.

It is assumed that the systematic planning of instruction began in the 1920s (Schott & Norbert, 2012). The Tyler‘s (1922) –Objectives for learning” and Pressey‘s (1926) –idea of teaching machines” are considered its pacesetters.

The US Army had been experimenting with systems approach for several years. (Molenda, 2019). The 1940s saw the adoption of ID methods in military training to

address challenges in World War II. Rapid mass training on the use of motion pictures and other audio-visual media came during this era. These skills imbibed in civilian life after the war accelerated the pace of change in education. In the 1950s projection screens were mounted in classrooms (Molenda, 2019).

In order to catch up with the Soviet Union launch of sputnik, the US Congress committed huge budget to education chiefly in science and math. This certainly affected the development of instruction.

In 1962, Glaser coined the term Instructional Design and Gagne's (1965) published the conditions of learning with behavioural and later cognitive orientations (Dick, Carey, & Carey, 2015). Gagne's domains of learning is done because of the implications for the goal analysis and the selection of the appropriate subordinate skills analyses techniques. The goals include verbal information, intellectual skills, psychomotor skills, attitudes, and cognitive strategies (Dick, Carey, & Carey, 2015).

The Dick & Carey model, first introduced in 1978, argues for a systematic approach rather than a set of isolated events (Dick, Carey, & Carey, 2015). ADDIE is acronym for Analyses, Design, Development, Implementation, Evaluation, and it has been used widely in instructional systems design. ADDIE model has been criticised for lacking clarity leading to the adoption of variants like Merrienboer's (1997) 4C/ID model or the Decision Oriented Instructional Design (DO-ID). Both the ADDIE and Dick & Carey models use a behavioural approach in designing instruction (Khalil & Elkhider, 2016).

ISD continues to evolve with emerging telecommunication technologies, advances in understanding how humans learn and other factors. Within education technology, the dominant paradigm is the systems approach to the design of instruction which sub divides the instructional planning process into logical steps.

For much of the 20th century, technology in education centred upon print media. Paper, pens, books and chalk were critical in communicating ideas, accessing information, and learning about the world. In the latter part of the 20th century, electronic media begun to replace print media. Word processing, email, fax, modems, CDROMs, DVDs, multimedia, teleconferencing, video conferencing, and the internet have become common tools for communicating ideas and accessing information.

With a firm knowledge that smart boards, electronic whiteboards were not in use in the municipality they were discounted in the survey. Even in the United States, a vast majority of primary and secondary schools continue to rely on intensive manual efforts to conduct the education of our children (Picciano, 2011).

Little literature is reviewed about videoconferencing and e-learning, in being not preferred by the author for that level. The author particularly compares chalkboard/marker board with the slide projector with its presentation application. Even before the students themselves could call for its abolishing the chalkboard has faded from the system.

Whilst there have been some modest gains, this is not enough. As Molnar, an American computer science professor puts it –The world of education has changed from an orderly world of disciplines…..to an infosphere in which communication technologies are increasingly important. While education is changing, it is not changing fast enough."

2.1.1 Components of the System Approach Model

With the system model, every component of the learning event is vital: instructors, learners, materials, instructional activities, delivery system, learning environments

all interact with one another. A change in one component affects other components (Creswell & Creswell, 2018). These components are thus presented.

1. Identify instructional goals
2. Conduct instructional analyses
3. Analyse learners and contexts
4. Write Performance objectives
5. Develop assessment instruments
6. Develop instructional strategy
7. Develop and select instructional materials
8. Design and conduct formative evaluation of instruction
9. Revise instruction
10. Design and conduct summative evaluation

There are a couple of system models of which Dick & Carey is one of the famous. All these methodologies lacked the technological component as computers and multimedia emerged, at least proliferate, much later.

2.2 Multimedia Tools for Teaching and Learning

A good general definition of multimedia is that, multimedia is the field concerned with the computer-controlled integration of text, graphics, drawings, still and moving images(video), animation, audio, and any other media where every type of information can be represented, stored, transmitted and processed digitally. These levels of digital media are well understood. Animations are still images to which motion has been added. Multimedia may be linear (presentation) or non-linear (interactive).

Multimedia tools and applications include computers, television, CDROMs, the internet, virtual reality, etc. These are typically the elements or the building blocks of a generalised multimedia environment, platform, or integrating tools (sahat.net, n.d).

The power of images and sounds expand every year. Data communication uses both LAN and WAN networks to deliver instructions via e-learning or distance learning. Distance education and blended learning attempts to separate the distance between teaching and learning and it is mainly aided by these data communication technologies. It is a well-known fact that television played a crucial role in delivering lessons during the lockdown period of the Covid 19 era. So do phones and other computers utilizing zoom platform and other Learning Management Systems/Virtual Classes for university lectures.

For teaching applications PowerPoint (Microsoft), Hyper Studio (Knowledge Adventure), Harvard Graphics (Software Publishing), can be used for simple multimedia presentations. Others are Corel Presentations, Lotus Freelance Graphics, Impress, etc.

Multimedia authoring tools which provide interactive platforms are another dimension. Teachers who wish to develop their own custom multimedia programs for use by students in a discovery learning and other pedagogical mode may use their authoring tools. We have Authorware Professional (Macromedia) and ToolBook (Asymetrix) that are ideal for these applications. They provide interactive platforms where students select options and direct the flow of programs.

Existing instructional applications are fast losing their value. The advent of the internet and the world wide web in the mid-1990s spawned another new wave of instructional technology applications. Other software such as TUTOR, MicroTUTOR, Coursewriter,

and PILOT were designed strictly for instruction. Integrated Learning Systems (ILS) can test students, keep records of their performance and adjust the lesson material depending on their progress. It generates individual student and group progress reports. These can be used by teachers and administrators for instructional planning.

Computer simulation and instructional gaming have found their way into the classroom. Simulation attempts to reproduce on a computer certain real life situations that may be impossible or costly to duplicate in classrooms, such as networking (Cisco packet tracer), electrical installation, flight simulation, etc. Games use graphics and sound to heighten student motivation and interest in motor race, virtual cop, mortal combat, zumah, etc. Instructional games are excellent supplement to some variety of a student‘s day.

Increasingly intelligent white boards are slowly creeping into the system. SMART Technologies is one of the leading manufacturers of whiteboards. Whiteboards such as smart boards can be used for a variety of instructional activities such as displaying a software program that is loaded onto a connected microcomputer, capture notes and illustrations as well as for video conferencing.

It is a notable fact that people learn better from the combination of words and pictures, than words alone. This multimedia principle forms the basis of the theoretical rational of multimedia learning (Mahayan, Gupta, Gupta, Kukreja, & Singh, 2020). Learning through multimedia is learning from words and pictures (Mayer, 2001). Words can be spoken or written and pictures can be static or dynamic. The five multimedia elements: text, images, sound, animation, and video combine appropriately to give effect. Video can serve as text replacement through narration scenario, simulation, and demonstration.

Jingles and songs have been used in kindergartens to enable children learn for a long time. In recent times motion graphics in the form of cartoons have found place among children. Children easily develop understanding of the storylines of more complex scenarios (Kumar & Jamil, 2016).

Advantages of Multimedia

- It is very user-friendly
- It is multi-sensorial
- It is integrated and interactive
- It is flexible
- It can be used for a wide variety of audiences

Disadvantages of Multimedia

- May lead to information overload
- It takes time to compile
- It can be expensive to set up
- Too much makes it unpractical (Pavithra, Aathilingam, & Prakash, 2018).

Multimedia system

Multimedia system is a system capable of processing multimedia data and applications.

Multimedia applications

Multimedia application is an application which uses a collection of multimedia sources. These elements include text, graphics, images, sound/audio, animation and /or video. Examples of multimedia applications are as follows:

- World Wide Web

- Hypermedia courseware
- Video conferencing
- Video-on-demand
- Interactive TV
- Groupware
- Home shopping
- Games
- Virtual Reality
- Digital Video editing and production systems
- Multimedia database systems

2.3.1 History of Multimedia

Newspapers were perhaps the first mass communication medium to employ multimedia (Marshall, 2001). Skills in using technological media in teaching have being in existence in the US since 1900s. The first official credit course in Visual Instruction was taught at the University of Minnesota in 1918 by Albert M. Field (Betrus & Molenda, n.d).

The voyage of Mimi, as elicited in Wikipedia, is a package of instructional materials combining various educational media effectively is considered the world‘s first multimedia. It consists of a TV drama series as the main media, a TV documentary, a text book, wall maps, computer software, etc.

In 1937 Starnes conducted survey on his visual instruction movement to determine the prevailing status of visual instruction courses in the US. The next decade saw the rapid growth of media in education.

Vannevar Bush wrote about Memex, an imaginary electromechanical device that serve as backup memory and processor, in 1945 (McCown, n.d). The audio-visual devices used during the World War II were generally effective and efficient in training large numbers of individuals from diverse backgrounds. So, after the war there was renewed interests in using audio-visual devices in schools (Reiser, 2001).

In earlier educational practice, multimedia distance learning was in delivery of remote lessons via multiple media such as television, radio and newspapers. Televisions became highly significant in delivering instruction in the 1950s. This phenomenon faded to usher in the computer. Today, computer technology is the main medium of multimedia distance education (Kisicek & Lauc, 2015). Computer assisted Instruction was done in the 1950s by researchers at IBM. The use of CDROMs and the internet followed much later.

In 1959, Patrick Suppes of Stanford University conducted experiments with CAI and eventually developed software especially designed for teaching basic skills such as reading, writing and arithmetic. In the late 1950s and 1960s, John Kemeny and Thomas Kurtz developed the Beginners All-Purpose Symbolic Instruction Code(BASIC), a programming language meant for everyone. Then Seymour Papert of MIT followed suite to develop the Logo language (Picciano, 2011).

Other educators in the late 1980 and early 1990s saw values in providing instructional computer experiences for reasons other than improving students performance. Benefits such as ensuring computer literacy (which is applied to a wider world), providing variety in instructional delivery, or releasing teacher time from record-keeping tasks were considered important enough to continue investing in technology.

The proliferation of computers in society during the 1980s and 1990s accelerated the transition from industrial age to information age (Betrus & Molenda, n.d). In 1989, Tim Berners-Lee proposed the World Wide Web which initiated the concept of hypermedia much like a spider web. Multimedia means that computer information can be represented through audio, video , and animation in addition to traditional media(i.e. Text, graphic, drawings, images). Hypermedia extends multimedia to the web.

In 1988, the US Congress Office of Technology Assessment (OTA) conducted a nation-wide survey on the use of computer technology for instruction in primary and secondary schools. In this study almost every school in the country had acquired some form of computer technology, the cost notwithstanding.

However, Larry Cuban (2000, 2001), a professor of education at Stanford University observed users seldom integrate machines with core curricular or instructional tasks. The others are occasional users and non-users (Picciano, 2011).

2.4 Dual Coding Theory:

Dual coding theory explains human behaviour and experience in terms of dynamic associative processes that operate on a rich network of modality-specific verbal and non-verbal representations, says Pavio (Soylu & Yelkin, 2013). This theory assumes cognition occurs in two independent but connected codes: a verbal code for language and a non-verbal code for mental imagery.

Dual coding theory was first introduced by Paivio in 1986 in the book –Mental Representations: Dual coding theory has its roots in practical use of imagery as a memory aid 2500 years ago (Paivio, 2006). Paivio‘s theory is based on the notion that redundant information improves content comprehension (Moreno, 2017).

The theories that emphasize the dominance of language arose from religious and educational opposition to imagery during the renaissance. Modern empirical evidence led to the revival of imagery and the beginning of an educationally relevant DCT.

In regard to concreteness, memory performance generally increases uniformly from abstract words (truth, justice) to concrete word s(e.g, chair, lobster) to objects(or their pictures). The nonverbal code is mnemonically stronger (contributes more to the additive effect) than the verbal code. Paivio predicted that multiple channel information processing is found to be a strong facilitator towards better performance in content comprehension (Moreno, 2017).

Mayer and Moreno (2017) contributed to the dual coding theory with evidence of the learning improvements and advantages of a dual information delivery system based on different sensorial working memories. The duo demonstrated in an experiment that with only visual stimulation (text and images), the visual working memory was likely to become overloaded while in the auditory group (audio and images) the fact that the information was delivered via two different channels must have helped the students to better comprehend the information (Moreno, 2017).

The two important categorisations in Paivio‘s dual coding theory are Logogens, as language generators; imagens as image generators; both being useful in cognition. Logogens are particularly for the visual and auditory aspects of verbal systems actuated by external stimuli or internally by other, previously activated mental representations. Imagens are connected with the non-verbal systems that are activated by external stimuli or internally, by other, previously activated mental representations. Mayer contends that learning is accompanied by establishing connections between compatible verbal and pictorial representations (Mutlu-Bayraktar, Cosgun, & Altan, 2019). One

hypothesis is that non-verbal and verbal codes, can have additive effects on recall (Soylu & Yelkin, 2013).

This theory would certainly be incorporated into the PowerPoint slide design which tries to explain the general concept and suitability of multimedia in teaching and learning ICT as opposed to the Blackboard Computing (BBC) or marker board ICT (MBI), largely necessitated due to the lack of resources or government policy.

A diagrammatic impression is presented in figure 1.

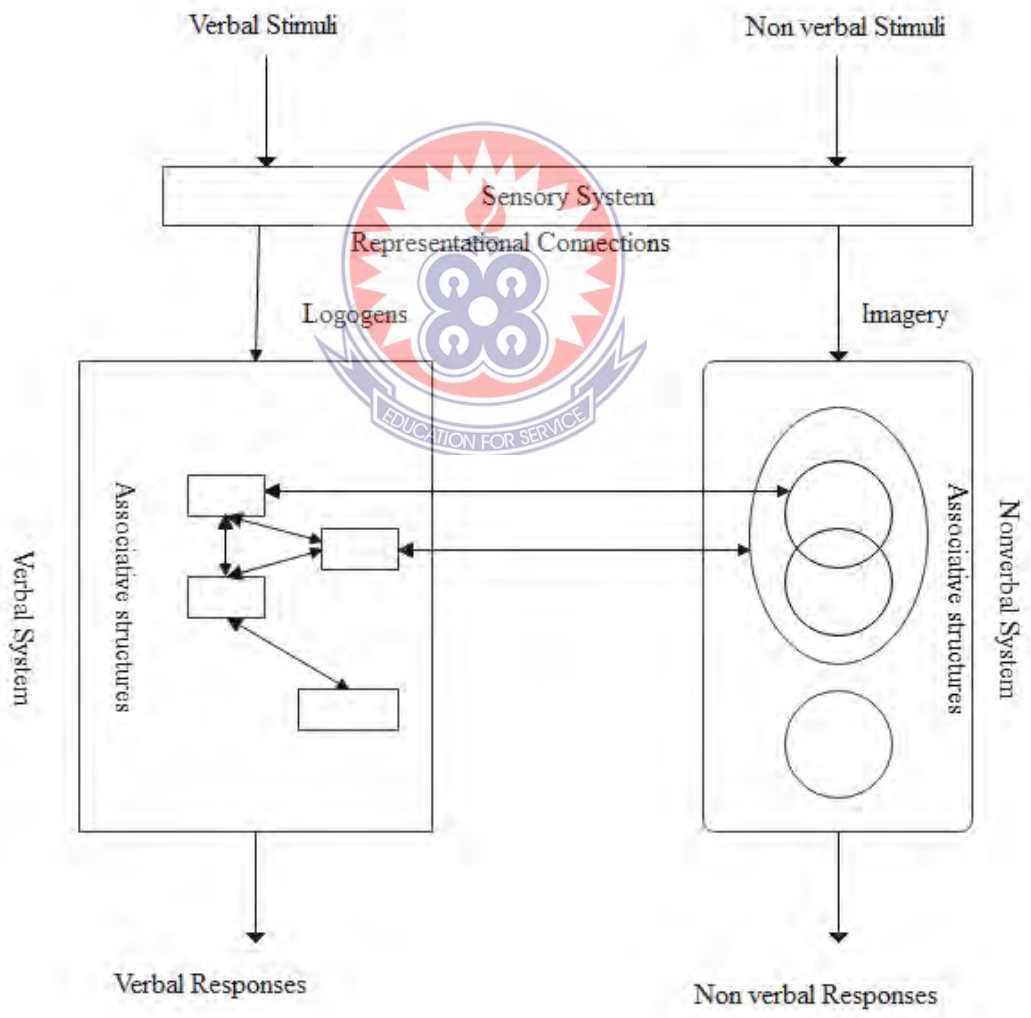

Figure 1: Subsystem representation for dual coding theory

Dual coding theory proposes that the verbal system is located in the right hemisphere. In opposition to the dual coding theory, the context availability method argues that the faster recognition of concrete versus abstract nouns results from a larger contextual support of concrete words and not from a distant non-verbal system (Schwanenflugel & Shoben, 1983) as cited in Soylu et al (2013). To paraphrase Soylu et al (2013), using blackboard or marker board computing alone to learn ICT is a common educational technique that may not be potent enough to provide the requisite understanding of more complex phenomena.

2.5 Cognitive Load Theory

Cognitive load theory assumes that for effective learning, the learner's cognitive architecture should be aligned with instructional conditions. One scholar, Dylan William, remarked that Sweller's cognitive load theory is the single most important thing for teachers to know (Kirschner, Park, Malone, & Jarodzka, n.d; Shibli, n.d).

The learner's cognitive architecture consists of sensory memory, working memory and long term memory. The theory assumes that learning takes place through very limited working memory and unlimited long term memory. The working memory is composed of two processors for auditory and visual information, respectively, with central and executive controls (Khalil & Elkhider, 2016; Mutlu-Bayraktar, Cosgun, & Altan, 2019).

Sweller stipulated that mental activity realised simultaneously with working memory is called "cognitive load" (Mutlu-Bayraktar, Cosgun, & Altan, 2019). The working memory processes three types of cognitive load: intrinsic, extraneous, and germane loads.

The intrinsic cognitive load (ICL) results from a number of interactive elements that the learner processes simultaneously in working memory. It is generated from the inherent

difficulty of the material itself, which can be influenced by prior knowledge of the topic. The extraneous cognitive (ECL) load is produced by suboptimal faulty presentation of instructional materials. Germane cognitive load (GCL) results from the learner interactions with the appropriate instructional design that contributes to learning. These elements that aid information processing, and contribute to the development of schemas (Shibli, nd; Khalil & Elkhider, 2016). Figure 2 gives a graphical/ diagrammatic impression.

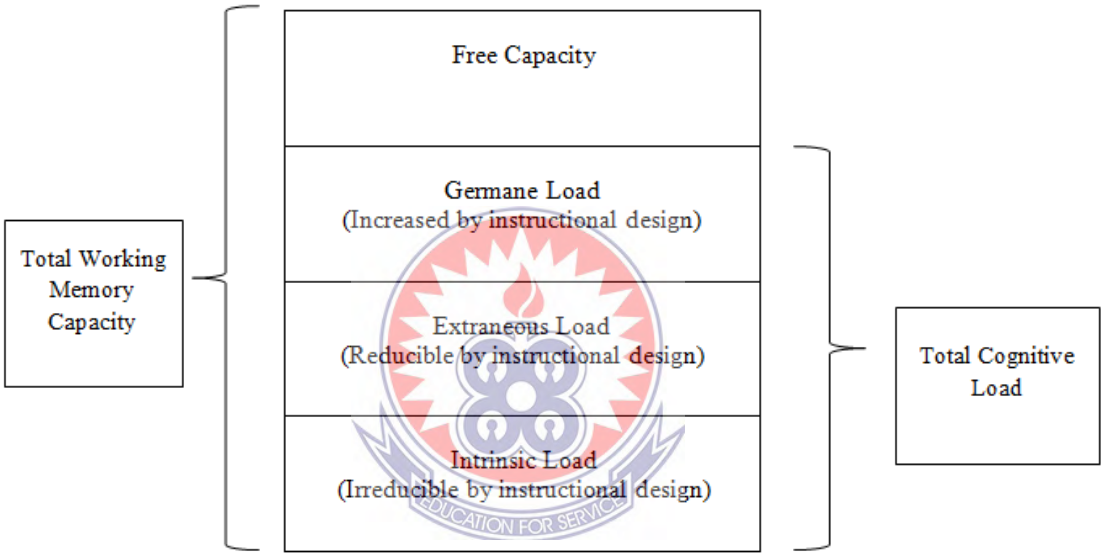

Figure 2: Types and nature of cognitive load. Adapted from Kirschner et al

In the nutshell, extraneous sources of load hinder learning. The intrinsic reflects the complexity of a given task in relation to the learners‘ level of expertise and germane sources of load promote learning by helping students engage in the process of schema formation and alteration (Kirschner, Park, Malone, & Jarodzka, n.d).

The general principle of cognitive load theory, therefore, is to reduce extraneous cognitive load, manage intrinsic cognitive load, and promote germane load. As Sweller et al (2011) puts it, the aim of instructional design should be to reduce unnecessary

working memory loads, and free the capacity for learning-related processing to accommodate the limited capacity of working memory. In other words, the aim should be to move knowledge to long-term memory because when a student is exposed to new material, they can draw on this previous knowledge and the cognitive load is reduced.

However, if the subject knowledge is incomplete, the student is unable to fall back on long-term memory resulting in the working memory being overloaded, leading to working memory failures. Breaking tasks into smaller subtasks can help reduce cognitive load. Constructivism can help reduce extraneous cognitive load. It is therefore not a good design practice to overload slides with text (Shibli, n.d).

Cognitive load may be measured by objectivity and causal relationship. Objectivity refers to using the reader's own self-reported tools or objective observations, physiological conditions and performance. The causal relationship is related to whether there is a direct or indirect link between cognitive load and observed phenomenon. Individuals can evaluate their own cognitive processes (Mutlu-Bayraktar, Cosgun, & Altan, 2019).

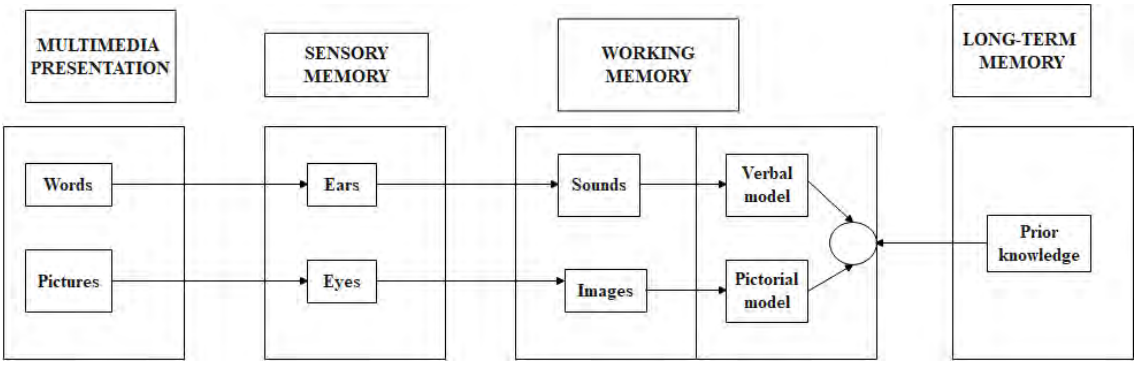

Figure 3: Illustration of Cognitive Load Theory. Adapted from Kirschner et al.

In sum, the working structure of human cognition must be taken into consideration when designing multimedia instructions to allow the learning to progress according to each learner‘s own cognitive process.

2.6 Cognitive Theory of Multimedia

Mayer developed a cognitive theory of multimedia learning based on Paivio‘s coding theory, and Sweller‘s theory of cognitive load. **Multimedia theory** or learning from words (verbal) and pictures (pictorial) is based on the well-grounded cognitive theory of multimedia. The theory comprises three principles: dual channel principle, limited capacity principle, and active processing principle.

The dual channel principle indicates there are two separate channels for processing verbal and pictorial information in working memory. The limited capacity principle deals with the limitation of working memory to simultaneously process several pieces of information. The active processing principle indicates that, for a meaningful learning to occur, different cognitive processes are necessary such as focussing the attention on the relevant learning context, mentally organising information in a coherent manner (Kirschner, Park, Malone, & Jarodzka, n.d). To reduce extraneous cognitive load requires coherence, signalling, redundancy, spatial contiguity, and temporal contiguity principle. Kirschner et al (n.d) further assert that in education and training using both paper-based and computer-based learning materials we see both convergence of opinions on and adoption of instructional design principles and practices for their use.

There are five cognitive processes in learning through multimedia.

1. Selection of relevant words from displayed text or narration.
2. Selection of relevant images from illustrations
3. Organisation of selected words in a coherent verbal presentation

4. Organisation of selected images into a coherent visual representation
5. Integration of the visual and the verbal and the existing knowledge (Kisicek & Lauc, 2015).

This idea of learning from variety of media elements is partly corroborated by Dr. Neil Fleming VARK style (Kumar & Jamil, 2016) . VARK is acronym for Visual, Aural, Read/Write and Kinaesthetic (Zhang, 2002).

Visual: You learn well when aided by images, pictures and special organisation of elements

Auditory: You learn well when aided by music, sound, rhyme, rhythm, speaking or listening

Reading/Writing: you learn well by reading or writing the material you want to learn

Kinaesthetic: You learn well when you can move your body, and /or used your hands and sense of touch. Writing and drawing diagrams are physical activities that can fall into this category as well.

Liard's sensory theory details it as follows: 75% of an adults knowledge was obtained by seeing, 13% was through hearing, the remaining 12% through touch, smell and taste combined (Kumar & Jamil, 2016; Fulbrook, 2019). Fleming emphasised that each individual has at least one learning style which is predominant. For instance some students are more visual than others. A graphical impression is presented below.

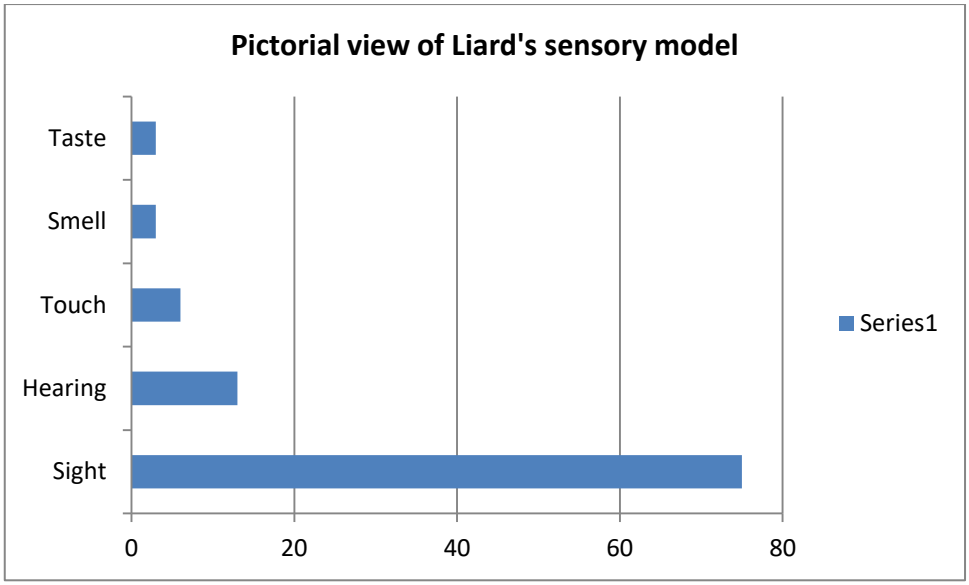

Figure 4: Pictorial View of Liard's Sensory Model. Adapted from Stevens-Fulbrook, 2019.

Now that multimedia learning materials have become commonplace and educators, trainers, instructional designers and educational policy makers have embraced the ability of such materials to personalise teaching, training, and learning, leading to more effective, efficient and possibly more enjoyable teaching and learning experiences, a concomitant increase in attempts is observable with respect to designing, developing, and implementing multimedia assessment (Kirschner, Park, Malone, & Jarodzka, n.d).

In line with these theories the PowerPoint presentation intends to reduce extraneous cognitive load. It also adopts the dual coding method as the research considers both verbal and non-verbal means in the presentation. PowerPoint is certainly electronic multimedia and a well-designed lesson takes into consideration, this theory too. The slide design and presentation skills would avoid simultaneous oral and text presentation.

2.7 Intercourse and significance

Multimedia has influenced education since the emergence of ENIAC, the world's first computer in 1946. In the US, spending on instructional technology in higher education has tripled in the last ten years (Zhang, 2002).

Multimedia classroom is a new form of classroom with increased integration of instructional technology and the application of cutting-edge technology to enhance learning. Zhang(2002) further assert learners have different learning styles in classrooms.

One could reduce cognitive load in a PPT presentation by minimising the amount of text on a slide (Khalil & Elkhider, 2016). This invariably calls in for alternatives such as pictures, diagrams and even videos. The old cliché goes, a picture is worth a thousand words!

These three famous theories: dual coding, cognitive load and cognitive theory of multimedia are interconnected and when incorporated the right way will deliver a good instruction. It can also be seen that these learning theories and multimedia theories are quite inseparable from each other.

It is significant to note that Gardner's multiple intelligences play a crucial role in instructional multimedia. Multimedia also relates to theories of brain functioning and learning theory, especially those that relate learning to sensory stimulation and multiple intelligence(Armstrong, 2000) as cited in (Picciano, 2011).

2.8 Empirical Review

Empirical review searches studies that have been undertaken in a similar area of study with a view to establish gaps, convergence, disagreement, that help to clearly identify, define and justify the research study in questions.

Multimedia is multi-sensory that stimulate multiple senses of the audience at a time (Kareem, 2018). Its interactive nature enables teachers to control the content and flow of information (Shah & Khan, 2015; Khan & Bhashani, 2020). Thomas & Israel (2014), as cited in (Khan & Bhashani, 2020), investigated in a study that performance of the students exposed to multimedia aided lectures was significantly different from the students taught conventionally.

Meanwhile, Khan& Islam (2019) observed that the ~~l~~ack of awareness and training of school teachers demotivate them to use multimedia technology as a teaching tool." Shah and Khan (2015) assessed the impact of multimedia aided teaching (MAT) on academic success of students. The result indicated MAT as more effective than the traditional one. He also examined student achievement and attitude towards multimedia at the elementary level in Pakistan. Shah & Khan (2015) reported that due to a decline of students attitude towards science, the European Commission recommended new forms of pedagogies and approaches to teaching and learning the science. Such attitude towards science invariably relate to ICT, especially when delivered via conventional methods. Attitude here connotes a learned disposition to respond positively or negatively towards a situation, an event or people (Shah & Khan, 2015).

The factors responsible for decline in attitude of students in learning sciences include quantity of instruction, students' motivation, quality of instruction, classroom environment, and medium of instruction.

In the United States, Zhang (2012) also investigated students‘ perception of multimedia classrooms at East Tennessee State University. His questionnaire has been particularly adopted in this research to test the African case on student interest. However, series of studies in the United States indicate that test scores in treatment classrooms that were randomly assigned to use software products did not differ from test scores that used traditional instructional methods. This survey was carried out using a quasi-experimental studies as this one (Picciano, 2011).

Kumar and Jamil (2016) studied its use in motion graphics for simulating lectures in higher education in Saudi. The duo concluded a higher retention for students who watched info graphic videos in class than lecture based sessions. Kabooka and Elyas (2018) studied the role of YouTube in multimedia instruction for vocabulary learning in Jeddah (Saudi Arabia). The choice of appropriate content was found to be beneficial. Goundar (2011) studied the impact of using mobile devices in education in China. Through extensive document analyses of related research, his work proffered a ground breaking teaching and learning technologies with added mobility advantage.

A Kenya-based project study of using technology in teaching in Sub Saharan Africa, showed positive gains for both boys and girls (Abrami, et al., 2020). Chigona (2013) studied the use of multimedia in digital storytelling among pre-service teachers in South Africa. She noted that there is considerable hope that technology can improve learning outcomes with reference to the design and content of instructional materials (Chigona, 2013). Kareem (2018) examined the impact of multimedia in learning outcomes in Biology in Nigeria. This registered significant impact in favour of multimedia approach. Onah et al (2020) found out that CAI had a significant impact on students‘ achievement in mathematics and physics in Enugu State.

Malcalm (2012) explored the role of policy makers in ICT development in Ghana. Pelgram asserted that teachers know how has been listed as a crucial factor that affect diffusion of ICT in schools (Malcalm, 2012). Moreover, Nyamful (2016) explored the place of ICT in music in ~~–u~~nderstanding of historical, cultural and philosophical movements, as well as listening and analytical skills." These skills undoubtedly affect retention capabilities hence academic performance.

Banji et al (2020) explored the place of ICT tools in basic schools in South Tongu district without any particular focus on secondary education or multimedia as projector use was zero among respondents. Not all, Deku et al (2017) studied its applications in English language, whereas Ayittey (2015) conducted multimedia instructions in Biology, both in the Central Region. Deku presented mixed aggregations while Ayittey spoke favourably on multimedia.

Asare and Agyemang(2020) investigated the problems hindering mouse skills development of basic school learners in a suburb of Mampong Municipal. They recommended ICT training to include non-ICT teachers. Nyarko et al (2021) studied the use of multimedia as a pedagogical tool in teaching mathematics at the colleges of education in Mampong, the study area. The authors are of the view that multimedia tools motivate learners' interest and create a better interaction and classroom atmosphere.

The bottom line is though studies have shown steady improvement of multimedia tools over traditional methods, the indication of some is that it holds no statistical significance. However, when it comes to attitude or interest aspect, much significance is shown (Shah & Khan, 2015). This research tests the situation in Mampong municipal to either confirm or disconfirm existing opinions in its own context.

2.9 Conceptual Framework

One can develop conceptual framework by himself using existing theories whether in whole or in part. Operationalization of variables in the survey helps explain the conceptual framework. Basically, the independent variable is influenced by the dependent variable. In this particular case, students' academic performance and interest are thought to be influenced by the mode of delivery, namely using multimedia tools or with traditional system of instructional delivery. The research work seeks to prove the level of statistical significance. A diagrammatic outlook on causal relationship of the dependent and independent variables is presented in figure 5.

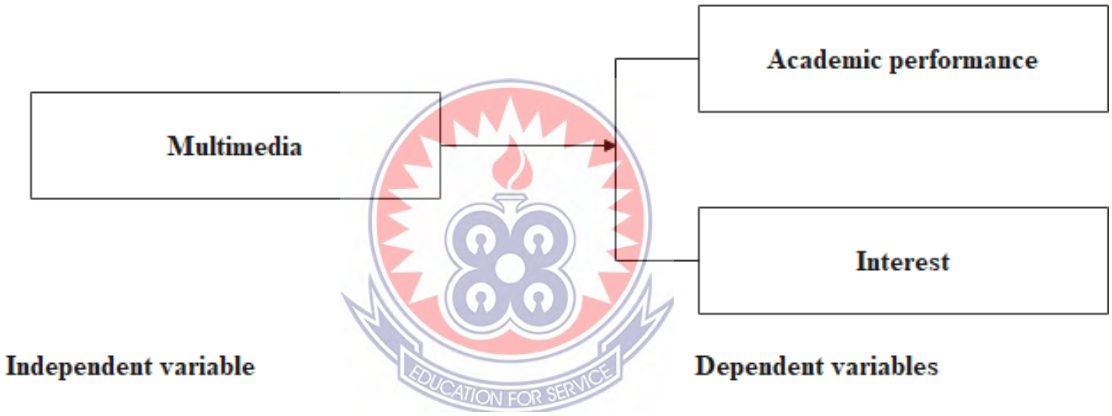

Figure 5: Simplified diagram of operationalization of the variables. Modified adaptation from Khan et al (2020).

A more refined form of it is presented in figure 6.

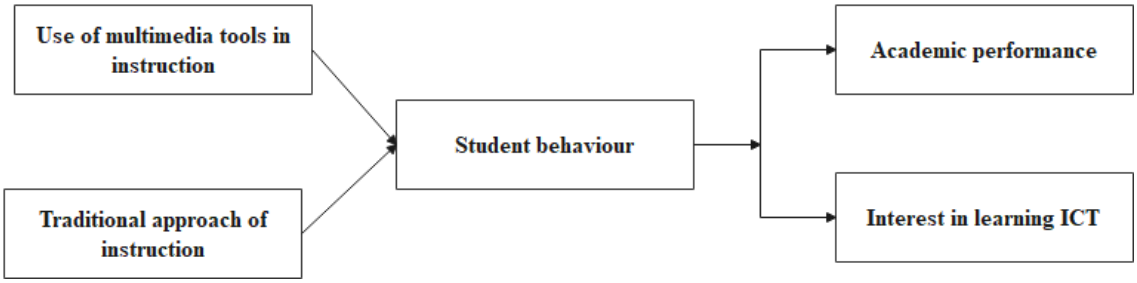

Figure 6: Refined Illustration of operationalisation of the variables

The conceptual figure discounted (held constant) mediating factors such as teacher behaviour as the time was considered too short to have studied thoroughly those qualities of the research instructor, and also due to the problem of self-reported data. Respondents were rather told to comment of their routine instructors (and not the project instructor). So, these are not supposed to affect any approach in any way regarding performance or interest but would prove useful in decision making. (It is however not claimed that the researcher behaviour in both types of classroom are exactly the same).

The conceptual framework of the study is displayed in figure 7:

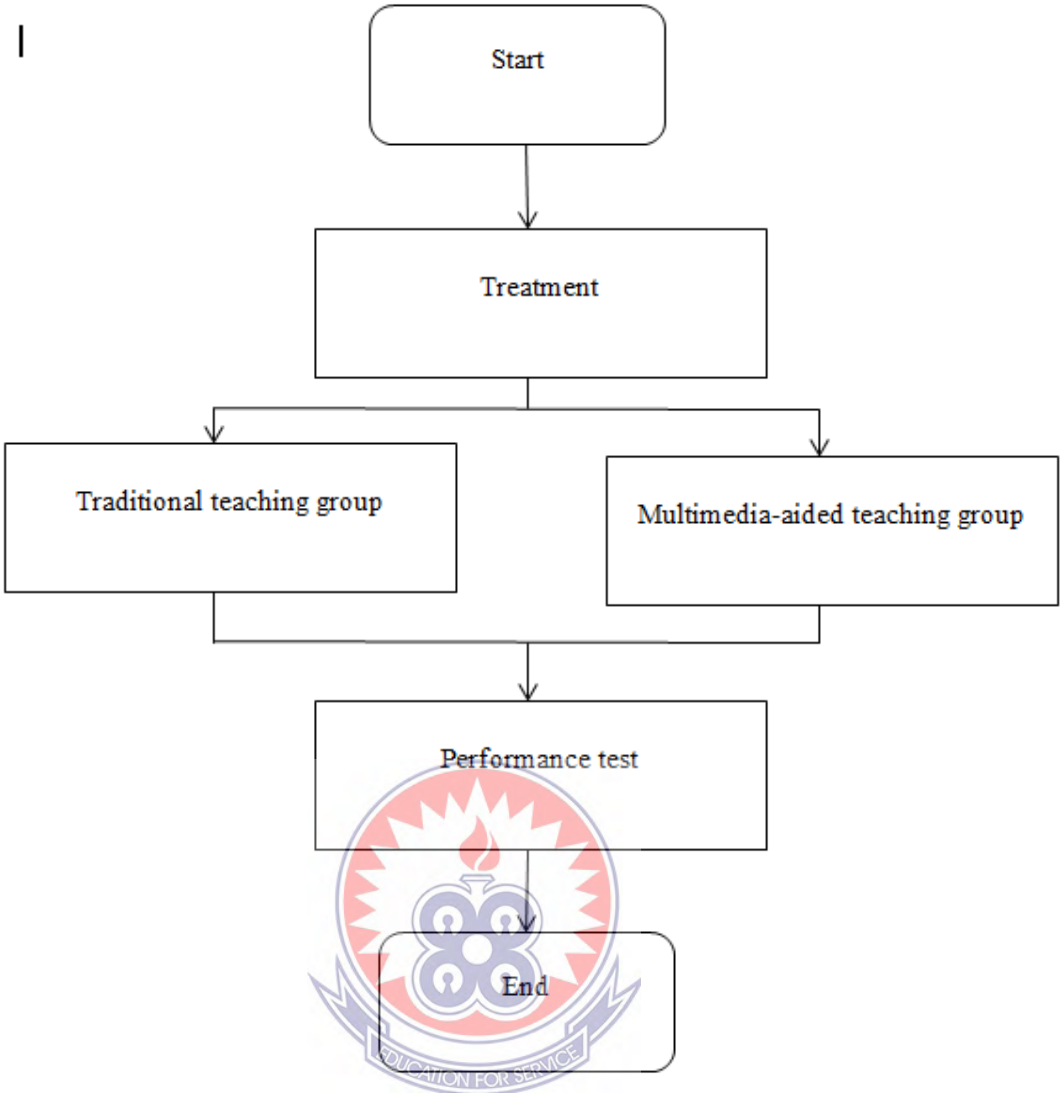

Figure 7: Conceptual Framework of the Study. Adapted from Ayittey (2015).

The first treatment is on academic performance. The second treatment measures student interest by interchanging treatment of both groups to enable them feel both approaches and respond appropriately. This has been adopted from Ayittey (Ayittey, 2015) and Shah & Khan's idea (Shah & Khan, 2015). But for convenience, the researcher further identified four phases in all which are not necessarily discrete units.

2.10 Policy aspect

The US Department of Education as cited in Malcalm (2012) says –the challenges for modern education systems call for the learning of new technologies to create engaging and learning materials for both educators and learners."

The UN Sustainable Development Goal (SDG) 4 seeks to –ensure inclusive and equitable quality education and promote live-long learning opportunities for all" (UN, n.d). These SDGs are well aligned with Africa Agenda 2063 and Ghana Agenda 2030 (Ghana, 2019). The transformational power of ICT can be used to make our pattern of production and consumption more sustainable. But strong policies are required to unleash its potentials (Ruchi, Suresh, Zubkov, & Shariq, 2020)

Earlier in 2003, Ghana formulated its first ICT in education policy. This has since received successive reviews (Banji, Okyere, & Dogbe, 2020). Banji et al (2020) further adds, the government as part of the –one laptop per child project" distributed laptops to pupils and students through the RLG Communications.

Since the inception of the 21st century, ICT has remained the major contemporary tool shaping the global economy and producing rapid changes in society (Banji, Okyere, & Dogbe, 2020). The Government of Ghana has placed a strong emphasis on the role of ICT in contributing to the socio-economic growth. The country's medium-term development plan captured in the Ghana Poverty Reduction Strategy Paper(GPRS I& II) and the Education Strategic Plan 2003-2015 all suggest the use of ICT as a means of reaching out to the poor in Ghana (Mangesi, 2007).

In 2004, Parliament passed into law Ghana's ICT for Accelerated Development (ICT4AD) policy which seeks among other things to promote ICT in education and deploy same in the community. Previous policies which never saw the light of day had

aimed to integrate ICT tools in all levels of education (Mangesi, 2007) and determine the type of ICT needed by schools for teaching and administration purposes. Some analysts contend that government should make it a policy to deploy the much needed ICT tools to rural community schools.

The digital economy drive of the Akufo-Addo government led by his Vice, Dr. Mahamudu Bawumia has seen Information Technology permeating into all facets of the economy including mobile money interoperability, biometric registrations, street and property addressing, etc. More so, the era of Covid has made the educational system more ICT-aware through the use of learning management systems and communication software.

Later the teacher unions went into an agreement with government where laptops are to be supplied to teachers on cost-sharing basis between teachers on one hand (bearing 30%) and government (70%) on the other. This was to improve the ICT drive by the government in the new (2019) curriculum. Nationwide distribution has been almost complete at the time of writing these lines.

Since the implementation of ICT in the pre-tertiary curriculum in 2007, the teaching of the subject is not without challenges. It is on this backdrop that this research is carried out. It seeks to influence the bottlenecks in the subject ICT itself to give room for its integration with other disciplines at the pre-tertiary level. As Zhang (2002) affirms Instructors have been struggling with these new technologies and their integration. These new concepts enable content development and provide innovative ways of communicating information (Almara'beh, Amer, & Sulieman, 2015).

CHAPTER THREE

METHODOLOGY

3.0 Introduction

This chapter deals with the methods, techniques and procedures used in conducting this research.

3.1 Research Design

The research uses a mixed methods study. The quantitative aspect is that of experimental design approach which allows a given variable(s) (in this case, academic performance and interest) to be manipulated along the lines of teaching methods (traditional approach versus multimedia tools). The research chiefly adopts a quantitative approach (really quasi-experimental design) to access students' performance and interest in multimedia. For the qualitative aspect, space was given at the end of the end of the research instrument for students to give their own input on issues that might not have been adequately captured. Accompanying classroom observation was also qualitative.

As stipulated by Creswell & Creswell (2018), the researcher not only selects a qualitative, quantitative, or mixed methods study to conduct; the inquirer also decides on a type of study within these three choices (Creswell & Creswell, 2018). The appropriateness of a research technique depends on numerous issues including but not limited to the research problem and the complexity of the knowledge necessary for the phenomena in question (Haniff, 2017).

This research approach, although mixed method, largely uses quantitative approach with experimental design to measure the aggregate output of the effects of all various

theories of multimedia and instructional design, taking multimedia as the focus. Experimental research seeks to determine if a specific treatment influences an outcome. The researcher assesses this by providing a specific treatment to one group and withholding it from another and then determining how both groups scored on an outcome (Creswell & Creswell, 2018). Creswell & Creswell (2018) further contends the best choice to test causal claims is true experiments. However, constraints and a peculiar need may lead one to draw purposive and convenient samples, with a sample size large enough to represent the population.

I employed two different phases of pre-test and post-test on chosen topic for the study. Pretesting was done to obtain baseline information before administering the various treatments. This seeks to confirm similarity of academic strength. Post-test was conducted to measure the impact of the various treatments. The topic appropriately chosen is The Internet: Concepts, Requirements and Terminologies**,** for being new to the participants while rich in multimedia content. This is taken out of the ICT (Core) Syllabus for SHS. Neither groups (experimental and control) have been taught this topic at the SHS. The pretesting assumed some basic previous knowledge from the JHS level. The tests examined the performance of the variables whilst the questionnaire, together with the author‘s own empirical observation, took care of the interest. The researcher could not take qualitative feedback from the ICT instructors to see their side of the story. The students are equally granted an opportunity to comment in short text any observation relevant to the study that has not been captured by the questionnaire. These shall be coded thematically and reported appropriately.

3.2 Target Population

The target population is all second year (Core ICT) students present at Amaniampong SHS and St. Joseph SHS at the time of the research (2020/2021 academic year). With

the tracking system, this translates into both Green(425) and Gold(352) second years for Great AMASS and that of St. Joseph (428 for Green, 467 for Gold). This sums up to one thousand seven hundred and sixty two (1762) comprising twenty classes each for both St. Joseph (895) and Amaniampong (777). Table 1 and 2 below shows the population of the two schools.

Table 1: Population of Experimental group (Gt. Amass)

FORM	MALE	FEMALE	TOTAL
F1(GREEN)	273	282	**555**
F1(GOLD)	263	255	**518**
F2(GREEN)	263	162	**425**
F2(GOLD)	187	165	**352**
F3(GREEN)	388	238	**626**
F3(GOLD)	289	307	**596**
TOTAL	**1663**	**1409**	**3072**

Source: Field Survey

Table 2: Population of Control group (St. Joseph)

FORM	MALE	FEMALE	TOTAL
F1(GREEN)	205	107	312
F1(GOLD)	268	149	417
F2(GREEN)	249	107	356
F2(GOLD)	258	209	467
F3	469	520	989
TOTAL	1449	1092	2541

Source: Field Survey

3.3 Sample and Sampling Technique

The sample was drawn from a target population comprising second year students (who offer ICT Core) at both schools: Amaniampong SHS and St. Joseph. This cross-sectional survey considers both green and gold track students at the time when all tracks were available from September, 2021. Each class of second year students is capable of being drawn for the sample. However individual members are not drawn to the sample. This ensures minimal or no interference with the academic schedules of the schools concerned. A simple random sample, using pieces of paper, was used to select science and art classes for the experimental group. For the control group a purposive sample of similar classes was used so as to create a good match in terms of strength.

The sample size for performing the test exercises was 210. Moreover, 217 was used for the interest survey. (This would be explained shortly).[1]

Table 3: Simplified Sample figures according to gender

Sch	Male	Female	Total
Amass	49	42	**91**
Joss	65	54	**119**
Total	**114**	**96**	**210**

Source: Field Survey

Generally, as a sample gets larger, the margin of error reduces and the level of confidence goes up. However, it is tedious and costly dealing with entire populations. According to Creswell & Creswell (2018), a sample size of at least 10% of the population is representative of the target population.

[1] The performance test requires that a student takes part in both pre-test and post- test for comparison. However a student who underwent both treatments of multimedia and traditional approach can respond to the survey questions.

For Great Amass, 10% of 352 yielded 35 whereas for St. Joseph, 10% of 428 yielded 43 for the Gold session. In order to be representative enough both tracks were covered giving a wider scope. For Amass 10% of Green track second years (425) yielded 43; St. Joseph also yielded 43. These calculated figures formed the minimum threshold required to obtain representative samples. Table 4 shows the actual figures, in further detail, engaged in the exercise.

Table 4: Detailed sampling figures according to gender

Sch	Track	Male	Female	Total
Amass	Gold	22	21	**43**
	Green	27	21	**48**
	Both	49	42	**91**
Joss	Gold	23	33	**56**
	Green	42	21	**63**
	Both	65	54	**119**
	Total	**114**	**96**	**210**

Source: Field Survey

Purposively, the groups/ classes drawn for the study each exceeds the minimum threshold (see next chapter). For St. Joseph a sample size of one hundred and nineteen (119) students comprising 65 boys (55%) and 54 girls (45%) was considered. For Amass, a sample size of ninety one (91) consisting of 49 boys (54%) and 42 girls (46%) took part in the exercise.

Creswell & Creswell (2018) further contend that a sample size typically may also be selected based on past studies. These category figures, serving as the sample size, is in consonance with previous research carried out by (Ayittey, 2015; Deku et al, 2017).

I must note some variation in terms of the number of respondents who participated in the instruments: pre-test, post-test and questionnaire. Students who underwent the treatments but failed to take part in both the pre-test or post-test were discounted in the performance measurement as both records are needed to determine the change in learning outcomes. They were however allowed to take part in the questionnaire on interest since they had sound knowledge of both the multimedia and traditional treatments. Due to this, a slightly different figure one hundred and thirty seven (137) for St. Joseph and eighty one (81) for Amass took part in the interest survey. This was permissible as the population was deemed homogenous being made of art and science students in both cases. Further statistics would be shown from the SPSS analysis in the next chapter.

The procedure for the random sampling was by inscribing the name of each class on identical pieces of paper and placed in a bowl with the inscriptions on the bottom side each piece. Students were randomly called to each make a random pick up of a piece of paper from the bowl and the classes checked. While science and art classes were randomly chosen for the experimental group, similar classes were purposively chosen for the control group in order to match up.

3.4 Research Instruments

The research instruments consists of two separate parts: tests (pre-test and post-test) and questionnaire; part one (ICT Performance Survey or IPS) was based on content of the topic to be treated. This is done before the first respective treatments. This constitutes the pre-test. Then a lesson using multimedia tools and applications was prepared on the given topic for the multimedia group (experimental group). It consisted of slide design incorporating appropriate animation and transition schemes to support

graphic outlook. The control group took the same treatment using a whiteboard mode of teaching and learning. The post-test was thus administered.

The content consisted of multiple choice questions made of twenty eight items with four options for each item. Students were tasked to mark the correct option for each item.

Questionnaires and surveys are often used in educational research for collecting information that is not always directly observable (Zhang, 2002). The questionnaires were read and explained to the respondents (students) as recommended by Amedahe and cited in Banji et al (2020). Participants were then given the opportunity to voluntarily provide their responses to the questions contained therein.

After both groups consequently taken through both methods, an assessment was made on a 5-point Likert Scale to determine their interest or comparative likening for the given methods. The scale range from SA= –Strongly agree", A= –Somewhat Agree", N= –Neutral", D= –Somewhat Disagree", SD= –Strongly Disagree". So SA was given 5 points whereas SD was given one point, across the spectrum. This was carried out after the alternative treatment. It included perceptions regarding both multimedia and traditional methods of teaching made. With twenty five items in all, the last twenty sixth item gives the student the latitude to write out their own comments that might not have been captured by the questionnaire but much related to multimedia. (The first three were socio-demographic data as gender, age, and track). In addition the questionnaire had three scales: we have the multimedia scale, conventional scale, and teacher behaviour scale. An additional instrument was the researcher's own empirical observation in the classroom.

3.5 Data Collection Procedure

Achievement tests and survey were used on quantitative data collected at the schools. On the issue of academic performance or achievement, the test instrument ICT Performance Test (IPT) was used for both the pre-test and post test procedures (IPT1&2). In measuring interest levels, the ICT Interest Survey (IIS) was used. Particularly each respondent was issued with one set of questionnaire and guided to complete it in an examination fashion as typical of educational environments. The researcher could not, through semi-structured interviews, collected bits of qualitative inputs from the educators themselves to see their view of it and try to make a reconciliation of the two as originally envisaged. The questionnaires also provide room for adding qualitative input which are thought to be outside the scope of the variable items on the scales used.

Phase 1: The pre-test instruments (IPT1) were administered to the two groups at their various schools to obtain base line information. This is used to determine their performance/achievement based on prior knowledge. This consists of multiple choice questions each with four options, twenty eight items in all. Each test item carried one mark. This lasted for sixty minutes. Each of the experimental and control groups were further sub divided into Gold and Green sub groups in line with Covid 19 protocol and the classroom or laboratory size.

Phase 2a: Traditional group: Participants were taken through sixty minutes each of teaching for each approach. The traditional group received instruction on the topic via marker board delivery.

Phase 2b: The multimedia group received instruction via multimedia aided teaching (MAT, particularly slide presentation with MS Power Point 2010). A conventional slide

design incorporating animation and transition schemes to support graphic outlook was carried out. A YouTube video (*Titled: The Dawn of the Net*) was incorporated into the PowerPoint to introduce the richness of multimedia and by way of proving a summary from another perspective.

The two lessons were prepared with contents from the teaching syllabus of ICT (Core), Unit 1, page 14 together with ICT for Senior High Schools with supporting documents from the web as well as the YouTube video. The contents were further enhanced to create a unique appeal that is still acceptable within their level. Each teaching session was one hour and the other one hour dedicated to answering the objective test.

Phase 3: Students from both groups were retested using the assessment instrument (IPT2). This enabled me ascertained the effects of the treatment applied to different the two groups. Some groups took it the same day as the treatment whereas others took it at a different day in conformity with the academic schedules. The results of the duo were compared through Excel and SPSS analyses.

Phase 4: Both groups were consequently taught both methods in order to enable them assess the methods used in relation to interest and attitude. This is where the Lickert scale assessment was used. So the instrument IIS was thus administered. It took sixty minutes for each group to be taken through the second approach as well as the questionnaire administration. The phases are so named for convenience and may not be seen as totally discrete entities.

3.6 Data Analysis and Presentation

The data obtained from those experiments (tests scores and questionnaires) were subjected to statistical analyses using Microsoft Excel 2010, SPSS (version 20.0) together with R data analyses software. The results are interpreted in the next chapter.

Tools used in presenting the data include tables and figures, graphs with concise interpretation done in clear language. There is also manual coding for qualitative responses.

3.7 Sources of Data

The study employed both primary and secondary sources. Triangulation is important in research study. Both scholarly and non-scholarly sources can be appropriate for your research purpose, depending on your research question. The mechanism of triangulation seeks to check sources presented from personal or non-scholarly sources with scholarly sources to make it acceptable to the academic community. Such cross verification validates the research data and widens ones scope of understanding of the issue. Where there are discrepancies it gives cause for us to re-examine and identify where the problem lies in a bid to lead to more accurate and trusted data. The literature review has been largely from secondary sources. The primary data source was through tests and questionnaires administered by the researcher and his aides. The largely quantitative data was supplemented by qualitative to give respondents (students) the latitude to express themselves which could give more meaning to the data. These were manually codified under themes and frequency counts.

3.8 Pilot Study

To check the research validity and reliability a pilot testing was carried out with few students from Kofiase Adventist Senior High School (KASHTEC), a school which is also located in the research catchment area. The pilot study was done on thirty-eight (38) first year students whose only source of previous knowledge is supposed to be from Junior High School education. This helped to iron out the practical challenges and inconsistencies related to instrumentation. These students were thought to be

unconnected with the experimental and control groups though they share similar characteristics. This included both the IPT and IIS.

3.9 Instrument Validity and Reliability

The pilot study enabled the validation of the research instruments and testing the reliability.

3.9.1 Validity

Trochim (cited in Haniff, 2017) as well as Creswell (2017) define validity as the degree to which a test measures what is supposed to measure. Margin of errors are practically inevitable. The research supervisor, an education and information technology expert, cross checked questions on a case-by-case basis, restructuring and simplifying where necessary taking into consideration content, concurrency and construct. There were enough questions which attempted to answer the research questions or hypothesis as much as possible. (The tests were based on enhanced content of the syllabus concerning the topic).

3.9.2 Reliability

This is a test done to determine the rate at which the instrument will produce the same results every time it is tested. Reliability must be determined for the results ought to be consistent in terms of quality whenever the test is done at different times (Haniff, 2017; Creswell, 2018). According to Hopkins (2012), cited by Haniff (2017), and Creswell (2018) sample of at least 10% of the population is considered representative of the entire target population.

The reliability of the test items was confirmed through subjection to SPSS analytical tools. Reliability was determined by the Cronbach alpha indicates the extent of deviation of individual responses from one another. Research shows a standard of $\alpha =$

0.5 is ok but 0.7 upward is better. From the pilot experiment on responses on interest levels of multimedia tools vis-à-vis traditional methods, it yielded an α value of 0.69 with thirty four valid responses, which indicates an acceptable level of deviation or variance of the responses. This was carried out using the test instrument IIS on thirty eight students of KASHTEC. All questions were therefore retained in the IIS to generate frequency counts on the salient issues rather than eliminating a number of them to ensure a very strong reliability. This is the Mampong municipal context!

The pilot experiment on performance levels yielded a mean of 12 and standard deviation of 2.7 with a range between 7 and 18. This was done using the test instrument IPT.

3.10 Ethical Considerations

The research was conducted in a decorous manner with all professionalism and ethical standards in place. An ethical form was filled at the Municipal Education office binding the researcher to standard code of ethics while I conducted the research. There I stated reference to the Municipal Director of Education, Mampong as well as the Head of Department, Information Technology Education (AAMSTED, Kumasi) promising to repeat same on the research instruments. The Municipal education directorate requested a copy of the report upon completion perhaps for policy consideration or ethical compliance.

The respondents (students) were made aware they could report any untoward incidences to their head of institution under whose permission the research was carried out. Based on the Municipal education director's directive, heads granted me access through the Assistant Head (Academic) and heads of ICT units. I arranged with the head of ICT

departments so that my project does not disrupt their individual academic calendars as far as possible.

The purpose of the research is disclosed to the students at the beginning of the research. They were made aware they were under no obligation to provide information or respond to a questionnaire although their compliance was much anticipated. I also assured them of their confidentiality and anonymity for their responses to the survey. All covid 19 protocols were duly observed. See plates at appendix.

I have also duly acknowledged and referenced all sources I have cited in this document. Details could be found under the references and acknowledgement pages.

3.11 Location and Organisational profile

The Mampong Municipality is one of the forty three (43) administrative districts in Ashanti Region. It is bounded to the south by Sekyere South District, to the east by Sekyere Central and the north by Ejura/Sekyedomase district (See map in Figure 8). The municipality covers an area of 23.9 sq km. Sixty one per cent (61%) of the settlement is rural, the rest being urban.

The two out of the four second cycle schools in the Mampong Municipal are included in the study. The third (KASHTEC) is only used for the pilot study. The remainder being a single sex (St. Monica‘s SHS) or Vocational/Technical school (Opoku Agyemang).

The municipal education directorate accounts to the Regional Director of Education as well as the Director General of GES. Both schools in the study area are mixed, public schools of equal strength.

Figure 8: District Map of Mampong Municipal (Source: Ghana Statistical Service, 2010)

CHAPTER FOUR

RESULTS AND DISCUSSION

4.0 Introduction

This part of the project details the findings of the study and provides discussions to that effect. The study aimed at comparing the effectiveness of using multimedia aided teaching with that of traditional mode of teaching as well as determining students' interests levels via the two methods in question.

Herein, two schools—1) Amaniampong SHS and 2)St. Joseph Seminary SHS representing the experimental and control groups respectively were pretested to obtain a baseline information of the two. Amaniampong SHS was taught a given topic in ICT. The compact exercise took place over a week using multimedia aided teaching whereas St. Joseph was taught the same topic using traditional mode of teaching. A post-test was done to ascertain the level of change in knowledge as a result of the two approaches. Then the multimedia group was taken through traditional mode of teaching and the traditional group(control group) was also taken through multimedia aided teaching so as to do comparison and determine the interest levels.

The respondents were drawn from the art and science classes through a simple random sampling process. The experimental and control groups consisted of students in the second year in their respective schools offering ICT core. Only the pilot study had used thirty eight (38) form one students from Kofiase Adventist Senior High School, assumed to have a similar previous knowledge from the Junior High level.

4.1 Demographic Data

Based on the data collected and analysed, the research brought to light certain findings. The sample size for the project itself was 210 students consisting of 114 Males (54%) and 96 Female (46%) as used in the performance tests. However for the interest survey a slightly higher figure of 217 was considered. (This has been explained under sampling technique in chapter three). The tracks are subgroups of the main group, so designed to deal with a manageable class size as well as observe the covid-19 protocols. The samples used in the performance tests for the experimental and control group are contained in table 5(by tracks) and table 6 (with various tracks put together).

Table 5: Sample values according to various categories

Sch	Track	Male	Female	Total
Amass	Gold	22	21	**43**
	Green	27	21	**48**
Joss	Gold	23	33	**56**
	Green	42	21	**63**
	Total	**114**	**96**	**210**

Source: Field Survey

The combined output appears in figure.

Table 6: Simplified output on sampling

Sch	Male	Female	Total
Amass	49	42	**91**
Joss	65	54	**119**
Total	**114**	**96**	**210**

In another vane, 80 (38%) were science students and (130) 62% art students. The St. Joseph students were 119 comprising 56 General Art and 63 Science students. That of Amass was 91 comprising 74 General Art and 17 Science students.

This represents 12.56% of the population of second years targeted in the study. This is in consonance with (Creswell & Creswell, 2018) recommendation that a sample size of at least 10% is representative of the entire population.

Due to the populous nature of these schools and the intension of the author to cover both tracks (Green & Gold) to create a more representative scenario the numbers were great. The class/laboratory size as well as covid-19 protocols compelled each group to be composed of two manageable subgroups (Green & Gold) for each school group.

From the survey 61.5% of respondents aged 16-17, 37.2% (18-19) and the other comprising (20-21) covered 0.9%. No significant negative perception of multimedia was registered as values from the Likert scale were consigned largely to agree (15.6%) and strongly agree(66.1%) for multimedia preference(Q4: see appendix). However few students expressed concerns about expressing themselves and asking questions in a multimedia setting, and therefore called for a complementary approach such as availing a whiteboard in a multimedia classroom. Students called for outright abolishment of the chalk-and-talk system in the educational system. Fortunately it is fading out, at least from the SHS level. 26.1% strongly agree they understand better when taught using chalkboard while 33.9% strongly disagree. The following section (Section 4.1) provides a detailed outcome of the experiment.

4.2 The Impact of Multimedia Tools in Teaching and Learning of ICT on Interest and Performance

This table 7 presents the summary of the learning outcomes using descriptive statistics on the topic thus treated for the experimental group. It contains both the pre-test and post-test for multimedia aided group (Amaniampong SHS).

Table 7: Means and Standard deviation of Pre-test and Post-test Scores (Experimental group)

Track	Pre-test		Post-test	
	M	**SD**	**M**	**SD**
Green	**14.21**	4.26	**17.96**	4.32
Gold	**14.79**	2.74	**19.07**	3.55
Both	**14.48**	3.62	**18.48**	3.99

Source: Field Survey

The results clearly indicate there was generally improvement in learning outcomes. For instance with the multimedia group, Pre-test (M=14.48; SD=3.62) and Post-test (M= 18.48; SD=3.99), has demonstrated that there is learning and acquisition of new knowledge. The gain made by the experimental group = **4.00 (18.48 - 14.48).**

On the interest perception scales registered similar gains as can be confirmed by the researcher‘s own observation. The field survey reveals a mean of 3.9 for multimedia and 3.3 for conventional methods of teaching (e.g. using marker board)

It could be seen that though both averages (out of a total of 5) were significant in term of their interest perception, the multimedia received favourable ranking.

4.3 The impact of Traditional Teaching Approach on Interest and Performance of Students

Table 8 presents both pre-test and post-test for traditional method group (St. Joseph Seminary SHS). This represents the control group. With respect to performance, Pre-test (M=14.46, SD=3.65) and with post-test (M=17.34 and SD=4.64).

Table 8: Means and Standard Deviations of Pre-test and Post-test Scores(Control group)

Track	Pre-test		Post-test	
	M	**SD**	**M**	**SD**
Green	**15.89**	3.68	**16.19**	3.85
Gold	**12.86**	2.75	**18.64**	5.13
Both	**14.46**	3.65	**17.34**	4.64

This demonstrates further improvement, the degree of variability notwithstanding. The gain made by the control group was **2.88 (17.34 - 14.46)**.

With regards to interest considerations for the traditional approach group, we again had 3.9 for multimedia but 3.7 for traditional mode.

These were actually taught using the traditional approach and examined before the multimedia was taught them in order to do effective comparison in the survey. This probably explains the high mean (3.7) for the traditional approach.

So, we are able to ascertain both methods improve learning outcome albeit to varying degrees. Even though the control group is seen to be have been slightly stronger at the beginning the post-test results show otherwise. In other words, it can be seen that the experimental group gained more than the control group. The differences in gains could

be explained from the multisensory nature of multimedia stimulating multiple senses which is difficult to entirely represent in a traditional classroom. Detailed results of individual students may be obtained from the appendix.

Interestingly, with regards to interest levels both groups have similar scoring in the comparison for multimedia although with varying scores for the traditional method. Further analyses would show whether there is significant statistical difference regarding the two categories of instruction on interest and performance.

4.4 Comparative analyses on students performances regarding multimedia-aided teaching and traditional method of instructional delivery.

The study advanced three hypotheses which were tested using independent t-test at 95% confidence level (5% significance level).

4.4.1 Hypothesis One (Differences in Interest)

Hypothesis one was to be determined using empirical evidence in the classroom atmosphere as well as responses to the questionnaire (which we shall see shortly). The students had to be introduced to both methods to ensure comparative analysis on interest levels. The hypothesis stipulated:

H01: There is no significant difference in the interest of students taught the given topic using multimedia tools and other traditional mode of delivery.

The interest levels were manifested in the multimedia class confirming this researcher‘s empirical observation by the author in teaching over the years. As both groups were consequently exposed to both methods for the sake of comparison and interest level determination, their responses from the instrument IIS was used. The questionnaire is made up of three scales in addition to the background information of the respondents.

One scale was on interest of multimedia and another was on traditional media. The third was general issues surrounding instructor‘s behaviour.

The general, Cronbach alpha = 0.69 for the twenty two items (excluding the socio-demographic data). Data from both groups are being used to establish it. We could also use t-test to compute the interest levels of students, looking at the differential between the traditional rankings versus the multimedia for both schools. However, each method is effective in its own sense: multimedia scale has mean 3.99 whereas the traditional scale has mean 3.26, both skewed to the right side.

Comparing the traditional scale with the multimedia scale on interest levels, we compute the following using SPSS. For multimedia scale, (n = 213, M=3.99, SD=0.69); For traditional (n = 213, M= 3.26, SD=0.85). (Four items had been excluded for incomplete data! This falls short of the original 217)

Δ Mean = (3.99-3.23= 0.76).

We further compute this using R data analyses software: (t = 4.2, df = 89, p-value = 5.6×10^{-5}), CI = 1.7 to 4.6 (95% confidence level). The calculated *p-value* is less than the standard 0.05 alpha; zero too does not lie within the confidence interval. Therefore the interest differential between the scales is statistically significant. This confirms the author‘s empirical observation in both types of classroom. The null hypothesis is thus rejected in favour of the alternative hypothesis.

The trend is not so different from the separate group levels. See table 9.

Table 9: Interest scale versus group

SCH	SCALE	MEAN
AMASS	MULTIMEDIA	3.9
	TRADITIONAL	3.3
JOSS	MULTIMEDIA	3.9
	TRADITIONAL	3.7

Source: Field Survey

Concerning instructor behaviour for both groups there was a bit of ambiguity as to whether it referred to the researcher or the routine instructors of the students . This scale should not be viewed as a mediating factor in this project but the background information of their instructors (routine subject teacher and not the researcher). This though could influence their understanding and interest of multimedia-aided lessons. At any rate, the time frame was not sufficient for them to have studied the behaviour of a new research instructor. Students were thus told to rank according to their routine instructors. Nevertheless the teacher behaviour scale registers an average of M = 4.1, SD = 0.89, with n = 217 across both schools. Two vital items on the scale include –My instructor is interested in the individual student needs and interests" had 50.5% –strongly agree." And –My instructor encourages participation in discussion and interacts with everyone" registers an even higher figure of 58.7%

The research also provided for qualitative input. Scores of students from the pilot study, through the experimental group to the control group recommended the use of multimedia. They called for abolishing of the chalk and talk system that seems to have already faded out at the SHS level. There were however few varying opinions calling

for an integrated approach to still keep the whiteboard in place in a multimedia classroom. These are fully covered in section 4.3.

4.4.2 Hypothesis Two (Differences in performance)

The second hypothesis of the study is recaptured below:

H02: There is no significant difference in the performance of students in instructions delivered via multimedia tools or traditional methods.

There is no significant difference on the performance of students in instructions delivered via multimedia tools or traditional method. The t-test compares the differences in pre-test and post-test scores obtained by the multimedia group (Experimental) and the conventional group (control). On average participants in multimedia group achieved higher results (M= 18.48 SD=3.99), than participants in the conventional group (M = 17.34, SD = 4.64).

With a sample size of 91(Amass) and 119 (Joss), we proceed with the analyses as follows:

(a) For Amass Pre-test, (n = 91, M = 14.48, SD = 3.62) and St. JOSS Pre-test (n = 119, M = 14.46, SD = 3.65). With two independent sample tests, R generates (t = -0.3, df = 208, p = 0.78, CI = -1.1 to 0.84).

Comparing with a standard p-value of 0.05 (5% significance level): 0.78 (calc) > 0.05. Therefore the difference between the two groups from the outset is not statistically significant. This base line information is important in experimental design to tell if both groups are of similar strengths.

(b) Considering the gains made by Amass (Experimental), Pre-test (n = 91, M = 14.48, SD = 3.62); Post-test (n = 91, M=18.48, SD = 3.99). This is a pairwise ranking with (t = -5.9, df = 90, p = 6.3×10^{-8}, CI= -4.5 to -2.2).

Since zero lies outside the CI or p value is less than 0.05, the difference is reckoned as statistically significant. This means there was appreciable gain in knowledge of participants in the experimental group.

(c) Considering the control group (JOSS), Pre-test (n= 119, M=14.46, SD = 5.65); Post-test (n=119, M = 17.34, SD = 4.64,). These are paired values with (t = -4.4, df =118, p-value = 2.1×10^{-5}), CI= (-4.2 to -1.6). Therefore the gain made by the control group is also statistically significant.

Now, how does the post-test of the two groups compare?

(d) Post-test (Amass) : (n = 91, M = 18.48, SD=3.99)

Post-test (JOSS): (n = 119, M = 17.34, SD = 4.64)

The two independent sample t-test yields: (t = 2.8, df = 208, p-value = 0.0053, CI = 0.53 to 2.99). Since p (0.0053) < 0.05 or zero lies outside the CI, the differences in knowledge gain hold statistical significance.

(e) Moreover, with regards to acquisition of knowledge, Δ Amass =18.48-14.48= 4.0; Δ JOSS =17.34-14.46 = 2.9. With Amass (n = 91, M = 4.00, SD = 3.5) and JOSS (n = 119, M = 2.9, SD = 5.3). This gives (t = 1.65, df = 208, p-value =0.10, CI = -0.2 to 2.3). Clearly this change is NOT statistically significant. (p(0.10) > 0.05.

The study revealed that although there is some significant difference (by post-test scores) between the experimental and control group regarding the treated topic, their change in means after the treatments is somehow demonstrative that there is no statistically significant difference between the two approaches. While their post-test scores differential may be statistically significant, the change in knowledge is not statistically significant.

However, it could be argued that multimedia gave the experimental group the overtaking edge. Multimedia approach can produce better results than traditional mode of delivering instructions. It is to be argued that some topics/presentations may exhibit heavy multimedia content than can be represented in a conventional classroom. This creates a vacuum for people who are taught through the traditional way as they do not really have the full complement of what is required. This supports the multisensory nature of multimedia stimulating multiple senses leading to more acquisition of information. However, this change is *NOT* deemed statistically significant.

4.4.3 Hypothesis Three (Statistical Significance on Gender)

Some researches generated interesting findings regarding instructional technology compared by gender (Zhang, 2012). Our third hypothesis is presented below.

H03: There is no significant difference in terms of gender in relation to performance using multimedia tools and traditional methods of instruction

Table 10 gives the aggregate values computed from the results in terms of means. Though the totals may be appreciated, any criteria could be used to make comparison.

Table 10: Students performance in pre-test and post-test by gender

	Pre-test		Post-test	
	Male	Female	Male	Female
Amass(Green)	15.31	12.48	18.27	17.38
Amass(Gold)	15.57	14.29	20.00	18.19
Amass(Both)	**15.44**	**13.39**	**19.10**	**17.79**
St. Joseph(Green)	14.43	16.6	14.81	15.38
St. Joseph(Gold)	13.17	12.64	17.83	19.21
St. Joseph(Both)	**13.8**	**14.62**	**16.32**	**17.295**

Source: Field Survey

A more abridged one with standard deviations (SDs) is presented in table 11.

Table 11: Simplified Pre-test and Post-test by Gender

	Gender	**Pre-test**		**Post-test**	
		M	**SD**	**M**	**SD**
Amass	Male	15.43	3.9	19.08	4.2
	Female	13.38	2.9	17.79	3.7
St. Joseph	Male	15.28	3.8	17.03	4.1
	Female	13.57	3.2	17.75	5.3

Since there are two different approaches and we are considering gender, we considered each group separately. There is varying trend between males and females regarding the two group of schools. For the experimental group the gains made by the males =

(19.06-15.43) =3.65 and the that of females = (17.79-13.38) = 4.40. The degree of statistical significance in terms of gender may be computed using the t-test. Δ Gains = 4.4-3.6=0.8. We may compute the t-test with Males (n = 49, m = 3.65, SD=3.5); Females (n = 42, M= 4.40, SD= 3.5) as independent samples.

This yields (t= -0.14, df = 89, p-value = 0.89, 95% CI: -1.69 to 1.47. Since p(0.89) > 0.05 alpha level, the differences in Male and Female of the experimental treatment group holds no statistical significance.

For the control group, the gains made by the males = (17.03-15.28) = 1.75 whereas the females have (17.75 - 13.57) = 4.18. Δ gains = 4.18-1.57= 2.61

We compute the t-test with Males (n = 64, M = 1.75, SD = 4.6); Females (n = 54, M = 4.24, SD= 5.6) also as independent samples. This yields (t= -1.28, df =116, p-value = 0.20. This too is not statistically significant.

Therefore there is no significance difference in terms of gender regarding performance, the approach notwithstanding. The change in knowledge however is slightly tiered towards the females. Hence hypothesis three is retained. This conforms to Zhang(2002) observation in a rather different environment.

4.5 Themes from Qualitative Data

The research did not only use experimental design but also provided opportunity for the participants to provide their own qualitative inputs. The researcher coded the responses from students with regards to qualitative inputs or comments and categorised them under four major themes: challenges with conventional approach, challenges with multimedia , praise for multimedia, and complimentary approach. Scores of students

expressed similar opinions in each instance. These statements are taken directly from the student responses and edited. The authors own comments are sparingly added.

4.5.1 Challenges with conventional approach

Chalk particles, they observed, are dangerous to the eyes.

Marker board is harder to learn with at some angles when there is [reflection from] sunlight.

We the students find it hard to learn using the traditional mode of teaching. So I think that we should ignore the traditional mode and install the multimedia mode of teaching.

One student decried the lack of practice as the teacher teaches only theory.

I am content with what I have or what I get, one student affirmed.

4.5.2 Challenges with multimedia

As one student puts it : Expression yourself is difficult with projector. But you can ask questions in traditional classroom.

One participant boldly questioned: How is it feasible to practice this kind of teaching with multimedia considering our present educational system?

The school needs more computers in order to let it progress effectively. The students have little knowledge as a result of lack of practice. Some students decried using computers for practical tuition is not working over here. They further entreated the teachers to teach the practicals to make things easier for them. This concern is significant looking at the quantitative output on the question –I have access to computer whenever necessary."

Table 12: Students Access to Computer

	Frequency	Per cent
STRONGLY DISAGREE	56	25.7
SOMEWHAT DISAGREE	30	13.8
NEUTRAL	18	8.3
SOMEWHAT AGREE	42	19.3
STRONGLY AGREE	70	32.1
Total	216	99.1

Source: SPSS Output on Access to Computer

This obviously covers both home and at school.

The multimedia perspective is very beneficial and helpful to students but our instructors do not take us to the laboratory (ICT) for practice. We only study in the classroom using the traditional mode of teaching perspective either by using marker board or chalk.

The students called for acceptance of smartphones and laptops in multimedia classroom to enhance the acquisition of knowledge. As one student captured it: —We must use phones in schools to help us in our researches."

As another student was concerned: when there is lights out, we have to wait till the lights is on again or we have to stop the lesson and postpone it.

Upon all the air conditioners, the multimedia classroom was very hot.

Upon all the three days programme the multimedia class was very boring.

We sat at the back and were not able to see from the projector.

Mostly during multimedia classes videos are not played back.

However, ways and means should be adopted in multimedia tuitions to ensure social and moral security as students can use broad and practical knowledge gained in such tuition(multimedia tuition) to do the negative, two students cautioned.

This was probably in response to a message about pornography which I relayed an unpopular story of Akwapem Poloo, a TV personality.

The computers are not enough. And the operating systems and apps are not current. We are allowed to use the computers only when we have ICT. We need newer versions of computer [programmes].

–Nevertheless, multimedia classroom is far better as compared to the other type of classroom."—survey response.

Multimedia classroom enhances better understanding provided students will be well coached during the lessons.

When network is not functioning the class is disrupted and there is wastage of airtime.

Students should be taught using multimedia only. Multimedia classroom enables students to understand whatever they are taught but not all students understand the multimedia way of teaching.

Other students are concerned of lack of physical contact during multimedia lessons. The researcher believes this refers to the attention upon individual student needs table by table, or computer by computer.

Multimedia classroom is only comfortable with the study of ICT and other reading and researching subjects like Biology. But somehow stressful with the study of calculating subjects like Chemistry, Physics and Mathematics.

Some students find it difficult to cope with the instructor because the students have low knowledge in computer learning.

4.5.3 Praise for Multimedia

One respondent captured it poetically: From my opinion, I think multimedia classroom teaching is the best among the rest.

Multimedia makes learning exciting and interesting to me.

Multimedia makes learning easier. Students are equipped with the requisite knowledge and skills.

I think there should be more application on the use of multimedia in teaching ICT to make students learning easier. Some observed multimedia is fast and easier.

One respondent observed vividly: Multimedia class is very interesting. I understand things taught in multimedia classroom more than things taught in other classrooms. I like the use of videos to explain things in the multimedia classroom.

It is easier to learn with projectors and smart boards in multimedia classrooms than the traditional classroom.

I think the multimedia class would help we the students well and improve our knowledge in computers and how to use them.

In my opinion students should be taught using multimedia tools because students of this generation are used to technology and the olden days of teaching is not helping at all.

One respondent remarked the instructor (author) as teaching better in the multimedia classroom compared to the traditional approach.

I think using modern technology in teaching is much more effective than traditional teaching of marker board and chalkboard and therefore every student must participate in multimedia classroom.

I would like to use smart board.

I really understand the teaching in multimedia classroom than other class because of the illustrations being shown. They are very clear to my understanding.

Multimedia class is interactive and interesting. I understand the course better due to the use of the projector.

In my opinion, I guess students must be taught using the multimedia classroom because many pupils gain remembrance when they watch it clearly on a technological platform.

My comment on multimedia classroom is that we live in a technological world where everything is based on the use of technology and not human strength. Therefore, multimedia should be taught in a classroom but not with chalkboard. It should rather be displayed to the learners to see and know how it is being operated to help the generation who know nothing about multimedia.

I wish that the multimedia classroom needs to be spread across all the classrooms in the country"---field survey.

In a multimedia classroom, we get chance to get more information about what the teacher is teaching as we get information like pictures, videos and other information.

Multimedia classroom provides a visual illustration of items and diagrams which seem complex hence makes it easier in studying diagrams in details for better understanding.

I believe multimedia classroom should be encouraged instead of the traditional way because in this 21st century, technology is fast growing and beside it is more effective.

Multimedia classroom is much preferred by students because students remember vivid image of what they learn rather than orals. These qualitative reporting corresponds to their quantitative data on the question –I understand better in a multimedia classroom."

Table 13: Assessment of multimedia classroom.

	Frequency	Per cent
STRONGLY DISAGREE	18	8.3
SOMEWHAT DISAGREE	6	2.8
NEUTRAL	15	6.9
SOMEWHAT AGREE	34	15.6
STRONGLY AGREE	144	66.1
Total	217	99.5

Source: SPSS Output on understanding in multimedia classroom

4.5.4 Complementary approach

I prefer studying in a class and a tutor who uses both marker board and multimedia to teach. So that the marker board will be used for explaining things or theory and the projector will be used for practical sessions.

I suggest that we can combine both the projector and the marker board altogether because there are some works which cannot be done on the projector. And it is not any teacher who will be able to use the projector unless they have been trained.

Whilst he holds his opinion, another student called for provision of smart board.

It is not surprising that the survey data registered 84% in favour of white board but 66.1% in favour of multimedia when students were quizzed –I understand better when am taught using [chalkboard, marker board , multimedia tools]. This record is partly due to the fact that students reflected of daily classrooms where they have been taught

using marker board in subject areas other than ICT. However, consistently chalk registered 33.9% strongly disagree. But the performance of the multimedia group is indicative of the position of multimedia scoring.

4.6 Discussions

The base line information shows both groups were of similar strength at the start of the research. As stated in the sampling technique, there is some variation in terms of the number of respondents (210 versus 217) who participated in the instruments: pre-test, post-test and questionnaire. Students who underwent the treatments but failed to take part in both the pre-test or post-test were discounted in the performance measurement (due to the problem of comparison). They were however allowed to take part in the questionnaire on interest, assuming a homogenous population, since they had sound knowledge of the treatments.

The results of the study indicated an existing difference in the learning outcomes of each group before and after exposure to their respective treatments. There were improvements in students learning outcomes as well as differential interest levels confirmed from both quantitative data and empirical classroom observation with regards to the two modes of pedagogical instruction.

The interest levels were generally, clearly, statistically significant for the groups either taken together or in separation. Both methods were effective even though the multimedia was found to have carried their interest to an extra mile. (The difference between the two approaches on interest levels was also statistically significant!). Multimedia scale registered an interest level 3.9 both groups while traditional scale had 3.3 and 3.7 respectively of multimedia group and traditional group. Moreover, the

students own qualitative inputs shows a greater likening for multimedia with all its challenges.

Both procedures contributed to improvement in performance, however change in average for the multimedia aided teaching group was slightly higher than that of the traditional method of teaching group even though they were deemed equal in terms of academic strength from the onset. Further, the research data shows there was no difference of statistical significance in terms of academic performance of both multimedia and traditional when compared. However, it is worth noting those taught using multimedia tools had improved more (Δ Amass M= 4.0, SD = 3.5; Δ JOSS M = 3.5, SD =5.3) with the p value (0.10) > 0.05, almost at the dividing line. This closeness to the standard value is a possible indication of the impact of multimedia tools. The two approaches are therefore complimentary as they both lead to improved knowledge.

The multimedia tools used in the experimental group must have caught the attention and enhanced interests in the multimedia classrooms. This converges with the author's observation in both classes. While multimedia classroom was full of variety, colour and liveliness, the traditional classroom was stale, stagnant and full of fatigue as students desired the lesson to come to an end. Moreover, differences in performance regardless of gender, is not statistically significant. However, this increased interest in multimedia classroom, confirmed by students qualitative responses and the researcher's observation, was not sufficient to cause a significant change in performance statistically when compared with the traditional approach. That is not to say the use of multimedia tools is not important as we can clearly see both methods are complimentarily significant.

With respect to the qualitative data, even though students appreciate challenges with multimedia, they almost unanimously called for the adoption of multimedia-aided teaching in our schools. There are few outliers, though, that think multimedia can not represent all shades of information, subject to variable factors as presence of electricity, as well as inability of a teacher/students to express themselves in certain ways. Further statistical analysis shows greater levels of agreements than disagreements by the students with regards to impact of multimedia tools in pedagogical instruction.

There have been conflicting researchers on this narrative depending on the location, subject or other parameters. Multimedia is more effective (Shah & Khan, 2015; Kareem, 2018; Khan et al, 2020; Almara'beh et al, 2015). They are complimentary: the difference is not significant (Zhang, 2002). Deku et al (2018) created a mixed scenario where some aspects were significant and others were not. The conflicting results on performance notwithstanding, students interest in a class is reportedly high. Such state of delight can stimulate them to pay attention to learn more, retain more and recall more which is expected to affect their academic output considerably. This has been confirmed by multimedia scales from both groups.

At any rate, early educators in the 1990s, saw that other benefits such as ensuring computer literacy (which is applied to a wider world), providing variety in instructional delivery, or releasing teacher time from record-keeping tasks were important enough to continue investing in technology (Picciano, 2011). However, these are outside the scope of the research objectives.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATION

5.0 Introduction

This chapter is the conclusion of the study and includes a summary of the findings/results, conclusions as well as recommendations arising out of the study.

Researches focusing on multimedia aided teaching have taken place in different localities as well as different academic disciplines. The primary purpose of this study was to investigate the impact of multimedia on students learning outcomes, and their interest in learning in Mampong Municipality.

Generally, the study leveraged quantitative methods, consisting of an experimental design approach complimented by questionnaire to investigate the research question. The qualitative inputs from students as well as the researcher‘s own observation were also taken into consideration.

5.1 Summary of Findings

The investigation has being on comparing multimedia-aided teaching to traditional mode of instructional delivery in terms of students‘ performance and interest. So, a total of 210 students, comprising ninety-one from the experimental group (Amaniampong SHS) and one hundred and nineteen from the control group (St. Joseph‘s Seminary SHS) were engaged in the study. Initial results from pre-testing shows the schools were of equal strengths. But after each group underwent its respective treatment and their knowledge was tested again. Results show both approaches are effective for the acquisition of knowledge. However, the change in learning outcomes was slightly in favour of the experimental group. Meanwhile, these changes when compared were

deemed not statistically significant (t = 1.65, p-value = 0.10). However, the post-test scores for inter-group comparison were statistically significant (t = 2.8, p-value = 0.0053). The impact of multimedia as demonstrated from the test show that it yields similar results as the traditional approach. Simply put, change in knowledge is almost the same. And acquisition of knowledge via the two approaches is regardless of gender.

For the interests of students in multimedia and traditional classroom, the researcher used observation in addition to the perception survey carried on the students. Both groups indicated their preference for multimedia-aided teaching over traditional methods of teaching (Mean of 3.99 versus 3.5). Snippets of their qualitative inputs from the questionnaires also demonstrate they are tiered towards usage of multimedia tools.

5.2 Conclusion

Educational technology seeks to improve performance by creating, using, managing appropriate technological processes and resources. It is a means through which learners experience their subject in a vicarious manner. (Almara'beh, Amer, & Sulieman, 2015).

No survey is entirely free of biases nor can it account for all possible factors which affect data from human subjects, nevertheless, some conclusions can be drawn from this study of the impact of multimedia on students‘ performance and interest.

Students from different backgrounds (arts and science), spanning both gold and green tracks of two public senior High Schools had similar perceptions of multimedia teaching. Most of the students have positive perception of multimedia aided teaching demonstrated by higher scores for _agree‘ and _strongly agree‘. Multimedia had average of 3.9 for both groups while conventional method of instructional delivery had an average of 3.5 (3.3 and 3.7 respectively) of the multimedia and traditional groups.

Students disinterest is partly due to the way that ICT itself is being taught. So far schools lack the capacity to integrate ICT into other disciplines. These problems could be infrastructural or technical. However, classroom observation supports the interest levels of students from the questionnaire survey.

Whilst there have been some modest gains, this is not enough. As Molnar, an American computer science professor puts it –The world of education has changed from an orderly world of disciplines…..to an infosphere in which communication technologies are increasingly important. While education is changing, it is not changing fast enough"(Picciano, 2011). This looks more relevant even as the new curriculum hinges on ICT as means of integrating with other disciplines.

The project work reported the results of research that sought to find the impact of multimedia on teaching visa vis the traditional mode of delivering pedagogical instruction in terms of students performance and interest. Both methods improve learning outcome albeit to varying degrees. The tests revealed that in general there was no significant difference in change in learning outcomes. However, the research also concludes that multimedia is effective for cognitive and attitude development of students. There are no gender disparities with regards to performance aided by multimedia tools. While this comparative change in performance is not statistically significant, interest levels are clearly manifest. Most students are interested in multimedia lessons than they do for traditional mode of teaching. This finding is that of classroom room survey and results from the students own opinion assessment.

5.3 Recommendation

There is the need to integrate ICT into other disciplines under the new curriculum (NaCCA , 2019). Both students and teachers must be equipped to accept this challenge.

The use of projectors and smart boards is recommended to stimulate the interest of students so as to enhance acquisition of knowledge. The demonstration method of teaching is also recommended to complement the white board delivery.

The challenges facing multimedia systems like frequent power outage, network stall, etc should be addressed with alternative solutions. Technical support and maintenance is very essential to effective use of multimedia (Zhang, 2002). The ICT coordinators at various schools should take up this challenge.

The adoption and modification of Zhang (2002) questionnaire and others on investigating multimedia and traditional teaching approach could be continually modified in the Ghanaian context. Such modification could provide a high value reliability and validity that could serve as the gold standard in conducting multimedia researches in the African context.

This study is regarded as convergent mixed methods design, albeit with minimal qualitative data. It is recommended that further research could consider a fully-fledged qualitative data as well as the quantitative using the above approach. Better still alternative investigations such as the Exploratory Sequential Mixed Methods Design or Explanatory Sequential Mixed Methods design could also be considered (Creswell, 2018).

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APPENDICES

APPENDIX I: PLATES OF STUDENTS AT THE TEACHING SESSIONS

1.1 Session with the Experimental group(Amaniampong SHS)

1.2 Session with the Control group(St. Joseph Seminary SHS)

1.3 Session with the Pilot study group(Kofiase Adventists SHTS)

APPENDIX II: REQUEST TO CONDUCT RESEARCH

Amaniampong SHS
P.O. Box 74
Mampong – Ashanti
May 12, 2021

Dear Sir,

PERMISSION TO UNDERTAKE AN EDUCATIONAL RESEARCH

Following my admission to read a **sandwich programme**, **Master of Science Information Technology Education**, I wish to apply seeking permission to undertake a research work in selected schools in the municipality.

Sir, as part of the requirements for the degree, I am to undertake a research project to be supervised by the Appiah-Menkah University of Skills Training and Entrepreneurial Development(Formerly University of Education, Winneba, Kumasi Campus). In this regard, I have decided to study the **Impact of Multimedia in Teaching and Learning.**

The research would require an experimental group (**Amaniampong Senior High School**) and a control group(a school of similar strength **to be determined**). Random samples of students in these schools are to be taken through multimedia lessons on a chosen topic and the impact of this method measured against traditional modes of delivery.

I would be very grateful if you could grant the kind permission to undertake the research in these schools.

Find attached relevant documents for your consideration and necessary action.

Thanks in anticipation

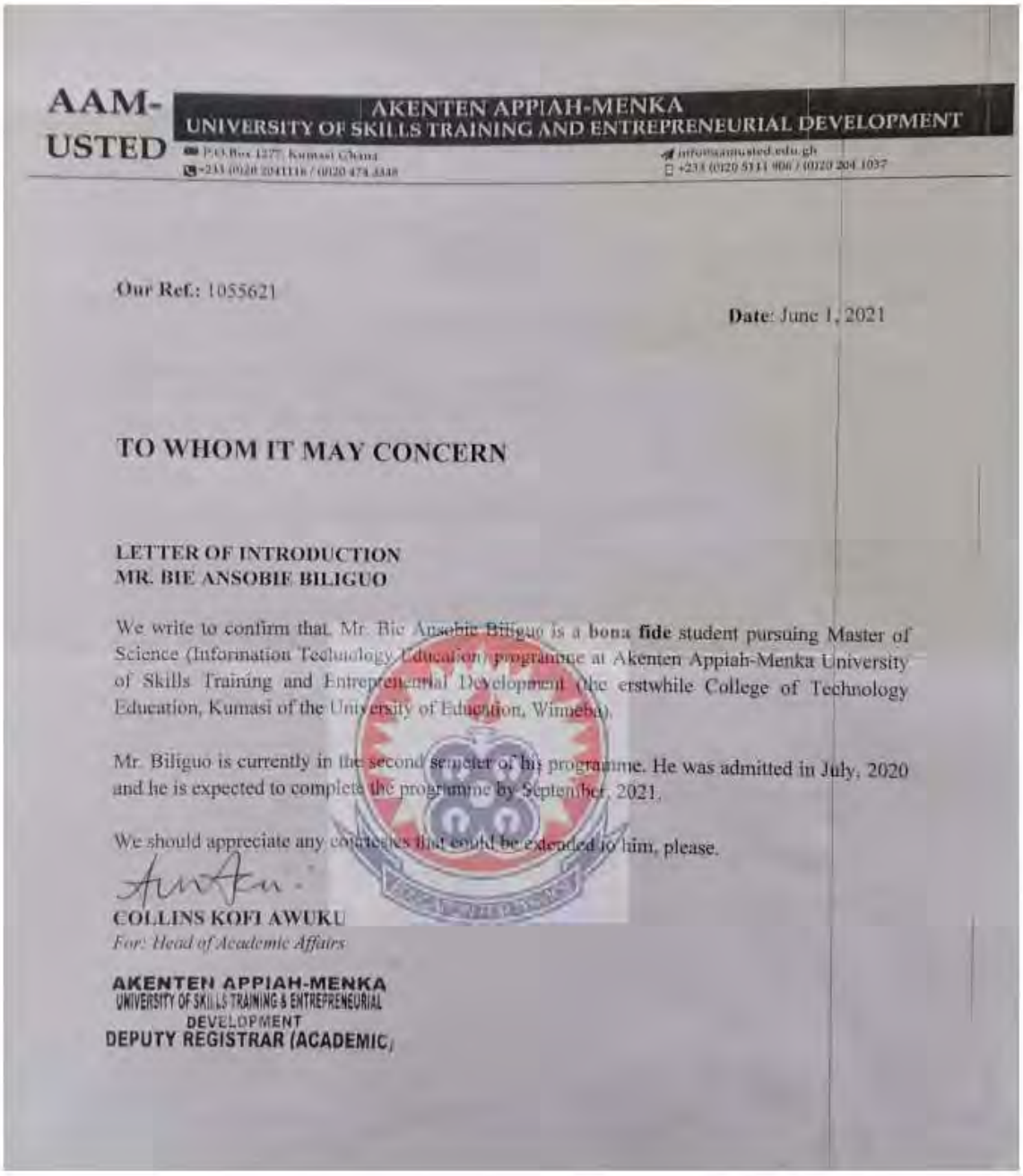
Yours Sincerely

Biliguo Bie Ansobie

The Municipal Director
Ghana Education Service
Mampong

THROUGH:
The Headmistress
Amaniampong SHS

APPENDIX III: INTRODUCTORY LETTER (AAMSTED, KUMASI)



AAM-USTED

AKENTEN APPIAH-MENKA
UNIVERSITY OF SKILLS TRAINING AND ENTREPRENEURIAL DEVELOPMENT

P.O.Box 1277, Kumasi Ghana
+233 (0)20 2041116 / (0)20 474 4338
info@aamusted.edu.gh
+233 (0)20 5111 906 / (0)20 204 1037

Our Ref.: 1055621

Date: June 1, 2021

TO WHOM IT MAY CONCERN

LETTER OF INTRODUCTION
MR. BIE ANSOBIE BILIGUO

We write to confirm that Mr. Bie Ansobie Biliguo is a bona **fide** student pursuing Master of Science (Information Technology Education) programme at Akenten Appiah-Menka University of Skills Training and Entrepreneurial Development (the erstwhile College of Technology Education, Kumasi of the University of Education, Winneba).

Mr. Biliguo is currently in the second semester of his programme. He was admitted in July, 2020 and he is expected to complete the programme by September, 2021.

We should appreciate any courtesies that could be extended to him, please.

COLLINS KOFI AWUKU
For: Head of Academic Affairs

AKENTEN APPIAH-MENKA
UNIVERSITY OF SKILLS TRAINING & ENTREPRENEURIAL DEVELOPMENT
DEPUTY REGISTRAR (ACADEMIC)

APPENDIX IV: INTRODUCTORY LETTER (MUNICIPAL EDUCATION DIRECTORATE, MAMPONG)

GHANA EDUCATION SERVICE

In case of reply the number and date of the letter should be quoted

My Ref. No: GES/ASH/MPG/EP.4P

Your Ref. No: .....

Mampong Municipal Education Office
P. O. Box 216,
Mampong-Ashanti
0248880410
Email:mampongeducationoffice@yahoo.com

REPUBLIC OF GHANA

1st June, 2021

BALIGUO BIE ANSOBIE (MR.)
AKENTEN APPIAH – MENKA UNIVERSITY OF SKILLS
TRAINING AND ENTREPRENEURIAL DEVELOPMENT
FACULTY OF MATHEMATICS AND SCIENCE
KUMASI

RE: PERMISSION TO UNDERTAKE AN EDUCATIONAL RESEARCH

Following your application to the Municipal Education Directorate, Mampong – Ashanti to carry out research on ***"Evaluating the Impact of Multimedia in Teaching and Learning ICT: A Case Study of Schools in Mampong Municipality"***. I am pleased to inform you that you have been granted permission to undertake your research in the selected Senior High Schools – Amamiampong SHS and St. Joseph Seminary SHS from June 2021 to September 2021.

You are duly advised to report to the named Schools authorities before embarking on the research.
I am by this letter requesting the Heads of the selected schools to kindly give the student Researcher the needed support to enable him conduct his research.

Note that:

1. All ethical issues in research must be duly observed and applied to the respondents in the selected Schools in this Municipal Education Directorate.
2. All COVID – 19 pandemic protocols must be duly observed in all the schools.
3. Consent of selected students and teachers must be sought before they are sampled and used for the research.

On completion of the research project, you are requested to submit one hardcopy of your report to this office.

I wish you good luck in your assignment.

GABRIEL ANTWI
MUNICIPAL DIRECTOR OF EDUCATION

Cc:

1. The Head of Department, AA- MUSTED, **Kumasi**
2. The Headmistress, Amamiampong SHS, **Mampong – Ashanti**
3. The Headmaster, St. Joseph Seminary SHS, **Mampong – Ashanti**

APPENDIX V: REQUEST TO USE SELECTED CLASSES AND TIMES FOR A RESEARCH PROJECT

Amaniampong SHS
P.O. Box 74
Mampong – Ashanti
October 19, 2021

Dear Madam,

PERMISSION TO USE SELECTED STUDENTS FOR A RESEARCH PROJECT AT THE COMPUTER LAB

This follows an earlier letter by the district director on my research project of which your school is part.

I would need a total of at least **eighty students**(80) to carry out the multimedia project. This is roughly two classes and will need a mix of second year **Green** and **Gold** students pursuing ICT Core.

The project is scheduled to take place between 1st - 7th November, 2021 during night preps at the ICT Lab for convenience, with two hours each day for three days for each of the two groups. Students would be taken through a treatment on a given topic in ICT and accessed on their performance via computer aided teaching as well as an opinion survey on the same.

The composition of the exact groups will be communicated in due course when the random sampling is done.

I would also wish to start my three weeks off to complete the said programme in Kumasi from **November 22, 2021.**

Thanks in anticipation.

Biligub Bie Ansobie

The Headmistress,
Amaniampong SHS

Attention
The Assistant Headmistress (Academic)
Amaniampong SHS

The Head of Department
Mathematics & ICT Dep't
Amaniampong SHS

APPENDIX VI: ICT PERFORMANCE TESTS (IPT)

IPT/AMASS/____

AKENTEN APPIAH-MENKA
UNIVERSITY OF SKILLS TRAINING AND ENTREPRENEURIAL DEVELOPMENT, KUMASI
TEST ON EVALUATING THE IMPACT OF MULTIMEDIA TOOLS IN TEACHING AND LEARNING ICT

Name of student…… Admission no……

***Purpose**: The goal of this research is to investigate the impact of multimedia tools on students' **PERFORMANCE** and interest.*

***Ethics**: You are under no obligation to provide answers. However your cooperation and sacrifice is highly anticipated.*

*In case of any problem kindly report to the **Head of your Institution** under whose permission this project is carried out.*

***Directions**: Each question has four possible responses. Read each question and carefully mark the one response that most clearly answers the given question.*

---

1. Which of these network protocols breaks down data into packets suitable for transmission
   (a) tcp
   (b) ip
   (c) http
   (d) ftp

2. The function of an ISP is to……
   (a) Maintain a local network
   (b) Setup and configure a LAN network
   (c) Connect users to the Internet
   (d) Run an internet café

3. Which of the following facilities are available on the internet?
   (a)Email
   (b) Chat
   (c) News group
   (d) All of them

4. Which appropriate protocol transfers software programs, product upgrades, and other types of computer files between computer systems connected to the internet is?
   (A) http
   (B) tcp
   (C) ftp
   (D) ip
5. Each computer on the internet has a unique address that identifies it as a node so that information can be sent to it. This unique number is called?
   (a) IP address
   (b) DNS address
   (c) Default gateway
   (d) Port number

6. A web client and a web server typically have programs that interact with each other using
   (a) http
   (b) ftp
   (c) tcp
   (d) pop

7. Which of these software requests the webpage from a server?
   (a) Javascript
   (b) Download manager
   (c) Configware
   (d) Web browser

8. Which of the following is not a merit of the internet?
   (a) Emailing
   (b) Easy communication
   (c) Sharing of information
   (d) Cyber fraud

9. All the following are negative aspects of the web except?
   (A) Software piracy
   (B) Video conferencing
   (C) Computer virus

(D) Scamming

10. One may connect to the internet using any one of the following media except
    (A) Phone line
    (B) Cable
    (C) Joystick
    (D) Satellite dish

11. The storehouse of information on the internet is called?
    (A) Network
    (B) Web
    (C) Web browser
    (D) Protocol

12. Converting analog data from a phone line to digital data appropriately describes
    (A) Modem
    (B) Modulation
    (C) Demodulation
    (D) Routing

13. TCP is a non-proprietary protocol. This means
    (a) It works on only IBM PCs
    (b) It works on any platform
    (c) It works alongside IP
    (d) It can communicate with apple machines

14. Which of these protocols tell how your webpage is displayed?
    (A) ftp
    (B) tcp
    (C) http
    (D) pop

15. The process of moving information from a web server to a client PC RAM best describes…..
    (a) uploading
    (b) downloading
    (c) saving
    (d) opening

16. The system which translates the host name of a machine into a given ip address on the net is known as
(A) Internet protocol service
(B) Internet Service Provider
(C) Domain Name Service

(D) Integrated Services Digital Network

17. Not-for-profit making organisations usually bear the domain name
(a) .com
(b) .org
(c) .gov
(d) .net

18. To retrieve a file from a file server to your host PC you mainly require
(A) Tcp
(B) http
(C) ftp
(D) ip

19. All the following are discussion forums on the net except…….
(a) Mailing list
(b) Hypermedia
(c) Chats
(d) Blogs

20. All the following are search engines on the web except?
(A) Google
(B) Ask
(C) Yahoo
(D) Twitter

21. Which of the following protocols is usually written as part of the web address?
(A) http
(B) tcp
(C) ip
(D) ftp

22. webpages are generally stored on
(A) supercomputer
(B) file server
(C) web servers
(D) mail server

23. Which of these software first initiates a request for a given webpage?
(a) Web browser
(b) Search engine
(c) Html

(d) Messenger

24. The general name for a document that contains links to text, graphics, sound and video files is that of
    (a) Hypertext
    (b) Hypermedia
    (c) Hyperlink
    (d) Spider

25. Which part of the browser window do we enter the URL?
    (A) Address bar
    (B) Home button
    (C) Bookmark button
    (D) Title bar

26. Rules on the ethical use of the internet are often called?
    (A) Etiquette
    (B) Protocol
    (C) Netiquette
    (D) Courtesy

27. The address www2021@yahoo.com is typically
    (A) Web address
    (B) Email address
    (C) Twitter handle
    (D) Ip address

28. In the address **gespromotions.com**, the hostname is
    (A) .com
    (B) promotions
    (C) http
    (D) gespromotions

****

APPENDIX VII: ICT INTEREST SURVEY (IIS)

IIS/SCH/_____

AKENTEN APPIAH-MENKA
UNIVERSITY OF SKILLS TRAINING AND ENTREPRENEURAL DEVELOPMENT, KUMASI
QUESTIONNAIRE ON EVALUATING THE IMPACT OF MULTIMEDIA TOOLS IN TEACHING AND LEARNING ICT

Stud. Name……..… Admission no……

Purpose*: The goal of this research is to investigate the impact of multimedia tools on students' performance and* ***INTEREST****.*

Ethics*: You are under no obligation to provide answers. However your cooperation and sacrifice is highly anticipated. Your privacy and confidentiality will be preserved.*

In case of any problem kindly report to the ***Head of your Institution*** *under whose permission this project is carried out.*

Directions*: The item scale has five possible responses. The responses range from 1(Strongly Disagree-SD) through 3 (Neither Agree nor Disagree or Neutral-N) to 5 (Strongly agree-SA).*

Read each item and carefully mark the one response that most clearly represents your agreement with the statement. Notice that this is not a test, and there are no ***RIGHT*** *or* ***WRONG*** *answers.*

Socio-demographic data: *Circle appropriately and specify where necessary*

Item	Scale
1. Gender	1= Male 2= Female

2. Age (as at last birthday)	1= 14-15 2= 16-17 3=18-19 4 = Other (Specify)_____
3. Track	1= Single 2= Gold 3= Green

Multimedia perspective: *In this section, we want your opinion on the effect of multimedia tools on performance and interest in ICT.*

1= strongly disagree, 2=somewhat disagree, 3= neither agree nor disagree, 4= somewhat agree, 5=strongly agree	**1**	**2**	**3**	**4**	**5**
4. I understand better when am taught in multimedia classroom					
5. I expect higher grades when I am taking a class in multimedia classroom					
6. I am satisfied with the projector installed in the multimedia classroom					
7. My instructor delivers course contents by using different technologies in multimedia classroom					
8. I have knowledge and skills needed to use appropriate applications for my class project and presentations					
9. I use computer-assisted instruction or other computer-based applications outside of class					
10. I have access to computer whenever necessary					
11. I would prefer to take a course from an instructor who uses technology in class					
12. I would take another course in multimedia classroom in future					

Traditional mode of teaching perspective: *Your opinion on the effect of using traditional mode of teaching on your performance and interest is required here.*

1= strongly disagree, 2=somewhat disagree, 3= neither agree nor disagree, 4= somewhat agree, 5= strongly agree	**1**	**2**	**3**	**4**	**5**
13. I am used to teaching via chalk-and-talk mode					
14. I am used to teaching using marker board					
15. I understand better when I am taught using chalkboard					
16. I understand better when I am taught using marker board					
17. I am satisfied with the marker board installed in the classroom					
18. I learn well when the teacher demonstrates via traditional media					
19. I expect higher grades when I am taking class via the traditional mode of teaching					
20. I will prefer to take a course delivered via chalkboard					
21. I will prefer to take a course delivered via marker board					

General observations: *Your opinion based on observations in both type of class room in relation to your teacher behaviour is required here.*

1 = strongly disagree, 2 = somewhat disagree, 3 = neither agree nor disagree, 4= somewhat agree, strongly agree	**1**	**2**	**3**	**4**	**5**
22. My instructor is well organised					
23. My instructor is interested in individual needs and interests					
24. My instructor encourages participation in discussion and interacts with everyone					
25. My instructor upholds my interest in class					

26. Do you have any other **comments/challenges** based on your personal experience and observation about multimedia classroom and other types of classroom? If so, please provide them below:

APPENDIX VIII: PILOT TESTING ON PERFORMANCE

(Marks out of 28)

IPT/KAS/01	13
IPT/KAS/02	8
IPT/KAS/03	10
IPT/KAS/04	18
IPT/KAS/05	15
IPT/KAS/06	14
IPT/KAS/07	13
IPT/KAS/08	9
IPT/KAS/09	9
IPT/KAS/10	13
IPT/KAS/11	12
IPT/KAS/12	13
IPT/KAS/13	9
IPT/KAS/14	11
IPT/KAS/15	12
IPT/KAS/16	10
IPT/KAS/17	10
IPT/KAS/18	8
IPT/KAS/19	11
IPT/KAS/20	13
IPT/KAS/21	7
IPT/KAS/22	13
IPT/KAS/23	15
IPT/KAS/24	12
IPT/KAS/25	12
IPT/KAS/26	6
IPT/KAS/27	8
IPT/KAS/28	12
IPT/KAS/29	13
IPT/KAS/30	15
IPT/KAS/31	17
IPT/KAS/32	12
IPT/KAS/33	12
IPT/KAS/34	12
IPT/KAS/35	13
IPT/KAS/36	12
IPT/KAS/37	16
IPT/KAS/38	15
Lowest	6
Highest	18
Mean	11.92105

APPENDIX IX: TEST SCORES FOR THE EXPERIMENTAL GROUP (GREEN SESSION)

RESEARCH ID	PRETEST	POST-TEST
46	15	21
1	18	23
21	22	22
1	11	14
15	11	19
26	8	13
8	19	22
40	8	5
48	11	12
28	11	12
21	21	26
5	12	20
37	22	22
20	14	15
Xx	20	14
36	16	23
	11	20
41	20	17
2	10	15
31	16	19
22	18	20
13	20	23
38	11	18
34	13	17
18	13	13
42	12	14
	16	19
16	8	20
10	12	14
32	18	21
33	9	13
17	7	23
24	8	17
3	20	22
11	10	16
4	15	22
30	13	15
19	13	15
35	17	22
20	22	28
12	17	18
23	13	21
6	17	15
39	9	15
47	13	14
44	12	15
9	16	20
43	14	18

*White indicates male and grey female

*xx Unnumbered questionnaire

APPENDIX X: TEST SCORES FOR EXPERIMENTAL GROUP(GOLD SESSION)

RESEARCH ID	PRETEST	POST-TEST
12	21	23
35	16	19
34	13	21
41	14	20
9	16	20
21	22	22
26	12	14
45	13	21
32	21	21
24	15	19
15	14	18
7	13	20
43	13	8
39	16	19
6	12	18
19	13	17
22	14	19
18	13	22
40	17	21
5	15	19
42	11	17
30	12	10
23	14	20
13	18	19
2	11	13
31	15	20
47	16	17
25	20	22
4	12	13
46	12	17
36	19	22
44	13	19
8	13	17
14	15	24
28	13	24
29	22	25
27	14	16
16	16	23
10	12	20
17	14	20
38	16	22
37	16	22
33	13	17
11	18	22

*White indicates male and grey female.

APPENDIX XI: TEST SCORES FOR THE CONTROL GROUP (GREEN SESSION

RESEARCH ID	PRETEST	POST-TEST
41	16	16
11	14	15
102	16	17
109	15	15
12	19	20
1	16	20
112	20	25
42	13	19
22	20	21
26	21	21
18	12	13
6	15	17
7	19	19
37	12	8
103	17	10
117	18	12
Xx	9	18
108	21	18
31	16	15
38	17	19
4	14	17
Xx	12	14
Xx	14	18
119	12	13
2	14	14
118	22	16
110	11	14
113	14	18
36	11	11
29	24	22
5	15	17
25	12	19
43	18	19
8	18	21
115	14	6
15	22	22
120	12	11
21	14	17
24	14	16
3	11	12
101	23	16
30	20	16
Xx	14	11
107	15	14
20	16	18
17	22	20
28	19	18
32	18	14
114	17	19
19	14	12
34	10	10
30	17	19
104	21	17
111	13	17
40	14	14
39	19	15
116	10	9
35	15	15
23	16	18
9	9	11
27	20	22
106	15	20
16	20	20

*White indicates male and grey female.

* xx indicates unnumbered questionaire

APPENDIX XII: TEST SCORES OF CONTROL GROUP (GOLD SESSION)

97	8	19
48	15	21
44	13	22
99	15	16
66	17	22
85	13	14
59	17	24
53	17	23
65	11	23
94	8	11
89	13	16
84	16	19
70	11	24
69	11	23
52	11	25
82	17	16
73	16	14
81	12	19
90	9	16
83	13	17
63	9	21

93	12	14
46	14	21
62	12	25
54	10	25
45	17	21
79	12	19
77	11	11
13	16	22
80	14	9
47	13	22
87	11	21
61	18	22
71	10	23
14	14	26
42	14	2
53	10	25
96	16	11
100	12	19
50	15	24
49	10	23
64	17	22

95	14	13
75	14	15
92	10	18
67	7	19
91	13	18
57	16	26
86	12	10
51	14	19

98	10	14
56	18	20
55	16	20
88	10	9
74	6	15
76	10	16

*White indicates male and grey female.