UNIVERSITY OF EDUCATION, WINNEBA

INTEGRATED SCIENCE TEACHERS' ATTITUDE AND USE OF DIGITAL RESOURCES IN PRIVATE BASIC SCHOOLS IN THE BIA WEST DISTRICT

ISAIAH KWARTENG
8180030010

**A thesis in the Department of Basic Education,
Faculty of Educational Studies, submitted to the School of
Graduate Studies in partial fulfilment
of the requirements for the award of the degree of
Master of Philosophy
(Basic Education)
in the University of Education, Winneba**

MARCH, 2021

DECLARATION

Student's Declaration

I, Isaiah Kwarteng, hereby declare that except references to other researcher's work or authors work, which have been duly cited and acknowledged, this thesis, is the result of my own work and that neither in whole nor in any part has been submitted for another degree elsewhere.

Signature: …….....……

Date: …….....…...

Supervisor's Declaration

I, hereby declare that the preparation and presentation of this thesis was supervised by me in accordance with the guideline on supervision of thesis laid down by the University of Education, Winneba.

PROF. SAKINA ACQUAH (Principal Supervisor)

Signature: …….....……

Date: …….....…...

DR. JAMES AWUNI AZURE (Co – Supervisor)

Signature: …….....……

Date: …….....…...

DEDICATION

This work is dedicated to my dear children; Jackie and Kofis, Adepa and Maafia, my sister Linda Kwarteng, my uncle Owusu Justice Braimah and my mother, Elizabeth Amankwah of blessed memory and to the staff of Jackof Preparatory School.

ACKNOWLEDGMENT

Throughout the process of completing this study, and especially in this COVID-19 pandemic era, while I pushed the pause button of my life to complete this thesis, I have received endless support from my family, friends, and colleagues.

I wish to express my profound gratitude to my supervisors, Prof. Sakina Acquah and Dr. James Awuni Azure whose encouragement, enlightening and insightful guidance helped to make this thesis a reality. Without your leadership, friendship and mentorship, I would not be writing this page today. To my own Akua Asantewaa Lucy, who believes I can be anything I want to be. You inspired me daily with your unwavering integrity. You are the most resilient person I have ever known, and you have taught me to laugh at myself and persevere. Your grace and humor sustained me. To my dad, Mr Alex Kwarteng and my Member of Parliament for Bia West Constituency, Dr. Augustine Tawiah who taught me to work hard and supported me financially throughout this study, I say may God bless you. Thank you to my professional mentor and friend Mr Courage Kobla Adenyoh of the Department of Basic Education, UEW for the assistance and guidance, may grace find you always in life. Additionally, I am forever grateful for the professional colleagues I get to spend my days with while "on the job" at Lamplighter Community JHS. I work with extraordinary teachers, and staff, and am I am honored to call them colleagues and friends especially Miss Dorcas Mensah.

Finally, I express my sincere appreciation to D.O James Owusu, Richard Yeboah (Coordinator IDel-Debiso Centre), Bernard Gyebi Blay, Philip Gyamah Jnr. Emmanuel Oduro Mensah and all the Management and Technical Staff of Adjoafuaman Football Club, the Power Boys. Shalom! Peace!!.

TABLE OF CONTENT

LIST OF TABLES

LIST OF FIGURES

ABBREVIATIONS

B, II:	Bia, Individual Interattitude
BECE:	Basic Education Certificate Examination
CC:	Creative Commons
GES:	Ghana Education Service
ICT:	Information and Communication Technology
JHS	Junior High School
JOWC:	Japan Open Courseware Consortium
MIT:	Massachusetts Institute of Technology
MOE:	Ministry of Education
OER:	Open Educational Resources
OU:	Open University
SAIDE:	South African Institute for Distance Education
SHS:	Senior High School
TESS INDIA:	Teacher Education through School-Based Supporting India
TESSA:	Teacher Education in Sub-Saharan Africa
T-TEL	Transforming Teacher Education and Learning
UNESCO:	United Nations Educational, Scientific and Cultural Organization

ABSTRACT

The purpose of the study was to investigate Integrated Science teachers' attitude towards the use of TESSA Science OER in classroom instructions. The study adopted the qualitative approach with case study research design. A sample of six Integrated Science teachers was drawn from Lamplighter Community Academy. Primary data was collected using semi structured interview guide. Data collected was analysed thematically. Results showed that, in general, participants expressed positive attitude toward OER, and benefited from using the resources in multiple ways. In spite of the benefits of OER, participants faced several challenges in using the resources, including the high cost of internet access. Based on the results the study concluded that using TESSA Science OER in Integrated Science teaching and learning improves teachers' pedagogical practice and students' conceptual interpretation of scientific facts. The time and cost of going online to get essential pdfs and other word documents for lesson delivery is quite stressful, especially for instructors who lacked the necessary abilities. The study recommended that Integrated Science teachers at Lamplighter Community Academy Basic school should always use TESSA Science OER in their classroom to enhance meaningful teaching and learning of the subject. The GES of the Bia West District should construct computer laboratories in all Basic schools within the district and equip them with easy access to network.

CHAPTER ONE

INTRODUCTION

1.0 Overview

This chapter deals with the background to the study, statement of the problem, purpose of the study, objectives of the study, research questions, significance of the study, delimitations of the study, limitations of the study and the organization of the study.

1.1 Background to the Study

Science is an important part of a school curriculum and thereafter in the world of work. Science, technology and innovation are central to economic prosperity. Being productive in Science and Technology depends on the adoption of scientific knowledge, skills and attitudes as a way of life (Semela, 2010). Development trends worldwide show that careers in science have immensely contributed to socio-economic and technological transformation. School science education is, therefore, crucial in laying the foundation for scientific and technological development in society. It is vehemently accepted that, science is the driver of a nation's socio-economic development as it forms the basis for technological advancement which helps in creating comfort and betterment in the lives of the masses of society (The Ministry of Education Culture Sports Science and Technology, 2011).

Ojimba (2012) certified this assertion by saying that, science is a vital tool for understanding and application of technological and engineering skills which are crucial for the achievement of the desired development of all nations across the world.

In view of this, most countries have made efforts to encourage and support effective learning of science at all levels of education. For instance, in Ghana science is made a compulsory or core subject at both the basic and senior high levels for all students and also forms a key requirement in admitting Senior High School (SHS) graduates into tertiary institutions across the country.

There are several ways of teaching science. One best way of teaching science at the basic level is through activity-based method where learners have practical and hand-on experience of the subject thereby enhancing better understanding. Activity-based learning is a process whereby students actively engage in the learning process rather than just sitting and listening to the lesson and in this regard, learning should be based on doing some hands-on experiments and discussion, practical activities, analysis and evaluation of the topic under discussion (Azuka, 2013).

The models of activity-based learning suggest that all learning activities involve some kind of learners' experiences which emphasizes observing and doing (Anwar, 2019). According to Anwer (2019), the idea of active learning is based on the premise that students learn best when they are actively involved in the teaching-learning process. Emaiku (2012) stated that "activity-based learning offers so many benefits for both teachers and students, for example, they reinforce course content, develop team building skills, enhance learners self-esteem, promote participatory learning, allow for opportunities for problem solving, promote the concept of discovery learning, strengthen learner's bond, help in practical application of course content, enhance communication with diverse learning, and prepare an enjoyable/exciting learning environment" (p. 212).

Yadar (2007) opined that no course in Science and Mathematics can be considered as complete without including some practical work. The practical work ought to be carried out by individuals either in Science laboratories or in classes. At school level, practical work is even more important because of the fact that we learn by doing. Scientific practices and applications are thus rendered more meaningful. It is an established truth that an object handled impresses itself more firmly on the mind than the object merely seen from a distance or in an illustration. Thus practical work forms an important feature in any Science and Mathematics Course (UNESCO, 2008).

All countries in Sub-Saharan Africa place emphasis on learner-centred education. So active learning approaches characterize their science, mathematics and technology curricula (Stutchbury & Ngman-Wara, 2012). Hence learner-centred education, participatory teaching, inquiry-based approaches, problem-solving and critical thinking are some of the key phrases that feature prominently in curriculum policy of African countries (Otttevanger, Van Den Akker, & Feiter, 2005). This is in line with current trends in Science education worldwide that learning is not a passive activity but an active one in which pupils actively construct knowledge through interaction with their existing knowledge, and ideas provided by materials, pupils and the teacher (Ottevanger *et al.,* 2005).

Yet, reports from Sub-Saharan Africa, including Ghana, consistently describe the pedagogy that actually dominates the classroom as: largely traditional, teacher-centred and content-driven, with notes taking and whole class teaching at all levels, in spite of the curriculum advising otherwise (Ottevanger *et al.,* 2005; Stutchbury & Ngman-Wara, 2012). Thus, there is very little evidence of the formulated curriculum ideas.

In addition, teaching is difficult especially for basic school teachers, as they find it challenging to achieve their lesson objectives. Evidence shows that although teachers and teacher educators understand what constitutes effective pedagogy, the barriers to implementation are often not considerred (Stutchbury & Ngman-Wara, 2012). Effective pedagogical techniques are not always modelled in teacher education courses and that is the reasons learner-centred approaches are not common in evidence in Ghanaian basic schools (Stutchbury & Ngman-Wara, 2012; Verspoor, 2008).

However, in recent times, Open Educational Resources (OER) have emerged as one of the most innovative as well as cost-effective teaching and learning resources that could improve the quality of educational offerings globally by optimizing the use of available resources (Kanwar, Kodhandaraman, & Umar, 2010).

OER supports learning, or the open sharing of teaching practices with a goal of improving education and training at the institutional, professional, and individual level.

According to DeRosa and Jhangiani (2017), the approach of engaging students as creators of information rather than just consumers of it is known as OER. OER is a type of experiential learning in which students demonstrate their understanding by making something. OERs are materials that may be freely reproduced, shared, edited, and remixed. Full courses, course materials, modules, textbooks, streaming videos, assessments, software, and any other tools, materials, or approaches used to enable access to information are all examples of open educational resources (The Hewlett Foundation, n.d.; 2014).

UNESCO (2012) defined Open Educational Resources (OER) as any teaching, learning and research materials in any medium, digital or otherwise, that reside in public domain or have been released under an open licence that permits no-cost of access, use, adaptation and redistribution by others with no or limited restrictions to improve teaching and learning (p. 20).

The commonly accessed OER in Africa is the Teacher Education in Sub-Saharan Africa (Hogan, Carlson, & Kirk, 2015). TESSA Science OER stretches across Sub-Saharan Africa linked to the curriculum, and designed to support teachers and teacher educators in developing active approaches to learning. A wealth of Science OER materials and guidance are freely available to be used, downloaded, distributed, adapted and re-uploaded to the TESSA website. Users can also share opinions and seek advice through the TESSA Forum. The network is coordinated by The Open University, UK (Hogan, Carlson, & Kirk, 2015).

According to Moon and Wolfenden (2007), the TESSA OER is categorized into subject-based modules. The modules of TESSA Science OER include Literacy, Science, Social Studies and the Arts, Numeracy and Life Skills which can be filtered by language for all instructors across the country to have access to it. The TESSA Science OER supports national curricula and provide examples of participatory pedagogy (Moon & Wolfenden, 2007). TESSA Science modules are made up of both primary and secondary Science units. These units were developed by Science educationists from Ghana, Zambia, Kenya, Tanzania and Uganda. The secondary Science units of the TESSA Science OER, for example are grouped onto pedagogical themes which reflect the skills and attributes of an effective teacher. These themes are, probing students understanding, making Science practical, making Science real

and relevant, problem-solving and creativity and teaching challenging ideas (Hogan, Carlson, & Kirk, 2015).

Integrated Science Teachers that use TESSA OER have a variety of advantages, including the ability to continue to attend to their own students while studying, and the ability to integrate teaching and learning within their own environment.

There is no need for teachers to relocate, particularly from rural areas, to receive training and continuity in the classroom is maintained (Hogan, Carlson, & Kirk, 2015). Traditional pre- and in-service programmes have provided qualifications but frequently given little attention to the pedagogic dimension and hence often had minimal impact in the classroom (Moon, Brown, & Ben-Peretz., 2000). One of the professional tasks of the TESSA Science OER is aimed at integrating theory and practice that is centering on daily classroom practice to improve the effectiveness of teacher-pupil interactions in almost all the subjects taught in Sub-Saharan countries (Moon, Leach, & Stevens, 2005).

Some teacher education institutions in Ghana, have embedded TESSA Science OER in their academic programmes and some of these institutions are partnering with the TESSA consortium. According to Acquah (2019), TESSA Science OER has been implemented in five partnering institutions in Ghana. These partnering institution include University of Education, Winneba, University of Cape Coast, Komenda College of Education, Fosu College of Education, and OLA College of Education.

At the University of Education, Winneba, the TESSA modules have been introduced at the Department of Basic Education as part of the Curriculum Material Study in Integrated Science and Methods of teaching Science courses (Acquah, 2019). Also,

Otami (2015) recommended that other departments of the university should be introduced to TESSA Science OER in general through frequent advertisement through department bullet boards and Radio Windy-Bay (UEW's radio) should be utilized.

Also, the Transforming Teacher Education and Learning (T-TEL) and education regulatory bodies such as National Teaching Council, Ghana Tertiary Education Commission have included the introduction of OER which contains the TESSA Science OER training programmes they run (Ministry of Education (MOE), 2018). This indicates that Science OER have indeed become a necessary innovative tool for teachers in Ghana and the adoption and sustainability is largely dependent on teachers' attitude.

1.2 Statement of Problem

Mensah and Somuah (2013) asserted that the growing trend of knowledge of Science and Technology is by no means a major contributing factor to the economic transformation of most of the world's economies. Science has changed the way the natural universe was viewed. When joined with engineering, modern technology, and the global economic system, the methods and results of scientific inquiry are found to have profoundly affected humanity's material and societal progress. These researchers further stated that the fast advances in science and technology have influenced the rate of economic development of nations, improved the quality of life in most parts of the world, and provided solutions to some major problems and needs of societies.

Unfortunately, through anecdotal accounts, it was observed that the performance of pupils currently in Integrated Science has declined. For example the chief examiners report (2018) revealed that Candidates' performance, on the whole, declined as compared to last year's. The same trend was observed in 2019 that majority of

candidates scored just above average with few being outstanding. This has led to a situation where majority of learners who graduate from the Basic level of education are unable to progress to the senior high level and subsequently to the University without a pass in Science. In effect, only a few pupils are able to offer Science in the senior high school and subsequently in the University due to poor performance in Science. In most cases, many of these students lump up in non-science related courses.

This situation could surmount to high rates of youthful unemployment and frustration in Ghana has become the bane of society. Already High rates of unemployment estimated at 35.6% (ILO, 2017), stressed education systems, socioeconomic disparities, and unsustainable patterns of internal, regional, and global migration.

There is limited documented evidence on Integrated Science teachers' attitude towards TESSA Science OER and their use of TESSA Science in Ghana, hence the need for this study.

1.3 Purpose of the Study

The purpose of the study was to investigate Integrated Science teachers' attitude towards TESSA Science OER and their use of TESSA Science OER in their classroom instructions.

1.4 Objectives of the Study

Specifically, the study sought to:

1. find out the attitude of Integrated Science teachers towards TESSA Science OER in Lamplighter Basic School.

2. examine how often Integrated Science teachers' use TESSA Science OER in their lesson deliveries in Lamplighter Basic School.
3. examine benefits Integrated Science teachers derive using the TESSA Science OER.
4. examine challenges Integrated Science teachers' face when using TESSA Science OER.

1.5 Research Questions

The study was guided by the following research questions:

1. What is the attitude of Integrated Science teachers in Lamplighter Basic School towards TESSA Science OER?
2. How often do Integrated Science teachers in Lamplighter Basic School use TESSA Science OER in their Science lessons?
3. What benefits do Integrated Science teachers derive in using TESSA Science OER in their Science lessons?
4. What kinds of challenges do Lamplighter Integrated Science teachers face in using TESSA Science OER?

1.6 Significance of the Study

The outcome of this study would benefit teachers, Lamplighter Community Junior High School, policy makers and educational researchers. The study will help improve the performance of Lamplighter Community Junior High School in Integrated Science and also clear certain myths they hold about science. It is hoped that the findings of this study will create the awareness among basic school teachers of TESSA Science OER and give them an insight on the use of the modules and how they will enhance effective science delivery at the basic level. Ultimately, this study aimed to assist

educational researchers, advocates and policy makers to better understand the current state of TESSA Science OER and their use.

1.7 Delimitations of the Study

According to Simon and Goes (2011), the delimitations of a study are those characteristics that arise from limitations in the scope of the study defining the boundaries of the study. The study only focused on examining the attitude and use of TESSA Science OER by Integrated Science teachers. Finally, the boundaries of this study was restricted to the use of JHS Integrated Science teachers within the Bia West District.

1.8 Organization of the Study

This work is organized into five main chapters. The chapter one consists introduction, which deals with the background to the study, statement of the problem, purpose of the study, research objectives, and research questions, significance of the study, and organization of the study. Chapter two was about review of literature. Chapter three comprises the research design, population under study, sampling techniques, and sources of data, research instruments and method of data analysis. Chapter four consists data presentation and discussion. Chapter five is concerned with summary of the findings, conclusion and recommendations.

CHAPTER TWO

LITERATURE REVIEW

2.0 Overview

Review of literature is a broad, comprehensive in depth, systematic and critical review of scholarly publications, including unpublished scholarly print materials, audio visuals and personal communications to establish an overview of what has already been studied in the field or area under intention of the investigation (Creswell, 2007). The chapter looks at the theoretical frameworks upon which the study is built. It addresses the nature of OER and TESSA Science OER.This chapter provides an overview of empirical literature on Open Education Resources (OER) relevant to the study. Related Literature based on the research questions were reviewed and it finally concludes with a summary of the literature review.

2.1 History of Open Educational Resources (OER)

Between 1994 and 1998, two concepts were developed that later set the stage for the development of OER. In 1994, Wayne Hodgins coined the term *learning objects* to describe digital resources that could be used to mediate learning (Metros & Bennett, 2002). The significance of the term in the development of OER is its propagation of the notion that electronic information resources can be designed and created in ways that enable their repurposing in different pedagogical circumstances.

In 1998, David Wiley coined the term *open content* (Unwin, Foote, Tate, & DiBiase, 2012) and used the term to describe any creative work that could be copied and modified by others. The significance of the concept of open content is that it popularized the notion that the principles of the free and open source software movement can be applied to educational resources. In 2001, the Creative Commons (CC) was established by Lawrence Lessig and

others to develop open content licenses similar to those used in open source software (Harmon, 2013). This development was essential for the growth of the OER movement, as it increased the confidence of users of the resources.

The Science OER movement has grown significantly in the last 16 years. The term OER was coined at the 2002 UNESCO forum on the impact of open courseware for higher education in developing countries (UNESCO, 2002). The conference, which attracted participants from several countries, was organized in response to developments in open courseware (a subset of OER) initiatives championed by the Massachusetts Institute of Technology (MIT). In the early 2000s, MIT's Council on Educational Technology introduced a plan to open its course content to the rest of the world for free (Kirkpatrick, 2006). There are growing OER initiatives around the world. In Japan, six prestigious universities formed the Japan Open Courseware Consortium (JOCW) in 2005 (Aoki, 2011).

Science OER projects have also been founded in China, Europe, and Africa. In Africa, OER Africa leads the way in the development of the resources. As stated on the OER Africa website, the project is a ground breaking initiative established by the South African Institute for Distance Education (SAIDE). The primary role of OER Africa is to support higher educational institutions across Africa in the development and use of Science OER to support teaching and learning (SAIDE, 2013). The notion of publicly releasing taxpayer-funded resources as OER was taken up in 2012 by the World Open Educational Resources Congress. In June 2012, the congress released the 2012 *Paris OER Declaration*. The declaration formally demands that governments openly license publicly funded educational materials (UNESCO, 2012). The premise of the declaration is that all resources, including

educational resources generated from publicly funded projects, should be placed in the public domain for equal access by all.

2.1.1 What is Science OER?

Several definitions of Science OER have been proposed (UNESCO, 2012; The OECD, 2007). UNESCO (2012) defines Science OER as the open provision of educational resources using information and communication technologies (ICTs), for consultation, use, and adaptation by a community of users for non-commercial purposes. Although this definition clearly identifies the relevance of ICTs in OER, its restriction of the resources to non-commercial use is incongruous to practices in open content licensing. Science OER can be defined as "digitized materials offered freely and openly for educators, students, and self-learners to use and reuse for teaching, learning and research purposes.

2.1.2 The nature and types of Open Educational Resource (OER)

OER include learning objects such as lecture materials, references, readings, simulations, experiments, and demonstrations, as well as syllabi, curricula, and teachers' guides (UNESCO, 2002). These are resources that can be used to support instructional activities as well as learning purposes. Wiley (2007) categorizes Science OER into two broad types: (a) Science OER designed for teaching and (b) Science OER designed for studying. Examples of Science OER designed for teaching include a set of presentation slides, syllabi, skeletal lecture notes, etc. These resources are designed on the assumption that they will be used by people with considerable knowledge in the content area. Science OER designed for studying include such materials as video lectures, interactive quizzes, and instructional simulations. These materials are usually heavy in content and are specifically designed to support learning.

Science OER are also teaching learning and research materials that are in the public domain or have been published with a license that allows free use or repurposing by others (Atkins, Brown & Hammond, 2007). Globally, Science OER seek to solve the problem of variable quality of education resources, teaching and student performance (UNESCO, 2014).

According to de Oliveira Neto, Pete, Daryono & Cartmill (2017), several studies have suggested that Science OER may be more useful for instructors in countries including countries in Sub-Saharan African that lack certain resources as compared to instructors in more developed countries. This is because OERs help to overcome some of the challenges associated with lower economic development, such as lower access to quality teaching materials that are affordable and flexible (de Oliveira Neto *et al.,* 2017).

Some of the examples of useful and learner-centred OERs online include; Teacher Education for Sub-Saharan African OER (TESSA Science OER), Teacher Education through School-based Supporting India (TESS INDIA), OER Africa, Open Course Ware, etc. These OERs are designed for learner-approaches and are also free to be accessed by teachers to build upon their professional skills and improve classroom instructional achievements (Master man, Wild, White & Manton, 2011). Again, these OER are hosted with teaching activities which can be adopted and integrated into different national curricula. In Addition to TESSA Science OER, a typical example is Teacher Education through School-based support in India (TESSA India), the resources found on TESS India focus on the development of pedagogical practices in relation to Language and Literacy, Science, Mathematics, and English, Each unit found on TESS India includes case studies, readings, reflective tests and most

importantly an opportunity to apply and refine all the practices in any classroom situation (TESS India).

2.1.3 Rationale and Aims of TESSA Science OER

The TESSA project was initiated in 2005 with aim to provide open educational resources (OER) and associated support for teacher educators and teachers in SSA as a way to expand teacher education and improve the quality of the programme offered (Harley & Barasa, 2012). Key objections were to:

- Create a network of African universities, working alongside the Open University (OU), UK and other international organizations to focus on the education and training needs of teachers in Sub-Saharan Africa;
- Support the exploration and development of school based of teacher education in which teachers develop their competencies and skills to meet the need of pupils in their own classrooms;
- Design and build a multilingual open Education Resource (OER) bank, modular and flexible in format, that is freely available to all teachers in the region.

2.1.4 The TESSA Science Materials

The TESSA science modules have been developed as part of the TESSA project and have designed to support pre-service secondary science teachers in five Sub Saharan African countries. Colleagues from five partner institutions worked together to develop a structure for the materials. In recognition of the link between pedagogy and values and beliefs, the starting point was an agreed vision of an effective science teacher. The vision of TESSA science modules is focused on teachers'

creativity in enhancing learner-centred approach of teaching. Studies have revealed that the pedagogical themes in the TESSA science reflect the vision (Ngman-Wara & Acquah, 2015).

The TESSA science modules are made up of both primary science and secondary science. The primary unit is grouped into three major modules (Table 1). Looking at life, investigating Materials, and Energy and Movement (Harley & Barasa, 2012)

Table 1. Themes and Sections that form the TESSA Primary Science Module

Module	Theme	Section	Keywords
Module 1	Looking at Life	Classifying living things etc.	Model, animals, plants, group work etc.
Module 2	Investigating Materials	Investigating and classifying materials etc.	Properties; Solid, gas, liquid
Module 3	Energy and Movement	Investigating forces Investigating movement	Forces, Friction etc.

Source: www.tessafrica.net

The secondary science unit is constructed around five pedagogical themes.

The total number of units is 15, three for each theme selected from Physics, Chemistry and Biology. The activities in the TESSA Science units support teachers to effectively teach (Stutchbury & Ngman-Wara, 2012).

Table 2. Themes and contexts that from the titles for the 15 TESSA Secondary Science

THEMES	SUBJECTS PHYSICS	CHEMISTRY	BIOLOGY
Probing pupils' understanding	Properties of matter	Elements, Mixtures and compounds	Classification and Adaptation
Making science Practical	Measurement	Acids, Bases and Salts	Transport
Making science relevant to real life	Pressure	Combustion	Respiration
Problem solving and Creativity	Forces	Atomic structure and Periodic Table	Nutrition
Dealing with challenging ideas in science	Electricity and Magnetism	States of Matter	Cells

Adopted from: Ngman-Wara and Acquah (2015)

Ngman-Wara and Acquah (2015) stated that the TESSA science materials are geared towards developing diverse skills needed by the 21st century science teacher. Also, there are case studies in the modules that seek to develop problem solving, critical thinking, and decision - making and at the same time providing opportunities for linking theory to practice, Similarly, there are many activities in the modules that seek to promote communication, collaboration critical thinking, investigative or research skills, problem solving, creativity and innovative skills.

Similarly, their use is likely to develop in teacher reflective skills. All these are supposed to promote and build diverse skills in the teacher. As teachers facilitate these activities with learners and model the behaviours, the learners invariably acquire these values and skills as well. TESSA Secondary Science is underpinned by the belief that active approaches to learning are likely to produce better outcomes

for pupils than teacher-led lessons in which pupils are passive participants (Ngman-Wara & Acquah, 2015).

2.2 Introduction of TESSA Science OER in Ghana

According to Anyanful and Anamuah-Mensah (2015) since 2008, over 4143 teachers have graduated from college of Education in Ghana having learnt about TESSA Science OER. They further explained that TESSA materials are integrated into teacher training programs and there are a number of other initiatives such as a thriving TESSA Clubs at the colleges of education. Also, Transforming Teacher Education and Learning (T-TEL) programme and education regulatory bodies which are designed to provide an online resource to support the 46 public colleges of education to improve their practice have included the introduction to OER including TESSA Science OER (Ministry of Education, 2018).

In addition, the TESSA Science OER has been in the University of Education for almost 10 years, especially in the Department of Basic Education. The TESSA modules have been introduced with the program of Department of basic Education as part of the Curriculum Material Study in integrated science and Methods of teaching science courses. Besides, some of the teachers in Lamplighter Community Academy JHS are product of the University of Education Winneba and were introduced to the TESSA modules when in school as well as the workshop organized by the researcher on the TESSA modules have exposed the integrated science teachers to the TESSA secondary science modules. They also had hands-on experience with the materials (Ngman-Wara & Acquah, 2015).

Several studies have been carried out on TESSA Science OER in Ghana. Ngman-Wara and Acquah, (2015) carried out a study on Ghanaian Junior High Science

Teachers' reflections on the Use of TESSA Secondary Science Modules, interactive approach of introducing TESSA Science OER to student teachers. Essuman (2015) evaluated experience of teacher on collaborative model of peer teacher in Ghana using TESSA Science OER. However, few studies had been carried out on the teachers' attitude and use of TESSA materials. This study sought to add to the existence knowledge of the subject.

2.3 Theoretical Framework

The study is situated within the framework of constructivism which focuses on the pedagogical importance of TESSA Science OER, the awareness and use of TESSA Science OER by Integrated Science teachers.

2.3.1 The Theory of Constructivism

This study is theoretically underpinned by Piaget's Theory of Constructivism. Piaget's theory of constructivism impacts learning curriculum because teachers have to make a curriculum plan which enhances their students' logical and conceptual growth. Teachers must put emphasis on the significant role that experiences or connections with the adjoining atmosphere-play in student education. For example, teachers must bear in mind the role those fundamental concepts, such as the permanence of objects, plays when it comes to establishing cognitive structures.

Piaget's theory of constructivism argues that people produce knowledge and form meaning based upon their experiences. Piaget's theory covered learning theories, teaching methods, and education reform. Two of the key components which create the construction of an individual's new knowledge are accommodation and assimilation. Assimilate causes an individual to incorporate new experiences into the old experiences. This causes the individual to develop new outlooks, rethink what were once misunderstandings, and

evaluate what is important, ultimately altering their perceptions. Accommodation, on the other hand, is reframing the world and new experiences into the mental capacity already present. Individuals conceive a particular fashion in which the world operates. When things do not operate within that context, they must accommodate and reframe the expectations with the outcomes.

Apart from learning theories, Piaget's theory of constructivism addresses how learning occurs, not focusing on what influences learning. The role of teachers is very important. Instead of giving a lecture the teachers in this theory function as facilitators whose role is to aid the student when it comes to their own understanding. This takes away focus from the teacher and lecture and puts it upon the student and their learning. The resources and lesson plans that must be initiated for this learning theory take a very different approach toward traditional learning as well. Instead of telling, the teacher must begin asking. Instead of answering questions that only align with their curriculum, the facilitator in this case must make it so that the student comes to the conclusions on their own instead of being told. Also, teachers are continually in conversation with the students, creating the learning experience that is open to new directions depending upon the needs of the student as the learning progresses. Teachers following Piaget's theory of constructivism must challenge the student by making them effective critical thinkers and not being merely a "teacher" but also a mentor, a consultant, and a coach.

Some strategies for teacher include having students working together and aiding to answer one another's questions. Another strategy includes designating one student as the "expert" on a subject and having them teach the class. Finally, allowing students to work in groups or pairs and research controversial topics which they must then present to the class.

Curriculum documents worldwide make explicit reference to the use of active learning approaches in the teaching of science. Active learning is anchored in the constructivist theory of learning. The constructivist theory has its theoretical foundations on Piaget theory of 'genetic epistemology'. According to Vygotsky, (1978); Driver and Bell (1986); Solomon (1987); Good & Brophy, (1995) the principle tenets of constructivism are, first learning is an active and social process. This therefore requires learners be actively engaged in learning in small social groups. This would engage them in negotiations of meaning of concepts and materials encountered as they actively construct new knowledge for themselves. Second, the responsibility of learning resides with the learner. This means that the learner has to choose to be actively involved in the learning process and should be willing and prepared to learn. Third, the role of a teacher is to facilitate the learning process by creating an appropriate learning environment. A teacher should plan for activities that actively engage learners and facilitate conceptual change. Fourth, learners' prior conceptions play a significant role in the learning process. Therefore, it is a teacher's responsibility to probe learners' prior conceptions to facilitate the provision of appropriate learning experiences that can enhance conceptual change. This will help learners to appreciate the relevance of science to real life and enable them deal with challenging concepts. The constructivist theory guided the development of TESSA OER based on five themes which include; probing students' understanding, making science practical, making science relevant and real, problem solving and creativity and dealing with challenging concepts.

2.4 Related Literature of the Study

The related literature explored issues reflected by the research questions. This addresses the awareness of integrated science teachers attitude towards Science OER,

their use of Science OER the benefits derived from TESSA Science OER and challenges faced when using TESSA Science OER

2.4.1 Teachers' Attitude towards Science OER

In the context of this study, it is anticipated that attitudes are latent and not directly observable, but that they nonetheless guide actions and behaviours that are observable (Simonson, 1979) which are used to determine an individual's attitude. Mishra and Singh (2017) ascertained that most teachers display a very positive attitude about creating and sharing OER, while being slightly less enthusiastic about using OER, Mishra and Singh further explained that educators' positive attitude towards Science OER was based on the belief that it would improve their professional image. Also Venkaiah (2008) reported a positive attitude among teachers towards Science OER in a study conducted in Indian Universities, This positive attitude did not however, result in increased use of OER in teaching and learning.

According to Westermann and Muggli (2017), an appreciable majority of the teachers indicated that the OER improved their learning outcomes. This assertion is confirmed by Cox and Trotter (2016) that most educators are quite positive about the potential of OER in their teaching, especially with regard to relevance. This sentiment is also shared by educators in Mongolia whose key concern was local relevance, irrespective of whether the material was openly licensed (Zagdragchaa & Trotter, 2017).

Wolfenden *et al.,* (2017) highlighted that the positive attitude exhibited by many teachers was based on the benefits they gained from exploring the OER. According to them, most educators ascertained that the use of Science OER gave them a quality benchmark which sometimes caused them to feel they were doing a substandard job compared to their international peers and that they were not using old methods. Similarly, Cox and Trotter

(2016) posited that educators used Science OER to check the quality of their teaching materials and Czerniewicz et al (2016) confirmed that educators' experience with OER exposed them to new open pedagogical strategies. This would eventually lead to the educators' positive attitude towards Science OER.

Conversely, de Oliveira Neto, *et al.,* (2017) reported in a study that 90% of instructors who had used OER were willing to use them again. This suggested that instructors' experiences with OER were positive enough to allow them to imagine future use opportunities. This again suggested that educators may also develop an attitude towards OER after using them, and their future use would depend on their attitude towards OER.

Some of the actions from some participants in several studies on TESSA used as determinants of participants' attitude towards TESSA Science OER. A set of variables identified in the literature relates to the personal attitudes of teachers towards TESSA Science OER (Van der Merwe, 2015), which includes their level of awareness around the concept (Mtebe & Raisamo, 2014), their intention to use OER (Lee, Yoon & Lee cited in Mishra & Singh, 2017) and their perception on OER's ease of use and pedagogical utility (Lee *et al.,* cited in Mishra & Singh, 2017).

Many teachers explained that the use of TESSA Science OER assisted students to develop more understanding of science through practical activities which complemented a positive attitude by the teachers towards TESSA Science OER (Shayo &William, 2015). Similarly, Wambugu and Keraro (2015) pointed out that teachers expressed positive attitude towards the TESSA Science OER as they found the materials useful for theory and practical lessons and enhanced learners' motivation and attitude towards learning of science. Also, in Ghana, in-service teachers confirmed a positive attitude towards TESSA Science OER by indicating that the modules enlightened them on the culture of reflective learning and

writing in their instructional activities (Essuman, 2015). In-service training teachers proved to have positive perception about TESSA Science OER when they indicated that the materials were excellent and that they provided adequate information on most of the topics in the Ghanaian science syllabus (Ngman-Wara & Acquah, 2015).

In conclusion, a positive attitude is developed if teachers perceive the TESSA materials to be beneficial in their classroom instructions, whilst a negative attitude may be developed if the materials are perceived not to be beneficial to their classroom instruction. Likewise, an easy access to the TESSA materials may create positive attitudes in teachers. On the other hand, if teachers find it difficult accessing the materials or they do not see the relevance in their classroom teachings then they may develop a negative attitude towards the TESSA Science OER.

2.4.2 Teachers' Use of Science OER

In a number of studies, the term "use" was employed to refer to copying original OER as well as adapting OER through some of versioning or combining (remixing (Hodgkinson-Williams, 2014). Globally, merely copying of the original OER material seemed to be a common practice amongst educators (Zagdragchaa & Trotter, 2017). However, some educators are identified for adopting the binary approach (version or combine) to OER use. Others either use OER in their original form with the textbook or reject it outright as inappropriate (Wolfenden et al, 2017).

Oates, Goger, Hashimi and Farahmand (2017) stated that most teachers use the OER to design their lesson plans effectively while some do not use any OER but relied solely on textbooks when preparing their lessons plans. This pattern is similar to Adala's (2017) study, which revealed that teachers used OER as a primary resource in their lesson plans while some of them supplemented and complemented their lessons with other resources

(textbooks), and even sometimes to the extent that they may not necessarily take a primary position.

Again, some educators perceived that because OER are free, they may be of poorer quality than the traditional, copyright educational materials sold by publishers (Boston Consulting Group, 2013) and thence might not use them. In contrast, other educators assume that OER would typically be of good quality because the OER materials are exposed to many expertise who may critique the materials if not appropriate (Stacey, 2007).

De Oliveira Neto, Pete, Daryono and Cartmill (2017) pointed out that the use of OER is low in Sub-Saharan Africa but comparatively in Africa, Ghanaian and Kenyan instructors had a higher OER use rate. In Sub-Saharan Africa including Ghana, most educators access the TESSA materials because the materials provide ideas for teaching, which is in line with the activity-based approach of their curriculum (Wolfenden, Auckloo, Buckler, & Cullen, 2017)

Masterman (2016) argued that there is a lack of a holistic repertoire of OER practices currently observable in the field. This means that it is very difficult to get evidence from OER users regarding the materials they use. Regarding this, Wolfenden *et al.,* (2017) stated, that the common OER used is evidenced in educators' lesson plans. Oates *et al.,* (2017) analyzed lesson plans as part of their study to identify changes in pedagogical practice by educators using OER. Their findings revealed the persistence of entrenched practices, such as using the textbook exclusively as the basis for lesson planning and delivery. Another evidence of Science OER use through lessons was reported in Ngman-Wara and Acquah's study (2015) where in-service science teachers used TESSA Science OER to prepare lessons for micro teaching sessions. The lessons provided an opportunity

for participants to acquire strategies for the integration of the resources in their lessons in the Ghanaian context.

Also, the use of TESSA materials had been found to be used by student teachers during teaching practice and this was meant to enhance the pedagogical experience of pre-service teachers (Wambugu & Keraro, 2015). Similarly, Shayo and Williams (2015) stated that teachers in Tanzanian schools who were introduced to the TESSA materials were using them in their teaching and learning activity. According to them Science teachers used the material as a means of assisting students to develop more understanding of science through practical activities.

De Oliveira Neto *et al.,* (2017) confirmed that few educators randomly adapt (modify) OER at least once. Several studies have indicated that though most teachers had experience using OER, many of them still continue to rely on the students' textbook to prepare lessons (Kasinathan & Ranganathan, 2017; Mishra & Singh, 2017). This contradiction may suggest that OER are deviation from entrenched practices and some teachers choose not to use OER despite having access to them.

2.4.3 Benefits Teachers derive in Using TESSA OER

TESSA is a demand-led research and development project providing a practical and scalable response to the huge need for more qualified and skilled teachers in sub-Saharan Africa (Moon, 2007; Wolfenden, 2017). TESSA, which focused on solving this challenge, was centred on the creation of a rich set of open educational resources, which could be adapted for multiple contexts and cultures to support classroom-focused teacher development (O'Sullivan, 2006). Since the emergence of the TESSA Science OER, students and teachers who have been introduced to have testified and have seen a tremendous improvement in its usage. A study conducted by Ngman-Wara & Acquah,

2015 in Winneba on Ghanaian Junior High Science Teachers' Reflections on the Use of TESSA Secondary Science Modules found out that the use of the TESSA resources provided innovative ways of presenting science lessons to pupils. Also, it helps the learners enjoy and fully participate in science lessons. A research conducted in Tanzania by Shayo and William (2015) on the use of TESSA materials concluded that, the use of TESSA materials in secondary schools and teacher colleges in Tanzania engages students into active learning environment as the materials contain both minds on and hands on activities. Through TESSA materials students can actively learn in groups through doing various activities related to their lessons, and also TESSA materials contribute to the availability of reference materials in the situation where schools and colleges lack enough books.

Onaifo (2016) asserted that, teachers have a positive attitude towards OER, and benefit from using the resources in multiple ways. They are motivated to use OER because the resources facilitate the completion of assigned academic tasks.

Acquah (2015) concluded that the use of the TESSA Lower Secondary Science OER will expose JHS science teachers to the needed content knowledge, which will enable them teach science effectively. Wolfenden, Freda, Umar, *et al.,* (2017) on their work using OER to improve teacher quality: emerging findings from TESSA stated that since 2008 TESSA OER have been integrated into teacher education programmes according to local needs, cultural, financial and policy environments. Data from early 2010 across 13 partner institutions in 9 countries shows:TESSA OER is use in 19 programmes (including B Ed, Diploma, Certificate and unaccredited CPD programmes), 690 teacher educators familiar with TESSA OER; in addition the Open University of Sudan reports awareness amongst

1,935 teaching supervisors, 303,300 teachers enrolled on programmes which use TESSA OER.

TESSA resources are OER, freely available in a variety of formats through the website. . As internet access increases it is likely that more teachers will use the TESSA tool kit directly to enhance their skills and further institutions will embed the use of TESSA resources in their programmes.

In all cases TESSA Science OER are supporting, and challenging, African teachers to experiment and reflect on their classroom practices.

In a study conducted by Wambugu and Karero (2015) study on improving science learning in Secondary Schools in Kenya, both pre-service and practicing teachers reported that TESSA Science OER, Enhance team work among teachers in lesson preparation, and also in the sharing of resources. The OER also enable teachers to link theory to practical experiences in the learning process. The OER enhance teachers' creativity and innovation developing learning resources. The materials help to minimize a teacher's monopoly in a lesson and encourage active learner engagement in science lessons. The materials were also found to encourage learners to link everyday experiences with what is learned in science lessons. In effect therefore the materials designated a teacher's role as a facilitator in the learning process.

The materials were found to provide an appropriate opportunity for learners to construct meanings for themselves and build on what they already knew. In addition the OER allow learner to share and exchange ideas with each other in the learning process. Because the OER are activity based, learners are able to develop science process skills, through active involvement in learning activities. Learners are therefore in a position to question their

prior conceptions as they tackle the tasks. This facilitates as smooth transition from misconceptions to conventionally acceptable scientific conceptions. The OER place emphasis on small group activities. This allows learners to workshayo in mixed ability groups and thus enhance the learning weak learners as they learn from their more able colleagues and in addition it boosts their self esteem.

2.5 Challenges Teachers face in Using Science OER

In spite of the factors that encourage teachers' use of OERs in classrooms, several studies have conducted empirical research on factors (barriers) that discourage the use of OER by teachers. Understanding the extent to which these barriers affect individuals and institutions may help in deciding how they are to be tackled (Becta, 2004). According to Wiley and Hilton (2009), four common obstacles to OER use and contributing are: the amount of time necessary to put OER in a format that can be shared, a desire to keep the resource from being seen by others; few if any external reward mechanisms for creating OER; and the concern that nobody will want to use the OER created. Several studies have revealed some of the challenges that affect the use of OER, among them include; infrastructure accessibility, time and internet bandwidth.

2.5.1 Infrastructure accessibility and IT skills

Effective adoption and integration of OER into teaching in schools depends mainly on availability and accessibility of technological resources such as computer and internet, software and smart-phones etc. This is confirmed by Yildrim's (2007) study, which identified access to technological resources as one of the effective ways to teachers' pedagogical use of OERs in teaching. Access to ICT infrastructure, computer tools, and resources in schools are necessary conditions for the integration of OER in education (Plomp, Anderson, Law, & Quale, 2009). Yet these facilities are lacking in many

institutions. Chigona and Chigona (2010) stated that lack of access to computer laboratories, and inadequate technological resources are factors that discourage teachers from using OERs in their teachings. Wolfenden *et al.,* (2017) also reported that limited access to laptops and desktop computers affect teachers use of TESSA Science OER.

Wambugu and Karero's (2015) study revealed that many schools lack ICT infrastructure such as computers and power. They further reported that shortage of computer facilities like printers hindered teachers from accessing the TESSA materials. They again indicated that printing cost was a big challenge to many of the teachers as they were not having personal computers.

According to Wambugu and Karero's (2015), many practicing teachers lacked the requisite ICT skills for accessing the TESSA Science OER even at the schools which had computers and internet connectivity. The effectiveness of OER environments in an international setting is highly dependent on the capabilities and skills of the recipients (OCLOS, 2007). Teachers need to be able to access the TESSA Science OER from the TESSA portal without difficulty and to easily integrate the TESSA Science OER into their lessons.

2.5.2 Time and internet connectivity

In line with the findings of numerous previous studies, the critical issue among the several challenges regarding the use of OER across all institutions is access to the internet (Wolfenden, *et al.,* (2017). The lack of OER internet facilities have been identified as a problem that affects teachers' access and use of TESSA Science OER (Shayo & William, 2015). Access to the internet is central and without it, individual use of OER is static. Many schools lack power and internet connectivity and therefore they do not promote OER use (Wambugu & Karero, 2015). Much of the reasoning around the selection of OER by educators was well understood on the fact that OER

reduce cost as compared to proprietary textbooks (Menon, Palachandra, Emmanuel &Kee, 2017). Contrary to this, the cost of internet for the access of OER has been confirmed to (as expressed through levels of satisfaction) affect OER use (Herrera, 2010).

High speed internet access is expensive. Currently the cost of access to such facility in African in times higher than that paid by developed world. To enhance access, TESSA Science OER are available as html pages in pdf and world format (Wolfenden *et al.,* 2017). Whilst the underpinning design of TESSA partial is premised on assumption that online mode of access and engagement will become more widely available, Wolfenden at al (2017) stated that it was envisaged that most teachers in sub-Saharan Africa would access the materials through the medium of print.

Peralta and Costa (2017) collected and analyzed data on teachers' confidence and competence may use of OERs in teaching. Their finding revealed that lack of teachers' times to learn new skills, large classes, and lack of collaboration among teachers was constraints to teachers' use of OER. Again, according to Wiley and Hiltons' (2009) study, one of the four common obstacles to OER use included the amount of time necessary to put OER in a format for classroom instructions.

2.6 Summary of Literature Review

The review looked at the detailed of activity-based teaching which TESSA Science OER is part as appropriate method for teaching science at the Basic Schools which aids in retention in the materials learned. The constructivism theory underpinned the study was as well explained with examples. The history of TESSA Science OER was covered, attitude of teachers towards the TESSA Science OER and how teachers use the TESSA materials to help improve the performance of the students was dealt with

and finally benefits derived in using the materials and challenges confronting the use of the TESSA modules were reviewed as well. A detailed account was reported on teachers' attitude towards TESSA OER, which suggested an overall attitude to be positive. Also, teachers' use TESSA Science OER suggested low usage.

The reviewed literature also identified some of the major challenges that prevent teachers from using TESSA Science OER such as ICT skills, OER - related hardware, and internet connectivity.

CHAPTER THREE

METHODOLOGY

3.0 Overview

This chapter provides detailed description of the methodology employed in the study. It discusses the research design, population, sample and sampling techniques, the research instruments, validity and reliability of the research instruments, procedure for data collection and method of data analysis and ethical considerations.

3.1 Setting

The study was carried out in the Bia West District with Essam/Debiso as the district capital in the Western North Region of Ghana. The district boundary with Ivory Coast in the north. It is also bounded in the East by the Bia East District, in the west by Juaboso District, and the South by Wiawso Municipal. The District has a land size of 1265.6527 sq. km with a population size of 88,939 people. The District has 247 communities, which have been zoned into six area councils namely, Adjoafua, Elluokrom, Akaatiso, Essam/Debiso, Yawmatwa and Oseikojokrom (Ghana Statistical Service, 2014).

The District with its educational office at Essam has 138 Primary Schools and 87 Junior High Schools (Private Schools inclusive). The District as well has 3 Senior High Schools and a College of Education known as the Bia Lamplighter College of Education. All schools in the District study Integrated Science as a subjects. The study was carried out in Bia Lamplighter Community Academy Basic School which serves as a demonstration school for the Bia Lamplighter College of Education.

Fig 2.1:Showing District Map of Bia West (Source: Ghana Statistics Service, 2014)

3.2 Philosophical Underpinning

The study is philosophically underpinned by the constructivist paradigm. Stake (1995) and Yin (2003) based their approach to case study on a constructivist paradigm. Constructivists claim that truth is relative and that it is dependent on one's perspective. This paradigm "recognizes the importance of the subjective human creation of meaning, but doesn't reject outright some notion of objectivity. Pluralism, not relativism, is stressed with focus on the circular dynamic tension of subject and object" (Miller & Crabtree, 1999, p. 10). Constructivism is built upon the premise of a social construction of reality (Searle, 1995). One of the advantages of this approach is the close collaboration between the researcher and the researched while enabling participants to tell their stories (Crabtree & Miller, 1999). Through these stories the participants are able to

describe their attitude of reality and this enables the researcher to better understand the participants' actions (Lather, 1992; Robottom & Hart, 1993).

3.3 Research Approach

The study adopted the qualitative research approach. Qualitative research consists of a set of interpretive material practices that make the world visible, and researchers study things in their natural settings, attempting to make sense of, or to interpret, phenomena in terms of the meanings people bring to them (Denzin & Lincoln, 2000). In particular, qualitative research is a naturalistic, interpretive approach concerned with understanding meanings, which people attach to phenomena within their social world. It is an in-depth and interpreted understanding of the social world of research participants by learning about their social and material circumstances, their experiences, perspectives and histories (Snape & Spencer, 2003). Qualitative research takes the premise that the social world is regulated by normative expectations and shared understanding. The norms in the society are obeyed for peaceful existence.

Qualitative study emphasizes the importance of understanding people's perspectives in the context of the conditions and circumstances of their lives. Thus, there is the need for researchers to employ heuristic principles, which refer to the theory and practice of interpretation. The researcher is not an objective, authoritative, politically neutral observer standing outside and above the text, but instead is historically positioned and locally situated as an observer of the human condition (Denzin & Lincoln, 2000).

In qualitative study, subjectivity of the researcher and of those being studied is a part of the research process. Researcher reflections on the actions and observations in the

field; their impressions, irritations, feelings and so on, become data in their own right, forming part of the interpretation. This is what qualitative research attempts to achieve (Creswell, 2014).

Science teachers responded to questionnaire items and were later interviewed. The basis of employing the qualitative approach was because it give a voice to study participants and ensure that study findings are grounded in participants' experiences (Wisdom & Creswell, 2013). Further, since different people hold different opinions and attitude about the world (Creswell, 2009; Johnson, & Christensen, 2012), it was ideal to get these different individuals' attitude and opinions on Integrated Science teachers' attitude towards TESSA Science OER and their use of TESSA Science OER in their classroom instructions.

3.4 Research Design

Burns (2000) defined research design as a blueprint for conducting a study with maximum control over factors that may interfere with the validity of the findings. A research design also refers to a detailed plan of how a research study is to be conducted by operationalizing variables to be measured, selecting samples of interest, and process of data collection to answer research questions and testing hypothesis, and the analysis of data (Creswell, 2014). Amedahe (2002) has noted that in every research study, the choice of a particular research design must be appropriate to the subject under investigation, and that the various designs in research have specific advantages and disadvantages.The purpose of research design is to achieve greater control of the study and to improve the validity of the study by examining the research problem (Bryman 2012). The study adopted the single case study research design (Barbie, 2012).

3.5 Population of the Study

Population is the entire aggregation of respondents that meet the designated set of criteria Bryman (2012). The target population for this study was all basic school Integrated Science teachers in the Bia West District. The accessible population was all public basic school Integrated Science teachers in the Bia West District. The accessible population was all Integrated Science teachers in the Lamplighter Community Academy Basic school made up of 8 teachers at the primary school level and 10 teachers at the JHS level.

3.6 Sample and Sampling Procedures

For purposes of accessibility and proximity, the Lamplighter Community Academy Basic school within the Debiso circuit was conveniently selected where the researcher happens to be the Head teacher for the school. A sample of six (6) teachers were interviewed for the study. Purposive sampling is one in which the researcher selects participants based on the purpose of the study. Maxwell (2005) defined purposive sampling as "a selection strategy in which particular settings, persons or activities are selected deliberately in order to provide information that cannot be gotten as well from other choices" (p. 88). Selecting Science teachers to be interviewed for this study was purposeful. The justification being that, Bia Lamplighter College of Education's core mandate is to train professional teachers and shares the same compound with the school, the Science teachers selected are all professional teachers trained by either UEW or UCC and already had some idea TESSA Science OER since these institutions have implemented the use of the OER in some of the courses they offer.

3.7 Instrument for Data Collection

Primary qualitative data was collected using semi-structured interattitude.

3.7.1 Semi-Structured Interattitude

I conducted six semi-structured interattitude on Integrated Science teachers in the Lamplighter Community Academy Basic school. The interview guide included demographic characteristics and other information relating to the research questions under study. The semi-structured interview guide centered on the collecting data on the qualitative research question for the study. The semi-structured interview guide made up of open-ended items to illicit responses from the respondents (Appendix A). The interview guide consisted of eleven items used to elicit the attitude, examine how often, benefits, challenges Integrated Science teachers' face when using TESSA Science

This falls in Bryman, (2008) view that it is "to glean the ways in which research participants view their social world" (p45). Berg (1998) added that these interview questions are typically asked of each interviewee in a systematic and consistent order, but the interviewers are allowed freedom to digress, that is, the interviewers are permitted (in fact expected) to probe far beyond the answers to their prepared and standardised questions. Creswell (2009) posits that interattitude have the potential to focus on understanding the thinking and behaviours of individuals and groups in specific situations. The interview is often viewed as a conversation between the interviewer and interviewee, in which the interviewer asks questions and the interviewee responds accordingly (Esterberg, 2002). First, qualitative interviewing is appropriately used when "studying people's understanding of the meaning in their *lived world*" (Kvale, 1996, p. 105). Second, the purpose of interviewing is to

find out what is in and on someone elses mind. “We interview people to find out from them those things we cant observe” (Patton, 1987, p. 196). Third, qualitative interattitude result in thick descriptions of the subject being studied that enable readers to make decisions about transferability of study results (Merriam, 2002). Finally, interattitude allow for triangulation of information obtained from other sources and, thus, increase the credibility of study findings (Emerson, Fretz, & Shaw, 1995; Merriam, 2002; Stake, 1995).

The justification for employing interview guide as a data collefction tool was because interattitude are flexible, allowing in-depth analysis from a relatively small sample size and place the focus of research on the attitude of participants. Further, the interviws are flexible and allow the interviewee to speak freely on the phenomena, a semi-structured interview is being examined. It allows people to freely and openly voice their opinions and concerns. If you elect to employ interattitude, Babbie and Rubin (2009) point out that you must decide whether to take notes (which is distracting) or film the interview (which is accurate but time consuming). Another option is to depend on one's memory to recollect what was said, or to ask respondents to write down their responses.

3.8 Trustworthiness of Interview Guide

Because qualitative research entails the researcher taking an active role in the collection and interpretation of others’ meaning making, to be credible, qualitative researchs must be rigorous and trustworthied. Stake (1995) cautioned qualitative researchers against narrow thinking, and instead suggested that researchers learn to understand their research as their participants do, rather than impose their own assumptions. In qualitative research, these protocols come under the name of,

"triangulation" (p.109). To increase the trustworthiness of the study's findings, the researcher employed strategies recommended by renowned qualitative researchers such as Lincoln & Guba, (1985) and Merrian (2002). In order to reduce threats to credibility (Lincoln & Guba, 1985), suggested qualitative researchers;

(a) to establish the trustworthiness of a qualitative study researchers have to ensure: credibility, transferability, dependability, and confirmability of qualitative findings (Babbie, Mouton, Voster & Prozesky, 2009). In this study, the researcher adopted Babbie, *et. al.* (2009) model of establishing trustworthiness as a means of evaluating the worth of the study through elements such as confirm, dependable and transfer of instrument. The model was adopted because it was conceptually developed and is widely accepted and used by qualitative researchers.

I) Credibility

The semi structured interview guide was subjected to credibility test to determine how confident the researcher is in the truth of the research findings (Babbie, *et, al.* 2009). The credibility of this study was increased by the use of member checks. This was determined through peer review process where the recorded interview responses and transcripts were presented to participants to verify.

II) Transferability semi structured interview was subjected to transferability to determine how the researcher demonstrated that the research findings were applicable to other context (Patton, 2007). To facilitate transferability of the results, the researcher provided vivid description of the ABL approach purposively.

III) Confirmability

Confirmability refers to a proof that data and interpretation of findings are not fabrications from the researchers' imaginations, but are truly derived from participants (Babbie *et, al.* 2009). To establish this, the audio recording were played back to the respondent to compare to the transcriptions. The qualitative findings were also highlighted by the researcher in every step of data analysis to provide justification for the decision taken (audit trial).

All researchers attempt to design and implement good/ethical and trustworthy studies. Indeed, qualitative researchers believe that if a study is credible, it has to be good in the ethical sense and be trustworthy.

Also, specific and identifying information about respondents, such as names, addresses, emails and age were not collected. Again, recordings of the interview sessions were privately kept and were not shared with any third party.

3.9 Data Collection Procedures

An introductory letter was obtained from the Head of Department of Basic Education, University of Education, Winneba was used to seek for permission from the Director of Bia West Education Office of the Ghana Education Service (GES) to collect the data for the study. A consent letter was issued to be given to the Headmaster and the Integrated Science teachers for the study. The researcher agreed on dates with the participants on the dates to interview them. The one-on-one semi-structured interview was used to collect the interview data. This was done to give the respondents the opportunity to freely express themselves in responding to the questions. In the interview, a tape recorder was used to record the voice responses of the participants.

Follow up questions were asked for clarification on the responses to the questions and probe some of their responses.

3.10 Data Analysis

A qualitative case research study involves a continuous interplay between data collection and data analysis (Strauss & Corbin, 1994). The researcher began analyzing data following the first interview to begin identifying patterns, and to facilitate subsequent data collection (Strauss & Corbin, 1998). Interattitude were audiotaped, transcribed (invivo) and analyzed thematically (inductive analysis) using a qualitative data analysis software, ATLAS.ti.

Thematic analysis is the method for identifying, analyzing and reporting patterns (themes) within data (Braun & Clarke, 2006;77). An inductive approach means the themes identified were strongly linked to the data itself (Patton, 1990). This method of analysis was appropriate because it is a flexible and useful research tool which can provide a rich and detailed, yet complex account of data. Prior to importing thr transcripts into ATLAS.ti software, the transcripts were read severally and summarized under themes based on the areas covered by the interview guide (Miles & Huberman, 1994), namely the attitude and use TESSA Science OER and benefits and challenges faced by teachers in accessing and using the TESSA materials. The transcripts were sent to the respondents to check for accuracy.

Further corrections were made and the corrected transcripts were used for discussion of the study. Stake (1995) contended that in qualitative analysis that, “there is no particular moment when data analysis begins (p. 71), which in this case made the researcher to analyze the interview data under the major themes of the research questions.

Following data transcription, I quickly immersed myself into the data to familiarize myself with the data. The audio-recorded interattitude were transcribed verbatim. This was achieved through repeated reading of transcripts. The transcripts were sent to the respondents to check for accuracy. Further corrections were made and the corrected transcripts were used for discussion of the study.

This transcripts were imported into ATLAS. Ti software and codes were generated inductively. The codes were finally developed into themes. This was done by rereading and identifying and establishing relationships among ideas and putting them into sets on the basis of logical similarities. The data were organised under the various themes generated from the codes to facilitate the discussion.

3.11 Ethical Considerations

Any social research study raises ethical considerations. This is because the research involves collecting data from people, and about people. There are numerous issues of ethical consideration in social research which the researcher needs to discuss with the participants. Punch (2001) summarised the main ones as; access, informed consent, deception, privacy, and confidentiality of data. It is unethical to collect information without the acknowledgement of participants, their informed willingness, and expressed consent. The ethical values considered were informed consent, anonymity, and confidentiality. Before the administration of the research instruments, permission was sought from respondents of the school and the purpose of the research was clearly explained to them.

After deciding on the setting of the study, the next important decision relates to how to obtain permission to access the place for the research. With this, the researcher first sought the consent of the school authorities of Sefwi Debiso. The purpose of the

study was stated to them, the procedure for the data collection and the type of research participants needed were also stated to them.

After the researcher has sought permission from the authorities, it was important for the researcher to gain informed consent of the participants of the study. Informed consent is an agreement of the relevant individual and organizations on the basis of appropriate information. It involves giving information about the study, how the study was carried out, the nature of their participation, the time requirement, the kind of data to be collected, and how it will be used and reported. This enabled the participants to decide to participate in the study or not. People make decision to participate in the study depending on the quality of information they receive from the researcher.

Anonymity and confidentiality of all participants were strictly ensured. Participants were encouraged to participate voluntarily, and participants were informed that they could withdraw from the study at any time, if they wish to do so. The researcher promised the anonymity of the research participants by ensuring that the names and addresses of the participants were not indicated in the study. These were replaced with codes. They were ensured that recorded information, instrument for the data collection, and dissemination of research finding did not contain the names of the research participants.

The research information gathered from the participants were not passed on to the department. All audio-recorded information was protectively stored in a personal recorder and later transferred to a personal password-protected laptop.

CHAPTER FOUR

DATA PRESENTATION AND DISCUSSION

4.0 Overview

This chapter presents the data obtained from the research respondents and its discussion of findings. It is presented in two sections. The first section deals with the demographics of the respondents whilst the second section deals with the data generated on Integrated Science teachers' attitude, use, benefits and challenges of the TESSA Science OER in Lamplighter Community Academy Basic School.

4.2 Demography of Respondents

The participants of this study comprised of six Integrated Science teachers in Lamplighter Community Academy Basic School. Their ages ranged 25 to 40 years old; one female, and five males. On average, participants had seven years experience of teaching integrated science. One participant reported fewer than five years of experience in teaching science. Four out of the six teachers were teaching in the Junior High School whilst the remaining two were teaching in the Upper Primary. Four teachers claimed to have had their Bachelor's degree in Basic Education from University of Education, Winneba (UEW) with the other two from the University of Cape Coast (UCC) with same qualifications.

All respondents were aware of the TESSA Science OER with the two Upper Primary Teachers excited and quick to draw the similarities in activities between the TESSA Science OER and the New Standard based Curriculum which they had had training on two months earlier to the time of this study.

Results from individual interattitude

4.3 Analysis of Interview Data

Four themes emerged from the data based on the research questions:

1. Integrated Science teachers' attitude of towards TESSA Science OER
2. Use of TESSA Science OER by Integrated Science teachers
3. Benefits derived in using TESSA Science OER
4. Challenges associated with the use of TESSA Science OER

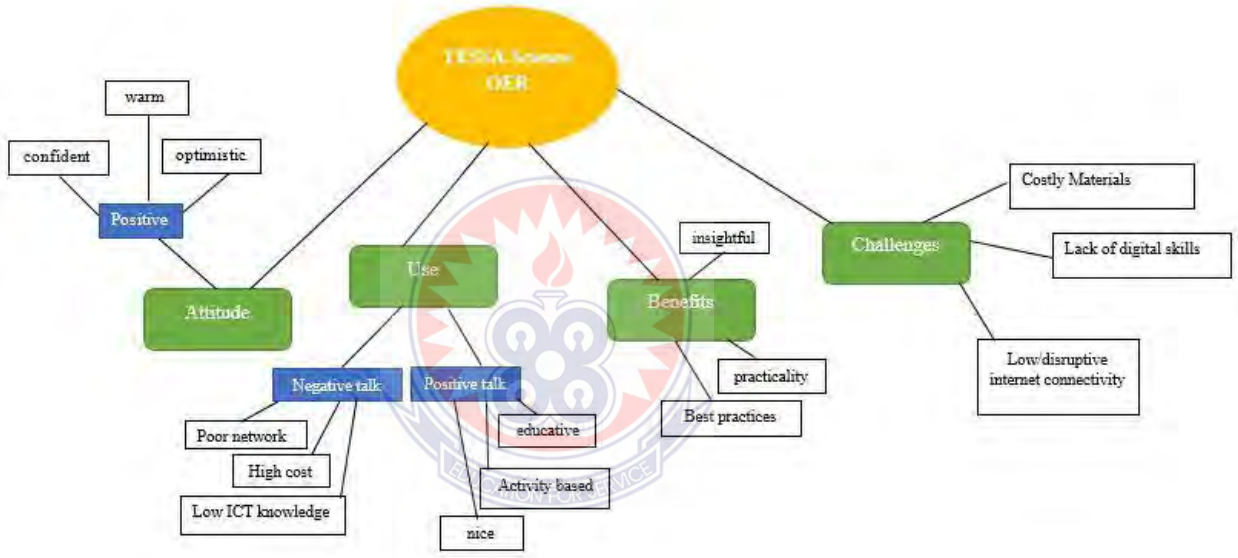

Fig 2: Thematic Framework of Attitude, Use, benefits and Challenges of TESSA Science OER

4.3.1 Research Question One: What are the attitude of Integrated Science teachers in Lamplighter Basic School towards TESSA Science OER?

Generally, respondents expressed positive attitude about the use of TESSA Science OER materials. Most respondents recounted how they got to know about TESSA OER in the following excerpts:

I asked about respondents' attitude towards TESSA Science OER after accessing it.

Below are some excerpts from the interview.

Teacher 1said;

"...I can confidently say that I exhibit positive attitudes towards the TESSA Science materials are activity oriented and very resourceful".
B, II with Integrated Science Teachers, Jan 2020

Teacher 4 said;

"It makes teaching and learning veeery very creative and meaningful so I always show warm attitudes towards its use".
B, II with Integrated Science Teachers, Jan 2020

Teacher 3 said:

"My attitudes towards TESSA Science OER is optimistic because using the materials for instruction makes teaching easier and also makes learners active participants"
B, II with Integrated Science Teachers, Jan 2020

The researcher was in the quest to find out if the respondents have you been using

TESSA Science OER after school. Below are some accounts;

Teacher 2said:

"Mmm yea, it is very nice and educative and had a lot of activities but I don't use it always due to poor network".
B, II with Integrated Science Teachers, Jan 2020

Teacher 5 said:

"It was introduced to me by my colleague in my former school. I remember I was once teaching living and non-living things and he came in to help me with a nice story and activity. So he introduced me to the TESSA site after the class and it was nice materials looking at the case studies and local materials used. My colleague had come from UCC as fresh science teacher and the students loved him so much"
B, II with Integrated Science Teachers, Jan 2020

Researcher: When was that and how do you see the materials?

Teacher 5 said:

"It is almost three years now. But because of my poor knowledge in IT and internet connectivity I don't normally go to the site. It was recently and after the training workshop that I tried accessing it and got to know that it is indeed made up of relevant teaching resources. In fact the materials are fantastic".
B, II with Integrated Science Teachers, Jan 2020

Teacher 4 stated:

"TESSA Science OER was first introduced to me at school. It was part of our general methods of teaching course in my first year at the Department of Basic Education, University of Education, Winneba. Much of TESSA OER was not done so I decided to access the materials myself. The training workshop further sustained my interest".
B, II with Integrated Science Teachers, Jan 2020

Respondents were further asked if they like the materials.

Teacher 4 stated:

"Yes, the materials are really good for the students".
B, II with Integrated Science Teachers, Jan 2020

Teacher 3 said:

"*I think TESSA Science OER is part of the methods of teaching courses in the University of Cape Coast, Basic Education where I had my first degree. In the first year, we were introduced to the TESSA Science OER. The printing of the modules from the website derail my interest but after rekindling my interest through the workshop I started accessing the materials."*
B, II with Integrated Science Teachers, Jan 2020

I further asked how respondents perceive TESSA Science OER. Respondents' acconts are stated below.

Teacher 1said;

"It is very resourceful…"
B, II with Integrated Science Teachers, Jan 2020

Teacher 2 said;

"It is very nice and very educative"
B, II with Integrated Science Teachers, Jan 2020

Teacher 6 said;

"Very excellent"
B, II with Integrated Science Teachers, Jan 2020

4.3.2 Research Question two: How often do Integrated Science teachers in Lamplighter Basic School use TESSA Science OER in their Science lessons?

I explored the number of times or how frequent respondents use the modules in their lesson preparation and delivery.

Teacher 1 stated :

"Yes I have sometimes been using it in my instruction".
B, II with Integrated Science Teachers, Jan 2020

Teacher 2 said:

"I have been using it every now and then to achieve my objectives and when I use the TESSA Science OER,the pupils are engaged and I only have to serve as a facilitator to them".
B, II with Integrated Science Teachers, Jan 2020

Teacher 4 said:

"On numerous occasions I use it to teach because of how learner centered it is".
B, II with Integrated Science Teachers, Jan 2020

These depit that the teachers develop their teaching activity based on leaner-centered approach and therefore plan their lessons on activity-based methods. Most of them confirmed that the activities found on TESSA Science OER site are compatible with their teaching style and hence use TESSA Science OER materials in lesson preparation and delivery.

4.3.3 Research Question three: What benefits do Integrated Science teachers derive in using TESSA Science OER in their Science lessons?

The complementary role of TESSA Science OER identified from the literature is that they generally make the process of teaching and learning easier and faster. TESSA Science OER are generally used by teachers to gain a better grasp of ideas and concepts when required. For example, before or after being presented with a challenging topic to handle, a teacher who is struggling with the understanding of certain ideas may access certain OER, such as video lectures, to gain a better understanding of the issues such as using additional channels of teaching, such as video lectures, podcasts of topical issues, and simulations to augment learning. In this study, the participants reported consulting certain OER to understand better specific topics or subjects that have not been clearly explained in either textbooks, or other teaching materials. Essentially, the participants perceived the TESSA materials as additional tutorial materials for teaching about specific topics about which they wish to be more knowledgeable.

In response to some benefits Science Teachers derive from TESSA Science OER, Teacher 6 contended that:

"Not all activities or examples are provided in the textbooks and the syllabus so you as a teacher have to be innovative at times by getting extra information somewhere which are in line with your objectives, and I think the TESSA Science OER provides the exact information needed to save the situation.

Teacher one indicated that;

"Sometimes, there may be an actual shortage of teaching and learning materials, thus, making the overall teaching process tedious. Surely, having timely access to a variety of information and learning resources makes the process of teaching and learning easier and quicker. Two teachers reported that the existence of TESSA Science OER, particularly as digital materials, makes access to learning materials faster and the learning process easier. They noted that sometimes official learning resources, such as textbooks are not always available or sufficient, and using TESSA Science OER becomes the only viable option".

B, II with Integrated Science Teachers, Jan 2020

Teacher three revealed that;

"The use of TESSA materials have really made teaching so easily for me and it is motivating to my students".

B, II with Integrated Science Teachers, Jan 2020

Teacher two revealed that;

"Because it is learner centered, students learn at their own pace and own their knowledge".

B, II with Integrated Science Teachers, Jan 2020

Teacher four stated that;

"The use of TESSA materials have really made teaching so easily for me and it is motivating to my students".

B, II with Integrated Science Teachers, Jan 2020

Teacher five revealed that;

"Even though it is stressful,there are so many benefits such as my students improving tremendously academically".

B, II with Integrated Science Teachers, Jan 2020

4.3.4 Research Question Four: What kind of challenges do Lamplighter Integrated Science teachers face in using TESSA Science OER?

This theme sought to find out the problems integrated science teachers face in accessing and using TESSA Science OER. The items on the problems mainly focused on cost of access, disruptions experienced, lack of digital access to OER.

On the challenge dealing with cost of access, many accounts were given by respondents. Teacher one contended that;

"*I have a laptop that can only work when powered on electricity. When the light goes off, I can't use it to teach because my battery is spoilt"*

B, II with Integrated Science Teachers, Jan 2020

Teacher two revealed that;

"*Going online depends largely on internet data which is too expensive to buy by some of us"*

B, II with Integrated Science Teachers, Jan 2020

Teacher three revealed that;

"*I don't have money to buy laptop computer but if the schhol would buy some for us that would be fine"*

B, II with Integrated Science Teachers, Jan 2020

Another challenge experienced by respondents was the disruptions in internet connectivity.

Teacher one contended that;

"*Most of the time the signal will come on and off and I cant access the link"*

B, II with Integrated Science Teachers, Jan 2020

Teacher two revealed that;

"*In my area the only network available is MTN, the signal is very weak and it takes time for a page to open"*

B, II with Integrated Science Teachers, Jan 2020

Teacher three stated that;

"*When I bundle data to access online services, in no time, the bundle finishes and this affects my lesson delivery"*

B, II with Integrated Science Teachers, Jan 2020

Teacher six said that;

data is costly, especially on android phones. It is very expensive

B, II with Integrated Science Teachers, Jan 2020

On the challenge dealing with skill level of respondents, many accounts emerged.

Teacher one contended that;

"*it is very difficult to access online materials. Some of us have low knowledge of ICT use"*

B, II with Integrated Science Teachers, Jan 2020

Teacher two revealed that;

"*As for me, even though I can use the laptop, I have some difficulty with using the internet"*

B, II with Integrated Science Teachers, Jan 2020

Teacher three revealed that;

"*I don't have sufficient knowledge in using the internet, I am BBC [Born before Computer]"*

B, II with Integrated Science Teachers, Jan 2020

In contrast some respondents stated that, they experienced no challenge in accessing TESSA OER materials for teaching and learning.

Teacher 6 said:

First of all, I want to say I don't have any challenges because I have a good device, and the network is usually good these days. So basically, and I normally go the college IT centre to access the wifi…

B, II with Integrated Science Teachers, Jan 2020

4.4 Discussion

The purpose of the stud was to investigate Integrated Science teachers' attitude towards TESSA Science OER and their use of TESSA Science OER in their classroom instructions. Primary qualitative data was collected using semi structured interview guide. Results on research question one revealed that respondents exhibited positive attitude towards TESSA Science OER. Their positive attitude was based on the relevance of TESSA Science OER in their classroom instructions. Clearly, participants had positive impressions of TESSA Science OER. Other than the ease of access, as well as making the process of teaching and learning easier. One of the Upper primary teachers who had training on the new standard based curriculum said she thinks the resources are particularly required to support teaching in Ghanaian schools:

Generally, I think it is more beneficial to us as Ghanaians because of how our teaching and learning is here. I don't think the learning here is sufficient. That's why we are really going extra. I think it will be better if learning in our classrooms are improved to the maximum capacity. I think the new curriculum has some element of TESSA in it looking at the activities which make students enjoy the lessons. In essence, participants liked to use TESSA OER because they offer potential benefits for both teachers and learners. In addition, the respondents appreciated that the TESSA materials help them to get variety of teaching methods and activities to

deliver their lessons. This supports the assertion outlined by Wambugu and Keraro (2015) that teachers expressed positive attitude towards the TESSA Science OER as they found the materials to be useful for theory and practical lessons and enhance learners' motivation.

Result on research question two indicated that respondents considered the TESSA Science OER as being appropriate in their content due to the enormous roles it play in enabling them to gather information from numerous angles. It was evident that the perceived utility of TESSA Science OER was instrumental in participants' attitudes toward the resources. This confirms the findings of Ngman-Wara and Acquah (2015) that the TESSA materials are excellent and that they provide adequate information on most of the topics in the Ghanaian science syllabus. Furthermore, the respondents agreed that TESSA Science OER gives them opportunity to learn new strategies and to enhance their instructional activities owing to the nature in which its use make instructors to employ numerous teaching and learning activities in the classroom. This finding is in line with Czerniewicz *et al.*, (2016) who confirmed that Science OER exposes educators to new open pedagogical strategies. Again, this finding confirms the statement that in Sub-Sahahran Africa including Ghana, most educators access the TESSA materials because the materials provide ideas for teaching, which is in line with the activity-based approach of their curriculum (Wolfenden, Auckloo, Buckler, & Cullen, 2017). This finding again corroborates Cox and Trotter (2017) assertion that most educators are quite positive about the potential of OER in their teaching, especially with regards to relevance. The interview further revealed that almost all the respondents really got to know about TESSA Science OER through their course of study. From the interview 'data, most of the respondents were convinced to access the TESSA OER by themselves as they shared their TESSA experiences. The interview

intended to find out their attitude for using TESSA Science OER. Essentially, all research participants were positively impressed with TESSA Science OER. The statement below, is a response to questions relating to a particular teacher's attitude towards TESSA OER, encapsulates this point insightfully. Participants' attitudes toward TESSA Science OER were strongly related to their perceived usefulness of the resources. This finding is supported by some of the principles of expected utility theory. According to Morgin (1977), the theory, in a basic sense, suggests that the decision to make use of certain resources is determined by their expected usefulness.

Result on research question three revealed that respondents agreed that TESSA OER have an additional or complementary role in their teaching and learning endeavors. In addition, given the difficult process of accessing official teaching and learning materials such as textbooks, TESSA OER provides an easy and quick alternative for teachers looking for teaching resources to complete many topics from the official curriculum. These mean that owing to the challenges in accessing official teaching and learning materials such as textbooks, TESSA Science OER provides an easy and quick alternative for teachers looking for teaching resources to complete many topics from the official curriculum. Finally, TESSA Science OER, particularly as digital materials, makes access to learning materials faster, improves pedagogical practices, and also makes the learning process easier (DeRosa, & Jhangiani, 2017).

The finding corroborates that of Wambugu and Keraro (2015) who contended that the use of TESSA materials enhanced the pedagogical experience of pre-service teachers. Similarly, Shayo and Williams (2015) stated that teachers in Tanzanian schools who were introduced to the TESSA materials used them in their teaching and learning activity. According to them Science teachers used the material as a means of

assisting pre-service teachers to develop their pedagogy and to improve their understanding of Science through practical activities.

Results on research question four showed that using OER presents several challenges. While the challenges educators face in using TESSA OER have been discussed well in the literature (UNESCO, 2002; Walsh, 2011; McGreal *et al.,* 2013; Mtebe & Raisamo, 2014), the challenges teachers in Sub Saharan Africa (SSA), including Ghana, face in using the resources have not been given a great deal of attention through empirical studies. One of the primary objectives of this study was to understand the challenges the teachers who participated in this study encountered in using TESSA Science OER. The analysis revealed the emergence of three core categories representing the challenges of using the resources. The categories are: (a) dealing with the cost of access, (b) experiencing disruptions, and (c) lacking sufficient skill for access. These results are elaborated upon in the next subsection.

Dealing with the cost of access

There are costs associated with using online resources such as TESSA Science OER. For some users, the cost of being online represents a significant challenge to the access of digital materials. It is important to note that the cost of online access varies from place to place. Nevertheless, the cost of online access in SSA is likely more adversely impactful on users because of the prevalence of poverty and other infrastructural challenges (Diallo, Thuo, & Wright, 2012). The responses of participants showed that cost is a challenge in the use of TESSA Science OER. On the whole, there were two main sources of financial worries regarding the use of Science OER reported by participants in this research: the cost of Internet subscription and the cost of purchasing Internet-enabled devices. It was established that the cost of being online represents a significant challenge to the access of

TESSA Science OER digital materials. Similarly, Herrera (2010) reported that the cost of internet for the access of OER has been confirmed to (as expressed through levels of satisfaction) affect OER use. Also, the irregularity of internet service was a major challenge to participants' use of TESSA Science OER pointing out that there are periods of time when access to the internet is unavailable. There are also instances of poor internet connection, whereby access to the network is possible, but it is spotty or too slow to support many regular online activities, including downloading and retrieving digital materials. The finding is similar to that of Shayo and William (2015) who contended that the lack of OER internet facilities are problems that affect teachers' access and use of TESSA OER. Similarly, Wambugu and Karero (2015) reported that access to the internet is central and without it, individual use of OER is static.

In addition, the lack of adequate knowledge for integrating TESSA Science OER in their lesson plans due to lack of the necessary computer hardware and skill for the access and adoption of TESSA Science OER posed a challenge to the use of Science OER. Similar result was found by Wambugu and Karero (2015) who pointed out that many practicing teachers lacked the requisite ICT skills for accessing the TESSA Science OER even at the schools which had computers and internet connectivity which in turn hinder the usage of the TESSA Science OER. Again, the respondents considered the TESSA Science OER as expensive because of the cost involved in the purchasing of internet data. It was disclosed that the use of the TESSA Science materials was also time consuming due to the activity-based nature of the TESSA materials and also their workloads which repels them from accessing the TESSA Science OER.

Experiencing disruptions

Access to the internet is increasingly becoming a basic necessity. As Haight, Quan-Haase, and Corbett (2014) indicated, the "lack of access to the internet can significantly undermine efforts to obtain employment, access current news and debates, and secure online government services" (p. 504). When we talk about the challenges of using digital resources, such as OER, the issues that naturally come to mind may include lack of awareness of the resources and quality assurance. In other words, consideration is given to how well users are able to locate, assess, and access relevant open materials within the vast maze of content online. However, accessing digital resources also involves being able to remain online long enough to retrieve desired materials. Thus, poor, irregular, or complete lack of access to the Internet would be a challenge for users of any online digital materials. As noted in these responses, the irregularity of internet service is a major challenge to participants' use of TESSA Science OER. There are also instances of poor internet connection, whereby access to the network is possible, but it is spotty or too slow to support many regular online activities, including downloading and retrieving digital materials. Participants reported that irregular and poor internet connection made it difficult, or sometimes impossible, for them to access the TESSA Science OER. On the whole, a good internet access experience requires certain kinds of devices, as participants reported. The cost of devices adds up to the overall cost of access to the Internet and to OER. As noted earlier, even though the cost of access was not necessarily a problem for all teachers, some participants reported finding it challenging to acquire devices well equipped for accessing online resources such as the TESSA Science OER.

Lack of digital skill to access OER

The rapid advancement and sophistication of online applications and computer programs mean that users require diverse digital skills in order to adopt and use such applications and programs. After gaining online access, possessing the required skills to navigate online spaces is essential for the efficient retrieval of online resources, such as TESSA Science OER. Evidently, digital skills are not equally spread among users, and younger users, particularly students at institutions of higher education, tend to experience far less operational and skill-related problems when accessing OER (Van Deursen & Van Dijk, 2009). However, the participants in this study found it challenging to efficiently access certain online resources because they did not possess adequate IT skills to do so. Van Deursen and Van Dijk (2009) mentioned several digital skills required for successful online navigation, including the knowledge of content provided by digital media and the application of proper information search behaviour.

Clearly, for almost all the participants, the cost of access to Science OER was a challenge. The second challenge related to the cost of accessing TESSA Science OER was that of purchasing internet-enabled devices, such as smartphones, tablets, and computers. Considering the economic circumstances of the teachers in the population under investigation, affordability of Internet-enabled devices may be quite challenging.

It was established that the cost of being online represents a significant challenge to the access of TESSA Science OER digital materials. Similarly, Herrera (2010) reported that the cost of internet for the access of OER has been confirmed to (as expressed through levels of satisfaction) affect OER use. Also, the irregularity of

internet service was a major challenge to participants' use of TESSA Science OER pointing out that there are periods of time when access to the internet is unavailable. There are also instances of poor internet connection, whereby access to the network is possible, but it is spotty or too slow to support many regular online activities, including downloading and retrieving digital materials. The finding is similar to that of Shayo and William (2015) who contended that the lack of OER internet facilities are problems that affect teachers' access and use of TESSA OER. Similarly, Wambugu and Karero (2015) reported that access to the internet is central and without it, individual use of OER is static.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.0 Overview

This chapter presents the summary of the study, main findings, conclusions and recommendations. The summary of the study focuses on the rubrics that guided the study. The main findings seek to address the research questions of the study. The chapter also presents some suggestions for further studies.

5.1 Summary of the Study

The study was conducted to explore Integrated Science teachers' attitude and use of TESSA Science OER in Lamplighter Community Academy Basic School. The objectives of the study were to:

1. find out the attitude of Integrated Science teachers towards TESSA Science OER in Lamplighter Basic School.
2. examine how often Integrated Science teachers' use TESSA Science OER in their lesson deliveries in Lamplighter Basic School.
3. examine the benefits Integrated Science teachers derive in using the TESSA Science OER.
4. examine the challenges Integrated Science teachers' face when using TESSA Science OER.

Piaget's theory of constructivism was adopted for the study. The study employed the qualitative and interpretivist as its approach and paradigm respectively. Case study was the design employed for the study. The population for this study was all basic school Integrated Science teachers in the Bia West District. The accessible population was all public basic school Integrated Science teachers in the Bia West

District. The target population was all Integrated Science teachers in the Lamplighter Community Academy Basic school. Purposive sampling was employed to select six participants for the study. Instrument employed for gathering data was an interview. Data were analyzed using thematic analysis.

5.2 Main Findings of the Study

The main findings of the study were;

Integrated Science teachers attitude on TESSA Science OER:

1. Integrated Science teachers had positive attitude towards TESSA Science OER due to the tremendous roles it play in enabling them to design appropriate instructional strategies for students to meaningfully grasp Integrated Science concepts.
2. The Integrated Science teachers teaching in Bia West District considered TESSA Science OER as appropriate for their content due to the enormous roles it play in enabling them to gather information from numerous angles.

Integrated Science teachers use of TESSA Science OER;

1. Teachers' often use the TESSA OER resources in their lesson delivery although they faced some challenges with its use.

Benefits Integrated Science teachers derive in using TESSA Science OER;

1. TESSA Science OER give teachers an additional or complementary role in their teaching and learning endeavors.
2. TESSA Science OER provide an easy and quick alternative for teachers looking for teaching resources to complete many topics from the official curriculum.
3. TESSA Science OER improves learner centered approach to teaching and learning and is motivating to learners.

Challenges affecting Integrated Science teachers' use of TESSA Science OER;

1. The cost of being online represents a significant challenge to the access of TESSA Science OER digital materials.
2. The irregularity of internet service is a major challenge to Integrated Science teachers use of TESSA Science OER.
3. Poor internet connection, resulting in the delay of downloading and retrieving digital materials pose problems Integrated Science teachers use of TESSA Science OER.
4. The resources necessary to access TESSA OER are expensive and requires technological skills by Integrated Science teachers.

5.3 Conclusion

The findings demonstrated that Integrated Science Teachers in Bia West District employ TESSA OER materials throughout their lesson despite certain hurdles due to the benefits received by teachers and their students from using them. Instructors have positive opinions regarding using TESSA Science OER in Integrated Science teaching and learning because it improves teachers' pedagogical practice and students' conceptual interpretation of scientific facts. The findings found that because TESSA Science OER makes instruction more activity-oriented, teachers frequently use it in class to help students bridge the gap between theory and practice. Furthermore, the time and cost of going online to get essential pdfs and other word documents for lesson delivery is quite stressful, especially for instructors who lack the necessary abilities, making it a disadvantage for teachers who use TESSA Science OER.

5.4 Recommendations

From the findings, it is recommended that Integrated Science teachers at Lamplighter Community Academy Basic school should always use TESSA Science OER in their classroom to enhance meaningful teaching and learning of the subject. In addition, they should frequently use TESSA Science OER to make lessons motivating for pupils to easily grasp scientific facts. Moreover, GES in collaboration with the MOE should furnish all and all construct computer laboratories in Basic schools in the country and equip them with easy access to network in order to thwart the challenges instructors go through when using TESSA Science OER. Finally, Integrated Science instructors in all basic schools within the country should try as much as possible to dedicate part of their time and download TESSA Science OER information to help improve teaching and learning of the discipline.

5.5 Suggestion for Further Studies

1. A study such as this should have employed mixed method approach and also use selected public basic schools within the District to enable more generalization of the findings.
2. A study should be carried out to how the TESSA Science OER improves classroom instruction in selected Junior High Schools in the Bia District.
3. Finally, a study should be conducted to investigate the impact of TESSA Science OER in improving Junior High School students understanding of Integrated Science in a selected basic school in the Bia District.

5.6 Limitations of the Study

The limitations of the study are characteristics of design or methodology that impact or influence the interpretation of the findings from research. They are the constraints on generalizability, applications to practice, and or utility of findings that are the

result of the ways in which you initially chose to design the study or the method used to establish internal and external validity or the result of unanticipated challenges that emerged during the study (Price & Judy, 2004).

The researcher would have liked to carry out the investigation to cover all the Junior High Schools in the Bia District in the Western North Region of Ghana but due to the COVID-19 pandemic, the researcher concentrated on only Lamplighter Community Junior High School.

REFERENCES

Abdo, M., & Semela, T. (2010). Teachers of poor communities: The tale of instructional media use in primary schools of Gedeo Zone, Southern Ethiopiaj. *Australian Journal of Teacher Education* (Online), 35(7), 78-92.

Acquah S. (2015). Interactive approach of introducing TESSA secondary science OER for extensive use: a focus on student teachers of UEW. DETA Conference 2015 in Mauritius. Retrieved on March 16, 2017 from: http://www.tessafrica.net/sites/www.tessafrica.net/files/files/TESSA%20final.pdf

The Ministry of Education Culture Sports Science and Technology. (2011). *How Science and Technology Are for Society*. https://www.mext.go.jp/component/english/__icsFiles/afieldfile/2011/03/03/1302821_002.pdf

Anwar, F. (2019). Activity-Based Teaching, Student Motivation and Academic Achievement. *Journal of Education and Educational Development*, *6*(1), 154–170. https://doi.org/10.22555/joeed.v6i1.1782

DeRosa, R. and Jhangiani, R. (2017) Open Pedagogy, in Mays, E. (ed.) *A Guide to making Open Textbooks with Students*, The Rebus Community

Hogan, P., Carlson, B. R., & Kirk, C. (2015). Open Educational Practices' Models using Open Educational Resources. *Presented at Open Education Global Consortium Conference. Banff, Alberta, Canada, 2015, April.* http://commons.nmu.edu/facwork_conferencepapers

Acquah, S. (2019). TESSA Science OER Reflections of the Profile Dimension for Teaching Basic School Science in Ghana. *International Journal of Psychology and Education*, *3*(03).

Adala, A. (2017). Assessing the impact of OER availability on the emergence of Open Educational Practices in Sub-Saharan Africa: The case of an ICT-integrated multinational teacher education programme in mathematics and science. Unpublished ROER4D report to the International Development Research Centre.

Amedahe, F. K. (2002). Fundamentals of educational research methods. *Mimeograph, UCC, Cape Coast*.

Anamuah-Mensah, J. (2015). Enhancing the teaching and learning of science and technology for nation building. GAST Annual Conference, Sekondi: Ghana.'

Atkins, D. E., Brown, J. S. & Hammond, A. L. (2007). A review of the Open Educational Resources (OER) movement: Achievements, challenges, and new opportunities. Menlo Park, CA: The William and Flora Hewlett Foundation.

Azuka, B. F. (2013). Assessment in primary school mathematics classrooms in Nigeria.

Azuka, B. F. (2013). *Assessment in primary school mathematics classrooms in Nigeria*.

Bandura, A. (1977). Self-efficacy: Toward a unifying theory of behavioral change.

Baruch, Y., & Holtom, B, C. (2008). Survey response rate levels and trends in organizational research. Human Relations, 6(8), 1 139-1 160.

Bednar, A. K., Cunningham, D., Duffy, T. M., & Perry, J. D. (1992). Theory into practice: How do we link. *Constructivism and the technology of instruction: A conversation*, *8*(1), 17-34.

Berg, B. (2001). Qualitative research methods for the social sciences.

Boakye, C., & Ampiah, J. G. (2017). Challenges and solutions: The experiences of newly qualified science teachers. *Sage Open*, *7*(2), 2158244017706710.

Boston Consulting Group (2013). The Open Education Resources ecosystem: An evaluation of the OER movement's current state and its progress toward mainstream adoption. Boston, MA: Boston Consulting Group. Retrieved from http://www.hewlett.org/sites/default/files/

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative research in psychology*, *3*(2), 77-101.

Brennan, R. L., Yin, P., & Kane, M. T. (2003). Methodology for examining the reliability of group mean difference scores. *Journal of Educational Measurement*, *40*(3), 207-230.

Bryman, A. (2016). *Social research methods*. Oxford university press.

Camci, F. (2012). Effects of activity based teaching grounded on active learning on students' academic skills and learning process. *Unpublished master's thesis). Adıyaman University, Institute of Sciences*.

Clements, K. I. & Pawlowski, J. M. (2012). User-oriented quality for OER: understanding teachers' attitude on re-use, quality, and trust. Journal of Computer Assisted Learning, 28(1), 4—14.

Collins, P. & Gillies, J. (2008) Working paper: the expansion of secondary education and the need for teachers: how big is the gap? USAID Education Improvement Prog 2

Coughlan, T. & Perryman, L.A. (2011). Something for everyone? The different approaches of academic disciplines to Open Educational Resources and the effect on widening participation. Journal of Open, Flexible and Distance Learning, 15(2), 1 1—27.

Cox, G. & Trotter, H, (2016). Institutional culture and OER policy: How structure, culture, and agency mediate OER policy potential in South African universities. The International Review of Research in Open and Distributed Learning, 17(5).

Cox, G., & Trotter, H. (2017). Factors shaping lecturers' adoption of OER at three South African universities.

Cox, G., & Trotter, H. (2017). Factors shaping lecturers' adoption of OER at three South African universities.

Crabtree, B. F. (1999). *Doing qualitative research*. sage.

Creswell, J. W. (2003). Research design. Qualitative, quantitative and mixed methods approaches (2nd ed.), Thousand Oaks, CA: Sage.

Creswell, J. W. (2008). Educational research: Planning, conducting, and evaluating quantitative and qualitative research (3rd ed.). Upper Saddle River, NJ: Pearson Education, Inc.

Creswell, J. W. (2012). Educational research: Planning, conducting, and evaluating quantitative and qualitative research (4th ed.). Boston, MA: Pearson.

Creswell, J. W. (2014). *Qualitative, quantitative and mixed methods approaches*. Sage.

Cronin, C. (2017). Openness and praxis: Exploring the use of Open Educational Practices in higher education. The International Review of Research in Open and Distributed Learning, 18(5).

Curriculum Research Development Division (2012). Teaching syllabus for Science (Junior High School). Accra: Ministry of Education.

Czerniewicz, L., Deacon, A., Glover, M. & Walji, S. (2016). MOOC-making and Open Educational Practices. Journal of Computing in Higher Education, 29, 81—97.

Czerniewicz, L., Deacon, A., Glover, M., & Walji, S. (2017). MOOC—making and open educational practices. *Journal of Computing in Higher Education*, *29*(1), 81-97.

Czerniewicz, L., Deacon, A., Glover, M., & Walji, S. (2017). MOOC—making and open educational practices. *Journal of Computing in Higher Education*, *29*(1), 81-97.

Daniel, I. O. A. (2013). Language as a Power Positioning Tool: National Open University of Nigeria (NOUN) English Course Materials as Genderised Examples. *Journal on English Language Teaching*, *3*(3), 7-15.

Daniel, J., Kanwar, A. & Uvalic'-Trumbic', S. (2009). Breaking higher education's iron triangle: Access, cost, and quality. Change: The Magazine of Higher Learning, 41, 30—35.

Darling-Hammond, L. (2000). Teacher quality and student achievement: A review of state policy evidence. Education policy analysis archives, 8(1), 1-15.

Darling-Hammond, L., Berry, B., & Thoreson, A. (2001). Does teacher cei•tification matter? Evaluating the evidence. Educational Evaluation

Davis F. D. (1989). Perceived Usefulness, Perceived Ease of Use, and User Acceptance of Information Technology. Source: MIS Quarterly, Vol. 13, No. (Sep., 1989), pp. 319-340.

Davis, H. C., Carr, L., Hey, J. M. N., Howard, Y, Millard, D, Morris, D. & White, S. (2010). Bootstrapping a culture of sharing to facilitate Open Educational Resources. IEEE Transactions on Learning Technologies, 3(2), 96—109.

De Hart, K., Chetty, Y. & Archer, E. (2015). Uptake of OER by staff in distance education in South Africa. The International Review of Research in Open and Distributed Learning, 16(2), 18—45.

De Hart, K., Chetty, Y., & Archer, E. (2015). Uptake of OER by staff in distance education in South Africa. The International Review of Research in Open and Distributed Learning, 16(2).

de Oliveira Neto, J. D, Pete, J., Daryono & Cartmill, T. (2017). OER use in the Global South: A baseline survey of higher education instructors. In C. Hodgkinson-Williams & P. B. Arinto (Eds.), Adoption and impact of OER in the Global South (pp. 69—1 18). Retrieved from https://doi.org/10.5281/zenodo.599535

Denzin, N. K. (2000). Aesthetics and the practices of qualitative inquiry. *Qualitative inquiry*, *6*(2), 256-265.

Devereux, J & Amos S. (2005). The University of Fort Hare's learne-centred Distance Education Programme, Open Learning 20(3) 277-284.

Dilley, P. (2004). Interattitude and the philosophy of qualitative research. *The Journal of Higher Education*, *75*(1), 127-132.

Dooley, K. E. (1995), The diffusion of computer technology and telecommunications: A comparative study of middle schools in the Texas Education Collaborative, Unpublished dissertation, College Station, TX: Texas A&M University

Driver, R. , & Bell, B. (1986). Students' thinking and the learning of science: A constructivist view. School Science Review, 67, 443-456.

ECDL (European Computer Driving Licence). (2011). Identifying essential ICT skills and building digital proficiency through appropri@te certification. Brussels:

EGRA (2013). Early Grade Reading Assessment Report Findings: Ghana Education Service, National Education Assessment Unit RTl International Education Assessment and Research Centre. Retrieved on January 09, 2018 from: https://globalreadingnetwork.net/eddata/ghana-2013-egra-and-egmafindings-report.

Ehlers, U. D. (201 1), Extending the territory: From open educational resources to open educational practices. Deutschland: Baden-Wurttemberg Corporative State University.

Emaikwu, S. O. (2012). *Assessing the relative effectiveness of three teaching methods in the measurement of students achievement in mathematics*.

Emerson, R. M., Fretz, R. I., & Shaw, L. L. (1995). Writing Ethnographic Fieldnotes, Chicago: University of Chicago. *Press.(佐藤郁哉・好井裕明・山田富秋訳, 1998,『方法としてのフィールドノート――現地取材から物語作成まで』新曜社).*

Entsuah-Mensah, R. E. M. (2004). The future of the youth in science and technology in Ghana Institute for Scientific and Technological Information (INSTI), CSIR Accra: Ghana

Essuman S. (2015). Using TESSA OERS to enrich the teaching and learning practices of basic school teachers. DETA 2015 conference Mauritius institute of education 20th — 24th July 2015.

Esterberg, K. G. (2002). *Qualitative methods in social research* (No. 300.18 E8).

Evans, J. E. (1980). Issues of Merit Pay in Higher Education: A Selective Bibliography.

Foote, K. E., Unwin, D. J., Tate, N. J., & DiBiase, D. (2012). GIS&T in higher education: challenges for educators, opportunities for education. *Teaching geographic information science and technology in higher education*, 3-15.

Fredriksen, B. , Brar, S. & Trucano, M. (2015). Getting textbooks to every child in Sub-Saharan Africa: Strategies for addressing the high cost and low availability problem. Washington, D.C.: World Bank. Retrieved from http://dx.doi.org/l O. 1596/978- I -4648-0540-0

Fusch, P. I., & Ness, L. R. (2015). Are we there yet? Data saturation in qualitative research. The Qualitative Report, 20(9), 1408-1416. Retrieved from http://www.nova.edu/ssss/QR/QR20/9/fusch1.pdf

Ghana Statistical Service (2014). 2010 population and housing census: Effutu Municipality analytical report. Accra: Ghana Statistical Service, GIS.

Giordano, D. & Leonardi, R. (2007). Web-Trace and the Learning of Visual Discrimination Skills in Proc, 1st International Workshop on Pen-based Learning Technologies (Catania, Italy): CD Published by IEEE Computer Society.

Goldhaber, D. , & Anthony, E. (2003). Teacher quality and student achievement. Urban diversity series. New York N. Y.: Eric Clearinghouse on Urban Education

Good, T.L., & Brophy, J. (1995). Contemporary Educational Psychology (5 th Ed). Longman Publishers: USA.

Granger, C., Morbey, M. L, Lotherington, H. , Owston, R., & Wideman, H. H. (2002). Factors contributing to teachers' successful implementation of IT. Journal of Computer Assisted Learning, 18, 480-488.

Guion, L. A., Diehl, D. C. & McDonald, D. (2011). Triangulation: Establishing the Validity of Qualitative Studies, FCS6014, one of a series of the Department of Family, Youth and Community Sciences, Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida.

Haight, M., Quan-Haase, A., & Corbett, B. A. (2014). Revisiting the digital divide in Canada: The impact of demographic factors on access to the internet, level of online activity, and social networking site usage. *Information, Communication & Society*, *17*(4), 503-519.

Harley, K. & Barasa, F. S. (2012). Formative Evaluation Report: TESSA New letter. Retrieved on November, 2017, from: http://www.tessafrica.net/sites/www.tessafrica.net/files/TESSA Formative aluation_Report_October_2012.pdf.

Harley, K., & Barasa, F. S. (2012). TESSA. *Teacher Education in Sub-Saharan Africa. Formative Evaluation Report*.

Harris, A. D., McGregor, J. C., Perencevich, E. N., Furuno, J. P., Zhu, J., Peterson, D. E., & Finkelstein, J. (2006). The use and interpretation of quasi-experimental studies in medical informatics. *Journal of the American Medical Informatics Association: JAMIA*, 13(1), 16–23. https://doi.org/10.1197/jamia.M1749

Hasan, D. E. & Billek, V. Y. (1975), Relationship between teachers' change in attitudes toward science and some professional variables, Journal of Research in Science Teaching, 12, 247-253.

Hennessy, S., Haßler, B. & Hofman, R. (2016). Pedagogic change by Zambian primary school teachers participating in the OER4Schools professional development programme for one year, Research Papers in Education, 31(4), 399-427.

Hernandez-Ramos, P. (2005). If Not Here, Where? Understanding Teachers' Use of Technology in Silicon Valley Schools. Journal of Research on Technology in Education, 38(1), 39-64.

Herrera, S. (2010). Open Educational Resources: How canopen education programs be sustainable? Access to Knowledge, 2(1), I-I 1 .

Hodgkinson-Williams, C. (2014). Degrees of ease: Adoption of OER, open textbooks and MOOCs in the Global South. Keynote address at the OER Asia Symposium, 24—27 June 2014. Penang, Malaysia. Retrieved from https://www.slideshare.net/ROER4D/hodgkinson- williams-2014-oer-asia

Hodgkinson-Williams, C., Arinto, P. B., Cartmill, T. & King, T. (2017). Factors influencing Open Educational Practices and OER in the Global South: Metasynthesis of the ROER4D project. In C. Hodgkinson-Williams & P. B. Arinto (Eds.), Adöption and impact of OER in the Global South (pp. 27—67). Retrieved from https://doi. org/10.5281/zenodo.1037088.

Jhangiani, R., Pitt, R., Hendricks, C., Key, J. & Lalonde, C. (2016). Exploring faculty use of Open Educational Resources at British Columbia post-Secondary institutions. BCcampus Research Report. Victoria, BC: BCcampus, Retrieved from http://bccampus.ca/ files/2016/01/BCFacultyUseOfOER final.pdf

Johnson, B. & Christensen, L. (2012). Educational Research, Qualitative, Quantitative and Mixed Approach (4th ed). California: SAGE Publication.

Jones, K. R. (2008). Will education be powerful enough to provide satisfying employment and economic stability? Career Development: NCDA Magazine No. 2, pp 22 28.

Kanwar, A., Kodhandaraman, B., & Umar, A. (2010). Toward sustainable open education resources: A perspective from the global south. *The Amer. Jrnl. of Distance Education*, *24*(2), 65-80.

Kanwar, X., Kodhandaraman, B. & Umar, A. (2010). Toward sustainable Open Education Resources: A perspective from the Global South. The American Journal of Distance Education, 24(2), 65—80.

Karunanayaka, S. & Naidu, S. (Eds.). (2016). Dreamweaving Open Educational Practices. Nawala: The Open University of Sri Lanka. Retrieved from http://www.ou.ac.lk/home/ images/OUSL/publications/Dreamweaving%200pen%20Educational%20Practices.pdf

Karunanayaka, S. P, (2012), Perceptions of teacher educators on the use of Open Educational Resources in teaching and learning. Research paper presented at the OUSL Annual Academic Sessions-

Karunanayaka, S., Fernando, C., De Silva, V. (2013). Designing an Online Learning Environment on Open Educational Resources for Science Education. AAOU Journal, Volume 8, No. l. pp I -I l.

Kasinathan, G. & Ranganathan, R. (2017). Teacher professional learning communities: A collaborative OER adoption approach in Karnataka, India. In C. Hodgkinson-Williams & P. B. Arinto (Eds.), Adoption and impact of OER in the Global South (pp. 499—548). Retrieved from https://doi.org/10.5281 /zenodo.601180

Kebritchi, M. (2010). Effect of a Computer Games on mathematic achievement and class motivation. Computer & Education, 55(2), 427-443.

Kirkpatrick, D., & Kirkpatrick, J. (2006). *Evaluating training programs: The four levels*. Berrett-Koehler Publishers.

Kissinger, J. S. (2011). A Collective Case Study of Mobile E-book Learning Experiences. (Doctoral Dissertation). UNF Theses and Dissertations. paper 127. Kola. A. J (2013). Importance of science education to na-tional development and problems militating against its development, American Journal of Educational Research, 1(7): 225- 229.

Knox, J. (2013). The limitations of access alone: Moving towards open processes in education technology. Open Praxis, 5(1), 21—29.

Krelja Kurelovic, E. (2016). Advantages and limitations of usage of Open Educational Resources in small countries. International Journal of Research in Education and Science, 2(1), 136—142.

Kumar, S. and Phrommathed, P. (2005) Research Methodology. In: Kumar, S. and Phrommathed, P., Eds., New Product Development, Springer, Berlin, 43-50. http://link.springer.com/content/pdf/10.1007/0-387-23273-7_3.pdf

Lai, W. T: & Chen, C. F. (2010). Behavioral intentions of public transit passenger —

Lakhotia, K., Harman, M., & Gross, H. (2013). AUSTIN: An open source tool for search based software testing of C programs. *Information and Software Technology*, *55*(1), 112-125.

Lawrence, S. (2007). The regulation of e-learning: New national and international policy perspectives. University of California, Berkeley: Center for Studies in Higher Education. Retrieved from http://escholarship.org/uc/item/74q6c70t.

Liamputtong, P. (2013*). Qualitative research methods (4th ed.).* South Melbourne: Oxford University Press.

Lincoln, Y. S., & Guba, E. G. (1985). *Naturalistic inquiry*. sage.

Masterman, L., Wild, J., White, D., Manton, M., Cameron, L., & Dalziel, J. (2011, December). The impact of OER on teaching and learning in UK universities: implications for Learning Design. In *Proceedings of the 6th international LAMS & learning design conference* (pp. 135-144).

McKerlich, R., Ives, C., & McGreal, R. (2013). Measuring use and creation of open educational resources in higher education. *International Review of Research in Open and Distributed Learning*, *14*(4), 90-103.

Menon, M., Palachandra, B., Emmanuel, J., & Kee, C. L. (2017). A study on the processes of OER integration for course development. *Unpublished ROER4D Report to the International Development Research Centre*.

Mensah, D. K., & Dandy, D. (2012). A practical guide to action & case study. Amakom- Kumasi: Payless Publication Limited.

Merriam, S. B. (2002). Introduction to qualitative research. *Qualitative research in practice: Examples for discussion and analysis*, *1*(1), 1-17.

Merriam, S.B. (1998) Qualitative Research and Case Study Applications in Education. Jossey-Bass Publishers, San Francisco.

Metros, S. E., & Bennett, K. (2002). Learning objects in higher education.

Miles, MB. & Huberman, AM. (1994). Qualitative data analysis (2nd ed.). Thousand Oaks, CA: Sage Publications.

Mills, J., & Birks, M. (2014). *Qualitative Methodology: A Practical Guide.* Retrieved from https://methods.sagepub.com/book/qualitative-methodology-a-practical-guide doi:10.4135/9781473920163

Ministry of Education -MOE. (2018). Teacher Reforms. Meet the Press Series Accra, Ministry of Information Conference Roo. Retrieved from https://www.graphic.com.gh/images/pdfs/moe meet_press_november2018.pdf

Mishra, S. & Singh, A. (2017). Higher education faculty attitude, motivation and perception of quality and barriers towards OER in India. In C. HodgkinsonWilliams & P. B. Arinto (Eds.), Adoption and impact of OER in the Global South (pp. 425—458). Retrieved from https://doi. org/10.5281/zenodo.602784

Mishra, S., Sharma, M., Sharma, R. C., Singh, A. & Thakur, A. (2016). Development of a scale to measure faculty attitudes towards Open Educational Resources. Open Praxis, 8(1), 55— 69.

Moon, B. Brown, S., & Ben-Peretz M., (2000). The open learning environment. Routledge International Companion to Education. London. Routledge.

Moon, B., & Villet, C. (2016). Digital learning: Reforming teacher education to promote access, equity and quality in sub-Saharan Africa.

Moon, B., Leach, J. & Stevens, M. P. (2005). Designing open and distance learning for teacher education in sub-Sahara Africa: A toolkit for educators and planners. Harvard: Africa Region Human Development.

Moon, R. & Wolfenden, F. (2007). Open educational resources, international cooperation and teacher education in Sub-Saharan Africa. In: EADTU's 20th Anniversary Conference, 8-9 Nov 2007, Lisbon, Portugal.

Moore, G. C. & Benbasat, I. (1991). Development of an instrument to measure the perceptions of adopting an information technology innovation. *Information System Research* 2(3), 192-222.

Moore, G.E. (1975) Progress in digital integrated electronics. International Electron Devices Meeting, IEEE, 1 1-13.

Morse, J. (1991). Strategies for sampling. In J. M. Morse (Ed.), Qualitative nursing research: A contemporary dialogue (pp. 127-146). Newbury Park, CA: Sage.

Mtebe, J. S. & Raisamo, R. (2014). Investigating perceived barriers to the use of Open Educational Resources in higher education in Tanzania. The International Review of Research in Open and Distributed Learning, 15(2).

Mtebe, J. S., & Raisamo, R. (2014). Investigating perceived barriers to the use of open educational resources in higher education in Tanzania. *International Review of Research in Open and Distributed Learning*, *15*(2), 43-66.

National Center for Education Statistics (2001). Teacher Preparation and Professional Development: 2000, Washington, DC: NCES.

Nazari, N., Rose, A., Oates, L., Hashimw., Shakir, O. & Siddiqi, B. (2016). Technical assessment of selected offices within the Afghan Ministry of Education for textbook development and distribution. Kabul: United States Agency for International Development (USAID). Retrieved on May 6, from http://pdf.usaid.gov/pdf docs/PA00M4W5.pdf.

Ndago, A. (2012, February 23). Poor performance of BECE results in Navrongo is wrong Bosco's Principal. Retrieved from Ghana News -SpyGhana.com

Newman, E. & Duwiejua, M. (2016). Models for innovative funding for higher education in Africa — The case of Ghana. In P. A. Okebukola (Ed.), Towards innovative models for funding higher education in Africa (pp. I—19). Retrieved from http://www.adeanet.org/en/ system/files/resources/aaufunding-book.pdf

Ngman-Wara E. & Acqual) S. (2015). "Ghanaian Junior High Science Teachers' Reflections on the Use of Tessa Secondary Science Modules." *American Journal of Educational Research*, 3(3), 377-382,

Niederhauser, D.S. & Stoddart, T. (2001). Teachers' Instructional Perspectives and Use of Educational Software. Teaching and Teacher Education: An International *Journal of Research and Studies.* 17 (l), 15-31.

Nind, M., Curtin, A. & Hall, K. (2016). Researching pedagogy. Oxford: Bloomsbury. OER Africa & University of Michigan. (2012). AgShare planning and pilot project: Impact study. Johannesburg: OER Africa.

Nonyongo, E. P. (2013). Training course team members and supporting OER development: The instructional designer's perspective. In Seventh Pan Commonwealth Forum on Open Learning (PCF7), 2—6 December 2013. Abuja, Nigeria.

Oates, L., Goger, L. K., Hashimi, J. & Farahmand, M. (2017). An early-stage impact study of localised OER in Afghanistan. In C. Hodgkinson-Williams & P. B. Arinto (Eds.), Adoption and impact of OER in the Global South (pp. 549—573). Retrieved from https://doi. org/10.5281/zenodo.600441

Oche, E. S. (2012). Assessing the relative effectiveness of three teaching methods in the measurement of students' achievement in mathematics. *Journal of Emerging Trends in Educational Research and Policy Studies*, *3*(4), 479-486.

OCLOS (2007). Open educational practices and resources. OLCOS Roadmap 2012.

O'Connor, J. P. (2003). Teachers are the problem in SMT, not girls. Retrieved on July 20, 2017 from http://www.adea.org

OECD (2007). Giving knowledge for free. The emergence of open educational resources OECD Publishing: Paris.

OECD (Organization for Economic Co-operation and Development). (2014). PISA 2012 results in focus. What 15-year-olds know and what they can do with what they know. Paris: Organization for Economic Co-operation and Development. Retrieved from http://www.oecd.org/pisa/keyfindings/pisa 2012-results-overview.pdf.

Ojimba, D. P. (2013). Scientific and technological literacy in Africa: Issues, problems and prospects' dimensions (IPP). *Educational Research International*, *2*(1), 141-145.

O'Leary, Z. (2014). The essential guide to doing your research project (2nd ed.). Thousand Oaks, CA: SAGE Publications, Inc.

Onaifo, D. (2016). Alternate academy: Investigating the use of open educational resources by students at the University of Lagos in Nigeria.

Orora, W., Keraro, F. N., & Wachanga, S. W. (2014). Using cooperative e-learning teaching strategy to enhance students' creativity in secondary school biology: A study of selected schools in Nakuru County, Kenya. *International Journal of Education and Practice,* Conscientia Beam, 2(6), 137-146.

Otami S (2015). The use of cell phones to access TESSA OERS: Experiences of students in Winneba, Ghana. DETA 2015 Conference: Education and Development In Africa: The Need For Access, Equity, Sugtainability, Quality And Relevance Within the Context Of Globalisation. Retrieved from: www.deta.up.ac.za

Otami S, Adzifome N. S. & Amihere A.K. (2015). Evaluation Of Collaborative model of peer teaching in Ghana using TESSA materials: Experiences of teacher. DETA 2015 Conference: Teacher Education and Development In Africa: The Need For Access, Equity, Sustainability, Quality And Relevance Within the Context Of Globalisation. Retrieved from: www.deta.up.ac.za.

Ottevanger, W., Van Den Akker, J. & Feiter, L. D. (2005). Developing science, mathematics and ICT (SMICT) in secondary education: Patterns and promising practices. African Region Human Development Working Paper series (SEIA thematic study report No. 7 Sept. 2005.

Oyelaran-Oyeyinka, B. & Adeya, C. N. (2004a). Dynamics of adoption and usage of ICTs in African universities: A study of Kenya and Nigeria. *Technovation,* 24(10), 841—851.

Patton, W. F. (2002). Detection technologies in proteome analysis. *Journal of Chromatography B*, *771*(1-2), 3-31.

Peralta, H. & Costa, F. A. (2017). Teacher's Competence and Confidence regarding the use of ICT. *Educational Science Journal*, 3, 75-84.

Peralta, H., & Costata, F. A. (2007). Teachers' competence and confidence regarding the use of ICT. *Sísifo-Educational Sciences Journal*, 75-84.

Plomp, T., Anderson, R. E., Law, N, & Quale, A. (2009). Preface. In T. Plomp, R. E. Anderson, N. Law, and A. Quale. Cross-national Information and Communication Technology: Policies and Practices in Education. A volume in Research in Educational Policy: Local, and Global Perspectives. Charlotte, NC, USA: Information Age Publishing. *Psychological Review*, 84(2), 191-215.

Price, J. H., & Murnan, J. (2004). Research limitations and the necessity of reporting them. *American Journal of Health Education*, *35*(2), 66.

Punch, S. (2001). Multiple methods and research relations with young people in rural Bolivia.

Reed, P. (2012). Awareness, attitudes and participation of teaching staff towards the' open content movement in one university. *Research in Learning Technology,* 20(4).

Robinson, J. P., Shaver, P. R., & Wrightsman, L. S. (1991). Criteria for scale selection and evaluation. In J. P. Robinson & L. S. Wrightsman (Eds.). Measures of personality and psychological attitudes (pp. 1-16). New York, NY: Academic Press.

Robinson, L. (2009). A summary of diffusion of innovation. Enabling change. Retrieved from http://www.enablingchange.com.au/Summary Diffusion Theory.pdf

Rogers, E. M. (1995) Diffusion ofinnovations (4th ed.). New York: The Free Press.

Rogers, E. M. (2003). Diffusion of innovations, Fifth ed. New York: Free Press.

Rolfe, V. (2012). Open educational resources: Staff attitudes and awareness. Research in Learning Technology, 20(1), 43-55.

Rubin, Allen & ER, Babbie. (2009). *Research Methods for Social Work*.

Russell, M., Bebell, D, O'Dwyer, L., & Duffany, K. (2003). Examining Teacher Technology Use. *Journal of Teacher Education - J TEACH EDUC*., 54, 297310.

Sáenz, M. P., Hernandez, U. & Hernández, Y. M. (20 17). *Co-creation of OER by teachers and teacher educators in Colombia*. In C. Hodgkinson-Williams & P. B. Arinto (Eds.), Adoption and impact of OER in the Global South (pp. 143—185). Retrieved from https://doi, org/10.5281/zenodo.604384

Saide, S., & Sheng, M. L. (2021). Knowledge exploration–exploitation and information technology: crisis management of teaching–learning scenario in the COVID-19 outbreak. *Technology Analysis & Strategic Management*, *33*(8), 927-942.

Salloum, S. L. & BouJaoude, S. (2008). Careful It is 1-120? Teachers' conceptions of chemicals. *International Journal of Science Education,* 30(1), 33-64,

Sclater, N. (2010). *Open Educational Resources: Motivations, logistics and sustainability*. In N. F. Ferrer & J. M. Alonso (Eds.), Content management for E-Learning (pp. 179—193). New York: Springer-Verlag.

Shadreck, M. & Mambanda, I. (2012). Science teacher quality and effectiveness: Gweru Urban junior secondary school students' point of view. *Asian social science*, 8(8), 121-135.

Shayo, R. (2005). Parties and political development in Tanzania.

Shayo, S. & William, (2015). Science Teaching and Learning using TESSA Material: An Experience from the Implementation in Tanzanian Context. Conference: Teacher Education and Development In Africa: The Need or Access, Equity, Sustainability, Quality And Relevance Within the Context Of Globalization. Retrieved from: www.deta.up.ac.za

Shayo, S. R. (2015). *Training needs of heads of schools within decentralized secondary education in Tanzania: a case study of Hai district* (Doctoral dissertation, The University of Dodoma).

Simon, M. (2011). Assumptions, limitations and delimitations.

Simonson R. M. (1979). Designing instruction for attitudinal outcomes. *Journal of instructional development* 2(l), 20-41.

Snape, D., & Spencer, L. (2003). *The foundations of qualitative research* in Ritchie, J. and Lewis, J (eds) Qualitative Research Practice.

Solomon, J. (1987). Social influences on the construction of pupil's understanding of science. *Studies in Science Education,* 14, 63-82.

Sounders, M., Lewis, P. & Thornhill, A. (2007). *Research Methods for Business Students.* (4th Ed.). England: Pearson Education Limited.

Stacey, P. (2007).Open Educational Resources in a global context. First Monday, 12(4). Retrieved from http://firstmonday.org/ojs/index.php/fm/article/view/1769/ 1649

Stake, R. (1995). *The art of case research*. Newbury.

Strauss, A., & Corbin, J. (1994). *Grounded theory methodology*: An overview.

Stutchbury K, & Katabaro J. (2011). TESSA Secondary Science: addressing the challenges facing science teacher-education in Sub-Saharan Africa. DETA 2011 Successful /innovative teacher education initiatives in priority areas that will serve a changing Africa.

Stutchbury, K. & Ngman-Wara, E. (2012). *Developing effective pedagogy: the thinking behind the TESSA secondary science project*. In: 56th ICET World Assembly: The Changing Global Perspective on the Role of Teacher and Teacher Education, 10-12 July 2012, Ghana.

Stutchbury, K. (2011). *Implementing change in Science Teacher Education in SubSaharan Africa: challenges and opportunities.* A presentation at the 23rd World Assembly of the International Council for the Education of Teachers (ICET). Glasgow July I Ith -14th, 2011

Sullivan, O. (2006). *Changing gender relations, changing families: Tracing the pace of change over time*. Rowman & Littlefield.

Tashakkori, A. & Teddlie, C. (Eds.) (2010). Handbook of mixed methods in social and behavioral research (2nd ed.). Thousand Oaks, CA: Sage.

Taylor, S., & Todd, P. A. (1995). Understanding information technology usage: A test of competing models. *Information Systems Research,* 6, 144-176.

TESS India (n.d.). Teacher Education through School-based Support in India. Retrieved on March 30, 2018 from: http://www.tess-india.edu.in/

Tsuma, O. G. K. (1998). *Science Education in the African Context*. Nairobi: Jomo Kenyatta Foundation.

T-TEL Professional Development Programme (2016). *OER Guidance for Colleges.* Published.by the Ministry of Education (Ghana), under Creative Commons Attribution-Share Alike 4.0 International. Available online at http:// oer.t tel.org.

UNESCO (2014). *Position paper on education post-2015. Paris: United Nations Educational, Scientific and Cultural Organization*. Retrieved from http://unesdoc.unesco.org/images/0022/002273/227336E.pdf

UNESCO. (2012). 2012 World open Educational Resources (OER) Congress, 2012 Paris OER Declaration.http://www.unesc0.org/new/fileadmin/MULTIMEDIA/HQ/C1/C1/pdf/Events/Paris%200ER%20Declara tion Ol.pdf. Accessed 18/10/12

United Nations Educational, Scientific, and Cultural Organization, Paris (France). (2008). *Education for All by 2015: Will We Make It?*. ERIC Clearinghouse.

United Nations Educational, Scientific, and Cultural Organization. (2002). Education for All: Is the World On Track?.

Van der Merwe, A. D. (2013). Are higher education institutions positioned to reap the dividends of open education resources? The case $ Durban University of Technology. International Business & Economics Research Journal, 12(9), 1119—1129.

Van der Merwe, A.D. (2015). *The attitudes of high school teachers to open education resQurces: A case study of selected South African schools*. OE Global Conference 2015. Retrieved from http://conference.oeconsortium.org/2015/wp-content/uploads/2015/01 /Alex van-der-Merwe.Open-education-conference-paper.pdf

Van Deursen, A. J., & van Dijk, J. A. (2009). Improving digital skills for the use of online public information and services. *Government Information Quarterly*, *26*(2), 333-340.

Venkaiah,.V. (2008). *Open Educational Resources in India: A study of attitudes and perceptions of distance teachers*. Hyderabad: B.R. Ambedkar Open University.

Verspoor, A. (2008), At the Crossroads: choices for secondary education in Sub Saharan Africa. Washington: The World Bank.

Vygotsky, L.S. (197Sub-Saharan Society. Campbridge : Harvard University Press.

Wachanga, S.W & Mwangi, J.G (2004). Effects of Cooperative Class Experiment Teaching Method on Secondary School Students Chemistry Achievement in Kenya's Nakuru District. *International Education Journal*, 5 (1), 26-36

Walsh, S. (2011). *Exploring classroom discourse: Language in action*. Routledge.

Wambugu P. W & Keraro F. N. (2015). Improving the Learning of Science in Secondary Schools in Kenya Using TESSA Science OERs. Theme: Current methods of teaching: Prospects and challenges. DETA 2015 Conference: Teacher Education and Development In Africa: The Need For Access, Equity, Sustainability, Quality And Relevance Within the Context Of Globalisation. Retrieved from: www.deta.up.ac.za

Wambugu P. W., Changeiywo J. & Ndiritu F. G. (2013). Effects of Experiential Cooperative Concept Mapping Instructional Approach on Secondary School Students' Achievement in Physics in Nyeri County, Kenya, *Asian Journal Of Social Sciences & Humanities* 2(3) 179-296.

Westermann J. W. & Muggli, V. J. I. (2017). Effectiveness of OER use in first- year higher education students' mathematical course performance: A case study. In C. Hodgkinson-Williams & P. B. Arinto (Eds.), Adoption and impact of OER in the Global South (pp. 187—229). Retrieved from https://doi.org/10.5281/zenodo.601203

Wiley, D. & Hilton, J. (2009). Openness, dynamic specialization, and the disaggregated future of higher education. *IRRODL,* 10(5), 14. Athabasca University Press.

Willems, J, & Bossu, C. (2012). Equity considerations for open educational resources in the glocalization of education. *Distance Education*, 33(2), 185—199.

Wisdom J & Creswell JW. (2013). *Mixed Methods: Integrating Quantitative and Qualitative Data Collection and Analysis While Studying Patient-Centered Medical Home Models*. Rockville, MD: Agency for Healthcare Research and Quality. AHRQ Publication No. 13-0028-EF.

Wolfenden, F., Auckloo, P. , Buckler, A. & Cullen, J. (2017). Teacher educators and OER in East Africa: Interrogating pedagogic change. In C. Hodgkinson-Williams & P. B. Arinto (Eds.), Adoption and impact of OER in the Global South (pp. 251—286). Retrieved from https://doi, org/10.5281/zenodo.600424

Wolfenden, F., Auckloo, P., Buckler, A., & Cullen, J. (2019). Teacher educators and OER in East Africa: Interrogating pedagogic change.

Wolfenden, F., Buckler, A., & Keraro, F. (2012). OER adaptation and reuse across cultural contexts in Sub Saharan Africa: Lessons from TESSA (Teacher Education in Sub Saharan Africa). *Journal of Interactive Media in Education*, 16.

Wong, E. M. L, & Li, S. C, (2008). Framing ICT implementation in a context of educational change: A multilevel analysis. School Effectiveness and School Improvement, /9(1), 99-120.

Yadar. K. (2007). *Teaching of Life Sciences*. New Delhi, Anmol Publication. Ltd. India

Yildirim, S. (2007). Current utilization of ICT in Turkish basic education schools: A review of teacher's ICT use and barriers to integration. International Journal ofInstructional *Media*, 34(2), 171-86.

Yin, R.K. (2003). *Case Study Research: Design and Methods*. Sage. Thousand Oaks, California

Zagdragchaa, B. & Trotter, H. (2017). Cultural-historical factors influencing OER adoption in Mongolia's higher education sector. In C. Hodgkinson-Williams & P. B. Arinto (Eds.), Adoption and impact of OER in the Global South (pp. 389—424). Retrieved from https://doi. org/10.5281/zenodo.5996

APPENDICES

APPENDIX A

INTERVIEW GUIDE FOR INTEGRATED SCIENCE TEACHERS ON THE ATTITUDE AND USE OF TESSA AND OTHER OERs.

Instruction: Thank you for your willingness to avail yourself for the interview. Please this exercise is solely for academic purpose. For that matter, I wish you could be sincere as you can to express your attitude because your responses are highly confidential. We may spend less than 20 minutes for this interview, and I wish you would permit me to record your voice for effective transcription which you will get access to before any publication. u may also equally ask for clarification or any sort.

Thank you.

1. How did you get to know about the TESSA OER?
2. What is preventing you from using the TESSA OER in teaching?
3. Do you think the TESSA OER has the potential of improving your classroom instructions?
4. Do you require any technical assistance in accessing and using the TESSA OER?

   a.i Yes/No ii. If yes/no Why?
5. What other OER are you familiar with aside the TESSA OER?
6. Do you think your school's head will permit you to incorporate the TESSA activities in your classroom lessons?
7. How will you consider the TESSA materials in terms of cost?

8. Do you have plan of using and/or keep using the TESSA OER in your classroom instructions?
9. Which aspect (s) on the TESSA modules do you usually adopt in your teachings?
10. What computer device do you use in accessing the TESSA OER?
11. Any additional comment regarding your reason for using or not using TESSA OERs and any other OERs

APPENDIX B

LETTER OF INTRODUCTION

UNIVERSITY OF EDUCATION, WINNEBA
FACULTY OF EDUCATIONAL STUDIES
DEPARTMENT OF BASIC EDUCATION
P. O. Box 25, Winneba, Ghana
+233 (050) 9212015
beducation@uew.edu.gh

Date: July 30, 2020

The Disctirct Director
Ghana Education Service
Bia West District
Essam

Dear Sir/Madam

LETTER OF INTRODUCTION

We forward to you, a letter from Mr Isaiah Kwarteng, a seond year Mphil student of the Department of Basic education, university of education Winneba, with registration number 8180030010.

Mr Isaiah Kwarteng is to carry out a research on the Topic: "*Integrated Science Teachers' Attitude and use of TESSA Science OER in Lamplighter Community Academy Basic School in Debiso in the Bia West District*"

We would be grateful if permission is granted him to carry out his study in the District.

Thank you.

Yours faithfully,

DEPT. OF BASIC EDUCATION
UNIVERSITY OF EDUCATION
WINNEBA, GHANA

.....

MRS. SAKINA ACQUAH (PHD)
(Ag. Head of Department)

APPENDIX C

Permission Letter from GES

GHANA EDUCATION SERVICE

In case of reply the Number and Date of this letter should be quoted

REPUBLIC OF GHANA

Disrict Education Office
P.O Box 18
Essam

TEL: 0332-22075

My Ref. No. GES/CR/EMEO/LC.80/VOL.4/37
Your Ref. No:.....

DATE: 10th March, 2020.

LETTER OF INTRODUCTION

We acknowledge receipt of your letter dated 12th February, 2020 introducing a second year M.Phil student of your department who is to conduct a research in the Municipality.

Permission has been granted to Mr. Arkaifie Paul , a second year M.Phil student of the Department of Basic Education, University of Education, Winneba to carry out a research in Junior High Schools within the Effutu Municipality from March to May, 2020.

Mr Isaiah Kwarteng is to carry out a research on the Topic: "*Integrated Science Teachers' Attitude and use of TESSA Science OER in Lamplighter Community Academy Basic School in Debiso in the Bia West District"*

This research should not disrupt teaching and learning in the schools and you should ensure hat he abides by the ethics of the teaching profession and the covid-19 safety protocols

NATHANIEL KOFI EFFUM
DISRICT DIRECTOR OF EDUCATION
BIA-WEST

Cc: THE HEADMASTER
LAMPLIGHER COMMUNITY
ACADEMY BASIC SCHOOL