HOW EXAMINEES PRIORITISE HIGH ORDER QUESTIONS DURING BIOLOGY EXAMINATION: A CASE OF DISTRICT BOARDING SECONDARY SCHOOLS IN CENTRAL EAST EDUCATION DIVISION OF MALAWI

M.Ed. (TESTING, MEASUREMENT AND EVALUATION) THESIS

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BEd. (Science) – University of Malawi

UNIVERSITY OF MALAWI

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BY

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Submitted to the Department of Education Foundations, School of Education, in partial fulfilment of the requirements for the degree of Master of Education (Testing, Measurement and Evaluation)

UNIVERSITY OF MALAWI

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DECLARATION

I, the undersigned, hereby declare that this thesis is my own original work which has not been submitted to any other institution for similar purposes. Where other people's work has been used, acknowledgements have been made.

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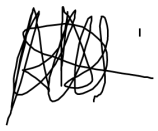

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19 July 2024

Date

CERTIFICATE OF APPROVAL

The undersigned certify that this thesis represents the student's own work and effort and has been submitted with our approval.

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DEDICATION

To my ambitious parents, Rhoda and David Sulani. My dear wife Susan, who endured the responsibility of taking care of our kids Wodala, Lughano and Thandizolathu while I pursued this project. Most importantly, I dedicate this work to the Lord God Almighty by whose hand all things are possible.

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ABSTRACT

Standardised examinations like Malawi School Certificate of Education (MSCE) comprise good proportions of High Order Questions (HOQs) and Low Order Questions (LOQs). Unlike LOQs, HOQs demand for higher levels of cognitive skills. Besides, HOQs carry more marks than LOQs in MSCE Biology examinations. Therefore, examinees with high ability to answer HOQs have high chances of scoring high in the subject. This, in turn, increases examinees' opportunity to pursue science programs in universities where Biology is a prerequisite. Training scientists is tantamount to attainment of Malawi's developmental aspirations. This ability comes with acquisition of high order thinking skills (HOTS) which is accelerated when teachers use Learner Centered Teaching (LCT) methods. The descriptive quantitative study sought for insight into how teachers of Biology in district boarding secondary schools (DBSSs) in Central East Education Division (CEED) of Malawi faired in imparting HOTS in examinees. A total of 312 examinees were randomly sampled from five randomly selected DBSSs in CEED. Data was collected using a questionnaire and a test and was descriptively and inferentially analysed using SPSS version 20. Cross tabulation of "school" versus "use of the methods" showed that LCT methods were employed in all the selected DBSSs whereby the response category "agree more" was significant at P=0.000. Up to 83% of aspects of LCT methods investigated in the questionnaire were found to have been significantly employed in all the selected schools. Furthermore, examinees who had undergone more learner centred lessons tended to prioritise HOQs less compared to those who underwent less learner centred lessons.

KEY WORDS

Cognitive skills

Difficulty levels

High order questions

High order thinking skills

Low order questions

Low order thinking skills

Prioritise

Standardised examinations

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

LIST OF ACRONYMS AND ABBREVIATIONS

ASEI:	Activity, Student-centred, Experiment, Improvisation
BT:	Bloom's Taxonomy
CDSS:	Community Day Secondary School
CEED:	Central East Education Division
CT:	Critical Thinking
DBR:	Design-based Research
DBSS:	District Boarding Secondary School
HOQs:	High Order Questions
HOTS:	High Order Thinking Skills
LCT:	Learner Centred Teaching
LOQs:	Low Order Questions
LOTS:	Low Order Thinking Skills
MAI:	Metacognitive Awareness Inventory
MANEB:	Malawi National Examinations Board
MoEST:	Ministry of Education, Science and Technology
MSCE:	Malawi School Certificate of Education
MSLQ:	Motivated Strategies for Learning Questionnaire
PBL:	Problem Based Learning
PDSI:	Plan, Do, See, Improve
SCAT:	Student Centered Approach to Teaching
SEED:	South East Education Division
SMASSE:	Strengthening Mathematics and Science in Secondary Education
SPSS:	Statistical Package for Social Scientists
SWS:	Student Worksheets
TCT:	Teacher Centred Teaching

CHAPTER ONE

INTRODUCTION TO THE PROBLEM AND ITS SETTING

1.1 Chapter overview

Chapter One provides background information to the research problem, justification of the research topic, statement of the research problem, purpose of the study including research objectives, and research questions. It further discusses the significance, limitations and delimitations of the study before finally providing definitions of terms and structure and outline of chapters of the write up.

1.2 Background to the study

In 1956, Doctor Benjamin Bloom developed a framework that categorised thinking processes into levels of knowledge, comprehension, application, analysis, synthesis and evaluation, from the least complex to the most complex. The framework was named Bloom's taxonomy (BT) of cognitive domains.

According to Ching and Silva (2017), the six categories of Bloom's taxonomy were not just a scheme of classification. Rather, they were a hierarchical organization of cognitive processes according to levels of complexity for the development of expected cognitive objectives. Hyder and Bhamani (2017) argued that several educationists and academicians regarded this model in facilitating learning achievement from lower level knowledge acquisition to higher order thinking.

Associated with higher order thinking are skills like critical, analytical, reasoning, reflective and science process, (Belecina & Ocampo, 2018). These are generally referred to as HOTS.

HOTS are valuable in the day to day life experiences of citizen in the modern society. Critical thinking (CT), for example, is very necessary in today's society (Nygren, Haglund, Samuelsson, Geijerstam & Prytz, 2018), such that Hussin, Harun and Shukor, (2019) referred to CT as a skill for citizens in the 21st century. Mgomezulu, Shawa and Wamba (2014), while holding the view that there is a level of overlap among CT, creative thinking and reflective thinking, claimed that students equipped with CT skills can contribute intellectually, socially, culturally and economically to society.

The major goal of educational institutions in imparting education is therefore to inculcate HOTS in students (Budsankom, Sawangboon, Damrongpanit & Chuensirimongkol, 2015; Shukla & Dungsungnoen, 2016). UNESCO (cited in Allybokus 2015) asserted that globalization has changed the way teachers teach in many parts of the world, moving away from traditional teacher centred teaching (TCT) approaches towards more LCT approaches. LCT approaches are well known to promote development of HOTS in students. Allybokus further stated that the shift from TCT to LCT was encouraged by industry and the business world. This was so because job markets sought multi-skilled graduates. Such personnel were capable of transferring book knowledge to real world functions, of adapting in a continuously evolving environment, of self-directed learning, of CT, of working autonomously and

as well as part of a team. Generally, this entailed acquisition of HOTS prior to the time of job seeking.

1.2.1 Current issues in the Malawi education system.

Prior to the previous secondary school curriculum review, the Open Society Initiative for Southern Africa (OSISA) (cited in Mgomezulu, Shawa & Wamba, 2014) observed that the Malawian education system had yet not made provision in the curriculum for the teaching of CT skills. This deprived learners of essential skills needed to be contributors to the development of the country. However, it was around the same time when Ministry of Education Science and Technology (MoEST) was geared to adopt an outcome based curriculum through Secondary School Curriculum and Assessment Review (SSCAR), which focuses on students' achievement.

This curriculum puts emphasis on use of learner centred teaching and learning approaches, including continuous assessment. To achieve the desired outcomes, students are introduced to new knowledge, skills, attitudes and values in the context of their existing knowledge, skills, attitudes and values so that they develop a deeper understanding as they learn and apply the knowledge. The achievements made at school are only truly beneficial when the students transfer them to life beyond the school and view learning as a lifelong process. This is essential in keeping pace with the changing social environment of home and work.

Introduction of national education standards is another milestone by MoEST in promoting teaching of HOTS in Malawian schools. Of the 26 education standards set, the first 6 relate to students' learning outcomes, the next 8 standards relate to key

aspects of the teaching process while the last 12 relate to the leadership and management processes for effective teaching and learning MoEST (2015). Nevertheless, all education standards are designed to contribute towards achievement of student learning outcomes as illustrated in Figure 1.1.

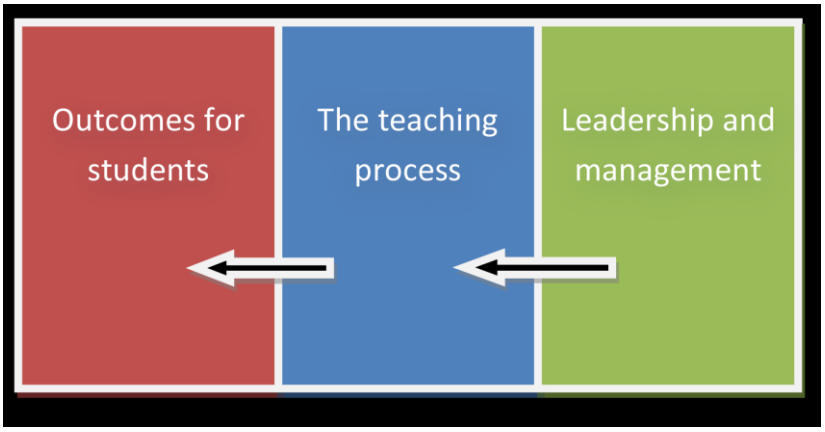

Figure 1.1 How education standards are related.

(Source: MoEST Malawi national education standards booklet).

MoEST advised that the relevant learning methods can be promoted through provision of enough teaching and learning resources and provision of adequate in-service training on participatory methods. Furthermore, aspects to be considered at school and classroom level to achieve effective learning include learner centered activities, variation of teaching and learning methods and continuous assessments, school based in-service training activities and study circles (MoEST, 2013).

Notwithstanding these efforts, the World Bank (2019) observed that despite heavy budgetary support on the education sector, education indicators show low achievement. The Human Capital Index (HCI) predicted that children born in Malawi would have 9.4 years of education by age 18. However, when adjusted for quality, the

time effectively spent acquiring necessary skills drops to the equivalent of just 5.4 years, a learning gap of four years (World Bank, 2019). As an intervention, the Equity with Quality and Learning at Secondary (EQUALS) project came in to lay the foundation for adoption of technology at various levels for nation-wide adoption over time.

At student level, firstly promoting use of digitized interactive math and science learning material in the 247 schools with potential for scalability in all other schools should the system capacity allow. Secondly, enabling access to low cost secondary education through ODL with digitized curriculum content.

At school and classroom level, construction and equipping of at least 100 ICT laboratories to facilitate the transfer of new pedagogical technologies to in-service math and science teachers by the teacher training institutions. Math and science teachers from the schools will have regular interactions with the cluster lead schools to learn project-based classroom approaches modeled on the MS4SSA initiative through the 80 cluster lead schools (reaching about 247 schools) located in the 13 target districts (World Bank, 2019).

These, among other interventions are indicators of efforts made in the Malawi education system to ensure that learners are adequately equipped with HOTS.

1.2.2 Higher order questions

HOQs are developed from the higher levels of BT cognitive domains (Monari, 2020). To answer these questions correctly, examinees are required to apply HOTS. Stanny (2016) asserted that since the time BT was published, teachers have relied on it to

guide how they write learning outcomes, structure learning activities, and write test questions to assess students' HOTS. Monari (2020) observed that although many educators understand the need to formulate HOQs that use the higher levels of BT, the opportunity of empowering students to respond to these questions by themselves was yet to be fully exploited.

Kusaeri (2019) conducted a study on HOTS type mathematics test whose results showed that the students were "less ready" to face HOTs type mathematics test. Being unaccustomed to non-routine and lengthy questions and lazy trait were among challenges for the students in facing HOTs type mathematics test.

Musliha, Sudana and (2021) stated that teachers' questions can stimulate the students' thinking process. Further to that, the author indicated that one of the effective ways to help the students to attain HOTS is teachers' questions. According to Kusaeri (2019), if teachers provide more varieties of HOQs, the students will have better ability to explore their reasoning when they face a variety of other questions. They will also get used to honing their ability to understand, analyze problems, create a math model, and find answer.

Unfortunately, teachers tend to use more LOQs than HOQs during lessons. A video analyses case study by Shahrill (2014) aimed at comparing levels of teacher questioning in mathematics classrooms between two countries of United States and Australia found one of the striking similarities to be the use of more LOQs than HOQs.

In an effective lesson employing HOQs, brainstorming is a very key part of the lesson because it helps to free students and empowers them as thinkers rather than be

complacent learners (Monari 2020). Students need to be exposed to the demands of such questions and therefore learn how to answer them. Students who have high learning abilities are better at answering HOQs compared to students in the medium and low categories (Yuliati & Lestari, 2018).

By investigating how examinees prioritised answering higher order questions during Malawi School Certificate of Education (MSCE) examinations, this study essentially aimed at sheding light on the extent to which examinees acquired HOTS at the completion of secondary school education cycle.

1.3 Justification of major elements of the topic

This section justifies why elements such as higher order questions, Biology paper I examination and DBSSs were of interest in this study.

1.3.1 High order questions

HOQs solicit examinees' application of HOTS. Since the major goal of educational institutions in imparting education is to inculcate HOTS in examinees (Shukla, 2016), there has been a worldwide advocacy for educational systems to adopt LCT techniques which effectively enhance development of HOTS in examinees. Examining the tendency of examinees to prioritise answering HOQs during examination taking session at MSCE could provide a reliable insight into determining how DBSSs were faring in instilling HOTS in examinees. This study assumed that the more examinees had attended LCT lessons during secondary school studies, the more they had acquired HOTS for answering HOQs and therefore the more the tendency to prioritise answering HOQs when taking MSCE Biology examination would be.

1.3.2 Biology paper I examination

Analysis of the Malawi National Examinations Board (MANEB) MSCE examination time tables for 2019 and 2020 showed that a total of 52 examination papers in 21 subject areas were administered in either years.

Any paper in any of these subject areas could be used in this study. However, biology was chosen for two reasons. Firstly, MSCE Biology is one of the key prerequisite subjects for admission of students into science based programs in various universities in Malawi and abroad. Training of experts in the field of science is critical if the nation is to realise its developmental aspirations packaged in the Malawi 2063 agenda.

According to National Planning Commission (NPC) (2020), Malawi's vision is to become an inclusively wealthy and self-reliant nation. For example, the vision leans on the three pillars of Agricultural productivity and commercialization, industrialization and urbanization. Effective implementation of these pillars shall require the nation to have well trained science experts. Therefore, basing the study on the subject of Biology was a way of contributing knowledge that would help the government to make informed decisions that would lead to realization of the nation's developmental vision.

Besides that, some attributes of the researcher necessitated choice of a paper in Biology. Professionally, the researcher is a qualified, experienced and practicing secondary school teacher, specializing in teaching Biology. In addition to that, the researcher has good understanding of examinations in Biology having undergone training by MANEB and having served as assistant examiner in Biology for over

seven years. With such attributes, subject-specific issues arising in the course of the study would be easily detected and addressed by the researcher. This would positively affect the validity and reliability of the findings.

Of the two Biology papers administered by MANEB at MSCE, paper I was chosen for the study because, unlike paper II, paper I comprised a relatively larger number of items. MANEB regulations stipulate that, MSCE Biology paper I shall have two sections. Section A shall have 10 questions which may have sub questions like 10a, 10b … etc, together worthy 70 marks. Section B shall comprise 3 restricted essay questions, together worthy 30 marks. Paper II shall comprise four compulsory questions in two sections.

Section A shall have two descriptive questions involving use of slides, photographs, thought experiments, and critique of experimental procedures worthy 20 marks. Section B shall have two practical questions worthy 20 marks (MANEB, 2020). However, the regulations are silent on proportions of HOQs and LOQs to be included in the sections of the papers.

It was therefore anticipated that for any chosen year, paper I would comprise a reasonable representation of both HOQs and LOQs than paper II would do. This was also tantamount to reliability and validity of the findings.

1.3.3 District Boarding Secondary Schools

In a booklet of names of students which were selected to various public secondary schools for the 2019/2020 academic year, Ministry of Education Science and Technology (MoEST) indicated that Central East Education Division (CEED) had 3 national secondary schools, 6 district day secondary schools, 9 DBSSs and 122

community day secondary schools (CDSSs). It was at the discretion of the researcher to choose between school categories of DBSSs and district day secondary schools whose schools were thought to be similar in terms of having a good quality and quantity of human, material and infrastructural resources and ability levels of students. These aspects are key to implementation of LCT methods in schools. Information obtained from samples of students in selected schools could be generalizable to all students in all schools of the chosen category. The other two categories were considered inappropriate on different premises.

On one hand, the national secondary schools were not similar as one was for boys only, another one was for girls only while the other one was co-educational. CDSSs on the other hand, were thought to have many discrepancies. Mlangeni and Chiotha (2015) described CDSSs as being diverse in nature citing unapproved CDSSs, rural CDSSs, CDSSs without subject specialists, CDSSs with majority of students operating from own home or in self-boarding hostels and CDSS with majority of students lacking home support or parental involvement in their education as categories of CDSSs. The differences among schools in these categories of schools would pose serious setbacks on generalizability of results.

1.4 Statement of the research problem

Nowadays, there is a greater value attached to HOTS. Survival of citizens in the society which is greatly influenced by information, science and technology calls for exhibition of such skills. Skills like critical, analytical, reflective and science process are necessary for solving day to day life problems leading to development at individual, societal and national levels. The central goal of education is therefore to help students develop HOTS to enable them to face the challenges in the day to day

life encounters (Saido, Siraj, Nordin & Amedy, 2015; Verdina, Gani & Sulastri, 2018).

The fifth developmental outcome of secondary education in the revised Malawi secondary school curriculum syllabi states that students should be able to apply scientific, technological, vocational and managerial skills in a creative and innovative way to identify problems and develop appropriate solutions, so as to participate productively in society. This implies acquisition of HOTS.

This outcome based curriculum emphasises teacher's use of LCT methods. According to Piaget (cited in Amineh & Asl 2015) the role of learners shifted from passive in the past to active in the constructivist theory.

BT is regarded very important in facilitating learning achievement from lower level knowledge acquisition to higher order thinking (Hyder & Bhamani 2017) which includes critical, analytical, reasoning, reflective and science process skills, (Belecina & Ocampo, 2018). BT classifies the different layers of learning process that students go through when the learning objectives are set for them in a teaching program (Sivaraman & Krishna 2015). BT was considered to be one of the most imperative elements in the work of educationists and academicians when designing curriculum, describing learning outcomes and objectives, and creating assessment of learning (Stanny, 2016). Stanny asserted that since the time BT was published, teachers have relied on it to guide how they write learning outcomes, structure learning activities, and write test questions to assess students' higher level thinking skills. This study therefore sought to ascertain the tendency of examinees in DBSSs in CEED to prioritize answering HOTS based questions MSCE Biology paper I. It was envisaged

that examinees' prioritisation of answering such questions would relate to the extent to which examinees had acquired HOTS at the time of completion of a four year secondary school cycle.

1.5 Purpose of the study

The purpose of this study was to determine how examinees in DBSSs of CEED prioritised answering HOQs during MSCE Biology papers I examination.

It was known that through use of LCT methods which underlie constructivism, examinees could be made to attain the ability to use HOTS presented in the BT.

However, what was not clear was how acquisition of HOTs would relate to examinees' prioritisation of HOQs during test taking. The study therefore undertook to fill this knowledge gap.

1.6 General objective

The general objective of this study was to investigate how examinees in DBSSs in CEED of Malawi prioritised answering high order questions when taking MSCE Biology paper I examination.

1.7 Specific objectives

The following specific objectives were used to achieve the general objective.

1. To compare examinees' levels of tendency to prioritise answering high order questions with prioritising low order questions in a test taking session.
2. To determine the extent to which teachers of Biology in DBSSs of CEED use LCT methods during delivery of lessons.

3. To examine the relationship between teachers' use of LCT methods and examinees' tendency to prioritize answering HOQs during MSCE Biology paper I examination.

1.8 Research questions

The study aimed at answering the general question: "How do examinees sitting for MSCE Biology paper I examination in DBSSs in CEED prioritise answering HOQs?" To answer the general question, the following specific questions were to be answered.

1. How do examinees' levels of tendency to prioritise answering HOQs compare with prioritising LOQs when taking MSCE Biology paper I examinations?
2. To what extent do teachers of Biology in DBSSs in CEED use LCT methods during delivery of lessons?
3. How does the teacher's use of LCT methods relate with examinees' tendency to prioritize answering high order questions when taking MSCE Biology Paper I examinations?

1.9 Significance of the study

The findings of this study will prompt Ministry of Education Science and Technology (MoEST) and other stake holders in the education sector to find ways of upholding teaching practices which are effective for enhancement of development of HOTS in Malawian secondary school students. This will lead to mass production of citizens capable of using critical, analytical, reasoning, reflective and science process skills, which will render them relevant and productive in the modern society. With such citizens, development of the nation will be accelerated.

1.10 Chapter one summary

Chapter One has introduced the research problem by providing background information to the research problem, justification of the elements of the research topic, statement of the research problem, purpose of the study including research objectives, research questions, significance of the study, limitations and delimitations of the study.

1.11 Structure and outline of chapters

The write up has five chapters. Each chapter consists of a number of sections. Some sections have subsections. Some subsections are further divided into parts, denoted by roman numerals.

Chapter One is an introduction that provides background to the study, justification of elements of the research topic, statement of the research problem, purpose of the study indicating research objectives, research questions, operational definitions of terms, significance of the study, limitations of the study, delimitation of the study.

Chapter Two reports a review of literature and empirical studies related to the topic under study. The chapter has eight sections beginning with a general introduction to the chapter followed by the study's theoretical framework. Follow up sections review literature related to the topic under study, related empirical studies conducted worldwide, empirical studies conducted in Africa and empirical studies conducted in Malawi. General themes tackled by the reviewed literature range from BT, constructivism, HOTS, critical thinking (CT) and problem based learning (PBL) to metacognition. The chapter ends with the summary of literature review.

Chapter Three outlines research methodology. Design of the research, study population, sampling, data collection techniques and tools, validity and reliability of data collection tools, data analysis techniques and ethical considerations have been discussed. The chapter ends with a summary.

Chapter Four provides details of how data was analysed. The methods and statistical tools that were used are shown clearly. The chapter shows the three focus areas of data analysis: (1) determining the extent to which different teaching methods were employed by teachers of Biology, (2) comparing examinees tendency to prioritise answering high order questions, (3) determining the relationship between examinees' prioritization of answering HOQs and their prioritization of answering LOQs.
The chapter further discusses findings from the analysis of data. Finally a summary of the chapter is provided.

Chapter Five provides conclusions drawn from results of data analysis, implications of the findings and recommendations to relevant stake holders. Related topics for further study have been outlined before providing chapter summary.

1.12 Operational definitions of terms

Central East Education Division

One of the six divisions of Malawi according to the educational system. It comprises the districts of Kasungu, Dowa, Ntchisi, Salima and Nkhotakota.

District boarding secondary school

Public secondary school with full boarding facilities which is fed with students selected from primary schools within the district in which it is located.

High order questions

Questions which require candidates to apply HOTS when answering.

Higher order thinking skills:

Skills which are associated with the analysis, synthesis and evaluation levels of the BT.

Malawi School Certificate of Education Examination

The national examination in Malawi's secondary education system which is administered at the end of a four year school cycle.

Prioritise

Tendency of examinees to choose which questions to answer first before answering others during the examination taking session.

Priority position

Pertaining to how a candidate ranked question to be answered first before others.

Range of priority positions

A group of priority positions relating to a bunch of questions attempted by a candidate at around the same time.

CHAPTER TWO

REVIEW OF LITERATURE

2.1 Introduction

This Chapter begins by introducing the theoretical framework in which BT is described while providing background information to the concept of HOTS which is the basis of the current study. Constructivism, a theory that proposes relevant pedagogical practices for enhancing HOTS in students is also described under the framework. Thereafter, literature on key thematic areas relevant to the topic of study is reviewed. These have been discussed basing on general literature as well as empirical studies conducted overseas, in Africa and in Malawi.

2.2 Theoretical framework

This study is based on two theoretical foundations of BT and constructivism.

2.2.1 Bloom's taxonomy

BT is a hierarchical structure representing six levels of thinking and learning skills that move from the lower to higher order skills, (Gichuhi, 2017). Sivaraman and Krishna (2015) described BT as a model that classifies the different layers of learning process that students go through when the learning objectives are set for them in a teaching program. BT is a well-defined and broadly accepted tool for categorizing

types of thinking into knowledge, comprehension, application, analysis, synthesis, and evaluation levels.

BT was primarily conceptualized and presented by Doctor Benjamin Bloom with the core purpose of ensuring that learning transforms into higher levels of thinking. Later on, the taxonomy was studied and revised by David Krathwohl.

2.2.1 .i. Types of thinking in BT

The original BT of 1956 categorised thinking into six levels of Knowledge, Comprehension, Application, Analysis, Synthesis and Evaluation. However Anderson et al.(cited in Gichuhi 2014) explained that the revised BT version of 2001 converts the different category titles to active verbs of Remembering, Understanding, Applying, Analysing, Creating, and Evaluating. Figure 2.1 is a diagram showing a conceptualised order of types of thinking in both the original and revised BT. The least complex level is at the bottom while the most complex level is at the top.

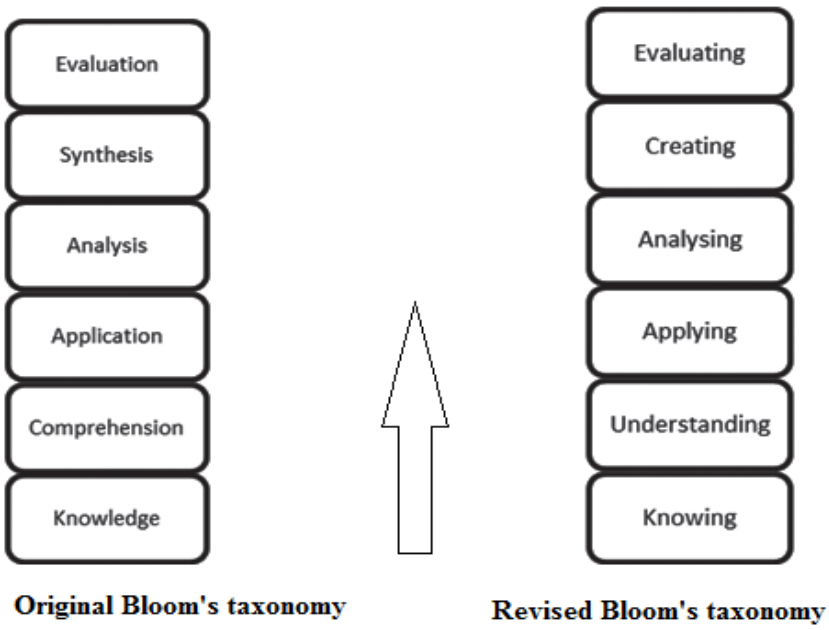

Figure 2.1 Conceptualised order of types of thinking in BT

Adams (cited in Ching& Silva, 2017) and Stanny (2016) described the categories of thinking in BT as follows: *Knowledge* is the foundational cognitive skill that refers to the retention of specific, discrete pieces of information, such as facts and definitions. *Comprehension* requires more cognitive processing than simply remembering information; appropriate learning objectives help learners begin to incorporate knowledge into their existing cognitive schemas. This allows learners to use knowledge, skills or techniques in new situations through *application*. Distinguishing between fact and opinion and identifying the claims upon which an argument is built requires *analysis*. *Evaluation* is important to critical thinking, appraising the validity and judging the relevance of a phenomenon.

Each of the categories is associated with action verbs which aid their identification. Table 2.1 describes the categories in the revised BT together with examples of associated action verbs.

Table 2.1 Categories of thinking in the revised Bloom's Taxonomy

LEVEL	DEFINITION	ACTION VERBS
Remembering	Recall of information.	List, memorize define, recognize, arrange, relate, label, recall, name.
Understanding	Interpret information in one's own words.	Classify, describe, discuss, explain, express, identify, indicate, locate, recognize report, restate, review, select.
Applying	Use knowledge or generalization in a new situation	Demonstrate, dramatize, apply, choose, employ, illustrate, interpret, operate, prepare, practice, schedule, sketch.
Analysis	Break down knowledge into parts and show relationship among parts.	Discriminate, differentiate, analyse, appraise, categorize, compare, contrast, criticize diagram, distinguish, examine, inventory question, experiment, test.
Evaluating	Making judgment based on criteria and standards.	Appraise, argue, attack, choose, compare, defend, evaluate, judge, predict, rate, score, select, support.
Creating	Bringing together parts of knowledge to form a whole and build relationships for new situations.	Arrange, assemble, collect, compose, construct, create, design, formulate, manage, organize, plan, prepare, propose, set up, synthesize, and write.

Adapted from; Krathwohl, D. R. (2002). A Revision of Bloom's taxonomy: An overview. *Theory into Practice, 4,* 212-218.

2.2.1 .ii Major groups of thinking skills in BT

The thinking skills in BT are classified into two major groups; lower order thinking skills (LOTS) and HOTS (Abdullah, Mokhtar, Halim, Ali, Tahir & Kohar, 2017; Verdina, Gani & Sulastri, 2018). LOTS consist of the first three aspects of BT, which are, remembering, understanding, and applying while HOTS consist of the last three aspects namely analyzing, evaluating and creating, (Budsankom, Sawangboon, Damrongpanit & Chuensirimongkol, 2015; Kusuma, Rosidin, Abdurrahman & Suyatna, 2017; Verdina, Gani & Sulastri, 2018). Nevertheless, some researchers like Fives and Barnes (2018) regarded the application category to be in the class of HOTS and not in the class of LOTS. This may be so because generalization of knowledge in a new situation (application) is a more complex task than mere retention of knowledge and interpretation of knowledge in one's own ways involved in remembering and understanding categories respectively.

Mindful that HOQs are developed from the higher levels of BT (Monari, 2020) and that to answer such questions examinees are required to apply HOTS, the current study attempts to find out how examinees prioritise HOQs during MSCE examinations. Given that LCT methods were employed in the DBSSs due to availability of adequate human, infrastructural and material resources, then it was expected that examinees had acquired HOTS by the time they completed the four year school cycle. MSCE examination was hereby regarded as the most appropriate tool for measuring attainment of HOTS by secondary school examinees. Acquisition of HOTS would enable examinees to work using the higher levels of thinking stipulated in the BT to devise an approach for attempting questions in the examination. Therefore, BT indeed underlies the current study.

2.3 Constructivism

According to Shah (2019), constructivism is a paradigm that hypothesizes learning as an active, contextualized, or constructive process in which learners construct knowledge based on their personal experiences and hypotheses of the environment. Learners, through social negotiation, continuously test their hypotheses and create new knowledge, correct previous knowledge, or confirm present knowledge.

Olusegun (2015) states that constructivism's central idea is that human learning are constructed. Orbiting around the idea of constructed knowledge is firstly the notion that learners construct new understandings using what they already know. There is no *tabula rasa* on which new knowledge is etched. Secondly, that learning is active rather than passive. Learners confront their understanding in light of what they encounter in the new learning situation. If what learners encounter is inconsistent with their current understanding, their understanding can change to accommodate new experience.

Advocates of this learning theory hold the position that learning takes place through a process in which knowledge is built on a foundation of prior knowledge and thus, that learning is a result from experiences and ideas (Dano-Hinosolango & Vedua-Dinagsao, 2014; Krahenbuhl, 2016). In the view of Aldamigh (2018) and Olusegun (2015), constructivism as a learning theory allows individuals to construct own meaning and make own understanding of the world around.

Constructivism has roots in philosophy, psychology, sociology, and education (Olusegun, 2015) and it has become one of the most influential philosophies in education in the twenty first century (Krahenbuhl, 2016).

According to Olusegun (2015) and Aldamigh (2018) constructivism theory was developed from the works of educators and psychologists Brunner, Piaget and Vygotsky.

Lev Vygotsky's main relevance to constructivism comes from theories about language, thought, and their mediation by society. According to Amineh and Asl (2015), Vygotsky held an anti-realist position and stated that the process of knowing was affected by other people and was mediated by community and culture. Piaget (cited in Amineh & Asl 2015) stated that the role of learners shifted from passive in the past to active in the constructivist theory. Teacher education professors overwhelmingly ascribed to constructivist pedagogy as an essential component for engaging in so called "best practices," (Krahenbuhl, 2016).

A constructivist classroom provides variety of activities to challenge students to accept individual differences, increase readiness to learn, discover new ideas, and construct own knowledge (Yadav, 2016). The view of Amineh and Asl (2015) was that constructivism described the way that students could make sense of the material and also how the materials could be taught effectively. The researchers directed that with constructivism as an educational theory in mind, teachers should consider what students know and allow them to put the knowledge into practice.

From a constructivist perspective, the primary responsibility of the teacher is to create and maintain a collaborative problem-solving environment, where students are

allowed to construct own knowledge, and the teacher acts as a facilitator and guide, (Olusegun, 2015).

The current study was purposed to find out how examinees prioritise HOQs during examinations.

To achieve this, the researcher investigated how much of LCT methods were used when teaching Biology to examinees in selected schools. Basing on the extents of use of LCT methods in respective schools, examinees' tendency to prioritise HOQs was compared. The focus on LCT methods indicates that the study stands on the foundation of constructivism since in the words of Piaget (cited in Amineh & Asl 2015), the role of learners shifted from passive in the past to active in the constructivist theory.

2.4 High order questions

To answer HOQs correctly, examinees are required to apply HOTS. Stanny (2016) asserted that since the time BT was published, teachers have relied on it to guide how they write learning outcomes, structure learning activities, and write test questions to assess students' HOTS. However, Monari (2020) observed that although many educators understood the need to formulate HOQs that use the higher levels of BT, the opportunity of empowering students to respond to HOQs by themselves was yet to be fully exploited. In agreement to this observation, results of a study by Kusaeri (2019) on HOTS type mathematics tests showed that students were "less ready" to face HOTS.

Musliha, Sudana and Wirza (2021) stated that teachers' questions can stimulate the students' thinking process. Further to that, the author indicated that teachers' questions form one of the effective ways to help students to attain HOTS. According to Kusaeri (2019), if teachers provide more varieties of HOQs, the students will have better ability to explore their reasoning when they face a variety of other questions. They will also get used to honing their ability to understand, analyze problems, create a math model, and find answer. Unfortunately, teachers tend to use more LOQs than HOQs during lessons.

A video analyses case study which was conducted by Shahrill (2014) whose aim was to compare levels of teacher questioning in mathematics classrooms between the two English speaking countries of United States and Australia found one of the striking similarities to be the use of more LOQs than HOQs.

In an effective lesson employing HOQs, brainstorming is a very key part of the lesson because it helps to free students and empowers them as thinkers rather than be complacent learners (Monari 2020). Students need to be exposed to the demands of such questions and therefore learn how to answer them. Students who have high learning abilities are better at answering HOQs compared to students in the medium and low categories (Yuliati & Lestari, 2018).

2.4.1 Implication of BT on higher order questions

BT provides the framework for understanding the types of thinking. It also provides the action verbs associated with each type of thinking, which are used in formulation of questions by teachers. Action verbs, when properly used in questions are key determinants of whether the questions are of high order or low order.

Since BT levels of analyzing, evaluating and creating are in the high order class (Budsankom, Sawangboon, Damrongpanit & Chuensirimongkol, 2015; Kusuma, Rosidin, Abdurrahman & Suyatna, 2017; Verdina, Gani & Sulastri, 2018), questions framed using action verbs from these levels become HOQs.

BT was considered to be one of the most imperative elements in the work of educationists and academicians when designing curriculum, describing learning outcomes and objectives, and creating assessment of learning (Stanny, 2016).
Stanny asserted that since the time BT was published, teachers have relied on it to guide how they write test questions to assess students' HOTS.

This study, therefore, assumed that examinees in DBSSs in CEED were more likely to display a level of tendency to prioritize answering HOQs during MSCE examinations. Skills for answering such questions would have been acquired by the end of their four year secondary school studies in which the outcome based curriculum was used. This assumption is based on the background that DBSSs were deemed to have adequate teaching and learning resources for implementation of LCT methods which are known to accelerate acquisition of HOTS by students.

Contrary results would indicate the need for DBSSs in CEED to scale up efforts to pursue the educational goal of instilling HOTS in students through adopting and practicing appropriate pedagogical methods and instructional activities reviewed in the this chapter.

2.5 Relevance of BT in education

BT was considered to be one of the most imperative elements in the work of educationists and academicians when designing curriculum, describing learning outcomes and objectives, and creating assessment of learning (Stanny, 2016). Stanny asserted that since the time BT was published, teachers have relied on it to guide how they write learning outcomes, structure learning activities, and write test questions to assess students' HOTS.

When Ching and Silva (2017) introduced alignment of the task of planning of educational objectives, instructional activities and assessment to Bloom's Taxonomy to develop competences in students at an institution of higher learning, three fold positive results were found: (1) students' average scores improved, (2) students recognized that the taxonomy enabled them to apply the acquired knowledge in new situations to help to solve problems (3) professors clearly saw improvements in the students' performance as well as their higher levels of engagement. The core purpose of developing BT was to ensure that learning transformed into higher levels of thinking (Hyder & Bhamani, 2016), and that the major goal of educational institutions was to inculcate higher order thinking skills in students (Budsankom, Sawangboon, Damrongpanit & Chuensirimongkol, 2015; Shukla & Dungsungnoen, 2016).

2.6 Constructivist teaching and learning approach.

Constructivist teaching and learning approach is based on the principles of LCT. Olusegun (2015) contended that the most important contribution of constructivism was the focus on student-centered learning. He further asserted that if efforts in

reforming education for all students were to succeed, then the focus was to be on students.

The researcher conducted a review of constructivism learning theory as a paradigm for teaching and learning which suggests that humans construct knowledge and meaning from experiences. The write up discussed conceptual understanding of the theory and basic characteristics of constructivists learning environment.

It also discussed such aspects as seven pedagogical goals of constructivist learning environments, six benefits of constructivism, significant differences between traditional classroom and constructivist classroom, principles of constructivism and implications of constructivism for teaching and learning. It was concluded from the review firstly, that teachers needed to reflect on their practice in order to apply these ideas to their work. Secondly, that constructivist teachers encourage students to constantly assess how the activity was helping them gain understanding.

This conclusion agreed with the one which was drawn from a study by Mwanda and Midigo (2019) in Kenya which stated that the constructivist instructional method was effective in improving learner achievement in biology and should therefore be adopted in secondary schools in teaching biology. The study aimed at investigating the effectiveness of constructivist method of instruction on learning of biology and challenges facing its implementation in secondary school students. The quasi-experimental non-equivalent groups with a post-test examination in which 477 students and 12 teachers participated, used constructivist instruction manual, post-test, attitude questionnaire and teacher's questionnaire to collect data. The data collected

was analyzed descriptively using mean and standard deviation values, while t-test and ANOVA were used to test the differences between group means at $\alpha=0.05$ level.

Findings confirmed that constructivist instructional approach pay positive influence on learners' achievement in biology. Recommendations made included that deliberate programs in implementing constructivist learning approach in secondary schools be conducted and that biology teachers should be encouraged to use constructivist method of instruction, since the method is more effective in learning biology compared to conventional methods.

Earlier on, Metto and Makewa (2014) conducted a study which sought to uncover the factors that had hindered the use of LCT methods in Kenyan public primary schools. The study, which was basically a review of related literature, yielded findings that revealed multiple elements that had combined to prevent the practice of LCT. These were grouped into teacher factors, teaching and learning material factors and learner factors. It was concluded that if Kenyan youth were to be prepared effectively to face life challenges of the 21st century, the country's education stakeholders were to endeavor to make teaching learner-centered rather than teacher-centered. The most important recommendation that was made was that systematic teacher training should be provided for effective implementation of LCT. Allybokus (2015) examined how 30 professionally trained teachers from eight state secondary schools in Mauritius understood LCT and how they implement it in class. The study also explored why the teachers chose this approach and which skills they thought were necessary for effective LCT. The qualitative study used a social-constructivist approach. Questionnaires, semi-structured interviews, focus groups, class observations and debriefing sessions were used to gather data. Among others, the study showed that

teacher' work contexts, beliefs and the pressure of an exams-oriented system shaped their understanding of LCT.

Further to that, LCT in Mauritian schools was only partially learner-centred with a mix of LCT and TCT. A similar study was done by Nyimbili, Namuyamba and Chakanika (2018) in which the usage of LCT in the teaching of English language in the secondary schools of Lundazi district in Zambia was assessed. The study sought to establish how students were learning English using LCT and to identify challenges in using the learner centred activities in the secondary schools. The mixed methods design study involved 72 students, 24 teachers of English and 4 secondary school heads of department for languages.

Similar to what Allybokus found in Mauritius, results from this study revealed that Teachers in secondary schools in Lundazi district in Zambia faced a number of challenges in implementing LCT including inadequate teaching and learning materials, over enrolment, rushing to cover the whole syllabus and teaching to make children pass examinations. The teachers were found not to be interested in teaching using LCT. Consequently, a limited number of learner centred activities was used.

Despite this, the researchers reported that they observed that students were interested in learning English using the learner centred activities. Use of the continuing teacher professional development meetings to share fully the process of teaching English language using LCT in the secondary schools was recommended. It was also recommended that government should control enrolment in secondary schools so that quality learning could be realized through teaching English using LCT.

2.7 Constructivist teaching methods versus traditional methods

Constructivist teaching and learning approach is one of the teaching approaches gaining popularity based on its principles of learner centered education, (Mwanda & Midigo, 2019). The basis of this approach is the argument by Yadav (2016) that knowledge is not merely passing information to students but to construct and reconstruct learning on the basis of previous experiences of an individual student. Unlike the traditional approaches of teaching, constructivist teaching encourages learners to construct their own knowledge and take control of their own learning (Aldamigh, 2018).

This view of learning sharply contrasts with teacher-centered approach to teaching in which learning is the passive transmission of information from one individual to another, a view in which reception, not construction is key (Olusegun, 2015).

Further to that, Duru (cited in Aldamigh 2018) explained that in teacher-centered classrooms, the teacher poses as an expert who selects, determines, and evaluates the educational process on behalf of students who are considered to lack the capacity to know what needs to be learnt and are therefore expected to accept, receive, memorize, and repeat what teachers teach.

2.8 Implication of adopting constructivism

Shifting from traditional methods to constructivist approaches entails that there should be a number of adjustments especially on the part of the teacher. In order to alter teachers' pedagogical practices to be aligned with a constructivist approach, teachers' beliefs toward students, learning, and teaching should also be considered, (Aldamigh, 2018). These beliefs strongly influence teachers' practices, which in turn affect the quality of student learning. Understanding of constructivism allows teachers to create an effective and vibrant learning environment for students.

2.9 Criticisms of constructivism

Listed below are criticisms by various researchers as cited in Alanazi (2016).

i. Constructivism promotes a teaching style with unguided or minimally guided instructions for students.

ii. When students learn with minimal instructions, they become "lost and frustrated".

iii. The practice of designing minimally-guided instruction ignores the importance and structure of working memory during learning.

iv. Minimally-guided approaches as practiced through constructivist approaches ignore empirical studies that have shown that unguided instructions are not effective in learning environments.

v. Constructivist approaches do not support the learning-related need that learners need to connect their knowledge to tangible objects in order to ensure that they have acquired the knowledge. Cognitive learning is not enough for individuals; learners need to display their learning outcomes in a tangible manner so that these tangible learning outcomes continue to shape and sharpen learners' thinking.

vi. Piagetian concept of constructivism overlooks important contextual factors in learning environments such as available educational resources, the need to integrate media into learning environments, learners' preferences, and the affordance of individual student thinking. This criticism suggests that constructivist approaches focus mainly on cognitive factors, ignoring other contributing environmental and technological factors.

vii. Constructivism views learners as interpreting the world differently and instructions are, therefore, not effective because critical concepts within the curriculum are not commonly constructed among learners. These critics argue that within constructivist-based pedagogies, giving learners adequate curricula is ineffective because curricula are centered towards all learners in the classroom while every individual has different thinking.

viii. Constructivism promotes group thinking and ignores the individuality of students even though learning should promote individual rights.

ix. Dominant students control interactions in the classroom and drive the whole class towards their thinking while leaving other students behind. That is, constructivist teaching overlooks the development of many students' skills because the activity is led by a few.

x. Constructivism is unsound from an economic perspective, as it is costly to train instructors in how to teach in constructivist methods, especially with school budgets often in precarious circumstances.

2.10 Key theoretical principles

Further review of literature tackles relevant theoretical principles connected to BT and constructivism.

2.10.1 Higher Order Thinking Skills

In this 21st century, where Information and Technology greatly influence the society, HOTS are strongly advocated for and have claimed immense industry demand. Such being the case, the major goal of educational institutions in imparting education is to inculcate HOTS in students (Budsankom, Sawangboon, Damrongpanit &

Chuensirimongkol, 2015; Shukla & Dungsungnoen, 2016). Further to this, Saido, Siraj, Nordin and Amedy (2015) and Verdina, Gani and Sulastri (2018) agreed that the central goal of science education is to help students to develop HOTS such as critical, reasoning, reflective and science process skills to enable them to face the challenges of daily life. Students with HOTS are able to create new knowledge and make appropriate and logical decisions, (Budsankom et al., 2015; Verdina, et al., 2018). This is so because using HOTS students are able to carefully observe events or natural phenomena that exist around.

Agarwal (2019) pinpointed that development of students' higher order learning is a critical component of education from both educational and scientific perspectives and that it is of practical interest that robust strategies that increase higher order learning must be developed. Development of proper instruments for teaching of HOTS either at subject level or concept level can play an important role in enhancing development of HOTS in students.

For example, in Indonesia, Apino and Retnawati (2017) developed and tested the instructional design to improve HOTS of students in learning mathematics. The design involved engaging students in activities like non-routine problem solving; to facilitate students to develop the ability to analyze and evaluate (critical thinking) and the ability to create (creative thinking); and to encourage students to construct their own knowledge so that learning becomes meaningful. An increase in pretest-posttest scores of students before and after administering the design was observed. This indicated that the design was effective in improving students' HOTS in learning mathematics.

Still in Indonesia, Verdina, Gani and Sulastri (2018) developed and tested student worksheets (SWS) based on curriculum of 2013 to improve students' HOTS in learning the concept of thermochemistry. The study involved 25 students of grade 11 from a secondary high school and 15 chemistry teachers in Banda Aceh. An essay test was used to measure HOTS. Data analysis revealed the N-gain value of 79% which is in the high category. This indicated that the developed SWS could improve students' HOTS. SWS were therefore recommended for use as material for teaching and learning of the concept of thermochemistry.

Understanding students' factors on learning of HOTS is also vital in achieving the goal of instilling HOTS in students. Budsankom, et al. (2015) conducted a study with the purpose of developing and identifying the validity of factors affecting HOTS of students.

The methodology involved applying a meta-analytic structural equation modeling analysis of a database of 166 primary empirical studies which focused on factors relating to the family characteristics, the intellectual characteristics, the psychological characteristics, and the classroom environment, which affect students' HOTS.

It was found that development of HOTS in students was more directly affected by psychological characteristics, classroom environment and intellectual characteristics respectively. Family characteristics were found to have insignificant effects on HOTS but had indirect effects on HOTS through psychological characteristic.

These findings were complemented by those of a study that was conducted by Yuliati and Lestari, (2018). The study aimed at explaining high-level thinking skills of students of Elementary School Teacher Education programs in solving HOTS-oriented questions in Instructional Evaluation courses. Qualitative research methods

using cognitive test instruments as data collection tools were employed and data was analysed using simple descriptive statistics. Students with high learning abilities were found to be better at answering HOTS oriented questions compared to students in the medium and low categories.

Teachers are also an important aspect to be considered in enhancing HOTS in students. Despite the expectation that teachers in school ought to teach to enhance development of HOTS in students, Schulz and Patrick (2016) sought evidence that critical and high order thinking are systematically taught and assessed in schools.

A total of 38 teachers in Kindergarten to Grade 9 classrooms from 14 schools in Newfoundland and Labrador, Canada, were interviewed to obtain their understanding of CT and higher order thinking in social studies and science, and how this affects instruction and assessment. It was revealed that the teachers believed that higher order thinking was important for all students, teaching thinking of thinking was attempted; however, there was insufficient knowledge on assessment of thinking.
The teachers indicated uncertainty about what higher order thinking meant and indicated unpreparedness to teach or assess higher order thinking.

Shukla and Dungsungnoen (2016), attempted to know teaching strategies for the inculcation of HOTS being practiced in Thailand and its relations with teachers' professional component such as designation, educational qualifications, teaching experience, research experience and training and workshop exposure. A total of 126 teachers participated in the study. A survey instrument was administered to teachers with the intention to measure the teaching strategies for imparting HOTS and

teacher's professional component. It was found that the teachers were using more knowledge development and application strategies. Furthermore, the teachers' professional components such as designation, teaching experience and qualification were significantly correlated with strategies used for imparting HOTS.

In Banjarmasin-Indonesia, Ramdiah, Abidinsyah, Royani and Husamah, (2019) conducted a study which aimed at describing the preparation of biology teachers in learning, analyzing the understanding of biology teachers about HOTS, and examining the efforts of biology teachers in developing HOTS for high school students. Forty-one senior high school biology teachers, who were involved in routine activities of the biology subject teacher working group, completed a questionnaire.

Revelations made by the study included that high school biology teachers in Banjarmasin prepared learning well but not consistently; some did not maximally prepare learning in accordance with the recommended education standards; teachers had moderate understanding of HOTS and were aware of the need to practice HOTS for students; the teacher's efforts in developing HOTS had not been realized and were less described in teaching activities because the HOTS aspect tended to be ignored.

It was recommended that whatever the case may be, HOTS were significant for students and had to be trained and managed well by teachers. As recommended by Yuliati and Lestari (2018), effort must be put into the training of pre-service teachers in HOTS so that they can train students to have HOTS through learning activities created when they become school teachers. Earlier on Saido, Siraj, Nordin and Amedy (2015) recommended in-service professional development programs for serving teachers to improve their own HOTS, focusing much on component skills of critical thinking and metacognition, for the teachers to be able to assist students to

improve in HOTS. The recommendation was made following a study that was conducted in Iraqi-Kurdistan region by the researchers. HOTS level of 7th grade students was assessed only to find that the majority of 7th grade students were at lower level of thinking skills n =278 (79.7%).

2.10.2 Critical thinking (CT)

This sub section discusses literature on CT basing on studies done overseas, in Africa and in Malawi separately. It also highlights influence of Problem Based Learning (PBL) on CT.

2.10.2.i Studies on CT conducted overseas

Critical thinking is described by Hussin, Harun and Shukor (2019) as comprising intellectual thinking skills like analyzing, reasoning, problem solving, creative thinking, making judgment and good decision making. Belecina and Ocampo (2018) provided two descriptions of CT. Firstly, that CT is the intellectually disciplined process of actively and skillfully conceptualizing, applying, analyzing, synthesizing, and/or evaluating information gathered from, or generated by, observation, experience, reflection, reasoning, or communication, as a guide to belief and action.

Secondly, that CT is characterized as the intentional application of rational, HOTS, such as analysis, synthesis, problem recognition and problem solving, inference, and evaluation. The researchers further indicated that critical thinkers employ higher level analytical skills to understand a problem and to work toward a means of solving the problem. CT has been favorably described in different contexts for its value in the contemporary world. CT was termed as “a lifelong skill” by the Tertiary Education Commission of New Zealand in the statement of Intent of 2015 - 2019 (cited in

Mehta, 2015), while Hussin, Harun and Shukor (2019) referred to CT as "a skill for citizens in the 21st century" .

Nold (2017) underscored the value of CT by recording that success in the classroom and workplace is a function of many attributes that change with the situation, but the ability to synthesize complex relationships and identify potential solutions to problems or innovation is a core competency. The researcher recorded that reports from numerous studies and the United States Department of Education indicated that university graduates lacked CT and problem solving skills that were needed for success in both the classroom and the modern workplace. The researcher therefore, conducted an action research project in which curricula in three business courses were modified to include and emphasize activities that research suggested help to develop CT. The aim was to assess how use of CT teaching methods could influence students' success. A modified Motivated Strategies for Learning Questionnaire (MSLQ) was administered at the beginning and at the end of an eight-week course to provide insight into how students self-assess constructs for success. Results from classes over a 15-month period in 2013 and 2014 indicated improvement in 14 of 15 elements for success. Three of these elements, intrinsic goal orientation, self-efficacy, and CT were statistically significant.

These findings indicated that CT positively influenced the success of students. Recommendations made were that it was worthwhile for stakeholders in the education sector to consider emphasizing enhancement of students' CT. Bearing in mind the importance of CT, it was important for the said stakeholders to see to it that teaching of CT was properly regulated. Lastly that there is need to standardize the way CT was taught across institutions.

In New Zealand, Mehta (2015) found that development of CT depended equally on the roles of students, teachers and systems. The researcher investigated the quality assurance for graduates who qualified the same level qualification from different tertiary institutions in terms of CT. This was achieved by reviewing the perceptions of educators about the nature of CT and identifying the teaching strategies employed by those educators to develop CT skills in students. On one hand, the researcher suggested that the Tertiary Education Commission should consider providing a definition of CT across the entire tertiary education sector to maintain the common understanding of CT among students and teachers. Such intervention would ensure that all students had similar opportunity to acquire CT skills for success in education, employment and life in general. On the other hand, monitoring should be done on the way CT was taught across subject areas.

According to Nygren, Haglund, Samuelsson, Geijerstam and Prytz (2018), CT among students comprise different subject-specific skills, such that a student who thinks critically in one subjects does not necessarily do so in other subjects. In addition, grades in different subjects are closely linked to student's abilities to answer questions designed to test CT in the subjects. This was established through analysis of 76 individual students' CT as expressed in Swedish national tests in history, physics, mathematics and Swedish.

Further than that, it was found that the same formulations of CT in two subjects may mean very different things when translated into assessments. Monitoring teaching of CT on subject area level was vital for ensuring that student were able to think critically in a diversity of dimensions which would aid them to successfully deal with different real life situations in the society.

While acknowledging that it was difficult to develop CT skills, Persky, Medina and Castleberry (2019) expressed optimism that it was possible to develop CT skills in students. This was reported following a literature review on the importance of and barriers to CT purposed to provide evidence-based recommendations to encourage development of CT skills in pharmacy students. It was found that challenges that hindered students from thinking critically included students' own perceptions, poor metacognitive skills, a fixed mindset, a non-automated skill set, heuristics (thinking shortcuts), biases and the fact that thinking is effortful.

According to these researchers, research and practice had proven that a thoughtful learning environment, seeing or hearing what was done to execute cognitive operations that students could emulate, and guidance and support of students' efforts until they could perform independently were some of the factors that could improve students' thinking ability. Conclusions drawn from the review included that (1) CT could be developed and augmented through a process of attitude alignment, absorption of knowledge, and learning new thinking skills. (2) CT could also develop when students learned to combat potentially hazardous CT roadblocks such as bias, heuristics, and simply not wanting to go through the effort of thinking on a higher level.

(3) By modeling expert thinking and using scaffolding techniques to support students' CT development, educators could instill both the desire and the drive for students to begin thinking critically. (4) Teaching CT skills required time and effort at the potential expense of other skills.

2.10.2.ii Studies on CT conducted in Africa

Developing CT skills and raising critical thinkers is considered amongst the purposes of education. With this in mind, Akinoglu and Baykin (2015) conducted a study which aimed at investigating the extent to which CT skills were reflected in the attainments of the secondary social studies curricula in Turkey. The qualitative case study examined attainments of three secondary school curricula in the field of social studies and data was obtained from document analysis. None of the examined three curricula were found to establish a direct relationship between attainments and CT skills. However, detailed examination revealed presence of attainments relevant to CT skills mostly in Geography curriculum (66.66%), followed by History (31.89%) and Democracy and Human Rights curriculum (16.66%).

With this revelation, the researchers commended that CT skills were included in the three secondary curricula at an adequate degree. A recommendation was however made to improve curricula by evaluating them in terms of CT skills and conduct comprehensive and comparative research, which could evaluate the prevailing circumstance of curricula for determining the inclusion levels of CT skills and other basic skills intended to be developed in all of the curricula. It was important that HOTS like CT should be reflected in school curricula.

However, the success of education in developing CT and raising critical thinkers also depends on readiness of educators to execute appropriate methods when teaching and their ability to overcome barriers to implementation of such methods. A qualitative study conducted by Saleh (2019) in Libya explored the conceptions, implementation and challenges of CT in the FL classroom. Application of content analysis to

responses of 24 EFL university instructors who completed an open-ended questionnaire sent via FB messenger, revealed different conceptions and misconceptions of CT. It also revealed that the majority of the participants implemented CT in different aspects of teaching. However, the effectiveness of this implementation was limited by some social, cultural and administrative barriers.

2.10.2.iii Promoting CT in Malawian

OSISA (cited in Mgomezulu, Shawa & Wamba, 2014) reported that there was no clear evidence in the Malawi primary and secondary school curricula that promoting CT was considered important. The three researchers conducted a study that drew on Piaget and Vygotsky's theory of (social) constructivism to advance approaches and practices that teachers could employ to promote CT in learners. The study aimed at showing how a teacher could simultaneously teach subject content and promote high order CT skills in learners. A lesson plan was developed that incorporated CT skills. How teachers could correct egocentric and sociocentric tendencies that might impede CT in learners was also shown. With the view that there was a level of overlap among CT, creative thinking and reflective thinking, the definitions of these terms were reviewed.

The researchers claimed that students who were equipped with CT skills could contribute intellectually, socially, culturally and economically to society.

However, efforts to develop HOTS, specifically CT, were greatly hampered by challenges such as inadequate teaching and learning materials, large class sizes and inadequate learning facilities. These factors made implementation of appropriate teaching methods impossible or ineffective.

Given these challenges, Chiphiko and Shawa (2014) investigated how primary school teachers implemented learner-centred approaches in Kasungu District. The study employed the progressivism learning theory propounded by John Dewey as the theoretical framework. Using qualitative methods, data was collected by interviewing 12 teachers (6 male and 6 female), classroom observations and document analysis. Results revealed that due to challenges mentioned, primary school teachers failed to plan for learner centered approaches at lesson planning level, failed to stimulate learners' interest during classroom instruction and failed to engage in CT and problem solving activities with learners in class.

2.10.2.iv Influence of Problem Based Learning (PBL) on CT

A number of researchers confirmed that PBL models were very important in developing CT in students (Belecina & Ocampo, 2018; Haridza & Irving, 2017; Hussin, Harun & Shukor, 2019; Nygren, Haglund, Samuelsson, Geijerstam & Prytz, 2018). Belecina and Ocampo (2018) contended that CT and problem solving had long been important terminologies in the context of education, but that within the framework of the 21st century classroom, the concepts takes on very specific definitions. With CT, higher level analytical skills are employed to understand a problem and to work toward a means by which it can be solved.

The researchers conducted a study with the aim of investigating the effect of using problem situations on the CT of graduate students in solving problems.

The experimental design involved a group of graduate students enrolled in Educational Statistics. Four problem situations were utilized that aimed at developing CT of students in problem solving. Students' CT was measured before and after the

problem situations were given. Results revealed that students' CT in problem solving significantly improved after using problem situations.

Haridza and Irving, (2017) observed that traditional teaching methods such as rote learning and memorization in teaching science for many decades created inactive learners who could not develop HOTS. Based on the performance test, it was noticed that students' CT skill in Public Middle School 3 Pontianak-Indonesia was in low level although the students' achievement scores were higher than school standards. This led to a study which aimed at developing CT skills of middle school students using Problem Based Learning 4 Core Areas (PBL4C) model. The study which took a classroom action research design with two cycles used observation checklist, rating scale, self and peer assessment as data collection methods. Analysis of the data yielded results that led to the conclusion that development of students' CT skills occurred when PBL4C model was applied in science classroom.

It was therefore recommended that, on one hand, teachers should act as facilitators in classrooms and should provide meaningful learning resources that could benefit students' CT skills. On the other hand, students should practice constantly to offer a sharp, accurate and appropriate solution.

The effectiveness of PBL models in enhancing development of CT increases greatly when the models are collaborated with other approaches. For example, Saputra, Joyoatmojo, Wardani and Sangka (2019) conducted a study in Indonesia on the topic "developing CT skills through the collaboration of Jigsaw model with PBL model." The aim of the study was to examine the effectiveness of collaboration of Jigsaw and

PBL models in developing students' CT skills. Experimental design using pre-experimental one group pretest-posttest was employed. Before and after the implementation of the two-model collaboration, 37 accounting students of class XI were given the tests of CT skills which were set in the same composition. The pretest and posttest scores were analyzed by examining t-test and gain score calculated using SPSS 23 program. Result indicated that there was a difference between the pretest score and the posttest score with the significance level of $0.000 < 0.05$. It was therefore concluded that implementation of the collaboration was effective in developing students' CT skills.

Still in Indonesia, Asyari, Irawati, Muhdhar, Susilo and Ibrohim (2016) conducted a study whose purpose was to improve the CT of biology students on an environment course through the implementation of PBL and Group Investigation through Lesson Study. A descriptive qualitative method was employed in studying 73 freshmen biology students who were divided into two classes. Data was collected using an essay test which covered several criteria of CT adapted from SOLO Taxonomy used to measure the students' CT. Results revealed that implementation of PBL and group investigation encouraged students to think critically through planning, arguing, stating questions and problems, and analysing and providing solutions to the surrounding environmental problems.

Two conclusions were finally made basing on the results. Firstly, that learning process on an environment course through the implementation of PBL integrated with group investigation through Lesson Study stimulated students' CT. Secondly, that the learning process which involved the students actively through the implementation of PBL integrated with GI encouraged the students to think critically by providing

arguments or opinions, stating problems, practicing to induce and deduce, and doing evaluation.

In Malaysia, Hussin, Harun and Shukor (2019) reviewed papers which discussed use of online tools in PBL and CT. The purpose of the review was to look into how the online tools were tackled by previous scholars and the latest trends on online tools in PBL to enhance CT skills. It was concluded from the findings that PBL, with the aid of online tools was one of the best teaching strategies to enhance students' CT skills.

2.10.3 Metacognition

Metacognition has been defined in a number of ways by different authors. Abdellah (2015) and Iftikhar (2015) postulated that metacognition referred to HOTS which involved active control over the cognitive processes engaged in learning. Zhou and Brown (2015) described metacognition as knowledge of cognition in general, as well as awareness and knowledge of one's own cognition. Aswegen, Swart and Oswald (2019) compliments this by indicating that metacognition was commonly known as being aware of one's own thinking when performing learning tasks and then using this knowledge to actively self-regulate what one was doing. Originally, Flavell (cited in Abdellah 2015), conceptualised metacognition as "knowledge and cognition about cognitive phenomena", simply stated, "thinking about thinking", an awareness and understanding of one's own thought processes and strategies, and the ability to consciously reflect and act on the knowledge of cognition to modify those processes and strategies.

The importance of metacognition on student's achievement of the intended learning cannot be over emphasized. As such, it is an area that has attracted the attention of many researchers.

Abdellah (2015) examined the relationship between metacognitive awareness and academic achievement, and its relation to teaching performance of pre-service female teachers in Ajman University in United Arab of Emirates. Using Metacognitive Awareness Inventory (MAI) and Teaching Performance Checklist on a sample of 75 pre-service of Professional Diploma Female Students, it was found that metacognition played a significant role in successful learning. Efforts to develop metacognition in students were therefore recommended. Advice was given that it developing students' metacognition should not be the role of teachers or the school only. It had has to be expanded to be developed and encouraged to use everywhere including homes, universities and clubs. Further to this, the researcher explained that teachers could enhance metacognition in students by engaging them in activities that involve planning how to approach a given learning task, monitoring comprehension, and evaluating progress towards the completion of a task.

Metacognitive strategies are also a useful resource to enhance reading comprehension of students (Iftikhar, 2015). The researcher conducted a literature review that described the importance, effectiveness; and practical opportunities to apply metacognition as a part of teachers' instructions.

The review aimed at answering questions of whether metacognitive strategies were helpful to enhance reading comprehension skills of students and whether the teaching

of metacognition was an effective tool to usher learners into becoming self-directed. The outcome was that metacognition was used and could be used to enhance students' comprehension skills.

The two studies discussed above agree not only on underscoring the fact that metacognition was vital in the process of learning but also on showing that it was possible to teach metacognition to students.

In South Africa, Tachie (2019) investigated the relevance of learners' use of meta-cognitive skills and strategies in mathematics problem-solving. The study which involved four rural schools, four mathematics teachers and four learners from different schools (one from each school) employed a qualitative approach including a case study design in which observation and semi-structured interviews were used to collect data. Content analysis of data yielded results that revealed that learners' use of metacognitive skills and strategies, such as task analysis, planning, monitoring, checking and reflection, self and group-monitoring skills, reading and writing skills, self-regulation skills and self-assessment helped them in solving problems in mathematics.

As educators endeavor to instill HOTS in students, interventions have also to be put in place to enhance metacognition in students. Through a design-based research (DBR) study, Aswegen, Swart and Oswald (2019) observed that it appeared, in the context of the study, that story-based intervention could be a feasible and effective learning tool to develop metacognition. Two intact Grade 4 class groups from two public schools in different socio-economic communities in the Western Cape participated in the study.

Pre-intervention and post-intervention data, comparing the 2 groups indicated that most learners seemed to have improved in terms of metacognition and strategy knowledge on most data collection instruments. However, the researchers acknowledged that at Grade 4 level, most of the respondents could not express themselves clearly which affected results. Reliability of these findings was therefore too low to be generalized to other situation but only in the context of that study.

2.10.4 Teaching methods for promoting acquisition of HOTS

Attempting to explain how examinees in DBSSs of CEED prioritise answering HOQs during MSCE examinations, research questions have been set which mainly focus on teachers' use of methods which enhance development of HOTS in students during lesson delivery and how the use of those methods affects students' acquisition of HOTS. The methods in question are discussed below.

Dagar and Yadav (2016) suggested the need to redefine education to include more CT by adopting constructivist pedagogy. Students' HOTS are known to develop when teachers adopt constructivist pedagogical methods. These are teaching methods which focus on active learning of students, (Krahenbuhl, 2016). Such methods are generally referred to as student centered approach to teaching (SCAT). Dano-Hinosolango and Vedua-Dinagsao (2014) further explained that when teachers use more of LCT in class, the learning skills and strategies of students develop significantly.

According to Qutoshi and Poudel (2014), advantages of using SCAT include that learners enjoy learning, learners feel proud of being partners in learning with teachers, and learners participate actively.

The researchers further indicated that in SCAT learners take responsibility for their own learning provided that the required amount of facilities are made available and a friendly learning environment is created, giving them a chance to explore their own learning process.

More importantly, Dano-Hinosolango and Vedua-Dinagsao (2014) affirmed that when teachers use more of LCT in class, the learning skills and strategies of students develop significantly. This is possible because teachers are able to provide more opportunities for the enhancement of the learning skills and strategies of the students Table 2.2 shows strengths and limitations of selected LCT methods.

Table 2.2 Strengths and limitations of selected LCT methods.

METHOD	DESCRIPTION	STRENGHTS	LIMITATIONS
Question and answer	Teacher prepares purposeful questions before the lesson which are asked and answered orally in the course of the lesson.	Stimulates interest in learners. Learners' thinking is directed. Helping learners to organize and interpret materials, Clarifies misconceptions. Learners' progress in a lesson is monitored.	LOQs encourage learners to memorise materials. Question may slow the process.
Discussion	Interaction between the teacher and	Learners are active. Learners learn from	Difficult to reach maximum

	learners and among learners themselves. Teacher sets a topic and regulates the discussion.	each other. Opportunity for CT. Gives good problem solving practice.	interaction in large groups. Difficult to assess individual performance.
Field trips and Educational visits	Method of teaching and learning outside the traditional classroom. Teacher prepares clear objectives and brief learners. Real learning takes place when learners have first hand information.	Learning occurs in an environment of real life situation. Learners enabled to clarify from classroom situation. Fills the gap between abstract ideas and the real world. Opportunity for practical activities.	Time consuming Required good arrangement and organisation Limited by school's financial constraints.
Group	Teacher the teacher organizes learners in working groups for a learning activity. Teacher defines the purpose of the activity and explains the task.	Sharing of resources where they are inadequate. Active participation. Sharing ideas.	Time consuming. Difficult to assess individual learners.

Project	Activity involving investigation and solution of problems that is planned and carried out to a conclusion. For group or individual students.	Planning skills are developed in learners. Learners become initiative. Learners acquire investigative skills.	Time consuming Errors due to background information.

Table developed from DTED(2009)

2.11 Strengthening Mathematics and Science in Secondary Education (SMASSE) -Malawi 2014 base line study

After a decade of SMASSE operations in Malawi, a base line study was conducted by Nampota and Selemani-Meke (2014) with the purpose of finding out the pedagogical perceptions, attitudes and practices of pre-service and in-service Mathematics and Science teachers and teacher trainers in Malawi. The aim was to highlight the extent to which these parties embraced the ASEI/PDSI principles of the SMASSE project. The study yielded the findings outlined below.

Findings on pedagogical perceptions of in-service teachers:

- On average, in-service teachers showed that they would use guided inquiry and open discovery approaches to teaching science and mathematics.
- Diploma in Education holding teachers had greater tendency to opt for more student centred, guided inquiry and open discovery methods than Bachelor of Education degree holding teachers.

- Gender of the teacher, the school type and the number of SMASSE trainings attended did not have an effect on the pedagogical perceptions of the teachers.

Findings on pedagogical perceptions of pre-service teachers:

- On average, pre-service teachers had a tendency to opt for guided inquiry and open discovery teaching approaches to teaching science and mathematics.
- Year 3 pre- service teachers were more likely to opt for direct interactive methods while more year 4 pre-service teachers opted for guided inquiry methods.
- Domasi College of Education pre-service teachers tended to opt for guided inquiry and open discovery approaches while Chancellor College pre-service teachers tended to opt for guided inquiry.

Findings on practice of in-service teachers:

- In practice in-service teachers' pedagogy did not follow guided inquiry/open discovery as purported in their perceptions.
- Only 30% of lessons were student centred and in 88% of the lessons students were not given a chance to evaluate the lesson.

Experiments were conducted only in 39% of the lessons despite this being part of the ASEI lesson plan.

Use of improvisation was only evident in 41% of the lessons despite claims by 67% of the teachers to have acquired improvisation skills from SMASSE trainings.

Further findings:

- Teacher academic qualifications mattered in the extent to which teachers incorporated student activities in the lessons. Teachers with high academic and

professional qualifications of Bachelor of Education and Diploma in Education incorporated adequate student activities in lessons and engaged students in them.

- Unqualified teachers (those whose highest qualifications were general degree, general diploma and MSCE) were less likely to implement student activities in lessons.

There were no major gender differences in the implementation of student centred lessons and use of experiments by the teachers. However, female teachers were by far more likely to incorporate student activities in the lessons than male teachers (70% and 37% respectively). The opposite was true on improvisation since more male teachers (38%) used improvised materials in lessons compared to only 8% of the female teachers.

Use of experiments was observed only in less than half the lessons with the Diploma in Education and general degree teachers implementing more experiments on average. Improvisation was rarely used by the teachers (only41%). Diploma in Education and general degree teachers performed slightly better than the other teachers in this regard.

Teachers with more SMASSE trainings had a greater tendency to incorporate student activities, student centred lessons, experimentation and improvisation in lessons.

Student evaluation did not seem to be implemented by the teachers irrespective of qualification, number of SMASSE trainings and type of school. Implementation of student centred lessons was a problem for most teachers irrespective of academic qualification and type of school. Students were not given adequate chances to give their prior experiences, come up with own predictions, discuss them, verify them and

present own observations or results to the class. Use of LCT practices, use of experiments and improvisation was more evident in grant aided secondary schools and least in CDSSs.

2.11.i SMASSE

SMASSE was one of the very few interventions the Government of Malawi, through ministry of education had successfully implemented nationwide which advocated for constructivist approach to teaching of science in secondary schools.

The primary aim of the project was to equip secondary school teachers of Mathematics and Science subjects with necessary pedagogical skills for successful teaching of the subjects through in-service trainings. SMASSE ideologies focused on LCT principles which enhance development of HOTS in students. The sole source of the information in this sub-section is a base line study on SMASSE which was conducted and reported by Nampota and Selemani-Meke (2014).

2.11.ii Operations of SMASSE programme in Malawi

In Malawi, SMASSE programme was piloted in 2004 in South East Education Division (SEED). Thereafter, it was extended national wide in phases. Primarily, the program was run as an in-service teacher training. At a later stage, it was extended as an intervention in the secondary teacher training institutions to ensure that SMASSE ideologies are known by teachers graduating from those institutions.

By 2014, SMASSE was already operating national wide aiming at improving the quality of secondary Mathematics and Science education by providing in-service training to mathematics and science teachers in order to improve pedagogy.

2.11. iii SMASSE ideologies

SMASSE programme used the principle of "Activity, Student-centred, Experiment, Improvisation (ASEI) where teachers were encouraged to use activities during lesson delivery, ensure that the lessons were students centred, and where applicable conduct experiments and use improvisation. The argument was that if a teacher used an activity in a lesson, there was a higher chance that the activity would involve students and therefore become student centred.

Similarly, use of experiments to verify abstract theories thereby enhancing student understanding of concepts. In addition, experiments help in student involvement and participation in the lesson so that the teacher can make the students think more. Where lack of equipment is the reason for lack of experiments as is usually the case, the teachers are trained to improvise so that they still include experimentation and/or activities in lessons.

Additionally, the teachers are encouraged to be reflective practitioners where they would go through the process of Plan, Do, See, Improve (PDSI) as a way of improving the teaching process.

An analysis of SMASSE ideologies points towards promotion of direct interaction and guided inquiry pedagogical orientations. Inclusion of activities and experiments that engage students enhances interaction and when this is coupled with activities by the students themselves, the pedagogy becomes student centred. Application of these ideologies is therefore vital in improving HOTS in secondary school students in Malawi.

2.12 Conflicts and controversies in the literature

Firstly, authors conflict on demarcation of HOTS from LOTS. For instance, Budsankom, Sawangboon, Damrongpanit and Chuensirimongkol, (2015), Kusuma, Rosidin, Abdurrahman and Suyatna, (2017) and Verdina, Gani and Sulastri, (2018) agree that HOTS comprise thinking levels of analyzing, evaluating and creating. However, Fives and Barnes (2018) include the thinking level of application in the group of HOTS.

Secondly, Agarwal (2019) acknowledged existence of a long standing and ongoing debate between educators and scientists on whether a foundation of factual knowledge should be built in students before engaging them in higher order learning, or to enhance higher order learning directly by engaging students in complex instructional techniques during the initial learning process.

Attempting to answer the question "Do students need fact knowledge before higher order learning?", the researcher engaged middle school students and college students in retrieval practice with fact questions, HOQs, or a mix of question types to examine the optimal type of retrieval practice for enhancing higher order learning. Critically, it was found that higher order and mixed quizzes improved higher order test performance, but fact quizzes did not. With this observation, a conclusion was drawn that building a foundation of knowledge via fact-based retrieval practice would be less potent than engaging directly in higher order retrieval practice**.** This conclusion is in conflict with the theory of BT which stipulates that teaching and learning should start from simple (fact) to complex (higher order) retrieval practice.

2.12.1 Gaps in the existing literature on areas relating to the topic of the current study.

The topic of this study has been supported by a huge volume of empirical studies and other literature from overseas. However the volumes were lower in African countries, and very low. in Malawi. This entailed existence of knowledge gap in Malawi on this topic. Findings of the current study will, therefore, contribute towards bridging of this knowledge gap.

Furthermore, in the text, the relationship between acquisition of HOTS and tendency to prioritise HOQs in exams by examinees was not expounded as well as the link between acquisition of HOTS and future practical use of the same was not discussed. Information on these areas would strengthen the feeling of how essential HOTS are. Unfortunately, literature supporting these concepts was not found from the sites visited by the researcher.

2.13 Chapter summary

Having presented BT and Constructivism as the theoretical framework for this study, the Chapter has presented a review of literature on HOTS and areas related to it.

CHAPTER THREE

METHODOLOGY

3.1 Chapter overview

This Chapter discusses the research design, methodology, study population as well as the study sample while justifying how they were arrived at. After that, data collection techniques, validity and reliability of data collection tools, data analysis techniques and ethical considerations relating to data collection are explained.

3.2 Research paradigm

The researcher employed an inductive approach in which examinees sampled from the five selected DBSSs were used as source of numerical data. The data was processed to identify patterns for the purpose of generalization to a population of examinees in all DBSSs in CEED. Where possible inferences were made to come up with the best explanation. According to (Antwi & Hamza 2017) this approach entails adoption of the quantitative research paradigm. Results were obtained when the figures were analysed using Statistical Package for Social Science (SPSS) version 20.

The approach was deemed advantageous in three ways. Firstly, as argued by Bryman (cited in Daniel 2016), quantitative research approach places emphasis on numbers and figures in the collection and analysis of data. On this, Connolly (cited in Daniel

2016) explained that the use of statistical data for the research descriptions and analysis reduces the time and effort which the researcher would have invested in describing results as data can be calculated and conducted by a computer through the use of SPSS.

Secondly, the use of scientific methods for data collection and analysis in quantitative approach makes generalization of results possible. Finally, Denscombe (cited in Daniel 2016) stated that quantitative approach allows "researcher detachment". The concern of the researcher being biased during either data collection or data analysis is minimized when the researcher is not in direct contact with participants. Data collection tools in this approach do not give room for direct interaction between the researcher and participants. In this way, the objectivity of the researcher is not compromised.

3.3 Research design

The study took a non experimental design which was descriptive in nature. Khaldi (2017) described non-experimental research design as a quantitative research design that does not involve manipulation of an independent variable by the researcher. On the other hand, Khaldi explained that descriptive studies describe phenomena as they exist, taking care not to influence subjects or events in any way. In this study, while trying to understand how examinees prioritised answering HOQs during MSCE testing session, variables, subjects and events were not manipulated in any way. Rather, it was desired that conditions in which data was collected in selected schools be similar.

In addition, the study was cross-sectional; data was collected only at one point, which was at the end of the four years of examinees' secondary school education. Specifically, data collection exercise was done two weeks before commencement of national examinations, at a time when coverage of syllabi was presumably complete in all participating schools.

3.4 Study population

The population that was studied comprised all form four students in the nine DBSSs of CEED. According to the 2016-2017 Ministry of Education Science and Technology (MoEST) form one selection booklet, the capacities of the nine institutions were as presented in Table 3.1.

Table 3.1 Capacity of the schools under study

Name of school	Capacity		Total
	Boys	Girls	
Chayamba	80	40	120
Chipoka	80	40	120
Dowa	60	20	80
Kasungu	60	20	80
Madisi	80	40	120
M'mbomba	60	40	100
Nkhotakota	80	40	120
Ntchisi	60	20	80
Salima	60	40	100
Total	620	300	920

From Table3.1 above, this study targeted a population of 920 examinees.

3.5 Sampling

Simple random selection method was used to select five schools from the nine DBSSs of CEED. A total of 312 examinees awaiting MSCE examination were sampled.

This represented 34% of the target population. This sample size took into account of data collection instruments that would be spoiled in the process of data collection. The sample size would still be above the researcher's preferred target of 30% after excluding the spoilt data collection instruments. In each of the selected schools, a sample of examinees was drawn using simple random selection. To achieve this, a number was assigned to each name of the examinees. Each number was written on a small piece of paper of the same size. The pieces of papers were then put in a small box. The box was shaken vigorously then a piece of paper was drawn from the box while looking away. This was repeated until the calculated sample size was arrived at. In so doing, selections were made purely by chance. This procedure was also the one used to select the participating schools. To achieve the 34% sample size from the targeted population, 60% of examinees in form four class of each selected school was sampled out for participation.

3.6 Data collection techniques and tools

The first data collection tool that was used was an examinees' questionnaire (see appendix A1) that was administered to all selected examinees in the selected schools. With this tool, data concerning the extent to which the examinees' teacher of Biology in their respective schools employed teaching methods that enhance development of HOTS in examinees during lesson delivery was collected. This data was collected from examinees because facts about what really took place in class during lessons were more likely to be report by examinees unlike subject teachers. Subject teachers

would possibly report what were regarded theoretically as good practices when practically those practices were not implemented at all during lesson delivery.

The second data collection tool that was used was a written test. The MSCE Biology paper I test form which was prepared and administered by Malawi National Examinations Board (MANEB)in 2019 (see appendix A2) was re-administered to the sample of examinees in each selected school in order to collect data on how examinees prioritized answering HOQs. The 2019 test form was chosen purposively because it was the only test form which had been administered by MANEB ever since the previous secondary school curriculum review. Examinees under study were the first group to have completed a four year secondary school cycle using the revised curriculum.

Prior to administration of the test, three experts in the subject of Biology analyzed questions on the test form and categorised them into high order and low order. Apart from that, question numbers of all items were erased from the question paper. In place of the question numbers, rectangles were inserted. Examinees were instructed to write question numbers inside a rectangle corresponding to each question basing on priority given to questions in the course of taking the examination. For example, an examinee who started taking the examination by answering the very last question on the test paper, had to indicate No.1 in the rectangle corresponding to that question. The follow up questions to be answered would be denoted No.2, No.3, and No.4…, regardless of the order in which questions appeared on the question paper. Examinees were to continue assigning numbers to questions while answering until all questions were answered and had question numbers assigned. Apart from removal of question

numbers and inclusion of the instruction on how examinees were expected to go about numbering the questions, all properties of the question paper were left as originally designed by MANEB so as to maintain the validity of the paper.

3.7 Validity and reliability of data collection tools

MANEB administers standardised examinations which are highly valid and reliable. The minor modification of the 2019 Biology paper I test form to serve as a data collection tool could likely not affect validity and reliability since major properties like structure and order of questions were not tampered with in any way.

Secondly, use of three subject experts in the field of teaching of Biology when designating questions on the examination paper to high order and low order categories also served to maintain high validity and reliability of the test form as a data collection tool. Further to that, the fact that the researcher was equally an expert in teaching of Biology at secondary school level provided assurance that the work that was done by the subject experts was properly appraised before being adopted. This also contributed towards assurance of validity and reliability of the test paper as a data collection tools.

3.8 Data analysis techniques

The information collected through the questionnaire and the test was coded and keyed into SPSS version 20 as nominal data which was also transferred to Microsoft excel. Microsoft excel was used to compute descriptive statistics such as frequencies and percentages. In addition, statistical tools such as bar graphs, pie charts, frequency tables, linear graphs and 100% stacked cylinders generated for easy presentation of

data. Inferential statistics (chi-square) was run using SPSS to generate results from various aspects of the data.

3.8.1 Analysis of data from the test papers

Data from test papers was firstly processed before it was used to answer the first and the third research question. Data processing involved organizing the data as described below. Since the test paper had a total of 34 items, then each item was assigned a "priority position". That is, for example, priority position 1 represented a question that was the first to be answered by the examinee. The question was therefore, indicated by the examinee as No.1. Similarly, priority position 2 represented a question that was the second to be answered by the examinee and was indicated as No.2. This continued until the last question to be answered was assigned priority position 34. After that, the priority positions were grouped into ranges as shown in Table 3.2.

Table 3.2 Division of priority positions into ranges

Range No.	Range of priority positions	Number if priority positions per range
1	1-5	5
2	6-10	5
3	11-15	5
4	16-20	5
5	21-25	5
6	26-30	5
7	31-34	4

The paper carried 34 questions, which corresponded to 34 priority positions. It was therefore, not possible to group priority positions into equal ranges.

For this reason, range number 7 was comprised of four priority positions while the rest had five priority positions each.

The 5, 5, 5, 5, 5, 5, 4 division was one of the possible ways of categorizing the 34 priority position into ranges allowing the least difference in sizes of ranges. A range of priority positions represented a batch of questions which were answered by an examinee in a particular space of time within the testing session. For example, on one extreme, range Number 1 represented a batch of five questions which were highly prioritised by a candidate to be answered at the onset of the testing session. On the other extreme, range Number 7 represented the batch of four questions which were least prioritised by the candidate and were answered very late in the testing session.

Analysis of data from test papers firstly aimed at answering the first research question, *"How do the examinees' levels of tendency to prioritise HOQs compare with prioritising LOQs in a test taking session?"* Microsoft Excel was used to obtain frequencies of HOQs and LOQs attempted by examinees at each priority position and per range of priority positions respectively. Frequencies per range were converted to percentages. In each school, the graph for HOQs and the graph for LOQs were plotted on the same axis. A similar graph was also plotted using combined data from all the five selected schools.

Secondly, alongside analysis of information from filled questionnaires, analysis of answered test papers aimed at answering the third research question; *"How does the teacher's use of LCT methods relate with examinees' tendency to prioritize answering*

HOQs when taking MSCE Biology paper I examinations?" Pearson's Chi-square test was firstly used to confirm whether LCT methods were used in the selected DBSSs. After that, data was displayed on a 100%-3 dimensional stacked cylinder for identification of a school where LCT methods were used the most and the one where the methods were used the least.

Examinees from a school whose teacher was identified as having been the highest user of LCT methods were compared with those from a school whose teacher was identified as having been the lowest user of LCT methods. Comparison was based on examinees' prioritization of answering HOQs in the test taking session. Linear graphs on frequencies of examinees' responses per range of priority positions for the two schools were plotted on the same axis. Comparison of the trends depicted by the graphs provided the answer to the third research question.

3.8.2 Analysis of data from the questionnaire

Analysis of data from the questionnaire aimed at answering the second research question; *"To what extent do teachers of Biology in DBSSs in CEED use LCT methods during lesson delivery?"* Frequencies, in terms of counts and percentages of examinees' responses, were computed from data from questionnaires from each of the five selected DBSSs separately. These were displayed on pie charts to show distribution of examinees' responses among the five response options on the scale ranging from 'Not at all' to 'To the a very great extent'. Similar analysis was also done on combined data to confirm these outcomes. Using Pearson's Chi-square significance in the use of various aspects of LCT methods was tested in order to come up with a plausible conclusion on the extent to which LCT methods were used.

3.9 Ethical considerations

In the first place, a letter of introduction (see appendix B2) was obtained from the Post graduate Coordinator in the Education Foundations department at Chancellor College which was used to access permission from authorities who were deemed as custodians of data sources.

With this letter, a written permission (see appendix B2) was obtained from the Executive director of MANEB to re-administer 2019 MSCE Biology paper I test form as a data collection tool for the study. Permission was also obtained from the Education Division Manager of CEED to conduct a study in some of the DBSSs within the area of his jurisdiction (see appendix B3). Further to that, prior to the date for data collection exercise, verbal permission was sought from head teachers of all the DBSSs which were selected for the exercise.

Secondly, head teachers of respective schools were in turn asked to explain the purpose of the study to the targeted examinees. It was taken into consideration that examinees, as custodians of data, had the rights to know be fed with necessary information about the activity so as to make informed decision on whether or not to participate in the study.

Lastly, during administration of data collection instruments, participants were instructed not to endorse names or any sign that could possibly lead to identification of individuals. This was meant to assure them that the responses provided in the exercise would never be traced to individuals to cause any harm or embarrassment.

3.10 Chapter summary

The Chapter has discussed the research paradigm, design and the methodology which were employed in the study. Key components like identification of study population and study sample, description of data collection tools, validity and reliability of data collection tools, data collection process, data analysis techniques and ethical considerations relating to data collection were also discussed.

CHAPTER FOUR

DATA PRESENTATION, INTERPRETATION AND DISCUSSION

4.1 Introduction

This Chapter presents the findings of the study while showing the methods of data analysis per research question and discussion of results. An overview of the examinees' questionnaire which was administered during data collection has also been provided.

4.2 Data analysis

4.2.1 Examinees' levels of tendency to prioritise answering HOQs compared with levels of tendency to prioritise answering LOQs.

In section 4.2.1.i data for each school has been analysed separately while in section 4.2.1.ii, combined data has been analysed.

4.2.1.i School by school analysis

Figures 4.1- 4.5 are graphs illustrating percentage counts of HOQs and LOQs attempted per range of priority positions in each of the participating schools.

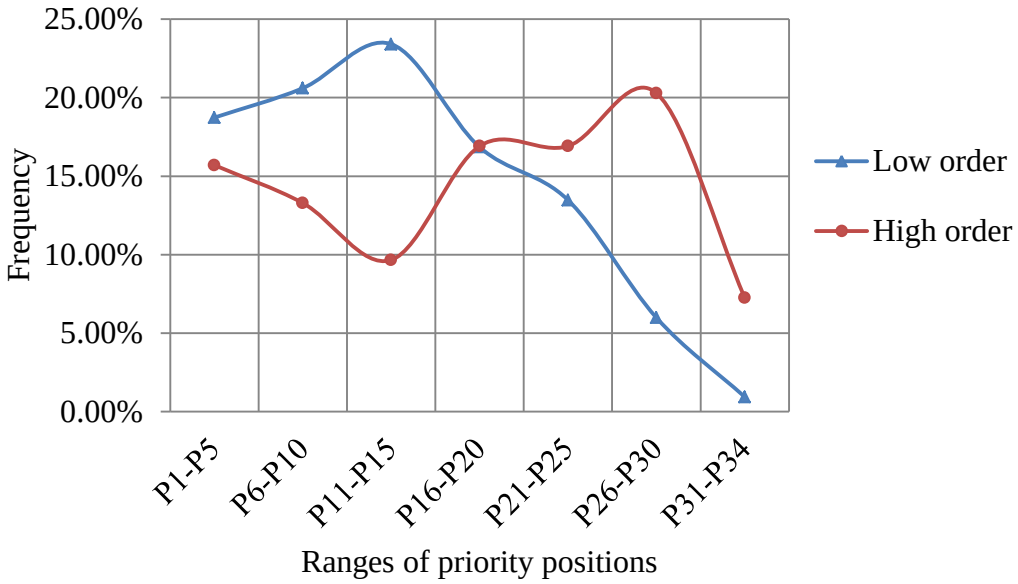

Figure 4.1 How examinees in school A prioritised answering HOQs and LOQs

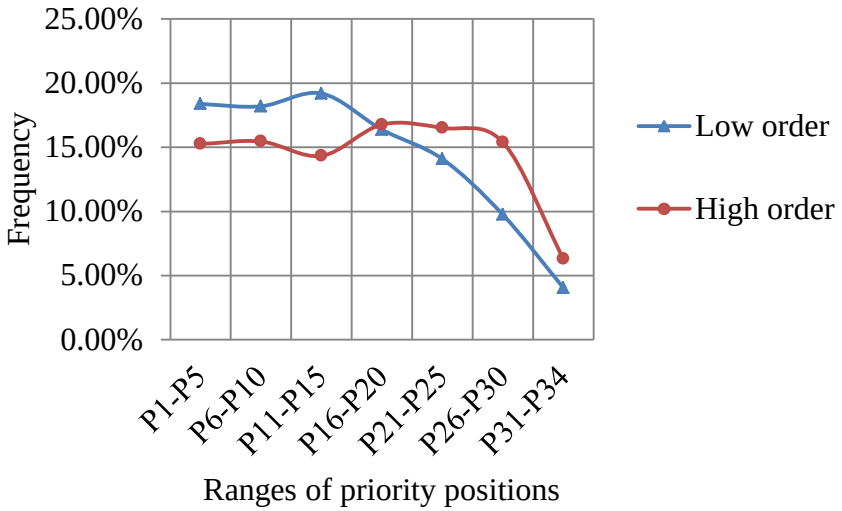

Figure 4.2 How examinees in school B prioritised answering HOQs and LOQs

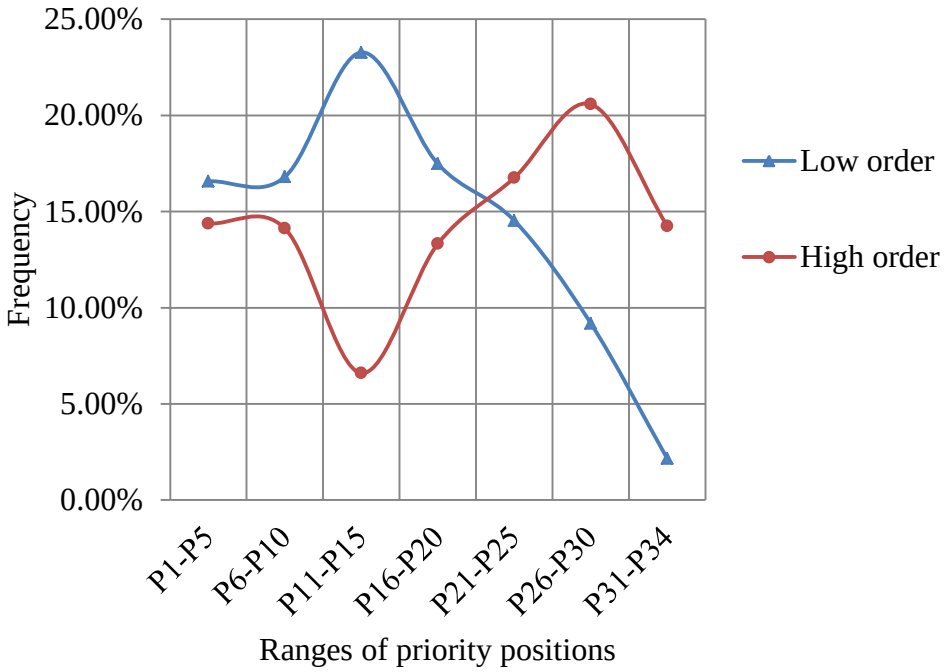

Figure 4.3 How examinees in school C prioritised answering HOQs and LOQs

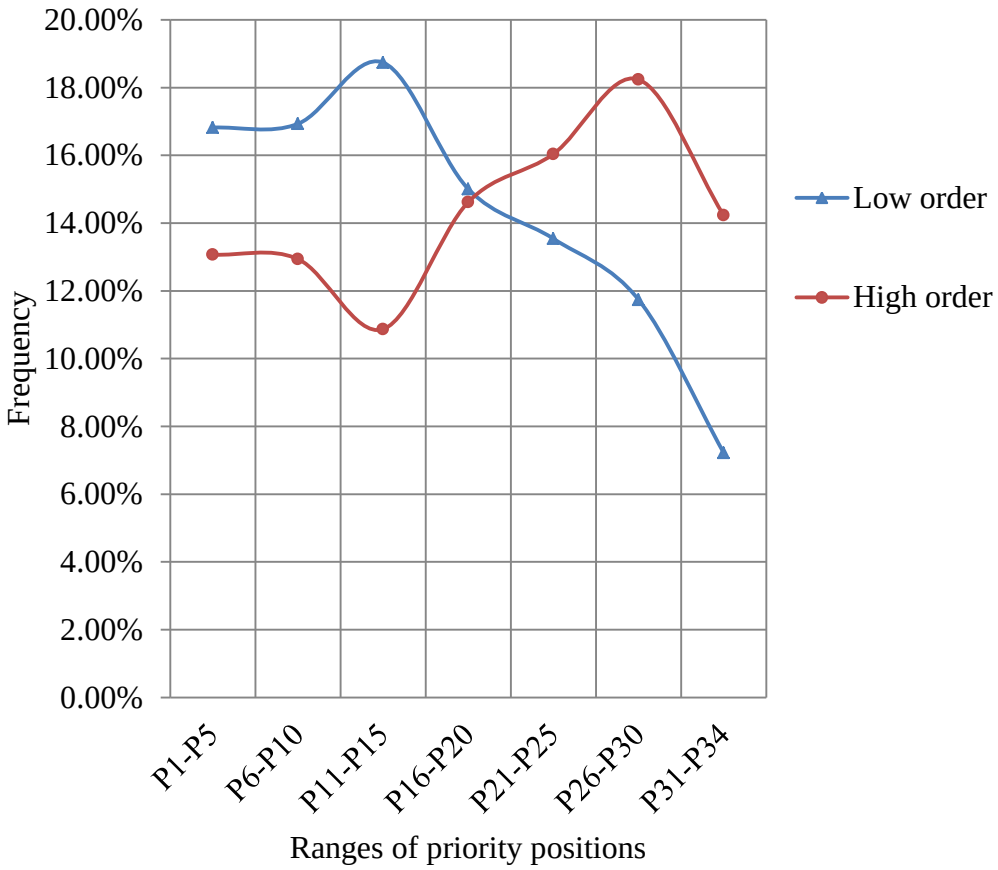

Figure 4.3 How examinees in school D prioritised answering HOQs and LOQs.

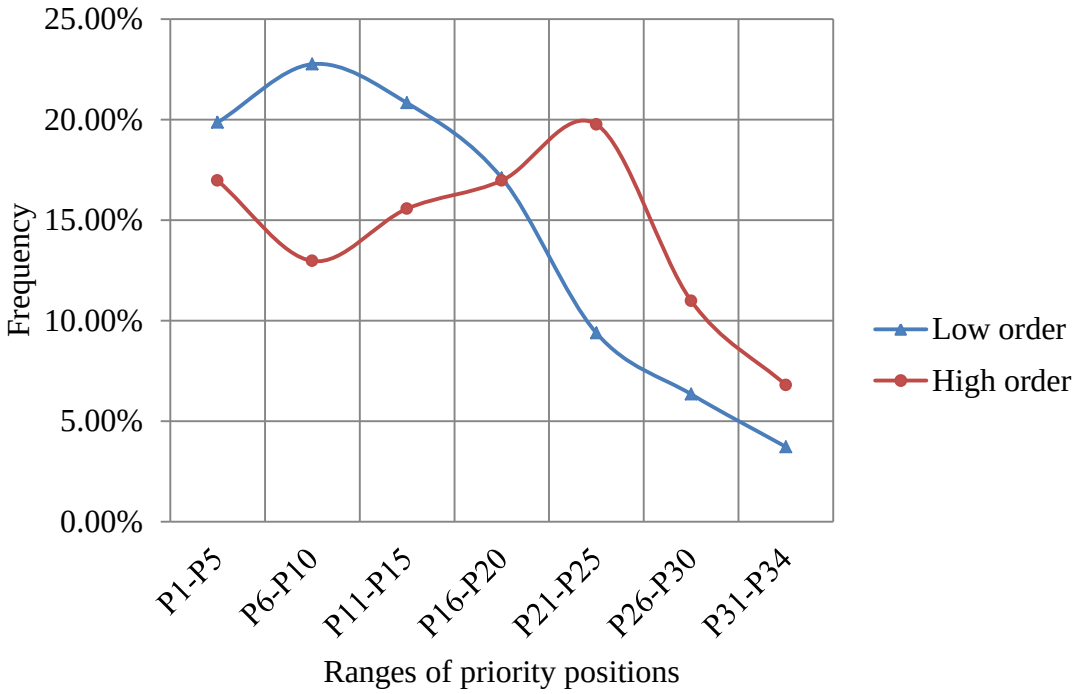

Figure 4.4 How examinees in school E prioritised answering HOQs and LOQs.

4.2.1.ii Analysis of combined data

To obtain the general trend representing all the participating DBSSs, percentage counts of responses were computed from combined data. Figure 4.6 is a graph illustrating such a trend.

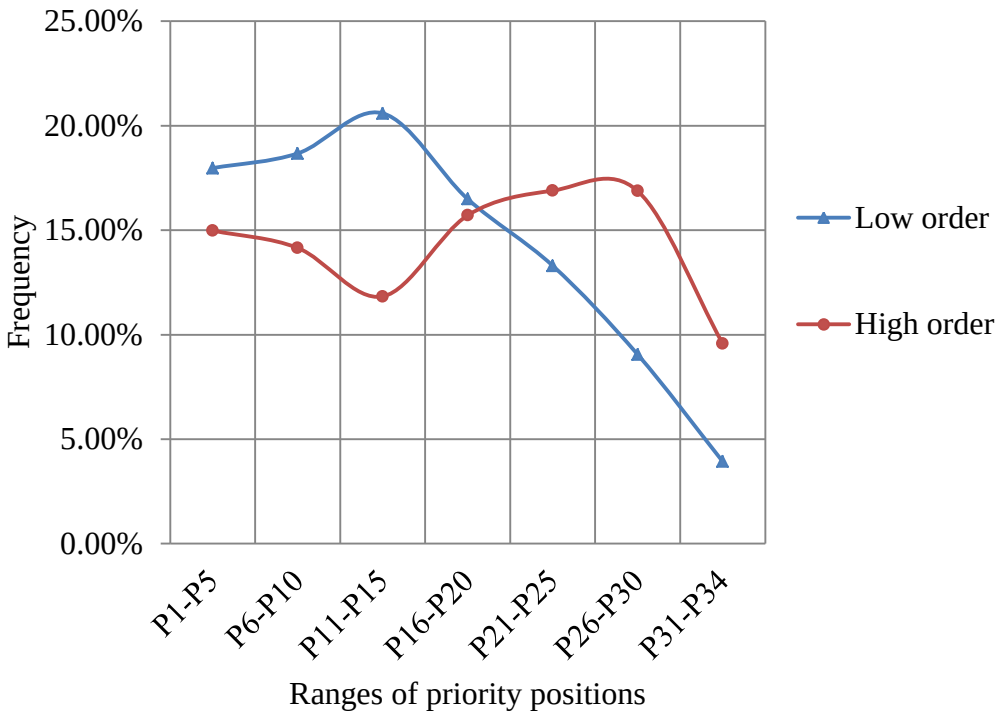

Figure 4.5 How examinees in the selected schools prioritised answering HOQs and LOQs.

Figures 4.1 to 4.5 as well as Figure 4.6 show a similar trend. Figure 4.6 in particular shows that excluding the middle range of priority positions in which 15.71% HOQs and 16.49% LOQs were answered, a total of 40.96% of HOQs were answered in the earlier three ranges while a total of 43.33% were answered in the latter three ranges. On the other hand, a total of 57.23% of LOQs were answered in the earlier three ranges while a total of 26.28% were answered in the last three ranges.

It was therefore concluded that the examinees' showed lower levels of tendency to prioritise answering HOQs than levels of tendency to prioritise answering LOQs in the test taking session.

Addressing HOQs requires application of higher level skills of the BT. This refers to the skills of analyzing, evaluating and creating, (Budsankom, Sawangboon, Damrongpanit & Chuensirimongkol, 2015; Kusuma, Rosidin, Abdurrahman & Suyatna, 2017; Verdina, Gani & Sulastri, 2018). As such, HOQs stand out among the routine questions. Kusaeri (2019) attributed the low tendency of examinees to prioritise answering HOQs to the examinees' state of being unaccustomed to non routine and lengthy questions, the lazy trait and examinees' lack of competence to generalize some information in the test item in order to design new strategies to solve the problems. Further to that, the author cited Suryapuspitarini, Wardono and Kartono, (2018) who explained that such low skill seems to be triggered by examinees' deficiency in identifying information provided in question item, in interpreting and sorting information in the question item, implementing strategy to find answer to the question, connecting inter-related concepts, and using reasoning to solve complex HOTs type test questions Also cited is Abdullah, Abidin, & Ali (2015) who found that examinees' difficulties in solving HOTs type test lie in ability to connect information and find solution to the problem.

4.2.2 The extent to which teachers of Biology in DBSSs of CEED used LCT methods.

4.2.2.i Aspects of LCT methods used by teachers of Biology

A questionnaire with six sections (see appendix AI) was administered to source opinions from the sampled examinees. Underlying the items in the sections was the basic proposition that teachers of Biology in the selected DBSSs had been employing specific aspects of LCT methods.

Examinees were required to tick in appropriate boxes at the end of each item to indicate the extent of agreement or disagreement with the items, where 1 = not at all, 2 = to a little extent, 3 = to a moderate extent, 4 = to a great extent and 5 = to a very great extent. Table 4.1 summarises the structure of the questionnaire.

Table 4.1 Summary of structure of the questionnaire

Section	Number of items	General categories of teaching methods.
A	8	Methods that encouraged questioning by examinees during Biology lessons.
B	5	Methods that accelerated development of metacognitive skills in examinees.
C	8	Methods that used learner activities during lesson.
D	3	Methods that enhanced understanding in examinees.
E	3	Methods that instilled problem solving techniques in examinees.
F	3	Methods that encouraged creativity in examinees.

In sections 4.2.2.ii and 4.2.2.iii pie charts in Figures 4.7 to 4.11 were used to illustrate distribution of examinee's responses in each school and in all selected schools respectively.

4.2.2.ii Distribution of examinees' responses per school.

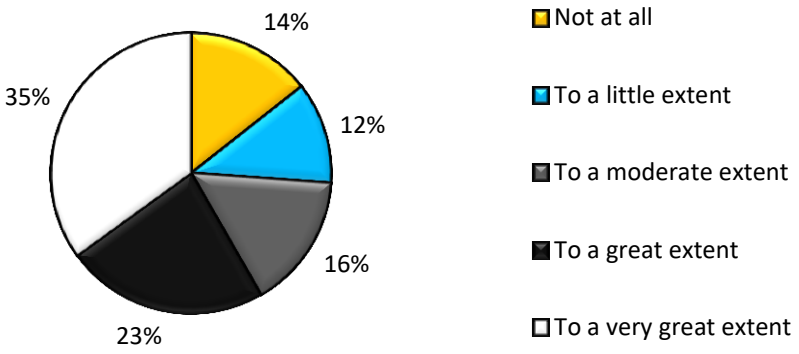

Figure 4.6 Distribution of examinee responses in school A

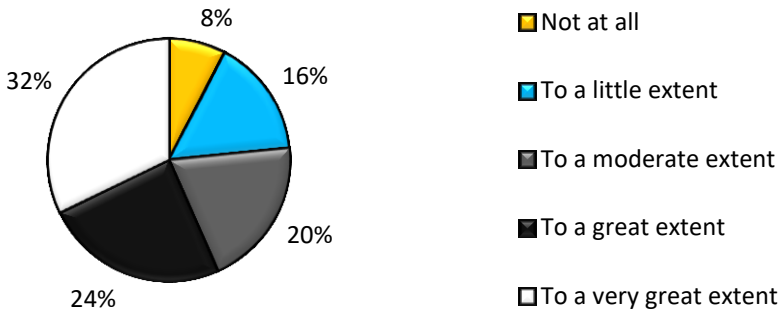

Figure 4.7 Distribution of examinee responses in school B.

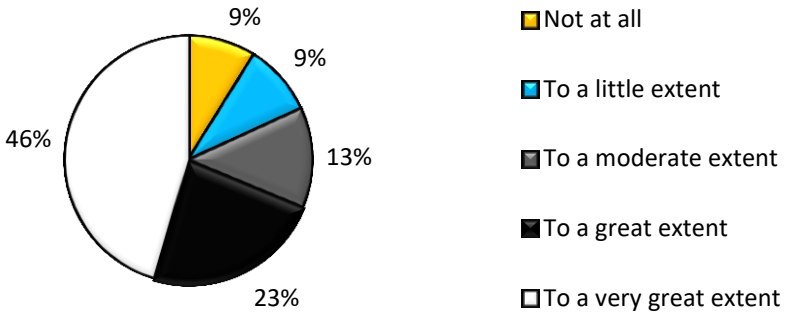

Figure 4.8 Distribution of examinee responses in school C

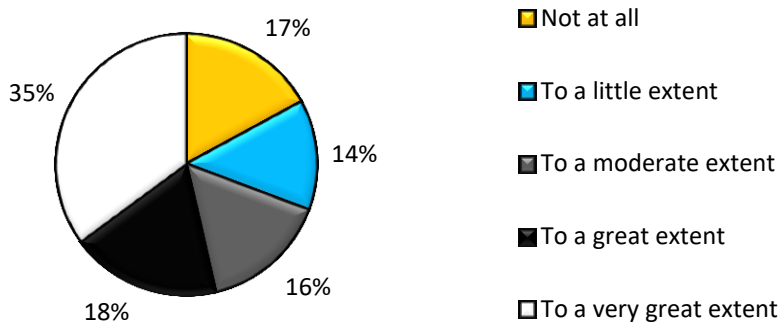

Figure 4. 9 Distribution of examinee responses in school D

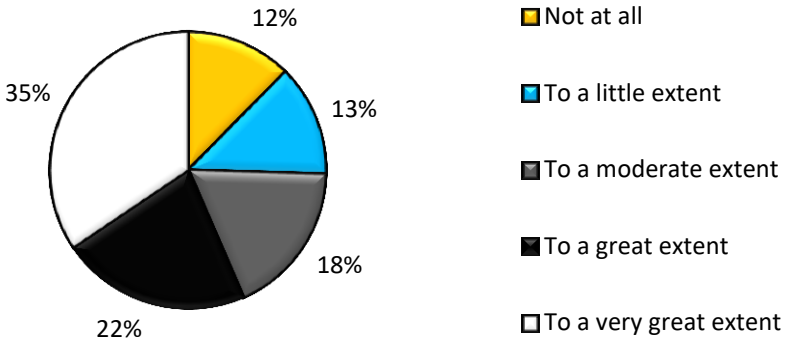

Figure 4.10 Distribution of examinee responses in school E.

The most frequently chosen response option in each school was “to a very great extent”. Across schools, this ranged from 32% to 46% of examinees’ responses. On the other hand, “not at all” was the least chosen response option in 60% of the schools ranging from 8% to 17% of examinees’ responses.

4.2.2.iii General distribution of examinees’ responses

The general view of distribution of examinees’ responses is illustrated by Figure 4.12

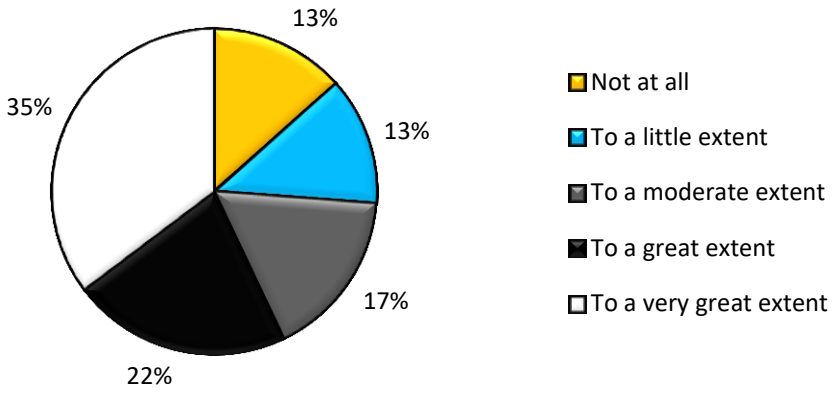

Figure 4.11 General distribution of examinees' responses for all selected schools.

The response option "to a very great extent" was the most frequently chosen, making up to 35% of all responses given by examinees. On the other extreme, "not at all" was one of the least frequently chosen response options, making only 13% of the responses.

In each of the pie charts, the largest sector represented the response option "to a very great extent". This confirms that according to the examinees, LCT methods were really employed in the selected schools.

For robustness sake, Pearson Chi-square test was run on examinees' responses in each section of the questionnaire. Cross tabulation of school versus aspects of LCT methods were performed. In each case, H_o= school and aspects of LCT methods are independent. H_1= school and aspects of LCT methods are related. Two sided asymptotic significance P-values of <0.05 necessitated rejection of H_o and acceptance of H_1, otherwise H_o was maintained.

In section A, the lowest P-value of 0.001was registered under the response option “to a great extent”. In sections B and F the same response option registered P-value of 0.000. This indicates that the aspects of encouraging questioning, accelerating metacognition and encouraging creativity were employed to a great extent in all the selected schools.

Sections C and E registered the lowest P-value of 0.000 under the response option “to the moderate extent”. This indicates that the aspects of enhancing understanding and instilling problem solving skills were employed to the moderate extent in all the selected schools.

In section D, the response option “not at all” registered the lowest P-value of 0.014. This shows that the aspect of enhancing understanding during Biology lessons was not practiced at all in all the selected schools.

Five out of the six aspects (83%) of LCT methods on the questionnaire were significantly employed in all the participating schools. It was therefore concluded that LCT methods were used to a high extent.

The high rate can be seen as the aftermath of SMASSE divisional in-sets of teachers of mathematics and science. Among other findings of a baseline survey by Nampota (2014), teachers with more SMASSE trainings had a greater tendency to incorporate student activities, student centred lessons, experimentation and improvisation in lessons.

The high rate can also be accrued to the high quality of teachers prevalent in DBSSs. Findings of the survey also speculated that teacher academic qualifications mattered in the extent to which teachers incorporated student activities in the lessons.

Unlike unqualified teachers, those with high academic and professional qualifications of Bachelor of Education and Diploma in Education incorporated adequate student activities in lessons and engaged students in them.

Much as this general rate of use of 80% appears to be high, individual aspects of LCT methods were used to different extents and one was not significantly used at all. The remaining 17% accounts for non use of the methods. According to Allybokus (2015), despite education policies recommending LCT for a more inclusive, integrated and holistic approach to education, most secondary education teachers generally use TCT methods even after having learned LCT in professional teaching courses. This is so because teachers' work contexts, personal beliefs and the pressure of an exams-oriented system shape their understanding of LCT such that most frequently what is practiced is a mix of LCT and TCT.

4.2.3 How teacher's use of LCT methods relate with examinees' tendency to prioritize answering HOQs during MSCE examination

Basing on examinees' responses to questionnaire items, analysis in Section 4.2.3.i aimed at providing a general confirmation of use of LCT methods across the selected schools. Thereafter analysis in Section 4.2.3.ii compared the schools in order to identify schools on the extreme ends of use of LCT methods. Eventually analysis in Section 4.2.3.iii compared examinees in the identified schools in order to ascertain

how teacher's use of LCT methods related with examinees' tendency to prioritise answering HOQs during MSCE examination

Primarily, examinees' responses were categorised into three using the following criterion.

Not at all + To a little extent = Disagree more.

To a moderate extent = Neutral

To a great extent + To a very great extent = Agree more.

4.2.3.i Use of LCT methods across the selected schools

Using SPSS, cross tabulation of "school" versus "use of the methods" was run in order to find out the levels of statistical significance in the extent to which LCT methods were employed across the selected schools. H_o = LCT methods were not significantly employed in the schools. H_1= LCT methods were significantly employed in the schools.

Chi-square test $P<0.05$ necessitated rejection of H_o leading to acceptance of H_1.

Pearson's Chi-square test yielded P-values of 0.076, 0.103 and 0.000 under response categories of "disagree more", "neutral" and "agree more" respectively.

Consequently, H_o was rejected and H_1 was accepted under the response category of "agree more" only. This result confirms that LCT methods were used during Biology lessons in all schools.

4.2.3.ii Identification of schools on the extreme ends of use of LCT methods

Furthermore, the 100% 3-dimensional stacked cylinder in Figure 4 was plotted to aid in identification of a school whose teacher was the highest user of LCT methods and the one whose teacher was the lowest user of LCT methods basing on examinees' responses.

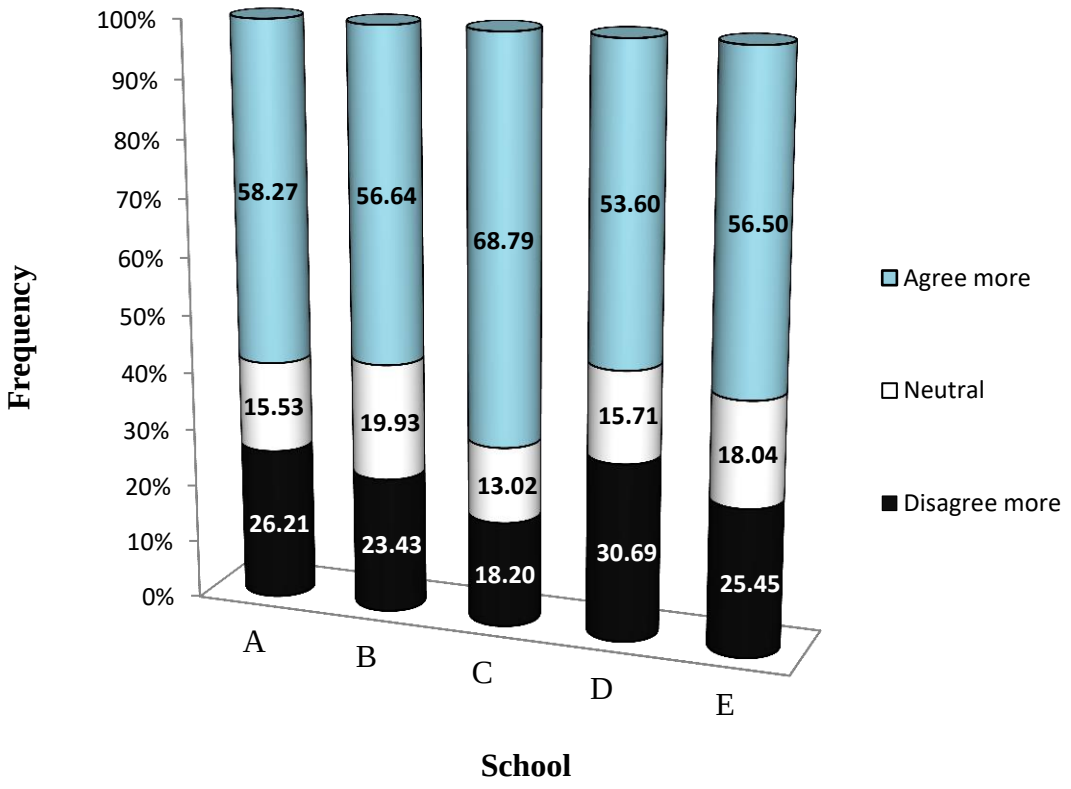

Figure 4.12 Use of LCT methods

Comparison of frequency values for portions of cylinders representing the category "agreed more" show that school C was where the methods were mostly employed, while school D was where the methods were least employed. This represented 68.79% and 53.60% of the examinee's responses respectively.

4.2.3. iii Tendency of examinees in school C to prioritise answering HOQs during MSCE examination compared with that of examinees in school D.

Data from the answered test papers in school C and school D was used to compare the tendency of examinees to prioritize answering HOQs during the MSCE Biology examination. The aim of the comparison was to understand how the teacher's use of, or deficiency in use of LCT methods relate to examinees' tendency to prioritize answering HOQs during MSCE examinations.

Figure 4.15 illustrates percentage counts of HOQs attempted by examinees in each range of priority positions in schools C and D.

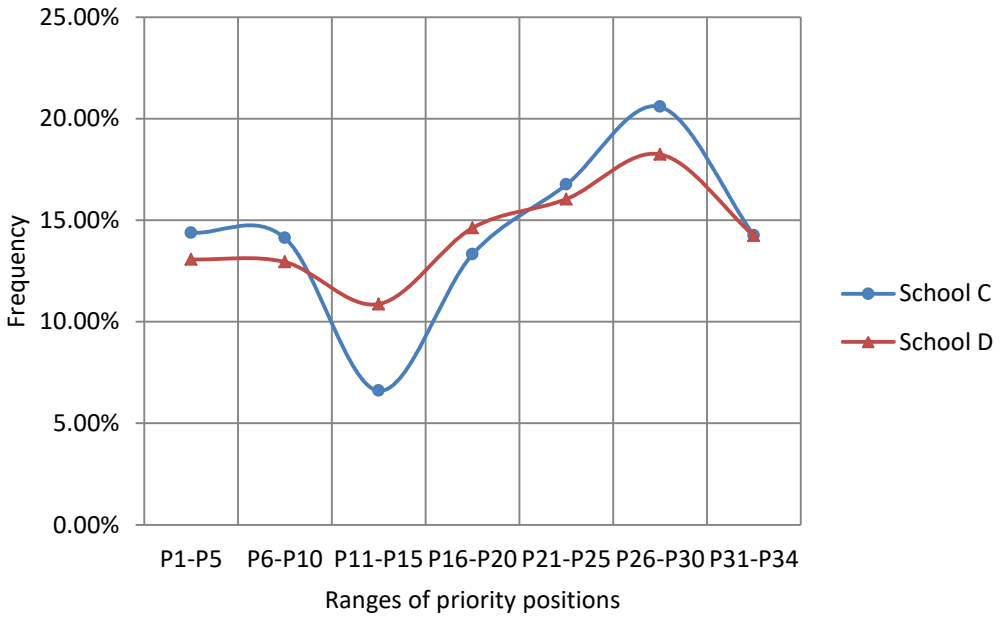

Figure 4.13 How examinees in school C and D prioritised answering HOQs

In school C and D, answering of HOQs declined from 14.38% and 13.07% respectively at the onset to the minimum point of 6.60% and 10.87% respectively in the third range of priority positions. The decrease implies that in the earlier part of the examination taking session examinees focused on answering LOQs instead. Thereafter, there was a steady increase to the maximum point of 20.58% and 18.24% respectively in the sixth range. This increase indicates that in the latter part of the examination taking session, examinees focused more on answering HOQs. Depletion

of HOQs led to the drop in the curves for both schools to 14.25% in the final range of priority.

The highly fluctuating curve for school C indicated a higher tendency of examinees to prioritise answering one type of questions at a particular time in the test taking session.

Frequency of HOQs which were answered declined to the minimum point in earlier ranges of priority positions and there after increased to the maximum point in latter ranges. This indicated a very low tendency to prioritise answering HOQs by examinees.

The less fluctuating curve for school D indicated a low tendency of examinees to prioritise answering one type of questions at a particular time in the test taking session. Frequency of HOQs which were answered declined very slightly in earlier ranges of priority positions, there after it also rose slightly in the latter ranges. Examinees in school D also showed lower tendency to prioritise answering HOQs. However, the tendency was not as low as that of examinees in school C.

It was concluded that higher use of LCT methods by the teacher corresponded with lower tendency of examinees to prioritise answering HOQs in a test taking session.

HOTS are known to develop when teachers adopt constructivist pedagogical methods (Dagar & Yadav, 2016). These are teaching methods which focus on active learning of students, (Krahenbuhl, 2016). This implies that examinees who were subjected to more LCT lessons were likely to have acquired more HOTS. According to Budsankom et al., (2015) and Verdina, et al., (2018), HOTS enable students to make

appropriate and logical decisions. Therefore, in as much as these examinees had the ability to tackle HOQs, they most likely found the majority of LOQs extremely easy to answer. Therefore, it was logical for them to prioritise more answering of LOQs while taking the examination.

It is a commonly practiced test taking approach for secondary school examinees to preview the test paper before beginning to answer questions with the aim of identifying items which can be answered without much effort and those requiring more effort.

When taking the test, difficult items are temporarily skipped with the aim of returning to them later in the session. Difficult items could be the type of questions the examinee has never seen before or a question in which the examinee gets stuck in early steps of providing the answer. Nevertheless, this conclusion is exclusive of cases where the teacher did not employ LCT methods at all. Such cases were not represented in the study sample.

This outcome sharply contradicts the researcher's prior expectation that examinees whose teacher had employed LCT more would prioritise more answering HOQs. The expectation was based on the assertion by Dano-Hinosolango and Vedua-Dinagsao (2014) that when teachers use more of student-centered teaching in class, the learning skills and strategies of students develop significantly. As such, the examinees were expected to prioritise more answering of HOQs than LOQs owing to the view that such students had sufficient cognitive tools necessary for addressing such questions.

4.3 Chapter summary

Firstly, it has been discovered that examinees in the selected DBSSs displayed lower levels of tendency to prioritise answering HOQs than levels of tendency to prioritise answering LOQs in the taking session.

Secondly, it has been confirmed that there was high extent of use of LCT methods by teachers of Biology across the selected schools. Five out of the six aspects (83%) of LCT methods probed through the on the questionnaire were significantly employed across the participating schools.

Finally, results have shown that contrary to the researcher's expectations stated earlier on, high use of LCT methods by the teacher of Biology corresponded with lower levels of tendency of examinees to prioritise answering HOQs when taking MSCE Biology paper I examinations.

CHAPTER FIVE

CONCLUSIONS, IMPLICATIONS, RECOMMENDATIONS AND SUGGESTIONS FOR FUTURE RESEARCH

5.1 Summary of the study

Chapter One introduced the research problem by providing background information to the research problem, justification of the elements of the research topic, statement of the research problem and purpose of the study. It further outlined research objectives, research questions, significance of the study, limitations and delimitations of the study, and structure of Chapters in the research write up.

In Chapter Two, BT of cognitive domains was presented as the study's theoretical framework. Literature on HOTS and related areas was reviewed. The review included empirical studies conducted worldwide including African countries and Malawi in particular. The literature review revealed that as much as there was a large volume of empirical studies which had been conducted worldwide on HOTS and related areas, only a reasonable amount had been conducted in African countries, but there was very little work that had been done in Malawi. The study was therefore purposed to contribute towards filling of the knowledge gap by unearthing issues relating to acquisition of HOTS by students in DBSSs of CEED, Malawi.

Research design and methodology employed in the study were discussed in Chapter Three. The chapter further shed light on how the study population and study samples were identified.

Data collection tools, validity and reliability of data collection tools, the data collection process, data analysis techniques and ethical considerations relating to data collection were also discussed in the chapter.

Chapter Four discussed quantitative data analysis procedures which were employed in the study. Results obtained from the analyses were outlined in the Chapter.

5.2 Conclusions

Conclusions drawn from results of this study are stated in line with the research questions as follows.

5.2.1 Examinees' levels of tendency to prioritise HOQs compared with prioritising LOQs.

It was concluded that examinees showed lower levels of tendency to prioritise answering HOQs than levels of tendency to prioritise answering LOQs in the test taking session. Excluding the middle range of priority positions in which 15.71% HOQs and 16.49% LOQs were answered, 40.96% of HOQs were answered in the earlier three ranges while 43.33% were answered in the latter three ranges. On the other hand, 57.23% of LOQs were answered in the earlier three ranges while 26.28% were answered in the last three ranges.

5.2.2 Extent of use of LCT methods by teachers.

Primary data analysis led to a conclusion that generally, LCT methods were used to greater extents by teachers of Biology across the selected DBSSs.

A pie chart developed from combined data from all the selected DBSSs displayed distribution of examinees' responses to questionnaire items as 35% "to a very great extent", 22% "to a great extent", 17% "to the moderate extent", 13% "to a little extent" and 13% "not at all". Higher percentages of examinees' responses were on the options that confirmed the use of the methods by teachers. Further analysis involved Pearson's chi-square test of the examinees' responses to determine the significance levels in the extent to which each aspect of LCT methods was used. Using the threshold significance level of $P<0.05$, the outcomes were as follows.

Teaching methods that encouraged questioning by examinees during lessons were employed in all the selected DBSSs "to a great extent" with P= 0.001.

Teaching methods that accelerated development of metacognitive skills in examinees were employed "to a very great extent" with P= 0.000.

Teaching methods that used learner activities during lesson were used "to the moderate extent" with the P-value of 0.000.

Teaching methods that enhanced understanding in examinees were not employed at all. Only the P-value for the response option "not at all" (P=0.014) was <0.05.

Teaching methods that instilled problem solving techniques in examinees were employed "to the moderate extent" in all the selected DBSSs with P= 0.000.

Teaching methods that encouraged creativity in examinees were used "to a great extent" with P= 0.000.

From the outcomes, two conclusions were drawn. Firstly, that LCT methods were used to a high extent by teachers across the selected DBSSs.

Five out of the six aspects (83%) of LCT methods investigated in the questionnaire were significantly employed in all the selected schools.

Secondly, that the methods were not perfectly employed in all the selected schools. Only one of the aspects (16.67%) of LCT methods which were studied was employed to a very great extent. The rest were used to lower extents including one which was not employed at all.

5.2.3 Teacher's use of LCT methods versus examinees' prioritisation of HOQs

At first, through SPSS cross tabulation of "school" versus "use of the methods", it was confirmed that LCT methods were used during Biology lessons in all schools. Pearson's Chi-square test yielded P-values of 0.076, 0.103 and 0.000 under response categories of "disagree more", "neutral" and "agree more" respectively. Using the thresh hold significance level of $P<0.05$ it was taken that examinees agreed more to the proposition that the teaching methods were used in the schools.

Secondly, it was found that from perspective of the participants, of the five selected DBSSs, LCT methods were highly employed in school C where the response option "agree more" formed 68.79% of all the examinees' responses and that the methods were least employed in school D where the response option "agree more" formed 53.60% of all examinees' responses.

Finally, it was concluded that higher use of LCT methods by teachers during delivery of Biology lessons corresponded with lower tendency of examinees to prioritise answering HOQs when taking MSCE Biology papers I examinations.

In School C, HOQs answered ranged from 6.60% in the third range of priority positions to 20.58% in the sixth range of priority position while in school D the range was from 10.87% to 18.24% in the same ranges of priority positions. The wider range in school C indicated a higher tendency of examinees to prioritise answering one type of questions at a particular time in the test taking session while a narrower range in school D indicated a low tendency of examinees to prioritise answering one type of questions at a particular time in the test taking session.

5.3 Implication

Results of the study imply that use of LCT methods by teachers during Biology lessons upgrades examinees' cognitive abilities. Examinees who underwent more LCT lessons and are believed to have acquired higher levels of HOTS showed lower tendency to prioritise answering HOQs compared to examinees who underwent less LCT lessons and are believed to have acquired lower levels of HOTS. With upgraded cognitive skills, the former found most of the LOQs very easy to answer. Consequently, priority was given to answering of LOQs than answering of HOQs.

However, it was outside the scope of the current study to determine the merits and demerits of the kind of prioritisation of question displayed by examinees who had acquired high levels of HOTS on test scores. This would possibly be addressed by future studies.

5.4 Recommendations

With regards to the findings of this study, the following recommendations are made.

Firstly, the Malawi Government, through MoEST, should ensure adequate supply of teaching and learning resources in secondary schools for effective implementation of LCT methods by teachers in all secondary schools in Malawi. Besides having found that LCT methods were used to a high extent by teachers across the selected DBSSs, it has been found that the methods were not perfectly employed in all the selected schools. Review of literature has shown that teacher's use of LCT accelerate development of HOTS in examinees better. Since the use of LCT methods frequently involves examinees in hands on activities, there is need for adequate supply of teaching and learning resources to schools.

Secondly, MoEST should not slack on its teacher development programs, for example, in-service trainings for teachers of science like SMASSE. Trainings of this nature are platforms where teachers share skills and techniques appropriate for effective teaching of science in schools. This would help in achievement of perfect use of LCT methods by teachers in all schools.

Finally, teachers of Biology in secondary schools should make deliberate efforts to be consistent at employing LCT methods when delivering lessons. The current study has revealed existence of disparities in the extent to which teachers of Biology employed LCT methods in DBSSs despite the similarity of the schools in terms of material and human resources. The study made no attempts to establish reasons for the said disparities. However, as indicated in literature review, factors such as teacher' work

contexts, beliefs, over enrolment, rushing to cover the whole syllabus and teaching to make children pass examinations, lack the necessary experience, knowledge and motivation are known to prevent individual teachers from practicing LCT.

5.5 Limitations of the study

During data collection exercise, a test was administered to examinees in different schools at different times. It was not feasible to administer the test to all participating examinees at the same time and same venue. Consequently, testing conditions might not have been standard to all sampled examinees. This might have compromised the validity and reliability of results.

The second limitation was that, contrary to the assumption that DBSSs used in this study were similar in many aspects, reality on the ground would prove otherwise. There were possibilities of prevalence of circumstances special to individual schools which would bring in serious disparities among the schools. These would have negative effect on the results of the study.

The last limitation concerned prevalence of missing data. During administration of the test, some examinees left some questions unanswered. Apart from that, some questions were answered without being assigned question numbers contrary to the instructions given to examinees. Both of these scenarios contributed towards the volume of missing data. Gaps in data might have affected data processing procedures negatively and in turn might have compromised the validity and reliability of findings.

5.6 Delimitation of the study

In the first place, the study focused only on understanding how examinees prioritized answering HOQs. It did not consider their performance. Data processing activities did not include scoring of test papers since scores by examinees were not necessary.

Secondly, generalization of findings, on one hand, was limited to the subject of Biology only. A similar study in another subject may bring different outcomes. On the other hand, generalization of findings was limited to district boarding secondary schools because of their similarities in terms of quality and quantity of physical as well as human resources available.

5.7 Suggestions for further study

The following are suggested areas for further study in relation to the current study.

1. Designing a performance based study to determine how examinees' prioritisation of answering questions of a particular level when taking examination relates with their overall performance in the examination.
2. Replicating the current study with a larger sample of examinees drawn from all education divisions of Malawi to find out the situation regarding all DBSSs of Malawi.
3. Modifying the current study into a pre-test post-test design to unearth the impact of employing appropriate teaching methods for enhancing development of HOTS in examinees on the tendency of examinees to prioritise answering questions of a particular level of difficulty.
4. Replicating the current study with addition of special data collection tools to get information from other stake holders like teachers and heads of schools in

respective schools that would supplement information sourced from examinees and serve in triangulation purposes to further fortify the validity of the study findings.

5. Replicating the study in a number of science subject areas to determine whether examinees' prioritisation of answering HOQs is subject specific or not.

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APPENDICES

Appendix A1 Examinees' questionnaire

Questionnaire for collecting data on the extent to which teachers of Biology in CEED employ teaching methods which enhance development of HOTS in examinees.

EXAMINEES' QUESTIONNAIRE

Name of School: _____

You are completing four years of secondary school studies at your institution. Biology is one of the subjects you have learnt all along. You are therefore being requested to provide information on teaching methods and strategies which were employed by your teacher of Biology. The information being sought in this questionnaire is meant for educational research purposes only and will not be used against anyone. Your responses will be held confidentially and your name is not required. Please provide information truthfully basing on your personal experience. Thank you in advance.

Instruction: Tick in the appropriate box to indicate the extent to which you agree with each of the following statements from a score of 1-5 (where 1=not at all, 2=to a little extent, 3=the moderate extent, 4=to a great extent, 5=to a very great extent).

A	**Encouraging questioning during Biology lessons.**	**Responses**				
		5	4	3	2	1
1	Students were always encouraged to ask questions during lessons.					
2	The class environment was always friendly for any student to ask questions without fear of negative reactions.					
3	Teacher was willing to answer questions posed by any student.					
4	Teacher involved other students to answer questions from students.					
5	Students were guided on how to find solution to their questions.					
6	Students were encouraged to elaborate when answering questions.					
7	Students were taught how to ask themselves good questions.					
8	Students were trained to give appropriate response to the type of question being asked.					
B	**Attending Biology lessons has improved the following metacognitive skills and strategies in you.**	**Responses**				
		5	4	3	2	1
1	Analysing the task so that it may be done properly.					
2	Planning how a task can best be done.					
3	Monitoring if the task is being done properly.					
4	Self-regulation					
5	Self-assessment					
C	**Use of student activities during Biology lessons.**	**Responses**				
		5	4	3	2	1
1	Students were involved in group activities during lessons.					
2	Activities during lessons motivated students to be active participants.					
3	A variety of activities was used depending on information being taught.					
5	Guidelines for group activities were always clearly stated.					
6	Students were always encouraged to constantly assess how the activity is helping them gain understanding.					
7	Through activities students learnt to accept individual differences and focus on solving the problem at hand.					
8	Students' groups were allowed to make presentations in class.					
9	Teacher clarified learning points after group presentations.					
D	**Enhancing students' understanding.**	**Responses**				
		5	4	3	2	1
1	Students were helped to process and understand information better.					
2	Students were aided to make inferences through "real-world" examples.					
3	Students were guided on how to connect one concept to another.					
E	**Problem solving techniques.**	**Responses**				
		5	4	3	2	1
1	Students were trained in a step-by-step method for solving problems.					
2	Students were offered different problem-solving methods.					
3	Students were encouraged to use alternative methods to solve problems.					
F	**Encouraging creativity.** **Students were trained to think creatively in the following ways.**	**Responses**				
		5	4	3	2	1
1	They were challenged to invent things (or make innovations).					
2	They were encouraged to imagine.					
3	They were allowed to design through hands on (practical) activities.					

End of questionnaire

Appendix A2: 2019 MSCE Biology paper I examination past paper (modified for collection of data on how examinees prioritise answering high order questions).

EXAMINATION NO.: _____

THE MALAWI NATIONAL EXAMINATIONS BOARD

2019 MALAWI SCHOOL CERTIFICATE OF EDUCATION EXAMINATION

BIOLOGY

(100 marks)

Subject Number: M022/I

Tuesday, 25 June

Time Allowed: 2 hours
8:00 – 10:00 am

PAPER I

Instructions

1. This paper contains **11** printed pages. Please check.
2. Before you begin, **fill** in your **Examination Number** at the top of the question paper and on all other sheets.
3. This paper has **two** sections, **A** and **B**. Section **A** has questions and Section **B** has questions.
4. Answer all questions in the spaces provided. The maximum number of marks for each answer is indicated against each question.
5. In the table provided on this page, **tick** against the question number you have answered.
6. At the end of the examination, hand in your paper to the invigilator when time is called to stop writing.

Question Number	Tick if answered	Do not write in these columns	
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			

Turn over

Section A (70 marks)

Answer **all** the **ten** questions in this section.

Figure 1 is a diagram showing a bacterium. Use it to answer the questions that follow.

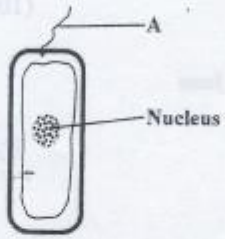

Figure 1

NO. Name the part labelled **A.**

_____

(1 mark)

NO. Describe how the bacterium moves.

_____

_____

(2 marks)

NO. Explain any **three** adaptations of birds for locomotion.

_____

_____

_____

_____

_____

_____

(6 marks)

Continued/...

Figure 2 is a diagram showing a transverse section of a stem. Use it to answer the questions that follow.

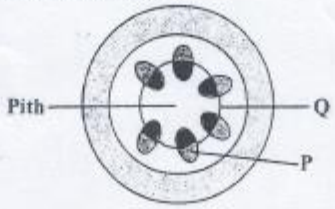

Figure 2

NO. Name the part labelled **P**.

_____

(1 mark)

NO. Give any **one** function of part labelled **Q**.

_____

(1 mark)

NO. Explain any **three** factors that affect the rate of diffusion in plants.

_____

_____

_____

_____

_____

_____

(6 marks)

NO. Explain the importance of a control variable in a scientific investigation.

_____

_____

_____

(2 marks)

Continued/...

NO. (Continued)

Give any **three** reasons for taking accurate measurements when conducting investigations in Biology.

(3 marks)

NO. Name any **two** respiratory diseases.

(2 marks)

NO. Explain any **two** adaptations of the alveolus for gaseous exchange.

(4 marks)

NO. Give any **two** structural differences between "a sperm" and "an ovum".

(2 marks)

Continued/...

NO.

(Continued)

State **two** functions of testes.

_____

_____ **(2 marks)**

NO.

State any **two** causes of maternal death.

_____

_____ **(2 marks)**

Figure 3 is a diagram showing a human embryo in the uterus.
Use it to answer the questions that follow.

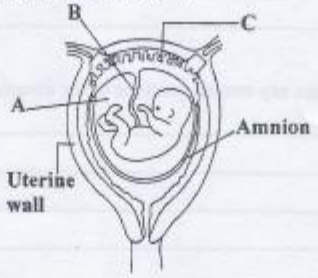

Figure 3

NO.

Name the parts labelled **B** and **C**.

B : _____

C : _____ **(2 marks)**

NO.

State any **two** functions of the part labelled **A**.

_____

_____ **(2 marks)**

Continued/

(Continued)

NO. Mention the **two** permanent methods of birth control.

_____

_____ **(2 marks)**

NO. Define each of the following terms:

(i) "Excretion" _____

_____

(ii) "Homeostasis" _____

_____ **(2 marks)**

No. Name any **two** excretory products from the kidney.

_____

_____ **(2 marks)**

No. Give any **two** similarities between a dialysis machine and the kidneys.

_____

_____

_____

_____ **(2 marks)**

NO. What type of immunity does a child acquire through recovering from a disease?

_____ **(1 mark)**

NO. Why is a person with anaemia **not** allowed to donate blood?

_____

_____ **(2 marks)**

Continued/...

(Continued)

NO. Explain how vaccination works.

_____

_____

(2 marks)

NO. Give any **two** functions of bones in a human body.

_____

_____

_____

(2 marks)

NO. Name the type of muscles to which the biceps muscles belong.

_____

(1 mark)

NO. State any **two** differences between muscles of the heart and triceps muscles.

_____

_____

_____

_____

(2 marks)

NO. Explain how albinism is caused.

_____

_____

(2 marks)

NO. Give any **two** negative biological effects of albinism in humans.

_____

_____

(2 marks)

Continued/...

(Continued)

Colour blindness is one of the sex-linked characters in humans. Allele for normal colour vision is dominant over allele for colour blindness. Use **R** for dorminant allele and **r** for recessive allele.

NO. Write the genotype for a male with normal colour vision.

_____

(1 mark)

NO. Use a punnet square to show the genotype of the offspring when a man with normal colour vision marries a colour blind woman.

(5 marks)

NO. Why is a female with heterozygous condition of sex-linked character called a carrier?

_____

_____

(2 marks)

NO. State any **two** uses of bacteria in biotechnology.

_____

_____

(2 marks)

Continued/...

Section B (30 marks)

Answer **all** the **three** questions in this section. Your answers should be in an essay form.

NO. Discuss any **five** causes of deficiency diseases.

(10 marks)

Continued/...

NO.

Explain any **five** contraceptive methods.

(10 marks)

Continued/...

NO. Explain any **five** adaptations of the mesophytes to their environment.

(10 marks)

END OF QUESTION PAPER

This paper contains 11 printed pages.

Appendix B1: Letter of introduction from the college's postgraduate programs coordinator

PRINCIPAL
Prof. R. Tambulasi, B.A (Pub Admin), BPA (Hons), MPA, Ph.D

CHANCELLOR COLLEGE
P.O. Box 280, Zomba, Malawi
Telephone: (265) 524 222
Fax: (265) 524 046
E-mail: principal@cc.ac.mw

6th October, 2020

To Whom It May Concern

Letter of Introduction: Allen D.W. Sulani

This letter serves to confirm that **Mr. Allen Sulani** is a registered postgraduate student in the Education Foundations Department, of the School of Education, of the University of Malawi, Chancellor College. He is studying under the Master of Education in Testing, Measurement & Evaluation program. He completed his coursework.

As a requirement for completion of his study program, he is conducting a research titled "***An Investigation on how Examinees prioritise answering Higher Order Questions during Malawi School Certificate of Education (MSCE) Biology Paper I Examination: A Case of Examinees in the District Boarding Secondary Schools in the Central East Education Division of Malawi***". This letter serves to request your institution/organization to assist our student to collect the required data.

For any inquiries please contact the undersigned via the following email address: med@cc.ac.mw

Sincerely yours,

UNIVERSITY OF MALAWI
CHANCELLOR COLLE - E
DEPT OF EDU FOUNDATION
2020 -10- 05
P O BOX 280
ZOMBA

Chikumbutso H. Manthalu, PhD.
Postgraduate Programmes Coordinator – EDF Department

Appendix B2: Permission from the office of the acting executive director, MANEB

THE MALAWI NATIONAL EXAMINATIONS BOARD

P.O. Box 191, ZOMBA, MALAWI. TEL. (265) 01 525 277, FAX: (265) 01 525 351
e-mail: maneb@sdnp.org.mw

ACTING EXECUTIVE DIRECTOR
Dorothy Cynthia Nampota, BEd, MA, PhD

All communications should be addressed to:
The Acting Executive Director

In reply please quote:
Our Ref.: C/1/6/11
Your Ref.:

CONFIDENTIAL

20th November, 2020

Allen Sulani

Email address: asulaniwodala@gmail.com

Dear Sir,

PERMISSION TO USE MSCE BIOLOGY PAST PAPER

We acknowledge receipt of your introductory letter from Chancellor College accompanying your request for permission to use 2018 MSCE Biology 1 paper for educational research purposes.

You are permitted to use the past paper and strictly for the purposes stated in the introductory letter.

Yours faithfully,

Dorothy C. Nampota
ACTING EXECUTIVE DIRECTOR

Appendix B3: Letter of authorization from the office of the Education Division Manager, CEED.

Tel (265) 01253611/612 - 01253612
Fax(265)01253227

All correspondence to be addressed to
The Education Division Manager
Our Ref No. CEED/PF/172133

CENTRAL EAST EDUCATION
DIVISION, PRIVATE BAG 233,
KASUNGU

Date: 5th October, 2018

MINISTRY OF EDUCATION SCIENCE AND TECHNOLOGY

The Headteachers
District Boarding Secondary Schools

REQUEST TO CONDUCT RESEARCH STUDY

The bearer of the letter is **Allen David Sulani.** He would like to conduct research study at your school as a continuation of his studies with Chancellor College.

Please assist him accordingly.

PP.

B.C. BANDA
EDUCATION DIVISION MANAGER (CEED)