Formal Education and Critical Thinking Skills for the Knowledge Economy in Zambia

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DECLARATION:

By submitting this thesis electronically, I declare that the entirety of the work contained therein is my own, original work, that I am the sole author thereof (save to the extent explicitly otherwise stated), that reproduction and publication thereof by Stellenbosch University will not infringe any third party rights and that I have not previously in its entirety or in part submitted it for obtaining any qualification.

Date: March 2016

OPSOMMING

Die tesis ondersoek tot watter mate die O-vlak eksamens van die Examinations Council of Zambia (ECZ) die ontwikkeling van die kritiese denkvaardighede van analise, evaluasie en kreatiwiteit ondersteun

Deur Bloom se Taksonomie toe te pas op geselekteerde eksamenvraestelle oor 'n 5 jaar tydperk, kom die tesis tot die gevolgtrekking dat sodanige vraestelle nie daarin slaag om die denkvaardighede te inkorporeer nie.

SUMMARY

This thesis investigates the question: Are GCE 'O' Level examinations administered by the Examinations Council of Zambia (ECZ) supporting the development of the critical thinking skills of analysis, evaluation and creation in Grade 12 school leavers given the backdrop of the Knowledge Economy (KE)?

Chapter 1 focuses on the background and context of the study. It also provides a brief overview of the knowledge economy and the centrality of critical thinking skills.

Chapter 2 gives a fuller description of the knowledge economy and globalization.

Chapter 3 describes Bloom's Taxonomy and critical thinking in order to make visible the theoretical framework for the study

Chapter 4 sets out the research method and demonstrates how the measuring instrument based on the revised Bloom's Taxonomy is applied to the analysis of examination papers

Chapter 5 deals with data analysis and interpretation, specific techniques employed and reasons for such strategies.

Chapter 6 discusses the findings, and comes to the conclusion that that the GCE 'O' Level examinations administered by the ECZ are not supporting the development of the critical thinking skills of analysis, creativity and evaluation in Grade 12 school leavers.

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Thank you to my loving wife for her incessant support and to dad and mum for everything they have done for me. Thanks also go to my colleagues, Kukena Solomon and Richard Thompson, for their professional advice; my niece Tayana for helping with the typing of the document; and my students at Chengelo School, Beverly and Luzia, for helping with the formatting of the document. Lastly, but by no means the least, thanks go to my supervisor, Prof. J. Kinghorn, without whose guidance and support this thesis would not have seen the light of day.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

ABBREVIATIONS

CIE   Cambridge International Examinations

ECZ   Examinations Council of Zambia

GCE   General Certificate of Education

IGCSE   International General Certificate of Secondary Education

KE   Knowledge Economy

MESVTEE   Ministry of Education, Science, Vocational Training and Early Education

MoE   Ministry of Education

Chapter 1

Critical Thinking Skills and Formal Education

1.1   Introduction

This thesis takes its point of departure from the generally accepted fact that the world is moving into a dispensation which can best be described as the knowledge economy (KE).

The knowledge economy is a multi-faceted phenomenon and its contours are still emerging. However, it is generally agreed that the development of personal critical thinking skills and their continuous application in all societal activities is a prerequisite for a society to function successfully in the era of the knowledge economy. Indeed, a key feature of society in those countries who are further up the ladder of the knowledge economy is the abundance and wide spread of people who command the capacity for critical thinking. It is no wonder that such societies stand out as beacons of innovation and quality service delivery, for without the ability to think critically neither of these attributes is possible.

There are a number of factors that support or inhibit the growth of critical thinking ability in a country. But few would disagree that the formal education system of a country is the major factor in this respect.

It is against this background that this thesis focusses its attention on the Zambian education system. The broadest objective of the thesis is to assess to what extent the formal Zambian education system contributes or does not contribute to the growth of a society in which the average member is capable of critical thinking.

The critical apex of any educational programme comes in the form of an examination. This is the moment in which not only the core content envisaged by the curriculum is exposed, but also (and for this thesis, more importantly) where the thinking skills which are expected to be mediated by the curriculum surface.

To approximate the broad objective of this research project, this thesis, therefore, narrows down to an investigation of formal assessment in the Zambian education system. It is assumed that an investigation of school exit examinations, as set by the Examination Council of Zambia (ECZ), should yield enough insight into the critical thinking skills expected to be developed and mediated by the formal curriculum.

The limited extent of research available on this topic in Zambia indicated a need of further research that could provide a better understanding of how effective the GCE 'O' Level examinations set by the ECZ are at supporting the development of critical thinking skills and to what degree they have incorporated these skills into their curriculum.

1.2   Background and context of study

Zambia is a landlocked sub-Saharan country sharing borders with Malawi, Mozambique, Zimbabwe, Botswana, Namibia, Angola, Democratic Republic of Congo and Tanzania. The country has a land area of about 752,612 square kilometres.[1] When Zambia gained its independence from Britain in 1964, of a total population of four million, 110 000 people had received six years of schooling.[2] 32 000 had completed the full primary school course of eight years. Only 4,420 had passed the two year Junior Secondary Course (Form II) and a mere 961 were known to have passed the Cambridge School Certificate (Form V).[3] The 1963 census showed that 76.6% of all men and 95.6% of all women were illiterate and that a mere 1500 Zambians had a school certificate.[4]

The situation has improved markedly but it is still far from satisfactory. By 1996, about 40% of the Zambian population were illiterate. The illiteracy rate was higher among

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1   Central Statistical Office 1996 Living Conditions Monitoring Survey Report

2   Carmody B 2004 The Evolution of Education in Zambia

3   Carmody B 2004 The Evolution of Education in Zambia

4   Alexander D J 1983 Problems of Educational Reform in Zambia

females than among males.[5] Out of a total population of about 9.5 million, 9,400 persons had completed a university degree at undergraduate or postgraduate level.[6] This represents only 0.2% of the total population.[7] The country has plans to improve literacy rates by 50% and to attain universal primary education by this year (2015).[8]

Education in Zambia has long been a major concern for many stakeholders: government, civil society, religious organizations as well as community leaders. It is recognized as a right of every individual. Education also contributes to the well-being and the quality of life of the whole society. In the Poverty Reduction Strategy Paper (PRSP) of 2001/2002[9], the government ranked as the main drivers of economic growth: agriculture, tourism and diversification from mining into small and medium scale businesses and industries.[10] This has implications for the kinds of skills and competencies that formal education needs to impart in order to effectively reduce poverty, hence the primacy of issues related to education. Therefore, the curriculum offered in schools has been designed to meet these national needs. For quite some time now, Zambia has had different types of schools that can broadly be classified as government and private. In Zambia, private schools include schools established by religious agencies, local and international companies, community schools run by local communities and NGOs, and trust schools that were originally established for children of people employed by the copper mines. Government schools receive funding through the Ministry of Education (MoE) while private schools in Zambia depend entirely on income from fees charged. The latter generally offer better quality education compared to government schools.

Under the prevailing economic conditions, the national situation is regrettably such that relatively few families can afford the school fees charged by private secondary schools. Therefore quality education has, in practice, remained for the most part the preserve of the

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5   Central Statistical Office 1996 Living Conditions Monitoring Survey Report

6   Central Statistical Office 1996 Living Conditions Monitoring Survey Report

7   Central Statistical Office 1996 Living Conditions Monitoring Survey Report

8   Ministry of Education 2010 Education Sector National Implementation Framework

9   Ministry of Education 2002 Strategic Plan 2003-2007

10   Ministry of Education 1996 Educating our Future

elite or the '*apamwambas*'. The government is seeking to change this situation. The government plans to change the policy framework so that it encourages private schools to admit pupils from vulnerable families by making these schools eligible to receive bursary assistance on behalf of such pupils.[11]

1.2.1 Structure of the Zambian Educational System

The Zambian educational system comprises four levels: early childhood, primary school, secondary school and tertiary level. Early childhood education is provided for the most part by private organisations and individuals. Pre-school attendance occurs mainly in urban areas.

Compulsory education comprises grades 1-7, implying that in theory all eligible children should attend school up to grade 7. There are competitive selection examination at grades 7 and 9 to enter junior and senior secondary school.

The Primary Education sub-sector offers schooling from Grades 1 to 7 and caters for children aged six to twelve years. The provision of primary education to children provides an environment that fosters desirable attitudes, values and behavioural change. With this goal in mind, for the past few decades, the MoE has put emphasis on the provision of primary education, enabling eligible children to access education at this level and ensuring that those who entered the school system were kept in school. Despite all its efforts, however, the MoE has not yet managed to achieve universal primary education, mainly due to the lack of available school places especially in urban areas and the lack of interest in schooling in rural areas.[12] The rationale for the provision of universal primary school education is that primary education lays a firm foundation upon which all other levels are built. There are four management agencies of basic schools in Zambia: Government, Private, Grant-Aided and Community Schools.

The Secondary School Education sub-sector in Zambia consists of learning at Grades 8 to 12 and provides for children aged between 14 and 18 years. Grades 8 and 9 constitute Junior Secondary School while Senior Secondary School consists of grades 10, 11 and 12.

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11   Ministry of Education 1996 *National Policy on Education*

12   Central Statistical Office (Zambia) 1996 *Living Conditions Monitoring Survey Report*

Admission to senior secondary school is dependent on obtaining a full certificate at the Junior Secondary School Leaving Examination at the end of Grade 9.[13] The Secondary School Education sub-sector in Zambia is critical in the education delivery system because it produces the cadre that go into the tertiary level and wage-sector employment.[14]

With its high rate of technological advances and new labour market needs, the knowledge economy correspondingly requires a change in the way skills training should be done. Thus governments are strategically responding to these challenges, bridging technological skills at different levels of human resource development. New technology and changing manufacturing processes have an effect on productivity and this is creating a demand for workers with higher-order skills as well as entrepreneurial and innovative traits.

The Zambian government has realised that skills training and development, supported by appropriate learning pathways and a suitable curriculum, are crucial factors if an educational system is to produce human resources that are efficient and effective at any job. Appropriate curricula and learning pathways must help equip individuals with essential competences and skills necessary to operate in a knowledge economy successfully, whether they are working in the formal job sector or running their own business.

The Zambian government is also aware of the fact that for skills-training to be appropriate and relevant, it should encompass a variety of different skills that are applicable to a range of jobs. The method of training is also significant. The training method should incorporate both best practices: nurturing and developing vocational and technical skills, and enabling learners to use a combination of their intellectual and practical skills in a way which adds value to their lives and the resources around them.

This has not been the case in Zambia for some time now. The education curriculum has fallen short in facilitating the acquisition of skills needed in the labour market. Against this background, government has developed a new school curriculum which enables learners to choose their preferred career path and guidance framework, to prepare them more

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13   Ministry of Education 2010 Education Sector National Implementation Framework

14   Ministry of Education 2010 Education Sector National Implementation Framework

effectively for the labour market.[15] The framework, which provides curriculum guidelines and structures for the school system levels, has been piloted in selected districts and schools in all the ten provinces of Zambia, and was evaluated before being fully implemented in January 2014.[16] The new national curriculum framework has revised the structure of the curriculum at all levels. The new curriculum was inspired by national policy documents, in particular the 1996 Education Policy, the 2011 Education Act, Action Development Plans, National Implementation Frameworks, the Vision 2030, the 1999 Baseline Survey Reports and the 2009 National Curriculum Symposium report.[17]

The framework includes early education, primary, secondary and tertiary education together with adult literacy. Figure 2.1 below is a schematic representation of how learning will take place under the new curriculum framework:

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15 Ministry of Education 2010 Education Sector National Implementation Framework

16 Ministry of Education 2010 Education Sector National Implementation Framework

17 Ministry of Education 2010 Education Sector National Implementation Framework
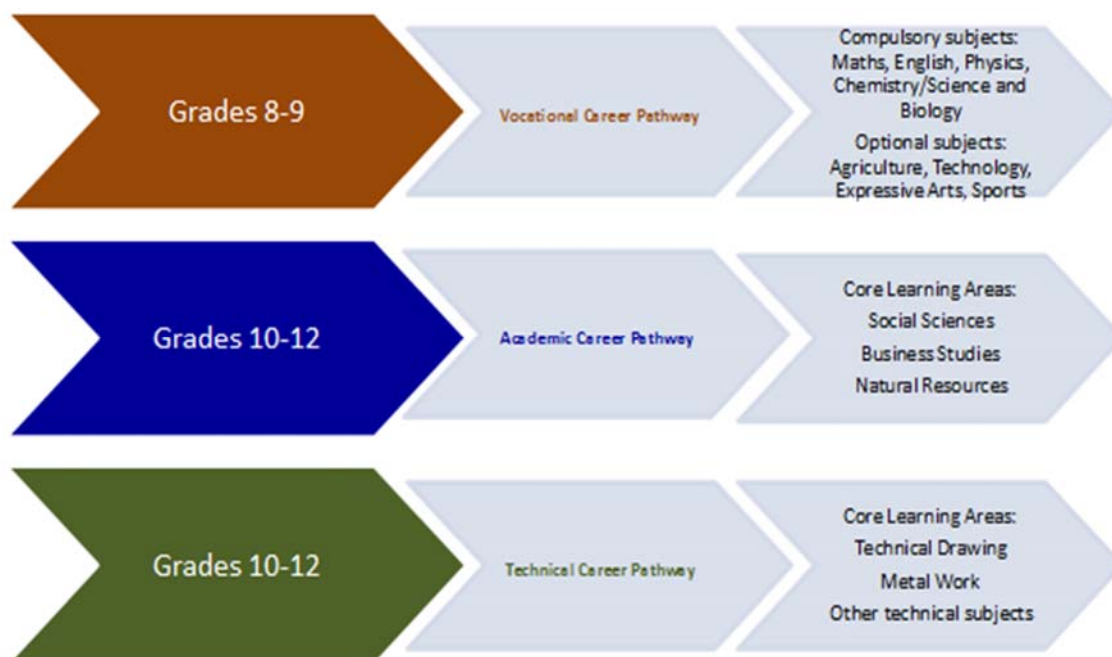
Figure 1. *Adapted from* **the** *New Zambian School Curriculum Framework[18]*

The new curriculum framework has increased the learner-teacher contact time from three to a maximum of six hours per day at primary school level. Practical subjects have been allotted more hours at secondary school level. It is anticipated that the revised curriculum would be responsive to the needs of individual learners and will equip them to contribute more effectively to national development. It is also hoped the revised curriculum will help mould many Zambians learners into self-reliant graduates who will to respond to the changing economic environment.

1.2.2   Formal Assessment in the Zambian Education System

The previous section gave an overview of the Zambian educational system and detailed the changes in the school curriculum that have been instituted recently. This section concerns the body responsible for conducting public exams in Zambia.

The Examinations Council of Zambia (ECZ) is the body that manages the formal assessment programme in Zambia. It was established in 1983 by an act of parliament to set and conduct examinations and award certificates to successful candidates.[19] Before this

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18   Ministry of Education 2010 Education Sector National Implementation Framework

19   www.exams-council.org.zm (accessed 30/09/2015)

enactment, the then Ministry of Education and Culture (currently Ministry of Education) under the Examinations Section used to manage the examinations. After the enactment of the act, the section continued to perform the function of administering the examinations while simultaneously developing an institutional framework and job descriptions for the ECZ. The ECZ was fully launched and operationalised in 1987 as a semi-autonomous public institution (Parastatal).[20] Prior to the establishment of the ECZ, the University Of Cambridge Local Examination Syndicate (UCLES) in the United Kingdom was the sole examining and awarding body. The UCLES examinations catered for many countries with different cultural contexts and, as such, it was felt that examinations under the auspices of UCLES did not really reflect the needs of Zambia.[21] The country was subject to the curricula, syllabi and regulations of the syndicate and had little say in the general policy of the syndicate examinations. In view of this, the government made the decision to localise School Certificate examinations, leading to the need for development in the construction, administration and marking of examinations. This gave rise to the establishment of the ECZ. The main functions of the ECZ as stipulated in the ECZ Act, No. 15 of 1983 are to: (1) Conduct examinations; (2) award certificates or diplomas to candidates who pass examinations conducted by the Council; (3) carry out relevant research in examinations; (4) advise any public institution on development and use of any system of testing or examining when requested to do so; (5) formulate syllabuses for examinations; (6) promote international recognition of qualifications conferred by the Council; (7) approve or reject appointment of examiners, and (8) organize for training of examiners, markers, supervisors and invigilators. [22]

Since its inception, the ECZ has been able to successfully perform its functions as outlined in the Act. The research staff at the ECZ who are tasked with the development of examinations are trained in the use of modern psychometrics, including classical item and test analysis, 2PL item response models, differential item functioning analysis, factor analysis, as well as general introductions to IRT-based linking, matrix-sampled assessments

20   www.exams-council.org.zm (accessed 30/09/2015)

21   www.exams-council.org.zm (accessed 30/09/2015)

22   www.exams-council.org.zm (accessed 30/09/2015)

and polytomous IRT models.[23] They have employed these methods since late 2013 in the context of the development and analysis of assessments. However, examination content development is limited to traditional curriculum-based assessment tasks. Relatively few item developers and test developers have experience with psychology, construct/latent trait measurement, or using broad cognitive frameworks in the development of instruments.[24] Furthermore, the item developers and test developers in Zambia use almost exclusively Bloom's Taxonomy to develop exam content. This relatively rigid adherence to Bloom's Taxonomy has resulted in some reluctance or difficulty on the part of item writers and test developers to adapt to a different cognitive framework.[25] Assessment and education in Zambia has historically focused on skills and knowledge necessary for academic advancement, rather than social, civic or economic participation.[26] Notwithstanding these challenges, the item and test development procedures used by the ECZ are well-defined and all development protocols generally follow best-practices. Clear efforts are made to ensure content is relevant and representative, item writers are demographically representative, and several stages of review, as well as pilot-testing and analysis, reduce the presence of poor-quality test items. Evidence from analysis of national assessment data as well as examinations data indicate that the items produced by the process are generally of high quality and free from obvious construction errors.

1.2.3   The Exam Development Protocols

This section describes the procedures followed in producing the final examination papers used at the Grade 12 public examinations in Zambia, a number of which were evaluated in this study.

The draft exam papers go through many stages of review as well as pre-testing and analysis in order to reduce the presence of poor-quality items in the final examination papers.

The ECZ has a network of over 3,000 item writers and draft paper setters for all levels.[27]

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23   PISA for Development 2014 Capacity Needs Analysis Report: Zambia

24   PISA for Development 2014 Capacity Needs Analysis Report: Zambia

25   PISA for Development 2014 Capacity Needs Analysis Report: Zambia

26   PISA for Development 2014 Capacity Needs Analysis Report: Zambia

27   PISA for Development 2014 Capacity Needs Analysis Report: Zambia

These represent all the subject areas and the different demographic areas of the country. These item writers and draft paper setters are trained by ECZ in the techniques of exam item construction and draft exam paper setting. When ECZ needs to set an examination paper in a particular subject, it invites item writers and draft paper setters to construct draft examination papers and submit them to the examination body for consideration. From the many draft question papers that are submitted by the item writers, about four or five draft exam papers are selected from which one draft exam paper is constructed. In order to evaluate learner performance on the test items, a number of quality control activities are undertaken to select the items to include in the final examination paper. Firstly the items are pre-tested, and then they are subjected to a pre-exam item analysis in order to select items that meet the acceptable psychometric benchmarks in terms of difficulty and discriminatory ability.[28]

The next important activity is a validation process which is carried out by practising teachers and other experts, namely examination and curriculum specialists, lecturers from universities and other tertiary institutions, In-Service Providers and Standard Officers from the Ministry of Education.[29] The validation process involves proof reading and checking in order to ascertain whether the items included in the draft exam paper represent the official curriculum and syllabi in terms of content and cognitive demands placed on learners.[30] It also involves carrying out distractor analyses in order to establish common mistakes and misconceptions of learners and making recommendations for remediation.[31] The process also includes scrutinizing learner performance item by item, according to the cognitive domains being tested and assessing the difficulty levels of the individual test items. In addition to this, the validation process evaluates the internal reliability of the tests.[32] Reliability refers to the ability of an assessment to give the same relative results each time it is used. The relative results should not change even if the assessment is carried

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28   PISA for Development 2014 Capacity Needs Analysis Report: Zambia

29   PISA for Development 2014 Capacity Needs Analysis Report: Zambia

30   PISA for Development 2014 Capacity Needs Analysis Report: Zambia

31   PISA for Development 2014 Capacity Needs Analysis Report: Zambia

32   PISA for Development 2014 Capacity Needs Analysis Report: Zambia

out at different times or by different assessors. After the validation process is over, the final product is made, taken for typesetting and then banked.

1.3   Research objective

The context of the modern day school is the KE. This context is very dynamic because there has been a recent explosion of knowledge. In order to work or operate successfully in this economy, students will need to have a certain set of thinking skills in addition to their academic and technical abilities. These critical thinking skills are very important because they enable entrants into the employment sector to approach their work with an improved ability to understand, analyse and resolve problems. It also makes them more creative and innovative, so that even if they are not absorbed into the formal employment sector they can become entrepreneurs. The educational system, and more specifically the public examinations, are supposed to support and stimulate the development of critical thinking skills.

Against this background, therefore, the general objective of the thesis is to assess to what extent the formal Zambian education system contributes to the growth in Zambia of a society which, on average, is capable of critical thinking. More specifically, the aim of this research is to assess whether or not GCE "O' Level examinations administered the ECZ are supporting the development of critical thinking skills of analysis, evaluation and creation in Grade 12 school leavers in Zambia, given the backdrop of the KE.

In summary this study aims to answer the following question:

"Are GCE 'O' Level examinations administered by the ECZ supporting the development of the critical thinking skills of analysis, evaluation and creation in Grade 12 school leavers, given the backdrop of the KE*?"*

1.4   Significance of the research

With the advent of the KE, there has been an exponential increase in the production of knowledge. The amount of knowledge has been said to double every year.[33] A search for information on '*the Tudors*', for example, using the Google search engine yields over 42 million websites: a vast quantity of information which very few can manage to explore in

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33   Simpson D and Toyn M 2011 Primary ICT Across the Curriculum

a lifetime.[34] Learners living in the KE, therefore, need strategies to manage this abundance of information. This is where the critical thinking skills of analysis and evaluation come in handy.

Another skill required to participate successfully in the KE is the ability to solve problems and engage in enquiry. Critical thinking skills empower one with the ability to do this. Furthermore, while rote learning and memorisation can achieve short-term goals like passing an examination, they do not empower people with the capacity to engage in life-long learning and to adapt to new information and new technologies. These are very important skills in the KE where change is an important feature.

On another note, good critical thinkers are more likely to get better grades and are often more employable as well.[35] Critical thinking skills are not only important in the academic domain but also in the social and interpersonal context, where adequate decision-making and problem-solving are necessary on a daily basis.

The foregoing demonstrates the need for our educational system to focus on the development of critical thinking skills, as opposed to encouraging the memorisation and regurgitation of information. This study offers several potential contributions to the body of knowledge on the impact of assessments on the development of critical thinking skills. This research should contribute to the formulation of policy to incorporate critical thinking skills in public examinations, in the delivery of the secondary school curriculum and in pre-service and in-service training of Zambian teachers.

1.5 Methodological considerations

This is a conceptual research thesis and relies on solid literature review. In order to answer the research question, this study employed the documentary analysis research method. More specifically, past examination question papers for the Zambian GCE 'O' Level Biology 5090 and Geography 2218 examinations for the years 2009-2013 set by the ECZ were analysed using Bloom's Taxonomy and reflections on critical thinking as the "tools". This post-examination, qualitative item analysis was carried out in order to determine the

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34   Simpson D and Toyn M 2011 Primary ICT Across the Curriculum

35   Holmes J and Clizbe E 1997 Facing the 21st Century

distribution of questions by cognitive level for the years 2009-2013 and the proportion of the all the questions that tested analysis, creation or evaluation.

The rationale for choosing the documentary analysis approach was that this approach was most suited to achieving the objective of this study and was consistent with the research paradigm. An empirical approach employing techniques such as surveys, questionnaires or interviews for data collection would not only have been inconsistent with the conceptual approach, but would have amounted to no more than taking an 'opinion poll' among people who for the most part are neither experts on the KE nor on the role of critical thinking skills in education. Furthermore, this being a small-scale research project, the method of documentary analysis provided a cost-effective method of collecting data and allowed for the extensive examination of vast amounts of information held in the documents that were consulted for this study. Additionally, the method that was employed to analyse the documents which were consulted for this study (i.e. past examination papers) has the necessary scientific rigour, coherence and consistency to produced data that is valid and reliable.

It must be acknowledged, however, that the approach adopted for this study has inherent limitations. The main weakness of this approach is that some of the documents used as sources of data comprised secondary data which was produced for purposes which were not specific to the aims of the investigation. The other weakness with the data collection method adopted for this study is that subjective judgements have been made with regard to the choice the subjects which have been analysed; only two subjects could be dealt with given the scale of the research. So it can be difficult to defend the credibility of the generalizations made from the findings of the research.

1.6   Delimiting the study

Firstly, although there is a perception in Zambia today that Grade 12 school leavers have a below-par competence in the critical thinking skills of analysis, evaluation and creation and that this is caused by the ineffective assessment of these skills by the ECZ, it does not follow that ineffective assessment is the only factor that has led to this phenomenon. Indeed there are several other variables in the Zambian educational system which could be responsible for the perceived low competence in critical thinking skills in Grade 12 school leavers. These include, among others, pre-service and in-service training of teachers which

places very little emphasis on critical thinking skills, pedagogical approaches which focus on memorisation and rote learning, and a weak emphasis on the development of critical thinking skills in the Zambian secondary school curriculum. Investigating all these variables and their impact on the development of critical thinking skills is not a plausible undertaking and is beyond the scope of this research.

To bring focus to the study, therefore, the research was narrowed down to an investigation of only one aspect of the Zambian educational system: the GCE 'O' Level examinations and whether or not they are supporting the development of critical thinking skills of analysis, evaluation and creation in Grade 12 (Form 5) school leavers given the backdrop of the KE. The focus of this study is on grade 12 school leavers because they form the cadre that goes into tertiary institutions such as universities. Also, given the fact that there are limited number of places at tertiary level since the Zambian educational system is pyramidal, most of the Grade 12 School Leavers find themselves on the streets.

Secondly, critical thinking is a neat concept on paper, but in real life it is entangled with a host of other skills, both cognitive and affective. Isolating critical thinking skills is desirable from a research and academic point of view, but is not possible in real life. Many aspects ascribed to critical thinking skills, or used to identify it, overlap with other human traits. We can, therefore, only approximate the object of investigation.

Thirdly, Bloom's theory, upon which this study is based, suggests that cognitive skills can be put into neat, cut-and-dried categories which do not overlap. In reality, the distinctions between these categories are artificial because solving any cognitive task may involve a number of cognitive skills. Additionally, Bloom proposes three domains of learning objectives: cognitive, affective and psychomotor. However, the distinction between "cognitive" and "affective" in particular can be artificial. By affective, Bloom refers to such things as feelings, beliefs and attitudes. The implication is that our knowledge cannot be affected by our feelings, attitudes and beliefs. In reality there is no knowledge which cannot be influenced by our beliefs and feelings; also, these beliefs, feelings and attitudes are there in the first place because of our knowledge.[36] In view of this, therefore, the

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36   Van Dyk J 1997 Letters to Lisa: Conversations With a Christian Teacher

categorisation of cognitive skills into distinct classes and distinction between cognitive and affective are only an approximation in order to simplify the analyses carried out in this study.

Fourthly, given the fact that the notion of knowledge economy is a contested concept and as such there is no single coherent theory or perspective on it, the research does not attempt a definitive analysis of all the arguments, claims and perspectives on the concept. The research is limited to only providing a brief description of the phenomenon by means of synthesising different and sometimes conflicting views in order to provide a background for the study.

1.7   Thesis layout

The structure of the thesis is as follows:

Chapter 2: Knowledge Economy and Globalisation

The chapter gives a fuller description of the knowledge economy and globalization.

Chapter 3: Bloom's Taxonomy and Critical Thinking

This chapter gives a description of Bloom's Taxonomy and Critical thinking in order to make the theoretical framework for the study visible.

Chapter 4: Case Analysis and Method

This chapter describes the chosen research method and demonstrates how the measuring instrument based on the revised Bloom's Taxonomy was applied to the analysis of examination papers.

Chapter 5: Findings of the Analysis

The discussion includes data analysis and interpretation, specific techniques employed and reasons for such strategies. In this chapter, data is organised and presented in various formats.

Chapter 6: Towards Developing Critical Thinking Skills

This is the final chapter and it discusses the findings, makes recommendations, and concludes the study.

Chapter 2

The Knowledge Economy and Globalisation

2.1   Introduction

This chapter gives an overview of the main features of the Knowledge Economy (henceforth abbreviated as KE) and its characteristics. The aim is to provide a theoretical foundation for one of the key variables of the study in order to allow a better understanding of the research. The KE is the global context in which the educational systems of the future will have to operate and it is expected that the Zambian educational system should endeavour to impart to students the skills necessary to effectively participate in it.

2.2   The notion of the knowledge economy

The KE is a multi-faceted phenomenon whose contours are still emerging. In the KE, the application of knowledge replaces capital, raw materials and labour as the main factors of production. In this KE, the productivity and competitiveness of firms or nations fundamentally depend upon their capacity to create, process and apply knowledge in order to gain competitive advantage over others.[37] This "knowledge productivity"[38] involves

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37 Castells M 2000 The Rise of the Network Society

38   Castells M 2000 The Rise of the Network Society

generating and sharing new knowledge as well as applying this new knowledge to the improvement and innovation of products, processes and services. In the KE, wealth and prosperity depend on people's capacity to be more innovative and creative than others, and to change jobs or develop new skills as economic fortunes change. Against this background, the most essential skills that citizens needed in the contemporary knowledge economy are not the ability to memorise and regurgitate subject content but higher-order skills like critical thinking along with discipline-specific knowledge and skills. In particular, workers need the critical thinking skills of analysis, creation and evaluation because these can help them to be more creative and innovative.

Since the end of the first decade of the twenty-first century, the terms 'knowledge economy' and 'knowledge society' have become everyday terms in scientific discourses, in national and transnational politics and in many other institutions.[39] Despite the fact that these terms are now pervasive, they remain contested concepts in the academia from which they originated.[40]This is because these terms are open to several interpretations because there is still no single comprehensive and coherent theory on the notion of the knowledge economy.

The term knowledge economy is a term that refers either to an economy of knowledge focused on the production and management of knowledge or to a knowledge-based economy.[41] In the second, more frequently used meaning, it refers to use of knowledge and knowledge technologies (such as Knowledge Management) to produce economic benefits as well as job creation. According to Castells,[42] the KE is an economy in which the "productivity and competitiveness of units or agents in it (be it firms, regions, or nations) fundamentally depend upon their capacity to generate, process, and efficiently apply knowledge-based information." The knowledge-based economy is a strongly inter-displinary economy involving economists, computer scientists, engineers, mathematicians, librarians, geographers, chemists and physicists as well as cognitivists, psychologists and

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39   Stehr N and Jason L. Mast in Rooney D et al (eds) Handbook on the Knowledge Economy

40   Stehr N and Jason L. Mast in Rooney D et al (eds) Handbook on the Knowledge Economy

41   www.en.m.wikipedia.org (lasted accessed 10/10/2015)

42   Castells M 2000 The Rise of the Network Society

sociologists.

Observers describe today's global economy as one in transition to a "knowledge economy" as extension of an "information society". This description suggests that the rules and practices that assured success in the industrial economy need re-formulating in a networked, globalised economy where knowledge resources such as "know-how" and "expertise" are as critical as other factors of production such as labour and capital.[43]

2.3   A brief historical perspective on the knowledge economy

According to Hargreaves[44], theories of the KE became widespread and were enunciated in response to the observation that the 'industrial society' was undergoing deep transformation. In academic discourse, a number terms were used to aptly describe the social and economic order that was emerging from about 1950 up to the close of the twentieth century. Some of these include: the 'affluent society' by John K.Galbraith [45], the 'post-industrial society' by Daniel Bell[46], 'neo-capitalism'[47], the 'risk society' by Ulrich Beck[48] and the 'network society' by Manuel Castells[49] .

Daniel Bell was the first person to use the phrase *knowledge society* to describe the emerging social and economic realities.[50] He predicted an economic change, from an industrial economy in which people for the most part used manual labour to produce things, to a post-industrial economy in which the bulk of the workforce deals with ideas and is concentrated in the services and communication sectors.

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43 www.en.m.wikipedia.org (lasted accessed 10/10/2015)

44 Hargreaves A 2003 Teaching in the Knowledge Society: Education in the Age of Insecurity

45 Galbraith J K 1958 The Affluent Society in Hargreaves A Teaching in the Knowledge Society: Education in the Age of Insecurity

46 Bell D 1973 The Coming of Post-Industrial Society: A Venture in Social Forecasting in Hargreaves A Teaching in the Knowledge Society: Education in the Age of Insecurity

47 Beck U 1992 Risk Society: Towards a New Modernity in Hargreaves A Teaching in the Knowledge Society: Education in the Age of Insecurity

48 Beck U 1992 Risk Society: Towards a New Modernity in Hargreaves A Teaching in the Knowledge Society: Education in the Age of Insecurity

49 Castells M 2000 The Rise of the Network Society

50 Bell D 1973 The Coming of Post-Industrial Society: A Venture in Social Forecasting in Hargreaves A Teaching in the Knowledge Society: Education in the Age of Insecurity

Bell predicted that this paradigm shift in the socio-economic realm would be increasingly dependent on research and development as well as people and institutions with scientific expertise. "The post-industrial society," he said, "is

> a knowledge society in a double sense: first, the sources of innovation are increasingly derived from research and development...second, the weight of the society-measured by a larger proportion of Gross National Product and a larger share of employment-is increasingly in the knowledge field."[51]

Bell also predicted a concomitant rapid expansion of the educational sphere so that, "by the year 2000, the United States will have become...a mass knowledge society," with large rates of enrolment in higher education.[52]

Bell's "prophecy" was partly correct. In the United States there continues to be expanding access to public education, higher education and adult education. Young people in increasing numbers are postponing entry into full-time paid employment and careers in order to attend tertiary education. What remains an open question, however, is whether this phenomenon is a precursor of a better knowledge society.[53]

Peter Drucker[54] has propagated this newer, more prevalent concept of the knowledge society. According to him, knowledge is the basic factor of production and not capital or labour. Knowledge when applied to work in the form of "productivity" and "innovation" is central to creating value. In the knowledge society, "knowledge workers" who work with their heads to produce ideas are the most dominant group.

 Manuel Castells[55] utilises the term "informational society" to summarise this emerging social and economic order. According to Castells, the world is *informational* "because the

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51   Bell D 1973 The Coming of the Post-Industrial Society: A Venture in Social Forecasting page 212 in Hargreaves A 2003 Teaching in the Knowledge Society: Education in the Age of Insecurity

52   Bell D 1973 The Coming of the Post-Industrial Society: A Venture in Social Forecasting page 242 in Hargreaves A 2003 Teaching in the Knowledge Society: Education in the Age of Insecurity

53   Hargreaves A 2003 Teaching in the Knowledge Society: Education in the Age of Insecurity

54   Drucker PF 1969 Age of Discontinuity: Guidelines to our Changing Society in Hargreaves A Teaching in the Knowledge Society: Education in the Age of Insecurity

55   Castells M 2000 The Rise of the Network Society

productivity and competitiveness of units or agents in this economy (be it firms, regions or nations) fundamentally depend upon their capacity to create, process and apply knowledge in order to gain competitive advantage over others."[56] Productivity in the informational society is dependent on knowledge creation, information processing and its dissemination. Additionally, he argues that the information society is *global* and *networked*. The knowledge economy is "global on account of the fact that the core activities of production, consumption, circulation, as well as their components (i.e. capital, labour, raw materials, management, information and technology markets) are organised on a global scale, either directly or through a network of linkages between economic agents."[57] According to Castells, a *global* economy "is an economy with the capacity to work as a unit in real time on a planetary scale."[58] This co-operation has been made possible by ICT infrastructure along with the deregulation and liberalisation policies adopted by both national governments and international institutions.[59] Lastly, the world economy is *networked* because under the present conditions, productivity is aided by a global network of interaction between business networks.[60]

It is widely believed that one of the most significant developments that led to the creation of a Knowledge Economy was the demise of the Soviet Union and Communism as a dominant economic and political ideology, along with a rise in Capitalism. Manuel Castells attributes this phenomenon to the failure of the command economic system to manage the transition to the Knowledge Economy.[61] The collapse of the Soviet Union tipped the balance of power towards those embracing democratic values and free-market economies.[62] It also led people to view the world as a single community.[63]

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56   Castells M 2000 The Rise of the Network Society page 77
57   Castells M 2000 The Rise of the Network Society page 77
58   Castells M 2000 The Rise of the Network Society page 77
59   Castells M 2000 The Rise of the Network Society
60   Castells M 2000 The Rise of the Network Society
61   Castells M 1999 End of Millennium
62   Friedman T L 2006 The World is Flat
63   Friedman T L 2006 The World is Flat

The other development that led to creation of the Knowledge Economy was the advent of the information technology revolution which began in the early 80's following the pioneering release of the Personal Computer (PC).[64] The PC removed the limit on the information that any single individual could accumulate, generate or disseminate and facilitated the digital representation of all forms of expression including words, music, numeric data and photos.[65] Telecommunications infrastructure and computer-networking technologies also created a further platform for information technology revolution and the knowledge economy. Dial-up modems and the linking of PC's to telephones enabled people to send emails and faxes and led to the diffusion of PC's. PC's were connected to a global network in the late 80's and early 90's, setting the stage for the Information Age.[66] This was made possible by a series of events which included the emergence of the internet and the launching of the World Wide Web that allowed the sending of digital content to any place in the world at little cost.[67] The World Wide Web was first created by Tim Berners-Lee, the British computer scientist. He and his co-workers also created a system of coding and organising information called hypertext markup language (HTML) which enhanced internet flexibility. This was in addition to a hypertext transfer protocol (HTTP) that facilitated communication between web browsers and web servers and a standard addressing system, the uniform resource locator (URL) that gave each website a unique location.[68]

 All these developments, together with the advent of internet browsers and the over-investment in fibre-optic cable driven by the huge demand for digital products, combined to wire the world together and to set the stage for globalisation, which is the main driver of the KE.[69]

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64   Friedman T L 2006 The World is Flat
65   Friedman T L 2006 The World is Flat
66   Friedman T L 2006 The World is Flat
67   Friedman T L 2006 The World is Flat
68   Friedman T L 2006 The World is Flat
69   Friedman T L 2006 The World is Flat

2.4 Characteristics of the Knowledge economy

The new economy (the KE) has characteristics which are quite distinct from the industrial economy. To begin with, the KE is knowledge intensive, and unlike the industrial economy, is based on the perspective that knowledge is the main resource for development and not capital and labour. Indeed, the emergence of the KE can be characterised in terms of the increasing role of knowledge as a factor of production.[70] In the new economy only a small percentage of the value of companies can be traced to tangible assets. The rest comes from such intangible knowledge assets as work-force skills, culture, speed, flexibility, technologies and so forth.[71] The KE relies mostly on the diffusion of knowledge, use of knowledge and creation of new knowledge. The KE has led to an enormous increase in the codification of knowledge. It has also brought about the digitalisation of information. Increasing codification of knowledge leads to shortages of tacit knowledge because of a shift in the balance of the stock of knowledge.[72] This codification also promotes a shift in the organisation and structure of production. Information and communication technologies (ICT) increasingly favour the diffusion of information.[73] In consumption, knowledge is not necessarily exhausted. Codification produces a convergence, and bridges different areas of competence. It also reduces the knowledge dispersion and increases the speed of turnover of the stock of knowledge.[74] The innovation system and its knowledge distribution power are critically important. The increased rate of codification and collection of information lead to a shift in focus towards tacit skills.[75] Learning is increasingly central for both people and organisations. Learning organisations are increasingly becoming networked organisations, since initiative, creativeness, problem solving and openness to change are becoming more and more important skills with networked organisations.[76] The

70   Houghton J and Sheehan P 2000 A Primer on the Knowledge Economy

71   Magalhaes R 2004 Organizational Knowledge and Technology

72   Houghton J and Sheehan P 2000 A Primer on the Knowledge Economy

73   Houghton J and Sheehan P 2000 A Primer on the Knowledge Economy

74   Houghton J and Sheehan P 2000 A Primer on the Knowledge Economy

75   Houghton J and Sheehan P 2000 A Primer on the Knowledge Economy

76   Houghton J and Sheehan P 2000 A Primer on the Knowledge Economy

transition to a knowledge-based system may make failure systemic. A knowledge-based economy is so fundamentally different from the resource-based system of the last century that conventional economic understanding must be re-examined.[77] Traditional economics is founded on a system that seeks to optimise the efficient allocation of scarce resources. But, because of the unique characteristics of information and knowledge, the very meaning of scarcity is changing. Indeed, scarcity that defies expansiveness of knowledge is the root of one of its most important defining features. Once knowledge is discovered and made public, there is, essentially, zero marginal cost to adding more users.

Knowledge does not wear out. People can replicate it practically without cost. It is a source of super-value and super-productivity. Knowledge can increase value without diminishing it somewhere else. Ideas and innovations have extensive externalities. Their benefits typically extend well beyond those who first put them forward, and it can be difficult to exclude other potential users of knowledge through intellectual property rights. In the knowledge economy, there are new ground rules. Knowledge has fundamentally different characteristics from ordinary commodities. These differences have crucial implications for the way knowledge economy must be organised. The whole nature of economic activity and our understanding is changing. Ideas and information exhibit very different characteristics from the goods and services of the industrial economy. In the case of innovation, ideas and information become contrary to the industrial economy, which would seem largely to be the case. While up-front development costs can be very high, the cost of reproduction and transmission of information and ideas is low.

In addition to the centrality of knowledge in the KE, the skills and competencies required in the workplace are different from those required in the traditional economy. In the industrial economy, only routine jobs requiring low-level skills like the ability to memorise subject content were present. By contrast, work in the KE demands human qualities like creativity, problem solving, critical thinking and learning how to learn alongside academic-specific knowledge and skills.

There are quite a few characteristics associated with the emerging knowledge economy.

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77   Houghton J and Sheehan P 2000 A Primer on the Knowledge Economy

Some of the more dominant ones are covered below.

The first disturbing feature of the knowledge-based economy is the increasing evidence of the polarisation of nations in economic terms. For example, in Zambia, there is a widening gap between the wealthy and the poor. Countries appear to be moving to two poles, one at high incomes, and the other at relatively low incomes. This polarisation of countries into different groups in terms of economic well-being and of living standards is becoming both more pronounced and persistent. Many observers contend that increasing inequality can be observed at international, national, regional, household and personal levels; that the rich are getting richer, while the poor are getting poorer.

Some economists predict that increasing returns from network economies and learning economies, characteristic of knowledge economies, will lead to the uneven distribution of industrial activity. They contend that the wealthy north will have the lion's share of industrial activity. Others contend that the expansion of the knowledge-driven economy will create a proliferation of material, cities and activities at all points and at all levels, suggesting that no one can expect to enjoy the continued control of markets. That the knowledge economy is experiencing the development of new business models proves to be true.

Another unsettling issue associated with the knowledge economy could be called the 'end of work thesis'[78] Rifkin[79] that posits that the rise of the knowledge society will radically decrease opportunities for gainful employment for the vast majority of workers. The more productive the workforce is in the knowledge society, the thesis argues, the fewer the opportunities for gainful employment. Other observers contend that we are nearing the end of the working society as we know it. There is some empirical evidence to support this perspective. The Panorama recently published findings of a study conducted by Deloitte and Oxford University showing that about 800, 000 jobs have been lost in the UK in the past 15 years because they have been replaced by computers or machines with human-like

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78   Rifkin J 1995 The End of Work: The Decline of the Global Labour Force and the Dawn of the Post Market Era in Rooney D et al (eds) Handbook on the Knowledge Economy

79   Rifkin J 1995 The End of Work: The Decline of the Global Labour Force and the Dawn of the Post Market Era in Rooney D et al (eds) Handbook on the Knowledge Economy

cognitive abilities.[80] There is much statistical data, however, which contradicts this perspective; empirical evidence shows that in the European Union (EU), at least, the percentage of the population getting into gainful employment is increasing.[81]

The third disturbing feature is the negative impact of the knowledge economy on professionals. As work becomes more and more dependent on knowledge skills, those with the required skills should be able to find stable employment. However, as knowledge-based productivity increases and as automation becomes the norm, the need for professionals to upskill or reskill becomes more necessary and urgent. In the knowledge economy professionals must approach education and the acquisition of knowledge as a life-long undertaking and not as a one-off investment. Put differently, while the knowledge economy may create room for more professionals, it also threatens workers with the potential of becoming outdated and irrelevant and thus demands that they refresh their skills frequently. This implies that workers must learn how to learn.

Lastly, the transformation of society to the knowledge economy will alter the typical workday and calendar, and redefine the traditional industrial era boundary between work life and the private sphere. With the advent of the internet and World Wide Web workers can even do their work tasks from their homes.

2.5 Globalisation

The KE is global. In fact, globalisation is the main driver of the KE. A global economy is an economy in which the different economic agents like corporations and nations have the capacity to work as a unit in real time on a planetary scale.[82] The world is able to operate as a global economy because of new infrastructure afforded by information and communication technologies and the decisive help of liberalisation and de-regulation policies implemented by governments and international institutions. According to one definition, globalisation refers to a multidimensional set of social processes that create, multiply, stretch and intensify worldwide social interdependences and exchanges, while at

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80   www.independent.co.uk (accessed on 19/09/2015)

81   Rifkin J 1995 The End of Work: The Decline of the Global Labour Force and the Dawn of the Post Market Era in Rooney D et al (eds) Handbook on the Knowledge Economy

82   Castells M 2000 The Rise of the Network Society

the same time fostering in people a growing awareness of deepening connections between the local and the distant.[83]

Globalisation is a set of social processes that are thought to transform our present social conditions into one of *globality*. Globality is a social condition characterised by the existence of global economic, political, cultural and environmental interconnections that make many of the currently existing borders and boundaries irrelevant.[84]

The four characteristics according to Steger[85] of globalisation are:

-The creation of new and multiplication of existing social networks and activities that increasingly overcome traditional political, economic, cultural and geography boundaries.

-The expansion and stretching of social relations and interdependencies. This is in seen in the making of certain products whose components are manufactured in different countries.

-The intensifying and accelerating of social exchanges. For example, via the internet and satellites, real-time pictures to consumers. Local happenings are shaped by events occurring miles away and vice-versa.

-Makes people increasingly aware of growing manifestations of social interdependencies.

It can be argued that the diffusion of information and knowledge has increased dramatically due to globalisation and the new ICTs. The new knowledge, or innovation, that formerly took years or months to spread, is now globally available in seconds.[86] This process speeds up new knowledge creation. This has caused the crucial ability to select and interpret new information and knowledge, and to turn it into profitable activities.

The KE is a network economy. The increase in availability of knowledge and information makes it impossible for individuals or a single company to master all the disciplines, and

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83   Steger M B 2003 Globalization: A Very Short Introduction
84   Steger M B 2003 Globalization: A Very Short Introduction
85   Steger M B 2003 Globalization: A Very Short Introduction
86   Berg L and Winden W 2004 Cities in the Knowledge Economy: New Governance Challenges

also make it difficult to monitor the latest developments. This results in an engagement in strategic networks to be crucial. Networks enable organisations to respond faster in rapidly changing markets and technologies. This becomes conducive to creativity producing new combinations.[87] All areas of business and community life were in a position to experience this revolution. In the internet, these technologies converged.[88] The phenomenon of the internet exemplifies the information revolution.[89] For example, during the first decade of its development, the internet remained a specialist research network.[90] By 1989, there were 159 000 internet hosts worldwide and, ten years later, there were more than 43 million.[91]

2.6 Conclusions

From this chapter it can be seen that the notion of the KE and other concepts associated with it, are still not uniformly understood. This is not only due to conceptual differences, but also due the fact that the KE is still emerging.

However, this does not mean that we cannot identify core features of the KE. Nor does it mean that education systems may continue as if there is no KE emerging.

The chapter also traced the events that set the stage for the new world order and served as precursors of the KE. It was observed that the most important events that set the stage for the KE were the discovery of the personal computer and the linking of these devices to form a global network enabling the seamless flow of information.

For the purposes of this thesis the KE can be described as the integrated application of advanced knowledge and skills – both in people and in systems - to produce economic benefits. The KE is, therefore, very far removed from an economy which is based on human physical labour, where typically economic benefits were produced through repetitive practices that could be learnt very quickly. The KE requires people and systems that adapt quickly and creatively.

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87   Houghton J and Sheehan P 2000 A Primer on the Knowledge Economy
88   Houghton J and Sheehan P 2000 A Primer on the Knowledge Economy
89   Houghton J and Sheehan P 2000 A Primer on the Knowledge Economy
90   Houghton J and Sheehan P 2000 A Primer on the Knowledge Economy
91   Houghton J and Sheehan P 2000 A Primer on the Knowledge Economy

It is in this context that critical thinking skills become crucial and the question arises to what extent the present education system prepares young people for such an economy.

Chapter 3

Bloom's Taxonomy and Critical Thinking

3.1   Introduction

In this chapter the theoretical foundations of the study are discussed. The chapter begins with a discussion of the Bloom's Taxonomy, a theory which is used not only as a tool for setting educational objectives but also for analysing past exam papers. This chapter also explores critical thinking and how it can be incorporated in examinations. These constitute a conceptual framework that will facilitate and contribute to data analysis, findings and conclusions of this study.

3.2   The Original Bloom's Taxonomy

Bloom's Taxonomy of educational objectives is a classification scheme of learning objectives which was proposed in 1956 by Benjamin Bloom and others.[92] The publication was the result of a series of conferences from 1949 to 1953, which were designed to

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92   Bloom B S et al 1956 Taxonomy of Educational Objectives: The Classification of Educational Goals; Handbook I: Cognitive Domain

improve cooperation between educators on the design of curricula and examinations.[93] The Taxonomy met the need that educators felt for a theoretical framework which could not only be used to facilitate the exchange of test materials and ideas about testing among themselves but also to stimulate research on testing and on the relationship between testing and education.[94] It was agreed that such a theoretical framework might best be obtained through a system of classifying educational objectives, since these provide the basis for developing curricula and tests and can act as a starting point for much of our educational research."[95]

The Bloom's Taxonomy of Educational Objectives was published in 1956. The revision of this framework was developed in much the same manner 45 years later by Krathwohl.[96]

Bloom's Taxonomy divides educational objectives into three "domains": Cognitive, Affective, and Psychomotor (sometimes loosely designated as *knowing/head*, *feeling/heart* and *doing/hands* respectively). The categories were ordered from simple to complex and from concrete to abstract. Within the domains, learning at the higher levels is dependent on having attained prerequisite knowledge and skills at lower levels.[97]

In the cognitive domain, the learning objectives are hierarchically organized into six major classes. Intellectual skills are seen as developing in the following order, from lowest to highest:

- knowledge- the ability to identify, define, recall and recognize
- comprehension-the ability to explain, restate, and demonstrate
- application-the ability to apply, generalize, organize, and restructure knowledge
- analysis-the ability to categorize, distinguish, deduce, and compare

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93   Krathwohl D R et al 2000 A Taxonomy for Learning, Teaching, and Assessing: A Revision of Bloom's Taxonomy of Educational Objectives

94   Krathwohl D R et al 2000 A Taxonomy for Learning, Teaching, and Assessing: A Revision of Bloom's Taxonomy of Educational Objectives

95   Bloom B S 1994 Reflections on the development and use of the Taxonomy in Anderson L W and Sosniak L A (eds.) Bloom's Taxonomy: A Forty-Year Retrospective.

96   Krathwohl D R et al 2000 A Taxonomy for Learning, Teaching, and Assessing: A Revision of Bloom's Taxonomy of Educational Objectives

97   Krathwohl D R et al 2000 A Taxonomy for Learning, Teaching, and Assessing: A Revision of Bloom's Taxonomy of Educational Objectives

- synthesis-the ability to produce, develop, write, and tell
- evaluation-the ability to justify, judge, argue, and assess[98]

A schematic representation of the original Bloom's Taxonomy is given in the figure below:
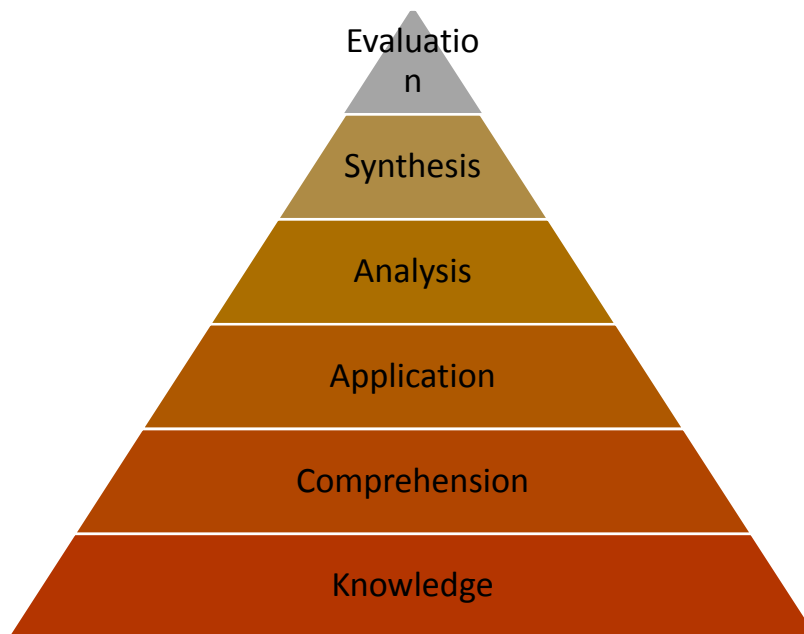
Figure 2 *Schematic representation of the original Bloom's Taxonomy*

Skills in the cognitive domain revolve around knowledge, comprehension, and critical thinking on a particular topic. Traditional education tends to emphasize the skills in this domain, particularly the lower-order objectives.

There are six levels in the cognitive domain, moving through the lowest order processes to the highest:

3.2.1 Cognitive Domain: Knowledge

In the original Taxonomy, knowledge is defined as the remembering of previously learned material.[99] This may involve the recalling of facts, terms, or complete theories. All that is

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98   Simpson D and Toyn M 2011 Primary ICT Across the Curriculum

99   Bloom B S et al 1956 Taxonomy of educational objectives: the classification of educational goals; Handbook I: Cognitive Domain

required is the bringing to mind of the appropriate information. Knowledge represents the lowest level of learning outcomes in the cognitive domain. Knowledge can be categorized into:

- Knowledge of terminology, specific facts
- Knowledge of conventions, trends and sequences, classifications and categories, criteria, methodology
- Knowledge of principles and generalizations, theories and structures[100]

Questions testing knowledge begin with terms like: what, define, describe, identify, label, list, match, name, outline, reproduce, select or state.[101]

3.2.2 Cognitive Domain: Comprehension

Comprehension can be defined as the ability to grasp the meaning of material.[102] This may be demonstrated by organizing, comparing, translating, interpreting, giving descriptions, and stating the main ideas. These learning outcomes go one step beyond the simple remembering of material. According to Krathwohl[103], comprehension involves translation, interpretation and extrapolation.

Questions testing comprehension usually begin with terms like: convert, defend, distinguish, estimate, explain, extend, generalize, give examples, infer, paraphrase, predict, rewrite and summarize.[104]

3.2.3 Cognitive Domain: Application

Application refers to the use of learned material in new and concrete situations. This may include the application of such things as rules, techniques, concepts, principles, laws and theories to solve problems in new situations. Learning outcomes in this area require a

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100 Krathwohl D R 2002 A Revision of Bloom's Taxonomy: An Overview *Theory into Practice* 41(4):212-218

101 Matiru B et al (eds) 1995 Teach Your Best: A Handbook for University Lecturers

102 Bloom B S *et al* 1956 Taxonomy of Educational Objectives: The Classification of Educational Eoals; Handbook I: Cognitive Domain

103 Krathwohl D R 2002 A Revision of Bloom's Taxonomy: An Overview *Theory into Practice* 41(4):212-218

104 Matiru B. et al (eds) 1995 Teach Your Best: A Handbook for University Lecturers

higher level of understanding than those under comprehension.[105]

Questions testing application usually begin with such terms as: change, compute, demonstrate, discover, manipulate, modify, operate, predict, prepare, produce, relate, show, solve and use.[106]

3.2.4 Cognitive Domain: Analysis

Analysis refers to the process of looking closely at different aspects/parts of a whole in order to determine its overall worth or effectiveness. Analysis may include the identification of the parts, the analysis of relationships between the parts, and the recognition of the organizational principles involved.[107] Learning outcomes here represent a higher intellectual level than comprehension and application because they require an understanding of both the content and the structural form of the material.[108]

Questions testing analysis skills usually begin with such terms as: differentiate, discriminate, distinguish, identify, illustrate, infer, outline, point out, relate, select, separate, and subdivide.[109]

3.2.5 Cognitive Domain: Synthesis

Synthesis or creation refers to the ability to put parts together to form a new whole.[110] Information is compiled together in a different way by combining elements in a new pattern or proposing alternative solutions. According to Nonaka[111], synthesis is the combination of multiple bodies of information to create new, more complex sets of knowledge.

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105 Bloom B S et al 1956 Taxonomy of Educational Objectives: The Classification of Educational Goals; Handbook I: Cognitive Domain

106 Matiru B. et al (eds) 1995 Teach Your Best: A Handbook for University Lecturers

107 Bloom B S et al 1956 Taxonomy of Educational Objectives: The Classification of Educational Goals; Handbook I: Cognitive Domain

108 Bloom B S et al 1956 Taxonomy of Educational Objectives: The Classification of Educational Goals; Handbook I: Cognitive Domain

109 Matiru B. et al (eds) 1995 Teach Your Best: A Handbook for University Lecturers

110 Bloom B S et al 1956 Taxonomy of Educational Objectives: The Classification of Educational Goals; Handbook I: Cognitive Domain

111 Nonaka I 1994 A Dynamic Theory of Organizational Knowledge Creation *Organizational Science* 5(1): 14-37

Synthesis can be demonstrated by:

- Production of a unique communication
- Production of a plan, or proposed set of operations
- Derivation of a set of abstract relations[112]

Questions testing synthesis usually begin with such terms as: categorize, combine, compile, compose, create, devise, design, generate, modify, organize, plan, rearrange, reconstruct, relates, reorganize, revise, rewrite, summarize, tell, and write.[113]

3.2.6 Cognitive Domain: Evaluation

Evaluation is the ability to judge the value, worth or significance of material (statement, novel, research report) for a given purpose. The judgements are to be based on definite criteria. These may be internal criteria (organisation) or external criteria (relevance to the purpose).[114]

An example of a question testing this cognitive level is: Do you feel that corporal punishment should be encouraged in schools?

Questions testing this cognitive level usually start with terms like: evaluate, judge, appraise and assess[115]

3.3 The Revised Taxonomy

In the 1980's there was an emphasis on the teaching of higher order thinking skills in light of the poor performance of students on questions requiring thinking and application skills. This phenomenon, along with the research and theory on the nature of knowledge and cognition, raised awareness as to the need to revise the Taxonomy.

A revised version of the Taxonomy was created in 2001. The original number of categories in the cognitive domain, six, was retained, but important changes were made. Three

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112 Krathwohl D R 2002 A Revision of Bloom's Taxonomy: An Overview *Theory into Practice* 41(4): 212-218

113 Matiru B. et al (eds) 1995 Teach Your Best: A Handbook for University Lecturers

114 Bloom B S et al 1956 Taxonomy of Educational Objectives: The Classification of Educational Goals; Handbook I: Cognitive Domain

115 Matiru B. et al (eds) 1995 Teach Your Best: A Handbook for University Lecturers

categories were renamed, the order of two was interchanged. The names of the categories which were retained were changed to verb form to match the way they are used in instructional objectives. The verb aspect of the original *Knowledge* category was renamed *Remember.* This because the term knowledge as used in this context has to do with remembering of things.[116]

Comprehension was renamed so that the class label would fit the way it was used by teachers in discussing their work. Because *understand* is a commonly used term in instructional objectives, its lack of inclusion did not sit well with educators and was a frequent source of criticism for the original Taxonomy. Indeed, the original developers of the Taxonomy considered using it, but decided against the idea because careful consideration showed that teachers did not know its precise meaning. However, the group that revised the Taxonomy felt that in popular usage *understand* was a prevalent synonym for comprehending. So, *Comprehension,* the second of the original classes in the cognitive domain, was renamed *understanding.*[117]

The labels *Application, Analysis,* and *Evaluation* were retained, but they were changed to their verb forms namely, *Apply*, *Analyse*, and *Evaluate. Synthesis* was renamed *Create* and changed places with *Evaluation*. All the original subcategories were replaced with gerunds, and called "cognitive processes."[118] With these changes, the categories and subcategories-cognitive processes-of the Cognitive Process dimension are as shown in Figure 3.

In the revised Taxonomy, 19 subcategories of the six major categories in the cognitive domain were identified and these were given more emphasis than the six major categories. These subcategories were termed specific cognitive processes. Indeed, the nature of the six

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116   Krathwohl D R 2002 A Revision of Bloom's Taxonomy: An Overview *Theory into Practice* 41(4): 212-218

117   Krathwohl D R 2002 A Revision of Bloom's Taxonomy: An Overview *Theory into Practice* 41(4): 212-218

118   Krathwohl D R 2002 A Revision of Bloom's Taxonomy: An Overview *Theory into Practice* 41(4): 212-218

major categories in the revised Taxonomy emerges most clearly from the descriptions of the specific cognitive processes. The revised Taxonomy, like the original one, is a hierarchy in the sense that the six major classes of the Cognitive domain are believed to increase in their complexity, with *remembering* being less complex than *understanding,* which is less complex than *applying,* and so on.[119] (See Fig 3 below).

However, in the revised Taxonomy the requirement to put the cognitive processes into neat, classes is relaxed and the categories are allowed to overlap one another. This is illustrated very clearly in the case of the category *Understanding.* Because its scope has been broadened over *Comprehending* in the original framework, some cognitive processes associated with *Understanding* (e.g., e*xplaining)* are more complex than at least one of the cognitive processes associated with **Applying** (e.g. *executing).* [120]

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119 Krathwohl D R 2002 A Revision of Bloom's Taxonomy: An Overview *Theory into Practice* 41(4): 212-218

120 Krathwohl D R 2002 A Revision of Bloom's Taxonomy: An Overview *Theory into Practice* 41(4): 212-218

Category	Sub-category

1.0 Remember
- 1.1 Recognising
- 1.2 Recalling

2.0 Understand
- 2.1 Interpreting
- 2.2 Exemplifying
- 2.3 Classifying
- 2.4 summarising
- 2.5 Infering
- 2.6 explaining

3.0 Apply
- 3.1 Executing
- 3.2 Implementing

4.0 Analyse
- 4.1 Differentiating
- 4.2 Organising
- 4.3 Attributing

5.0 Evaluate
- 5.1 Checking
- 5.2 Critiquing

6.0 Create
- 6.1 Generating
- 6.2 Planning
- 6.3 Producing
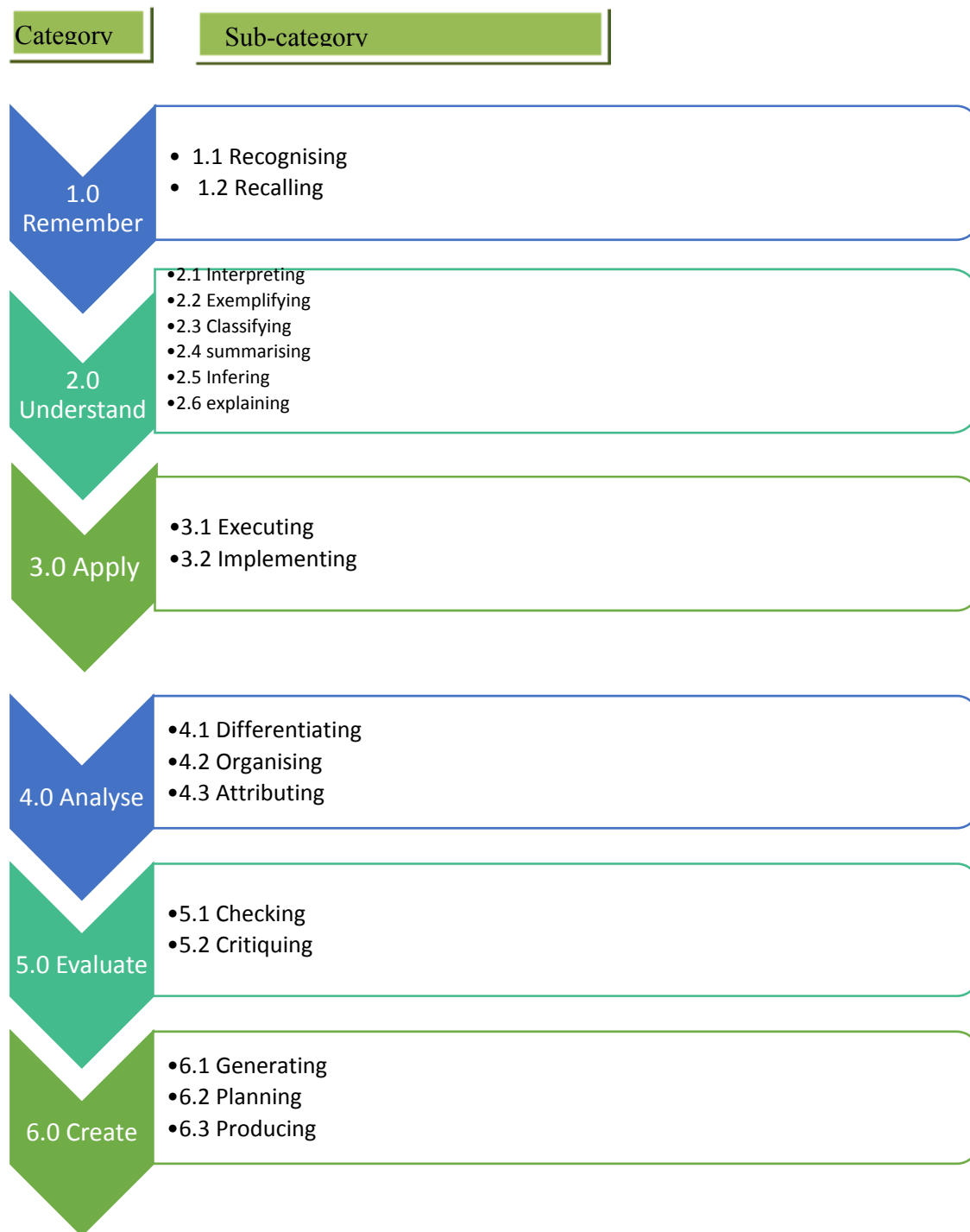
Figure 3: *Structure of the Cognitive Process Dimension of the Revised Taxonomy*[121]

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121 Krathwohl D R 2002 A Revision of Bloom's Taxonomy: An Overview *Theory into Practice* 41(4): 212-218

37
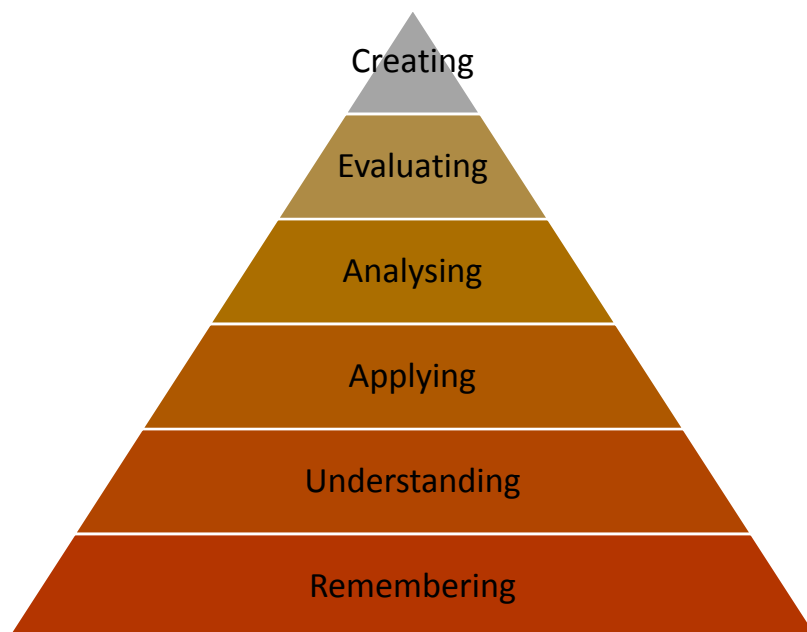
Figure 4 *Schematic representation of the revised Bloom's Taxonomy*

In the revised Taxonomy, the possibility of constructing a two-dimensional table called a Taxonomy table instead of a hierarchy of classes became apparent because any learning objective can be represented in two dimensions. The knowledge dimension, ranging from concrete (factual) knowledge to abstract (metacognitive) knowledge, would form the vertical axis of the table, whereas the Cognitive Process Dimension, a continuum of increasing cognitive complexity, would form the horizontal axis. The knowledge and cognitive process categories intersect and form cells. Consequently, any learning objective could be classified in one or more cells in the Taxonomy Table that correspond with the column(s) appropriate for categorising the verb(s) denoting the action to be measured and the row(s) appropriate for categorising the noun(s) in the objective.[122]

3.4   Revised Bloom's Taxonomy as an Interpretive Framework

The revised version of Bloom's Taxonomy, just like the original version, not only provides

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122   Krathwohl DR. 2002. A Revision of Bloom's Taxonomy: An Overview. *Theory into Practice* 41 (4): 212-218.

a theoretical framework for the classification of learning objectives but also a basis for developing tests and curriculum and, more importantly for the purpose of this research, a tool with which past examination papers can be analysed and evaluated. In other words, the revised Bloom's Taxonomy can be used to formulate an interpretive framework which can be used to evaluate past examination papers.

Bloom's Taxonomy gives a number of illustrative 'active' verbs that can be used for stating specific learning objectives for each level in the cognitive domain (and the psychomotor and affective domains) (see Figure 6). Active verbs such as 'write' or 'analyze' describe a measurable activity and these verbs are neither vague, nor open to various interpretations. Active verbs differ from 'static' verbs such as 'know' or 'understand' which describe a state and are open to many interpretations.[123] Examination content developers use active verbs as command or task words in questions designed to test a particular assessment objective. Assessment objectives describe the knowledge, skills and abilities students are expected to demonstrate at the end of a course. The task word used in a particular examination question gives an indication of what type of skill in the cognitive domain is being tested. If, for example, a question in an examination requires a student to "*describe* the purification of copper using electrolysis", it would be evident from the Taxonomy that the skill being tested is *remembering*. If, on the other hand, a question in an examination asks a student to "*suggest* an improvement to an experimental procedure", it would be mean that the skill of *evaluation* was being tested. It must be borne in mind, however, that meaning of the task word depends in part on the context in which they are used.

Cognitive Level	Illustrative Verbs for Stating Specific Learning Outcomes
Remembering	Define, describe, identify, label, list, match, name, outline, reproduce, select, state, recall, repeat, recite, arrange, order, relate
Understanding	Convert, defend, distinguish, estimate, explain, extend, generalise, give examples, infer, predict, rewrite, summarise

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123   Matiru M et al 1995 Teach Your Best: A Handbook for University Lecturers

Applying	Change, compute, demonstrate, discover, manipulate, modify, operate, predict, prepare, produce, relate, show, solve
Analysing	Break down, diagram, differentiate, compare, contrast, discriminate, distinguish, illustrate, infer, outline, point out, relate, select, separate, subdivide
Evaluating	Appraise, compare, contrast, conclude, criticise, describe, discriminate, explain, justify, interpret, relate, summarise, support
Creating	Categorize, combine, compile, compose, create, devise, design, explain, generate, modify, organise, plan, rearrange, reconstruct, relate, reorganise, revise, rewrite, summarise, tell, write

Figure 5: *Examples of verbs pointing to learning outcomes in the cognitive domain.*[124]

The list of verbs given in Figure 5 is neither definitive nor exhaustive and so a glossary giving a brief description of the terms used in the examination paper of interest could be consulted in the evaluation of some questions.

3.5   Critical Thinking

3.5.1 Definitions of Thinking and Thinking Skills

Bruner[125] defined *thinking* as the "*mental processes and acts of going beyond the information given*." Thinking has also been conceptualised as an activity of the mind in a human being. In their attempt to by-pass the involvement of the mind in the explanation of any deliberate action by any animate organism, behaviourists depicted such an action

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124   Matiru B et al 1995 Teach Your Best: A Handbook for University Lecturers

125   Bruner J S 1973 Going Beyond the Information Given.

simply in terms of Stimulus eliciting a Response[126], as follows:

Stimulus	→	Response

This is often the case with what is known as *reflex action*, such as the automatic withdrawal of the hand upon receiving a burning sensation on a fingertip after touching a hot object. Reflex action is involuntary. This was originally demonstrated in the experiments conducted by Pavlov on dogs, which were observed to involuntarily salivate (response) upon seeing food (stimulus).

However, in subsequent years, cognitive psychologists advocated the view that in human beings some form of mental processing (other than mere reflexes) intervenes between the advent of a stimulus and that of a response. Vocate postulates the existence of what he calls the Function Barrier (FB) and suggests that it is the source of such intervening processing.[127] The mental action model may thus be depicted as follows:

Stimulus	→	Function Barrier	→	Response

It is such mental processes that are referred to as *thinking* in our conceptualisation of the term here. This scenario illustrates what Bruner[128] refers to as (mentally) *going beyond the information given*.

3.5.2 Two Types of Thinking

Thinking can be categorized into two. These two categories of thinking are *cognition* and *meta-cognition*.

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126   Skinner B F 1953 Science and Human Behaviour

127   Vocate D 1987 The Functions of Spoken Language in the Development of Higher Mental Processes

128   Bruner J S 1973 Going Beyond the Information Given.

a) Cognition

In simple terms, *cognition* refers to the human ability to know.[129] It also refers to the *processes* of making sense of what is presented as a stimulus. In this type of thinking, the starting point of the thinking process is perceiving something physically; this means a stimulus is received by the neurological system through any of the sensory organs: eyes (sight), ears (sound), skin (touch), nostrils (smell), and tongue (taste). The process involves establishing *what it is* that the neurological system has received and contextualizing the perceived object in the repertoire of the knowledge gained from past learning (or experience). This type of thinking makes use of *ideas* stored in long term memory as *concepts*. These ideas, also referred to as *cognitive maps* or *cognitive schemata,* are mental representations of how the world works stored in the mind of an individual.[130] This type of thinking is termed *conceptual thinking*. People do not develop these cognitive maps in isolation, but in interaction with other individuals and so their understanding of the world is said to be *socially constructed*.[131] Conceptual thinking often comes after *perceptual thinking*, especially in children. Animals are thought to be incapable of conceptual thinking as they do not have a stock of concepts stored in the form of words and are unable to bring concepts back to the focal point of consciousness simply by recalling these words. Included in conceptual thinking are *logical reasoning* (either deductive or inductive), *remembering*, and *imagining* (either the past or the future).

It is of vital importance to clarify not only the distinction between perceptual thinking and conceptual thinking, but also the relevance of this distinction in order to clarify the focus of concern in our study; namely, the promotion of critical thinking skills in the young through appropriate assessment.

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129 De Wit B and Meyer R 1999 Strategy Synthesis: Resolving Strategy Paradoxes to Create Resolving Strategy Paradoxes to Create Competitive Advantage

130 De Wit B and Meyer R 1999 Strategy Synthesis: Resolving Strategy Paradoxes to Create Resolving Strategy Paradoxes to Create Competitive Advantage

131 Weick K E 1979 The Social Psychology of Organizing in De Wit B and Meyer R 1999 Strategy Synthesis: Resolving Strategy Paradoxes to Create Competitive Advantage

b) Perceptual Thinking

Perceptual thinking is the one that is basic to human beings and it is present in infants. This type of thinking happens in a concrete context in the very process of the context unfolding, and it often forms part of the very context that is unfolding. When a hungry lion sees a herd of buffaloes, its instinctive reaction is to want to kill one of them for food. But it has to think and decide upon a number of things, such as: *which particular one*, *how* to approach it, and *exactly when* to pounce. More often than not, the lion will choose the one which appears weak, and this entails scrutinizing the state of health or physique of the buffalo in question; the lion will rarely attack a very strong looking bull. It will also try to isolate the prey, knowing from past experience that other buffaloes might come to its rescue. The lion will choose the moment of attack very strategically, such as when the prey is the least alert, and it employs some mental judgement to decide *when exactly*.

In the case of a lion, knowing from past experience will not mean accessing concepts stored in long term memory in form of words, since it has no words. Rather, it will involve an automatic flash back into consciousness of the images of a buffalo tossing a lion into the air, as might have been registered onto the relevant cognitive map. Thus for a lion, knowing from past experience is part of perceptual thinking (which is thinking by the use of physical images mentally represented) and not conceptual thinking (which is thinking by the use of concepts stored in words).

Perceptual thinking is also found in human beings. The mental "gymnastics" described above in relation to a hungry lion stalking buffaloes often take place in the mind of many a human hunter, with the exception that the human being would most likely go for the fattest buffalo instead of the weakest or frail-looking one. It is important to stress that perceptual thinking involves decision making and the devising of deliberate strategies to solve a problem in the most effective manner in order to get the desired results efficiently and with the minimum amount of effort. These are valuable thinking skills for every child to acquire as preparation for life. In other words, the sort of teaching that will cultivate thinking skills in children is that which works to sharpen their perceptual thinking.

c) Conceptual Thinking

Conceptual thinking is the sort of thinking that uses for the most part the concepts attained or acquired through past experience or learning and stored in long term memory. Vygotsky[132] defines a concept as a unit idea abstracted from perceivable defining attributes and tagged by one word for mental storage. A human being is capable of either *reflecting on* (remembering) what went on at a certain point in time in the past, *imagining* what is going to happen at some point in time in the future, or indeed *planning* what should happen (and how it should happen) by making use of ideas stored in their long-term memory. As stated before, lower animals are believed to lack the capacities described above because they lack the words with which to call to consciousness the relevant concepts. Human beings are believed to be superior to animals at conceptual thinking precisely because they possess words to use to call to mind the ideas that are the grist for this sort of thinking. Nobody can dispute the value of this sort of thinking in human life. Therefore the sort of teaching that aims to truly prepare children for life ought to be that which can cultivate such skills in them.

Having established what thinking is and what it is entails, critical thinking can now be discussed. It has been established that everyone thinks; it is our nature to do so. But much of our thinking, left to itself, is biased, distorted, partial, uninformed or down-right prejudiced. Yet the quality of our life and what we produce, make, or build depends specifically on the quality of our thought. Sloppy thinking is costly, both in monetary terms and in the quality of life. However, excellence in thought does not come naturally to human beings; it must be systematically cultivated. Learning to think in critically analytical and evaluative ways means using mental processes such as attention, categorisation, selection and judgement.[133]

Dewey defines critical thinking as an "active, persistent and careful consideration of a belief or supposed form of knowledge in the light of the grounds which supports it and the further conclusions to which it tends."[134] Critical thinking has also been referred to as

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132 Vygotsky L S 1962 Thought and Language.

133 Cottrell S 2005 Critical Thinking Skills: Developing Effective Analysis and Argument

134 Dewey J 1909 How We Think: A Restatement of the Relation of Reflective Thinking in Educative Process

"reasonable reflective thinking focused on deciding what to believe or do."[135] It has also been described as "thinking about thinking."[136] The National Council for Excellence in Critical Thinking defines critical thinking as "the intellectually disciplined process of actively and skilfully conceptualizing, applying, analysing, synthesizing, and/or evaluating information gathered from, or generated by, observation, experience, reflection, reasoning, or communication, as a guide to belief and action".[137] More recently, critical thinking has been described as "the process of purposeful, self-regulatory judgement, which uses reasoned consideration to evidence, context, conceptualizations, methods, and criteria."[138] Within the critical social theory philosophical frame, critical thinking is commonly understood to involve commitment to the social and political practice of participatory democracy, willingness to imagine or remain open to considering alternative perspectives, willingness to integrate new or revised perspectives into our ways of thinking and acting, and willingness to foster criticality in others.[139]

 "Critical" as used in the expression "critical thinking" indicates the centrality of the thinking to an issue, question or problem of concern. "Critical" in this context does not have connotations of "disapproval" or "negativity." Critical thinking has many positive and important applications. For example, formulating a workable solution to a complex personal problem, deciding as a group on what course of action to take, or evaluating an argument and deciding whether or not it worthy of acceptance are all practical applications of critical thought. Richard Paul categorised critical thinking as either weak or strong.[140] The weak-sense critical thinker is a highly skilled but selfishly motivated pseudo-intellectual who works to advance one's personal agenda without seriously considering the

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135   Brookfield S D 2000 Contesting Criticality: Epistemological and Practical Contradictions in Critical Reflection

136   Ennis R H 1993 Critical Thinking Assessment. *Theory into Practice* 32(3): 179-186

137   Scriven M and Paul R W 1987 Critical Thinking as Defined by the National Council for Excellence in Critical Thinking

138   Raiskums B W 2008 An Analysis of the Concept Criticality in Adult Education

139   Facione P A 1992 A Critical Thinking: What It is and Why It Counts

140   Paul R W and Elder L 2007 Defining Critical Thinking. Available at www.criticalthinking.org/aboutCT/define_critical_thinking.cfm (accessed 06/10/2015)

ethical consequences and implications. Conceived as such, the weak-sense critical thinker is often highly skilled but uses those skills selectively so as to pursue unjust and selfish ends.[141] By contrast, the strong-sense critical thinker skilfully enters into the logic of problems and issues to see a problem for what it is without any egocentric and/or socio-centric bias. When conceptualised in this way, the strong-sense mind seeks to actively, systematically, reflectively, and fair-mindedly construct insight with sensitivity to expose and address the many obstacles that compromise high quality thought and learning. For example, using strong critical thinking we might evaluate an argument as worthy of acceptance because it is valid and based on true premises. Upon reflection, a speaker may be evaluated as a credible source of knowledge on a given topic.

Critical thinking occurs whenever one judges, decides, or solves a problem; in general, critical thinking is applied whenever one must decide what to believe or what to do, and how to do so in a reasonable and reflective way. Reading, writing, speaking, and listening can all be done critically or uncritically. Critical thinking is crucial to becoming a close reader and a substantive writer. Expressed in most general terms, critical thinking is "a way of taking up the problems of life."[142]

Critical thinking demands a persistent effort to examine any belief or supposed form of knowledge in the light of the evidence that supports it and the further conclusions to which it tends.[143] It generally requires ability to recognize problems, to find workable means for meeting those problems, to gather and marshal pertinent information, to recognize unstated assumptions and values, to comprehend and use language with accuracy, clarity, and discrimination, to interpret data, to appraise evidence and evaluate arguments, to recognize the existence (or non-existence) of logical relationships between propositions, to draw warranted conclusions and generalizations, to put to test the conclusions and generalizations at which one arrives, to reconstruct one's patterns of beliefs on the basis of wider experience, and to render accurate judgements about specific things and qualities in

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141 www.criticalthinking.org/aboutCT/define_critical_thinking.cfm (accessed 06/10/2015)

142 Ruggerio V R Neglected Issues in the Field of Critical Thinking in Fasko D 2003 Critical Thinking and Reasoning: Current Research, Theory, and Practice

143 Fischer A 2001 Critical thinking: An introduction.

everyday life.[144]

In its exemplary form, critical thinking is based on universal intellectual values that transcend subject matter divisions: clarity, accuracy, precision, consistency, relevance, sound evidence, good reasons, depth, breadth, and fairness.[145]

It entails the examination of those structures or elements of thought implicit in all reasoning: purpose, problem, or question-at-issue; assumptions; concepts; empirical grounding; reasoning leading to conclusions; implications and consequences; objections from alternative viewpoints; and frame of reference. Critical thinking — in being responsive to variable subject matter, issues, and purposes — is incorporated in a family of interwoven modes of thinking, among them: scientific thinking, mathematical thinking, historical thinking, anthropological thinking, economic thinking, moral thinking, and philosophical thinking.

Critical thinking can be seen as having two components: 1) a set of information and belief generating and processing skills, and 2) the habit, based on intellectual commitment, of using those skills to guide behaviour. It is thus to be contrasted with: 1) the mere acquisition and retention of information alone, because it involves a particular way in which information is sought and treated; 2) the mere possession of a set of skills, because it involves the continual use of them; and 3) the mere use of those skills ("as an exercise") without acceptance of their results.

In a nutshell, then, critical thinking is purposeful, analytical and reflective thinking which is conducted through the skills of analysis, evaluation and inference. Critical thinking is used to decide what to believe and what to do.

In the context of critical thinking, analysis refers to the ability to identify:-

- the structure of an argument
- the propositions within an argument and the role they play. The propositions include the main conclusions, premises and reasons to support the conclusions.

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144 Fischer A 2001 Critical thinking: An introduction.

145 Scriven M and Paul R W 1987 8th Annual International Conference on Critical Thinking and Education Reform

47

- the sources of evidence used within an argument.
- the balance of evidence for and against a claim.

Evaluation, on the other hand, refers to the ability determine the strengths and weaknesses of an argument through the assessment of

- the credibility of the proposition
- the relevance of the proposition
- logical strength of the argument structure.

Inference refers to the ability to gather relevant and logical evidence based on the analysis, evaluate the available evidence and draw conclusions.

3.5.3   Attributes of Critical Thinking

The descriptions of critical thinking reviewed so far imply at six distinguishing attributes of critical thinking. Critical thinking is understood to be a kind of thinking that

- Encourages one to reflect on his/her own ways of making decisions or solving problems.
- Makes one examine the basis of his/her own beliefs and reasoning and use them as a vantage point for critical analysis.
- Helps us base our thoughts on logic and insight in a structured way and not on our biases and prejudices.
- Considers carefully the arguments of others and in order to ascertain their validity.
- -Makes use of scepticism (an element of polite doubt) to suggest an alternative to a stated position by asking: 'what if…?'
- -Makes one recognise that there is more than one possible solution.

3.5.4   Incorporating Critical Thinking in Assessment

It is very important to incorporate critical thinking in assessment if its development in students is to be promoted. Incorporating critical thinking skills in assessment requires including the following type of questions in examinations:-

Analysis Questions

In these type of questions, learners are asked whether events are adequately explained or if information or circumstances might explain outcomes more reasonably. Questions testing analysis usually begin with terms like analyse, deduce, compare and contrast.

48

Synthesis Questions

Synthesis or creation refers to the ability to put parts together to form a new whole. Information is compiled together in a different way by combining elements in a new pattern or proposing alternative solutions. Synthesis questions require creative problem solving using original thinking. These questions require students to use the full range of their knowledge and experiences to a problem to solve it creatively. Questions testing synthesis usually begin with terms like combine, compile, devise, design and find.

Evaluation Questions

These type of questions require a learner to judge if a piece of work is right or wrong, good or bad according to the criteria which the learner defines. Examples of these type of questions include: 'What can we learn from this event?' or "What can we do to prevent such events from happening again?" Questions testing evaluation usually begin with terms like evaluate, assess, argue, judge and justify.

3.5.5   Promoting critical thinking

Research shows that critical thinking can be largely promoted through exposing learners to non-routine or divergent questions. This can be achieved if the learning environment that the students find themselves in follows the constructivist approach whereby students construct their own knowledge. One technique involves reversing the standard questions. Examples include:

(i)   Giving a graph and students being asked to interpret it

(ii)   Giving an equation and asking learners to make up a word problem for it.

(iii) Giving a solution and asking learners to make up an equation or system of equations having that solution.

3.6   Conclusion

In this chapter the theoretical foundations of the study were discussed. It began with discussion of the Bloom's Taxonomy, a theory which is used not only as a tool for classifying educational objectives but also for facilitating the analysis of past exam papers. About 42 years after it was written, the original Taxonomy was revised in order to make it

more relevant. The order of the last two cognitive levels was changed and the labels for the first and last classes were changed to remembering and creating respectively. This chapter also explored critical thinking and demonstrated how it can be incorporated in examinations. These two concepts were the lenses through which the research problem was investigated.

Chapter 4

Case Analysis and Method

4.1 Introduction

The previous chapter discussed the theoretical foundations of the study. In this chapter the interpretive instrument derived from Bloom's theory, as well as reflections on critical thinking and some principles of hermeneutics, is applied to the analysis of a number of past examination papers set by the ECZ. This chapter will also illustrate the way in which the instrument was used to measure Zambian examinations. The chapter commences by introducing the research paradigm. It then describes the structure of the Geography and Biology examination papers. This is followed by an explanation of the research methodology as well as the data collection methods.

4.2 Method of analysis

In order to answer the research question, a post-examination documentary analysis of a selected number GCE 'O' Level past exam papers was conducted using mainly Bloom's Taxonomy as the interpretive instrument. More specifically, past examination papers for GCE 'O' Level Geography 2218 and Biology 5090 were analysed using Bloom's Taxonomy. The past examination papers used were for the years 2009 to 2013. The rationale behind choosing documentary analysis approach was that this approach was most suited to achieving the objective of this study and was consistent with the research paradigm. An empirical approach employing techniques such as a surveys, questionnaires

or interviews for data collection would not only have been inconsistent with the conceptual approach, but would have amounted to no more than taking an 'opinion poll' among people who for the most part are neither experts on the KE nor on the role of critical thinking skills in education. Furthermore, this being a small-scale research project, the method of documentary analysis provided a cost-effective method of collecting data and enabled an extensive examination of the vast amounts of information held in the documents consulted for this study. Additionally, the method used to analyse the primary documents which were used in this study (i.e. past examination papers) has the necessary rigour, coherence and consistency. It produced data that is valid and reliable.

Insights obtained from the analysis of the exam items in the selected sample of past papers using the 'tools' alluded to above were used to inform the evaluation of the Zambian GCE 'O' Level past exam papers in order to ascertain what proportion of the questions set in each of the selected subjects tested for the critical thinking skills of analysis, creation and evaluation. The subjects whose past examination papers were evaluated were chosen according to the principles of judgemental sampling. One of the two subjects chosen is a scientific subject because the researcher is a scientist and therefore has a better understanding of science questions. Though subjective judgements have been made with regard to the choice of subjects to include in the sample, the generalizations made from the findings are credible.

4.3   The examination papers

As has been mentioned above, the examination papers which are analysed according to Bloom's Taxonomy are Geography 2218 and Biology 5090. The examination papers analysed come from the years 2009-2013. These examination papers are based on the Zambian GCE 'O' level Geography and Biology syllabus respectively and were set by the Examinations Council of Zambia (ECZ). Students sit these papers at the end of senior secondary school which encompasses Grades 10, 11 and 12. The ECZ is the body responsible for managing the public examinations in Zambia.

4.3.1   Structure of the Geography 2218 Examination

The Geography 2218 exam consists of two components: paper 1 and paper 2.

Paper 1	1 hour 30 minutes
A multiple-choice paper consisting of 50 multiple-choice questions. This paper tests mostly recall and understanding but also has questions testing observational, interpretation and analysis skills. The total mark for paper 1 is 50.	

Paper 2	2 hours
This paper has two sections. Section A has a small number of compulsory, structured questions of variable mark value. 45 marks in total are available for this section. Section B has four questions to choose from and candidates must answer three. These questions are of the restricted response type. These are so called because the form and content of the response is limited. Each question is worth 10 marks. The total mark for paper 2 is 75.	

4.3.2 Structure of the Biology 5090 Examination

The Biology 5090 exam has three components-paper1, 2 and 3.

Paper 1	50 minutes
This paper consists of forty compulsory multiple-choice items. These are based mainly on memorisation, information handling and problem solving. The total mark for paper 1 is 40.	

Paper 2	1hour 45 minutes
This paper has two sections. Section A has a series of compulsory short answer questions of variable mark value. 44 marks in total are available for this section. These questions test information handling and problem solving.	

Section B has five questions to choose from and candidates are asked to answer three. These questions are of the structured free response type. These questions test memorisation and understanding. Each question is worth 12 marks. The total mark for paper 2 is 80.

| **Paper 3** | **1hour 15minutes** |

This paper has two practical questions. These questions test student's experimental skills and their proficiency at handling laboratory apparatus. They also test their capacity to evaluate experimental procedures. The total mark for paper 3 is 40.

4.4 Data Collection Method

Consistent with the paradigm for this study, a qualitative method of data collection was used. The qualitative method of data collection yielded quantitative data which was amenable to statistical analysis. The method used for data collection was the post-examination evaluation of past examination questions using Bloom's Taxonomy. The application of the measuring instrument derived from Bloom's Taxonomy to the analysis of test items in the selected sample of past papers enabled the researcher to ascertain what proportion of the questions set in both of the selected subjects tested the critical thinking skills of analysis, creation and evaluation.

A total of ten Geography examination papers were analysed. Altogether, 503 questions were analysed. On the other hand, the Biology 5090 examination has three component papers and a total of 15 examination papers were analysed. Altogether, 525 Biology questions were evaluated.

More specifically, the following procedure was followed when analysing examination questions:

(i)   The command or task word, which is usually found at the beginning of a particular question, was identified.

54

(ii)   The task word identified was then used in conjunction with Figure 6 which is based on the revised Bloom's Taxonomy to determine what level of the cognitive domain the question was testing. Bloom's Taxonomy gives a number of illustrative 'active' verbs that can be used for stating specific learning outcomes for each level in the cognitive domain. Active verbs such as 'write' or 'analyse' describe an activity and are not open to various interpretations. These are different from 'static' verbs such as 'know' or 'understand' which describe a state and are open to many interpretations.[146] When setting examinations, examiners use these verbs as task words in questions testing a particular assessment objective. Assessment objectives describe the knowledge, skills and abilities students are expected to demonstrate at the end of a course. The task word used in a particular examination question gives an indication of which level of the cognitive domain is being tested.

(iii)   Given that the meaning of a task word depends in part on the context in which it is used, some principles of hermeneutics were sometimes employed to interpret some questions. The above procedure is illustrated below using some Geography and Biology question papers.

4.5 Illustration of the analysis of Question Papers

The procedure for analysing question papers is illustrated in this section using a small sample of question papers.

Three question papers are shown below. According to the textual analysis, and using classification of verbs – in line with the revised Bloom's Taxonomy – annotations were made in each paper to indicate the learning outcome that was tested.

In the text below the annotations have been superimposed on the paper and written in red.

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146   Matiru B et al (eds) 1995 Teach Your Best: A Handbook for University Lecturers

EXAMINATIONS COUNCIL OF ZAMBIA
Joint Examination for the School Certificate
and General Certificate of Education Ordinary Level

GEOGRAPHY

2218/2

PAPER 2

Thursday   5 NOVEMBER 2009   2 hours

Additional material
Answer Booklet

Time: 2 hours

INSTRUCTIONS TO CANDIDATES

Write your name, centre number and candidate number in the spaces provided on the **Answer Booklet**.

There are **twelve (12)** questions in this paper.

Answer only four (4) questions according to the instructions below:

1   Answer **one** question from **Section A.**

2   Answer **one** question from **Section B.**

3   Answer **one** question from **Section C.**

4 .   You are free to choose the **fourth** question from any Section: **A, B** or **C.**

Write your answers in the **Answer Booklet** provided.

INFORMATION FOR CANDIDATES

The number of marks is given in brackets [ ] at the end of each question or part question.

The Insert contains **Figures 1,2** and **3.**

Sketch maps and diagrams should be drawn whenever they serve to illustrate an answer.

Cell phones and calculators are not allowed in the examination room.

Page 2 of 4

Section A: Zambia

1   **Study Figure 1 (Insert) of Zambia.**

(a) On **Figure 1**, in the spaces below the map, name the:
This task word requires one to state or indentify. Indicates that the question is testing

(i) Power transmission system **A**. *memorisation.*

(ii) Power Station **B**.   [2]

(b) With reference to the Zambian situation:

(i) Describe the process of charcoal production.   [4]
Task word indicates that question testing memorisation.

(ii) Explain how the use of charcoal as a source of energy affects the
Task word requires one to why something occurs. Question tests
quality of the environment. *recall.*   [4]

(c) What is being done to reduce reliance on charcoal and wood fuel as
main sources of energy in the rural areas?   [2]
This task word indicates that the question is testing recall/memorisation.   **[12]**

2   With reference to Zambia:

(a) (i) Describe the mining centres which have been opened or
re-opened in the last ten or so years and state the different minerals mined
at each named centre. *Task indicates that question testing memorisation*   [3]

(ii) Explain the factors which have motivated the opening or
re-opening of several mining centres in the last ten or so years.   [4]
Task word tests understanding

(b) (i) What are the main environmental concerns in all areas where
mines are being opened or re-opened?   [3]
Task word indicates that question testing recall/memorisation

(ii) How are the environmental problems brought about by the
opening or re-opening of mines being tackled?   [2]
Requires one to say in what way, to what extent or by what means. Indicates that question   **[12]**
testing understanding.

3   With reference to deforestation in Zambia:
Reqiures one to refer to an aspect of a feature by a short   [4]
(a) (i) State its causes, *statement, words or a single word. Question tests recall.*

(ii) Explain its effects. *Task word tests understanding.*   [4]

(b) Describe the measures taken to reduce its effects.   [4]
Task word indicates that question is testing recal/memorisation.   **[12]**

Indicates that some psychomotor skills required.

4   (a) (i) Draw a sketch map of Zambia and on it mark and name the
Kafue National Park. *Task word idicates that question is testing recall.*   [2]

(ii) Explain why the Kafue National Park has a large variety of wildlife.   [4]
Task word indicates that question is testing understanding

(b) (i) What is the difference between a Game Reserve and a National Park?   [2]
In this context this term indicates that question is testing analysis

(ii) What is game cropping and why is it necessary?   [4]
Indicates that reason required. Understanding **[12]**
Indicates that memorisation being tested.   being tested.

5 (a) With reference to the use of animals as a means of transport:

(i)   State any **two** types of animals used for transportation. [1]
This task word indicates that questions tests recall/memorisation

(ii) Name any **four** provinces where animals are used for transportation on a large scale. [2]
This task word incates that question tests memorisation,

(iii) Explain the importance of this form of transport, [3]
This task word indicates that question tests understanding.

(iv) Give the limitations of this form of transport. [3]
This tests evaluation as it requires one to critically examine the issue at hand.

(b) Briefly describe the forms of information communication that have been introduced in Zambia in recent years. [3]

[12]

Section B: The Sub-Region

6 **Study Figure 2 (Insert) of Zimbabwe:**

(a) On **Figure 2**, in spaces provided below the map, name the tourist attractions **A**, **B** and **C**. [3]
This task word indicates that question tests recall

(b) (i)   Define the term "game ranching". [1]
This task word indicates that question tests recall

(ii) Describe the products from game ranches in Zimbabwe. [3]
Indicates that question tests recall

(c) (i)   Most national parks are infested with tsetse flies. Explain why wild animals do not suffer from trypanosomiasis. [1]
This task word indicates that the question tests understanding

(ii) Why are human settlements generally not allowed in National Parks? [4]
This word implies that an explanation is required. Therefore question tests understanding.

[12]

7 (a) With reference to the motor assembly industry in Kenya:

(i)   Name a centre where motor vehicles are assembled. [1]
Task word indicates that the question tests memorisation.

(ii) Explain why the motor assembly is located there? [5]
This task word indicates that the question tests understanding.

(iii) What is the importance of the motor assembly to the country? [3]
This question tests memorisation.

(b) Briefly explain the problems linked to the use of motor vehicles. [3]
This task word indicates that the question tests understanding

[12]

8 With reference to fishing in Namibia:
This task word indicates that the question tests understanding

(a) Explain its importance. [4]

(b) What factors have supported large scale fishing? [4]
This question tests memorisation.

(c) What are the threats to the fishing industry? [4]
This question tests memorisation.

[12]

9 Give a geographical account of the road transport network in the sub-region under the following sub-headings;

(a) existing trunk routes. [4]

(b) ports used for foreign trade. [4]

(c) goods transported. [4]

This phrase indicates that the question tests creation/synthesis. [12]

[Turn over

Section C: Settlements and Population Studies.

10   **Study Figure 3 (Insert) of Zambia.**

Choose **one** of the densely populated areas **I** or **II** and **one** of the sparsely populated areas **III** or **IV**.

For the areas chosen:

(a)   Identify the areas. — This task word indicates that question testing memorisation.   [2]

(b)   State how the population density has been influenced by the economic activities.   [10]

This task word indicates that question testing memorisation.   **[12]**

11   For any **one** of the cities: Livingstone, Lusaka or Ndola;

(a)   Describe the characteristics of shanty compounds which have developed there.
This task word indicates that question testing memorisation.   [4]

This task word indicates that question testing understanding.

(b)   Explain how the problem of shortage of accommodation is being tackled.   [2]

(c)   (i)   Describe the types of public transport available within town.   [2]
This task word indicates that the question is testing memorisation.

(ii)   Explain the changes in volume of traffic flow from time to time of the day and from day to day.   [4]
This task word indicates that the question testing understanding   **[12]**

In this context, one is required to examine the resource given and not answer from memory. So evaluation is being tested.

12   (a)   (i)   Describe the patterns of internal migration in Zambia.   [4]

(ii)   For any two patterns described in (i) above, give reasons to explain the patterns.   These task words indicate that question is testing understanding.   [6]

(b)   Briefly explain why Solwezi is one of the fastest growing towns in Zambia.   [2]
[12]

This task word indicates that the question is testing understanding.

EXAMINATIONS COUNCIL OF ZAMBIA

Joint Examination for the School Certificate
and General Certificate of Education Ordinary Level

GEOGRAPHY   2218/1

PAPER 1

Tuesday   10 NOVEMBER 2009   1 hour 30 minutes

1:50 000 Survey Map is enclosed with this question paper.

Additional materials:
  Multiple Choice answer sheet
  Soft pencil (type HB is recommended)

TIME   1 hour 30 minutes

INSTRUCTIONS TO CANDIDATES

Do not open this booklet until you are told to do so.

Write your name, centre number and examination number on the answer sheet in the spaces provided unless this has already been done for you.

There are **fifty (50)** questions in this paper. Answer **all** the questions. For each question, there are four possible answers, **A, B, C** and **D**. Choose the one you consider correct and record your choice in clear pencil on the separate answer sheet.

Read very carefully the instructions on the answer sheet.

INFORMATION FOR CANDIDATES

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.

Cell phones and calculators are not allowed in the examination room.

This question paper consists of 16 printed pages.

                                                              [Turn over

60

Section A: Mapwork and Basic Techniques

Questions 1 to 12 are based on the 1:50 000 map extract of Kildonan (Zimbabwe).

1   At what longitude and latitude is settlement Wynhill, found in grid square 3872, approximately located? The context in which this word is used implies working out something. This question tests the application of knowledge,

    A   30° 34'E and 16° 25'S

    B   30° 34'E and 17° 25'S

    C   30° 34'S and 16° 25'E

    D   38° 05'E and 72° 08'S

2   Which one of the following is **not** found in grid square 3667? his question tests recall.

    A   Borehole

    B   Plantation

    C   Reservoir

    D   Settlement

3   According to map evidence, which one of the following **cannot** be used as evidence that there is mining taking place? This question tests evaluation as it requires one to examine map evidence.

    A   Mine dump

    B   Mining trench

    C   Quarry

    D   Smelting plant

4   What is the general direction of river flow in the area west of the railway? This question tests understanding as it requires one interpret map evidence.

    A   North to South

    B   Northwest to Southeast

    C   South to North

    D   Southeast to Northwest

5   In which grid square is there the most rugged relief? This question tests understanding.

    A   4266

    B   4367

    C   4569

    D   4571

6   Study part of the map extract below which shows the position of a river.
     Which one of the points **A, B, C** or **D** lies at the highest position?
     This question tests observation and analysis
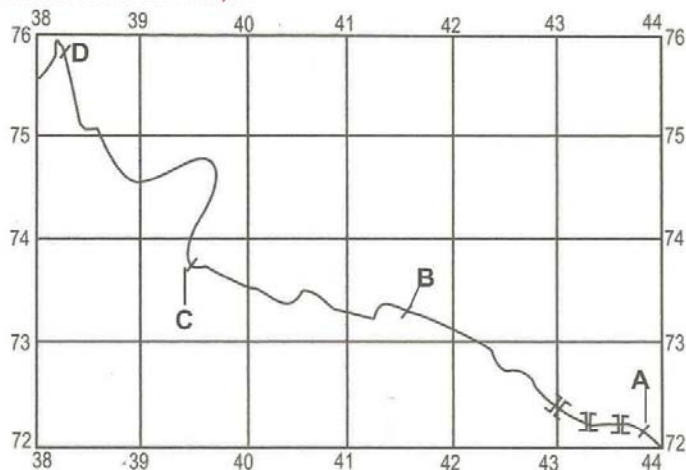
7   Study the factors below.

     (i)   Presence of minerals

     (ii)   Relatively flat land

     (iii) Very dense bush

     (iv)   Rich agricultural land on the western side

     According to map evidence, which combination of factors above determined the course
     of both the railway and the wide tarred road?

     A   (i), (ii) and (iii)

     B   (i), (ii) and (iv)

     C   (i), (iii) and (iv)

     D   (ii),(iii) and (iv)
     This question tests evaluation since it involves eamining map evidence.

8   Study the diagram showing part of the map extract.
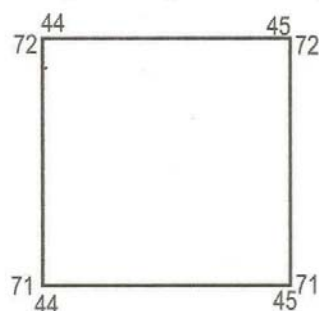
     Which one of the following landforms is found in the grid square?

     A   Cliff

     B   Gorge

     C   Mountain peak

     D   Saddle
     This question tests understanding.

[Turn over

Page 4 of 16

9   According to map evidence, why is there much denser bush east of the railway line than west of it? This question tests evaluation.

	West	East
A	Cultivation led to tree clearance	Mountain discourage agriculture
B	Trees cut for firewood	Area has been reafforested
C	Receives little rainfall	Receives high rainfall
D	Used for mining	Conserved forest

10   What is the distance of the wide tarred road in the south western part of the map extract? This question requires calculating the distance. This implies the application of knowledge.

   A   5.6km

   B   8.4km

   C   8.6km

   D   8.8km

11   In which of the following grid squares do most of the employed people live?

   This question tests evaluation as it requires the examination of map evidence.

   A   3667

   B   3969

   C   4475

   D   4476

12   All of the following are evident at Kildonan except ...

   A   gold mining.

   B   land destruction.

   C   mine prospecting.

   D   water storage.

   This question tests evaluation as it involves the examination of map evidence.

Section B: Elements of Physical Geography

13   From which of the following can time be calculated?

   A   0°S/N

   B   30°N

   C   40°S

   D   50°E

This question tests recall.

14   Study the map of Africa below.
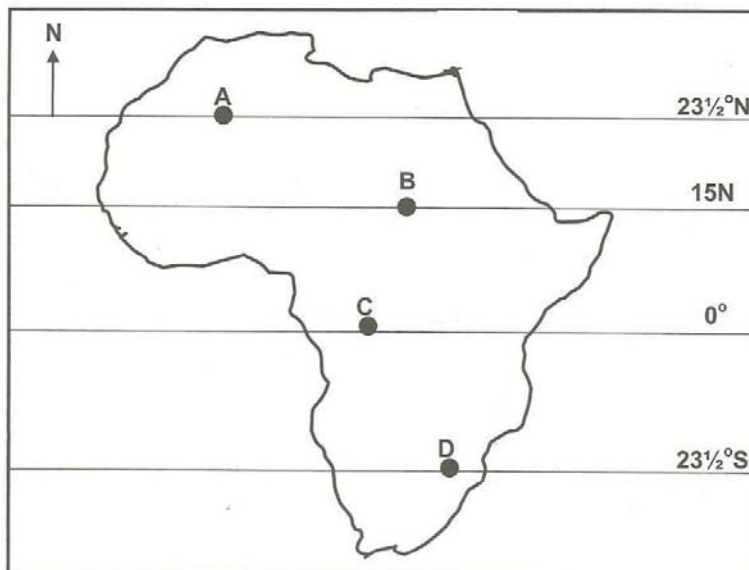
Which one of the places **A, B, C** or **D** experiences the shortest day light on 30th May?
This question tests recall.

15   Which one of the following causes the most chemical weathering?

A   Biotic weathering

B   Frost action

C   Rain water

D   Temperature variations
This question tests recall.

16   Study the diagram below showing a river profile.
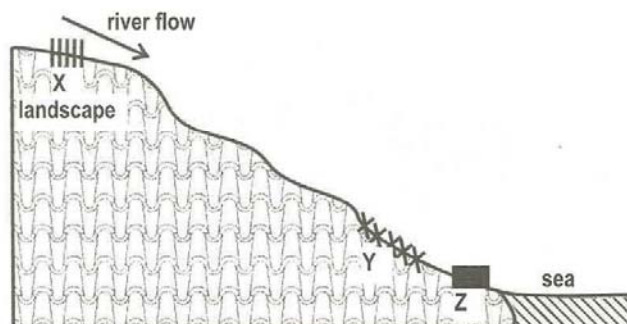
Which one of the following are predominant at **X, Y** and **Z**?

	X	Y	Z
A	Clay	Sand	Potholes
B	Potholes	Sand	Clay
C	Potholes	Clay	Sand
D	Sand	Potholes	Clay

This question tests understanding.

[Turn over

17 Study the map below.
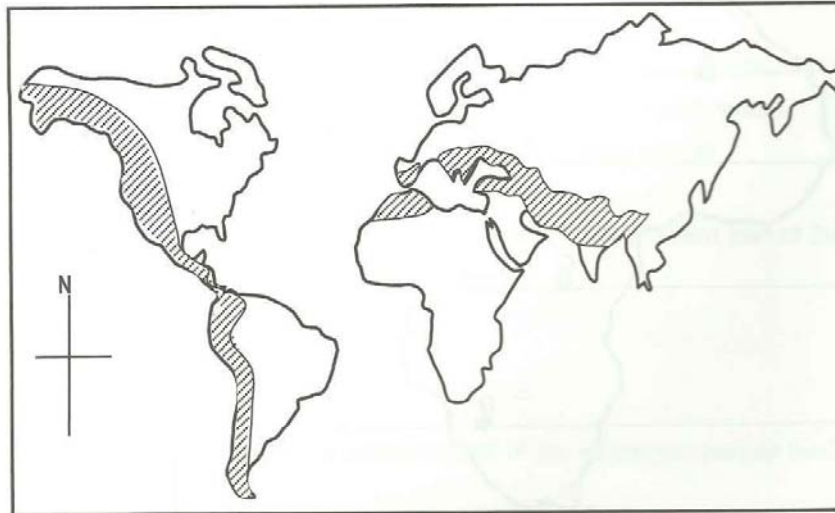
What feature **A, B, C** or **D** shown below shows the landform found in the shaded area?
This questions tests recall.

A

C

B

D
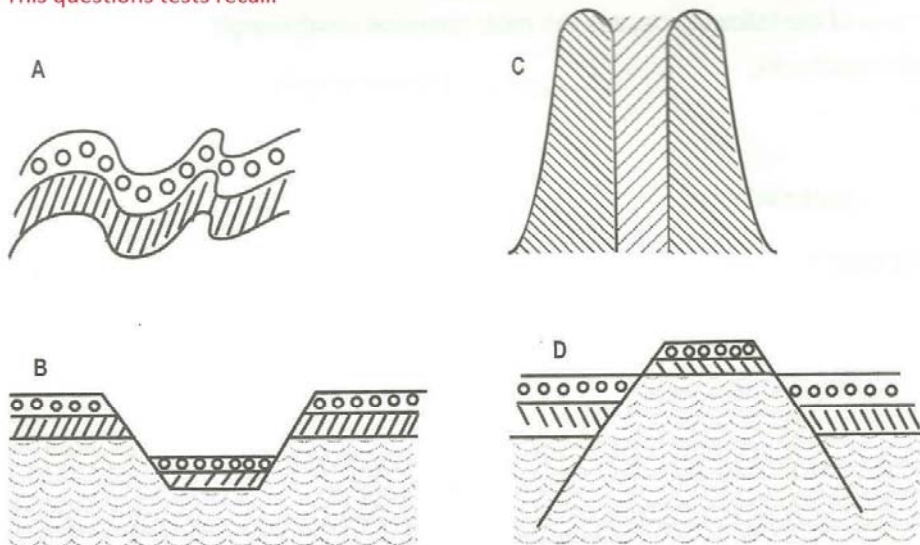
18 "There were collapsed roads and bridges, raging fires, shattered buildings, landslides and roads criss-crossed by gapping cracks. The death toll stood at 300 people" What caused the disaster quoted above?

A   Earthquake
B   Flood
C   Tornado
D   Tsunami

This question tests analysis because it requires one to make an inference

19 Why was chemical weathering faster in the past?

A   Acid rainfalls were more common than today.

B   Climates were warmer than today.

C   More sedimentary rocks existed than today.

D   Rocks were softer than today.

This tests understanding.

20 Which one of the following provides evidence that there is very hot rock near the surface?

A   Existence of a crater.

B   Existence of a geyser.

C   Presence of horst.

D   Presence of a lava plateau.

This questions tests recall/memorisation.

21 Study the wind vane below as seen by a pupil from beneath the pole.
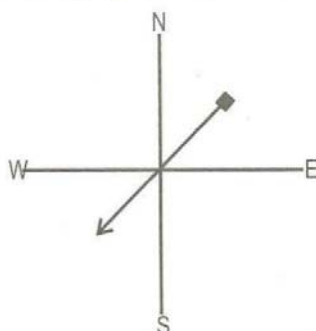
Where, on the wind rose, did the pupil record the wind direction?

This question tests recall/memorisation.
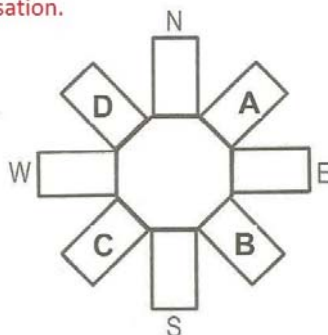
22 Which one of the following should **not** be placed in the Stevenson's Screen?

A   Anemometer

B   Magnet

C   Hygrometer

D   Six's thermometer

This question tests recall/memorisation.

[Turn over

23 Study the diagram below showing weather information for station **Z**.
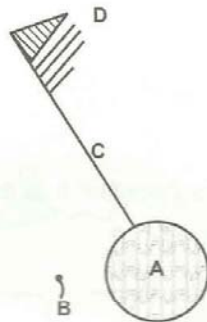
Which of **A, B, C** or **D** depended on the use of the wind vane to be measured?
This question tests recall/memorisation.

24 Depletion of ozone layer cannot be mimised by increased dependence use of • • • .

A   coal in industries.

B   hydro-electricity.

C   geo-thermal power.

D   tidal power.
This questions tests understanding.

25 Study the map of Africa below.
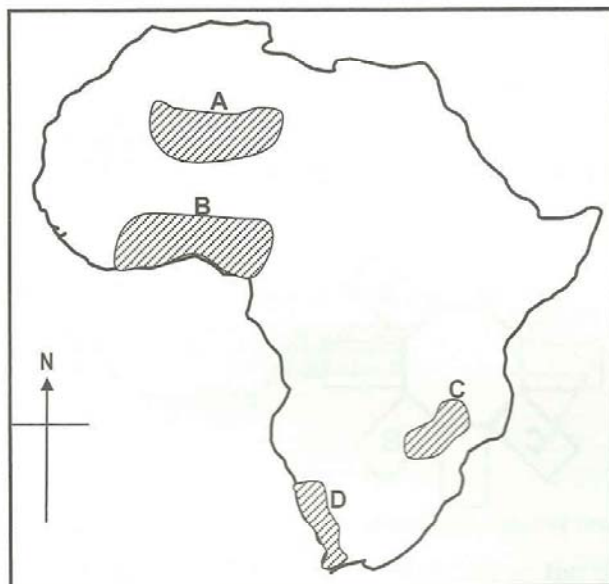
Which one of the shaded areas **A, B, C** or **D** is characterized by dry warm summers?
This question tests understanding.

26 Which one of the following is **not** correct regarding the siting of a rain gauge?

A   It should be firmly fastened.

B   It should be placed in an open space.

C   It should be sheltered to prevent excessive evaporation.

D   The funnel should be at least 30 centimetres above the ground.

Georgraphy/2218/1/Z/2009

This question tests recall/memorisation.

27 Equatorial and Savanna climates are similar in that both •••
    A   have high rainfall only in summer.
    B   have high temperature all year round.
    C   receive convectional rainfall.
    D   have small temperature range of below 3°C.
This question tests recall/memorisation.

Study the climatic graph below and then answer questions 28 and 29.

Annual temperature range 8°C

Annual rainfall 635mm
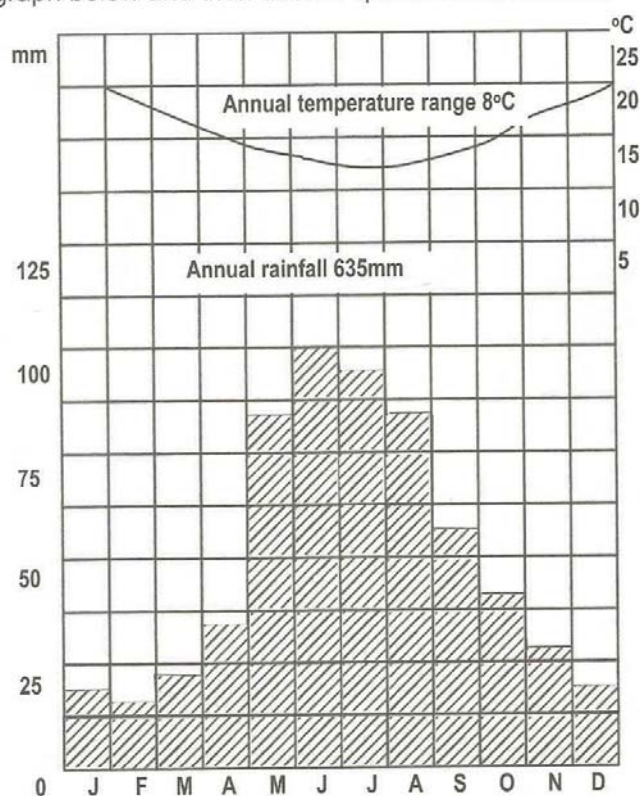
28 What type of climate is represented by the graph?

    A   Equatorial
    B   Mediterranean
    C   Savanna
    D   Temperate Continental
This question tests analysis as it involves making an inference.

29 How do plants found in the climatic region named in question 28 adapt to climatic
    conditions of the region?
    A   Get rid of excess moisture
    B   Withstand low temperature
    C   Withstand prolonged drought
    D   Withstand extreme temperature
This question tests recall/memorisation.

30 Which one of the following is **not** a characteristic feature of the equatorial vegetation?

    A   Trees compete for light
    B   Trees compete for water
    C   Trees have thin barks
    D   Presence of parastic plants on some trees

[Turn over

This question tests recall/memorisation.

Section C: Elements of World Human Geography

31 Study the map below.
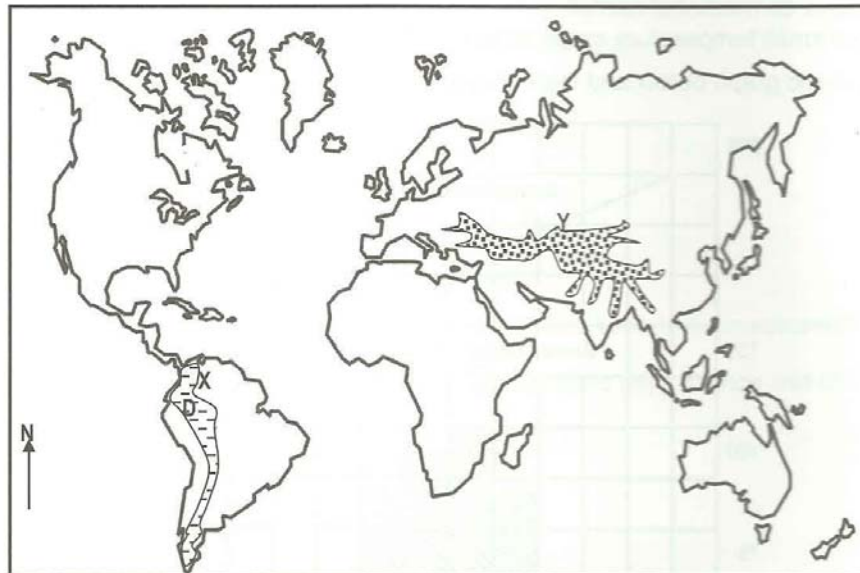
The main reason why areas labelled **X** and **Y** are sparsely populated is that they ...

A   are dry and infertile.

B   are mountainous.

C   have thick forests.

D   have very large ranches.

This question tests recall/memorisation.

32 Study the figure below which shows world population growth pattern.
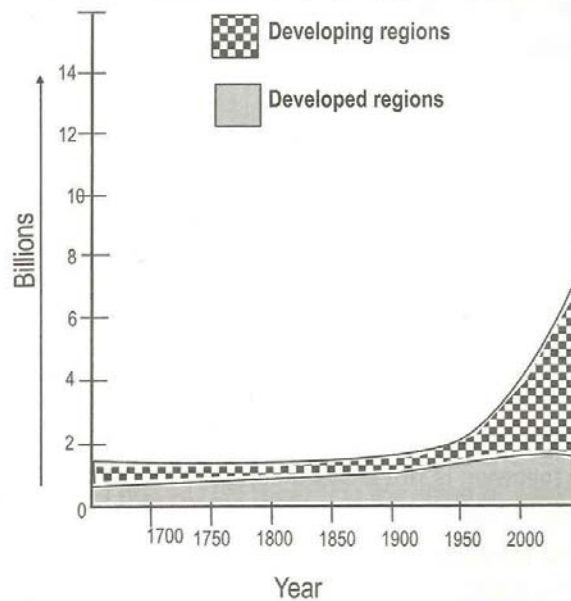
Which one of the following best explains the sharper increase in population in developin regions between 1950 and 2000?

Geography/2218/1/Z/2009

A   Existence of policies on early marriages.

B   Family values and improvements in medical facilities.

C   High prevalence of births of twins and triplets.

D   Use of contraceptives by many families.

This question tests recall/memorisation.

33 Which one of the following countries has the largest population?

A   Bangladeshi

B   China

C   India

D   Pakistan

This question tests recall/memorisation.

34 Which one of the following terms refers to the permanent movement of professionals out of a country?

A   Brain drain

B   Emigration

C   Immigration

D   Migration

This qustion tests recall/memorisation.

35 Which one of the following is **not** a requirement of intensive rice cultivation in South East Asia?

A   Flat land

B   Many workers

C   Plenty of rainfall

D   Quick transport

This question tests recall/memorisation.

36 The table below shows the uses of a certain crop.

Chemical uses	Home uses	Other products/uses
• Acids • Drugs • Medicines	• Baking • Cooking • Sweetener • Syrup	• Pharmaceuticals • Stockfeed • Fuel • Wax • Paper

Which crop is this?

A   Cotton

B   Maize

C   Sugar cane

D   Wheat

This question tests analysis as it involves inference.

[Turn over

37 Study the map of Australia below.
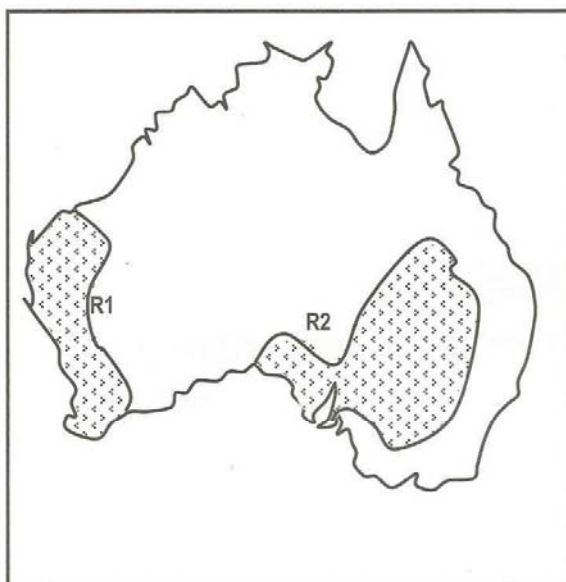
Which one of the following shows the major type of farming found in the areas labelled **R1** and **R2**?

A Cattle rearing

B Rice cultivation

C Sheep farming

D When farming

This question tests recall/memorisation

38 Which one of the following is **not** a way of controlling the spread of livestock diseases?

A Encouraging free range grazing.

B Killing of all affected livestock.

C Mounting control points along transit routes.

D Regular vaccination of livestock

This question tests recall/memorisation

39 Which one of the following types of farming would be found closest to the Central Business District (CBD)?

A Beef ranching

B Diary farming

C Cotton Production

D Poultry farming

This question tests understanding.

40 Which type of farming is largely associated with the production of sugar cane, rubber and coffee?

A Intensive farming

B Plantation farming

C Semi-permanent cultivation

D Shifting cultivation

This question tests recall/memorisation.

41 Study the diagram below.
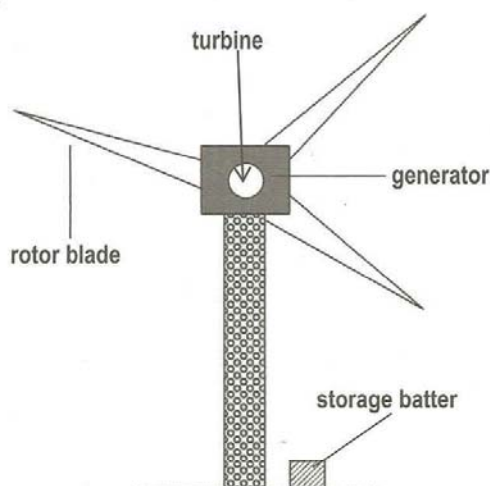
The best location for this power plant is ...

A   forested areas.

B   lowland areas.

C   mountain valleys.

D   upland areas.

This question tests understanding.

42 Which one of the following is a non-renewable source of power?

A   Geothermal

B   Gas

C   Wind

D   Tidal

This question tests recall/memorisation.

43 Which one of the following is regarded as power of "yesterday"?

A   Coal

B   Natural gas

C   Petroleum

D   Solar energy

This question tests recall/memorisation.

44 Which one of the following sources of fuel and power is **not** a fossil?

A   Coal

B   Geothermal

C   Natural gas

D   Petroleum

This question tests recall/memorisation.

45 Which one of the following iron and steel centres has never been associated with the production of coal, limestone or iron ore?

A   Birmingham

B   Cleaveland

C   Pittsburg

D   Youngstown

This question tests recall/memorisation.

[Turn over

44 Study the diagram below which shows types of coal.
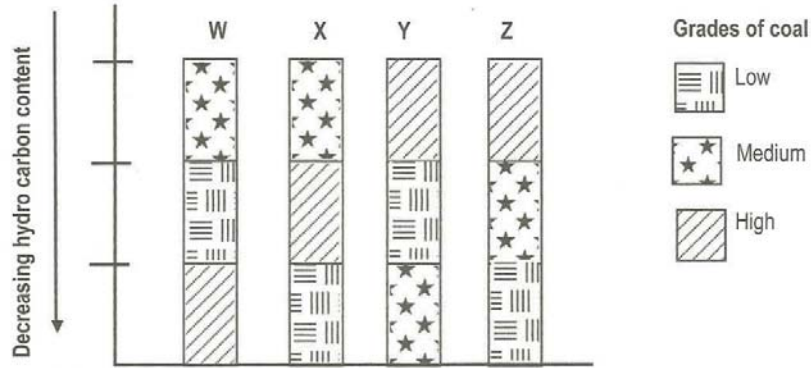
Which bar graph shows the correct order of the types of coal?

A   W

B   X

C   Y

D   Z

This question tests recall/memorisation.

47 The diagram below shows the occurrence of a rock rich in iron ore.
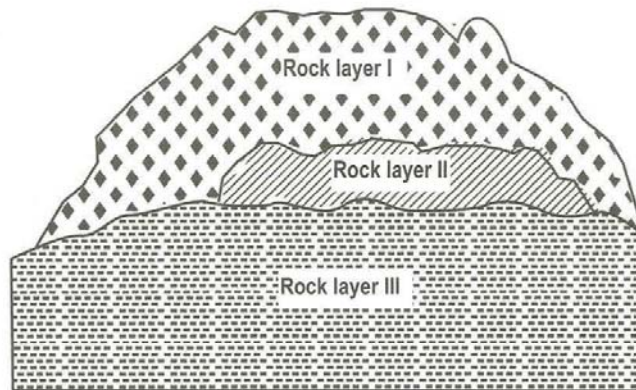
Having discovered that rock layer II was rich in magnetite, the prospector recommended that an open cast method of mining be used.

What would be the greatest challenge of using this method to extract the iron ore?

A   Possibility of land slides

B   Possibilities of rock falls

C   Possibilities of volcanic eruption

D   Removal of the overburden

This question tests analysis.

48 Study the map of Australia below.
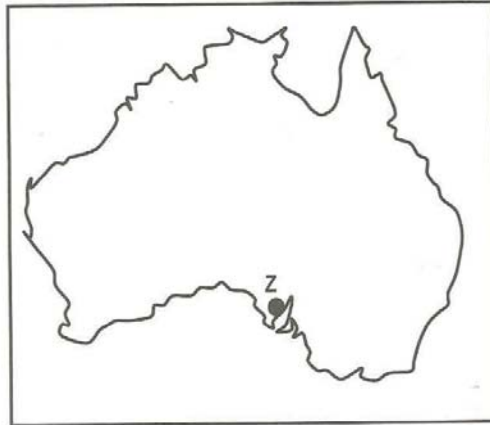
What local raw material attracted the iron and steel plant to the site marked **Z**?

A   Coal

B   Chrome

C   Iron ore

D   Limestone

This question tests recall/memorisation.

49 What raw material is used in the second stage of iron and steel manufacturing?

`A   Alloy steel

B   Iron ore

C   Pig iron

D   Steel scrap

This question tests recall/memorisation.

[Turn over

50 Study the diagram below.
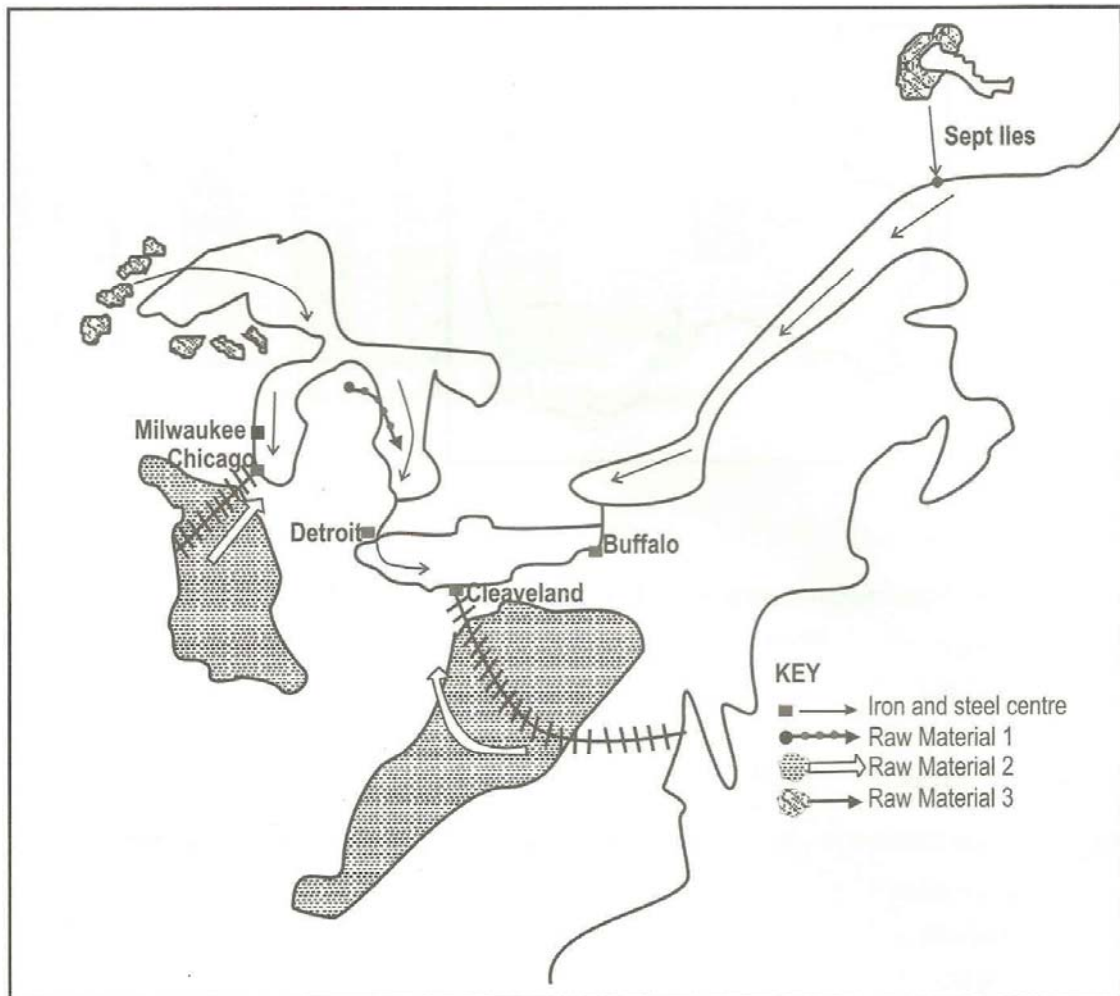
Which factor, apart from those shown on the map, attracted the location of the integrated iron and steel centres along the Great Lakes?

A   Availability of coal.

B   Availability of iron ore.

C   Presence of limestone.

D   Presence of a market.

This question tests recall/memorisation.

	Centre Number	Candidate Number

Candidate Name_____

EXAMINATIONS COUNCIL OF ZAMBIA
Joint Examination for the School Certificate
and General Certificate of Education Ordinary Level

BIOLOGY   **5090/2**
PAPER 2 Theory

Monday   **9 NOVEMBER 2009**   **1 hour 45 minutes**

Additional materials:
Answer Booklet

TIME: 1 hour 45 minutes

INSTRUCTIONS TO CANDIDATES

Write your name, centre number and candidate number in the spaces at the top of this page and on the Answer Paper used.

There are **ten** questions in this paper.

Section A

Answer **all** questions.

Write your answers in the spaces provided on the question paper.

Section B

Answer any **three** questions.

Write your answers in the Answer Booklet provided.

At the end of the examination:

1. fasten the Answer Booklet used securely to the question paper,
2. **enter** the numbers of the Section B questions you have answered in the grid on the right.

INFORMATION FOR CANDIDATES
The intended number of marks is given in brackets [ ] at the end of each question or part question.

You are advised to spend no longer than one hour on Section A and no longer than 45 minutes on Section B.

Cell phones are not allowed in the examination room.

FOR EXAMINER'S USE	
Section A	
Section B	
Total	

This question paper consists of 7 printed pages

©ECZ/2009/Y4   [Turn over

1   **Figure. 1.1** shows some cells taken from a vascular tissue of a plant.
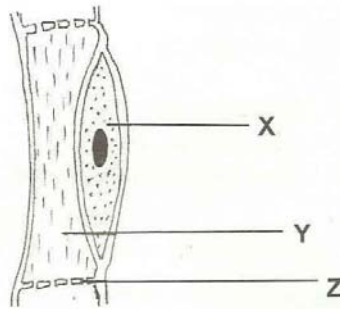
Figure 1.1.

(a) Identify the cells **X** and **Y** and structure labelled **Z**.
    ↳ This task word idicates that the question is testing

Cell **X** ....memorisation..

Cell **Y** ....

Structure **Z** .... [3]

(b) What are the functions of the cells labelled
    ↳ This task word indicates that the question is testing memorisation.

   (i)   **X** ....

          .... [1]

   (ii)   **Y** ....

          .... [1]

   (iii) What structure, in the human body, performs a similar function as
          structure **Y**? This task word indicates that the question is testing memorisation..

          ....

          .... [1]

(c) What two conditions are necessary for osmosis to take place?
    ↳ This task word indicates that the question is testing memorisation.

       1   ....

           ....

       2   ....

           .... [2]

                                                                          [Total 8]

2 (a) **Figure 2.1** shows the amount of lactic acid in the blood before, during and after a heavy exercise.
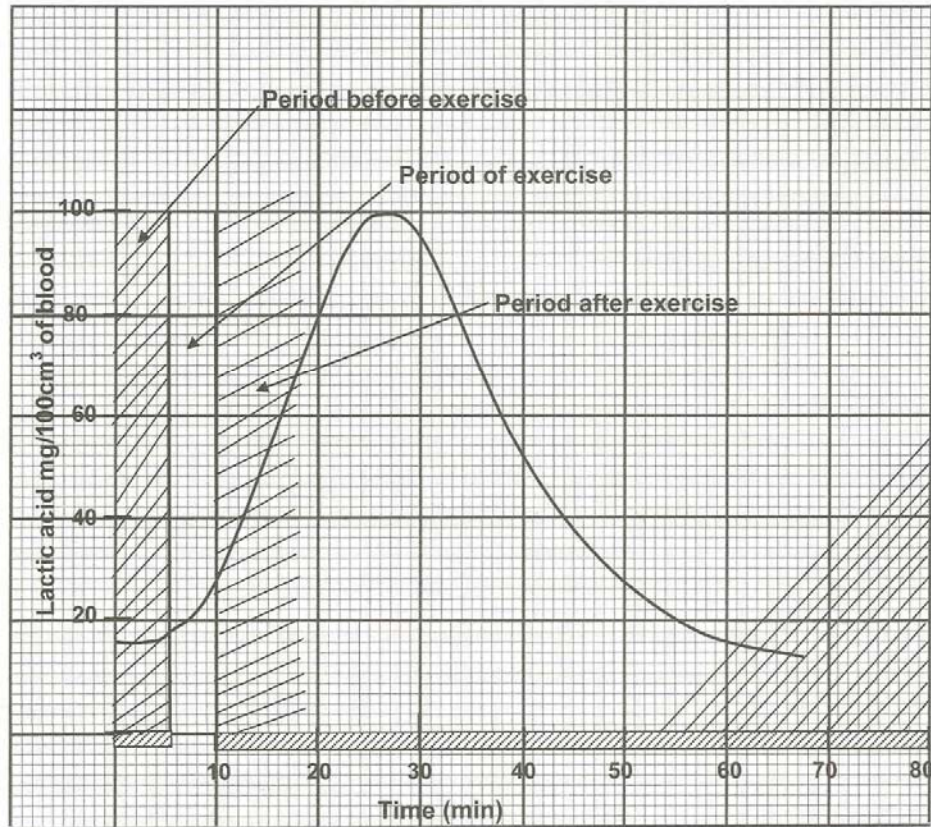
Figure 2.1

(a) (i) What was the level of lactic acid in the blood before the exercise?

.... [1]

This task word tests recall

(ii) How much lactic acid was produced at 20 minutes after the exercise?

.... [1]

These words show that one needs to interpret the graph. This questions tests understanding

(iii) How long did it take for the lactic acid to reach its highest level after the exercise had began?

.... [1]

These words show that one needs to interpret the graph. This question tests understanding.

(b) **(i)** What is the reason for the build up of lactic acid in the blood?

....

.... [1]

An explanation is reqired as indicated by this phrase. Question tests understanding

(ii) What are the effects of the build up of this lactic acid on the person?

This word indicates that question tests recall

....

.... [2]

(iii) Compare the products of the process taking place during the heavy exercise to that which takes place in yeast cells?

This task word shows that this questions tests analysis.

....

....

.... [2]

(c) Suggest **two** uses of the process identified in **b (i)**

This task word indicates that the application of knowledge is required in this question

1 ....

2 ....

.... [2]

[Total 10]

3 **(a)** Complete the **Table 3.1**, by filling in the blank spaces.

	HORMONE	SOURCE	ACTION
(i)		Ovary	Begins rebuilding the lining of the uterus
(ii)	Thyroxine	Thyroid gland	
(iii)		Adrenal gland	

This task word shows that this question tests recall.

Table 3.1

[4]

(b) What happens to the hormones after completing their action in target organs?

....

.... [2]

This question tests recall.

For
Examiner's
Use

This task word tests recall

(c) State two ways in which hormones and nerve impulses differ in controlling body processes?

1 ....

....

2 ....

.... [2]

[Total 8]

4   Figure. 4.1 and Figure 4.2 show pyramids of food relationship among organisms in a forest and a lake.

| Owls |
| Frogs |
| Insects |
| A |

Figure 4.1 Forest

| Vultures |
| Crocodiles |
| Fish |
| Algae |
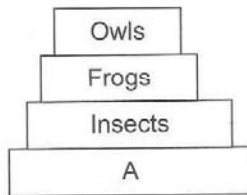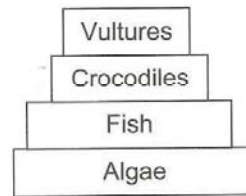
Figure 4.2 Lake

(a) (i) Identify the organism found in trophic level labelled **A** in **Figure 4.1**.

This task word tests recall

....

.... [1]

(ii) What would happen if the population of insects in **Figure 4.1** reduced?

....

....

.... [2]

(b) (i) What is the ultimate source of energy for both pyramids?

This question tests recall

.... [1]

(ii) Explain the differences in energy between trophic levels as you go up the pyramids. *This task word tests understanding*

....

....

.... [2]

(c) Traces of DDT applied on a nearby farm were washed by rain into the lake and were taken up by algae in **Figure 4.2**.

Why was there more DDT in organisms in the fourth trophic level of **Figure 4.2** than in those in the first trophic level?

....

....

....

.... [2]

This question tests understanding

[Total 8]

5 (a) Haemophilia is an example of a sex-linked inherited disease arising from a blood disorder.

This question tests recall

(i) What is a sex-linked characteristic?

....

.... [1]

(ii) Explain why males are more likely to suffer from sex-linked diseases than female? *This task word tests understanding*

....

....

....

.... [2]

(b) Colour blindness is another sex-linked disease. Using a genetic diagram show the chances of having a colour blind child from a couple made up of a normal male parent and a carrier female parent. (Use the symbols X^R and X^r)

In this context, this task word tests the application of knowledge

[7]

[Total 10]

For Examiner's Use

Section B

Answer any **three** questions.
All answers should be in sentence form in paragraphs.

6 (a) Explain how leaves are adapted to carry out photosynthesis.   [4]

This task word incates that understanding is being tested

(b) How does a plant get and use the following elements:

(i) Nitrogen — This word indicates that an explanation is required.
This question tests understanding

(ii) Magnesium   [4]

(c) Explain how enzyme activity is affected by the pH and concentration
of the substrate.   [4]

This task word indicates that underdaning is being tested in these questions   [Total: 12]

7 (a) (i) Explain the role of the kidney in excretion.   [3]

(ii) Explain the role of the kidneys in homeostasis.   [3]

(b) Describe the disadvantages of a kidney transplant.   [3]

This task word indicates that question tests recall.

(c) Explain why there is limited excretion of nitrogenous wastes
and salts in plants.   [3]

This task word indicates that understanding is being tested in this question   [Total: 12]

8 (a) What are the advantages of sexual reproduction over asexual
reproduction in flowering plants?   [5]

This question tests analysis as one is required to compare sexual with asexual reproduction

(b) Explain how asexual reproduction in a fungi, such as a Rhizopus, takes place. [3]

This task word shows that this question tests understanding

(c) Describe the sequence of events which take place in a flower from
pollination to fertilization.   [4]

This task word indicates that this question tests recall.   [Total: 12]

9 (a) What is the importance of the following in relation to blood?

(i) Leukemia — This question tests recall

(ii) Sickle cell anaemia   [2]

This task word indicates that this question tests understanding

(b) Explain the role of house flies in disease transmission.   [2]

(c) Discuss the cause, signs, symptoms and prevention of malaria.   [8]

rom a scientific point of view, this involves giving a critical account of main points of a topic. Indicates that evaluation being tested.   [Total: 12]

10 (a) (i) Explain the importance of transpiration.   [3]

This task word indicates that the question tests understanding

(ii) Explain how **two** named environmental factors affect the rate
of transpiration.   [4]

This task word indicates that the question tests understanding

(b) Describe the role of blood in transporting materials in the body.   [5]

This task word implies that question is testing recall.   [Total 12 marks]

4.6   Comparison of Question Papers using t-test

In this study, it was necessary to compare and analyse the two subjects in order to establish whether or not there was a significant difference between subjects in terms of testing critical thinking skills. It was also necessary to compare the components of a particular subject for the same purpose. The most appropriate statistical test for this purpose is the *t*-test. The *t*-test provides the researcher with a statistical measure of significance. It uses the means of the two sets of data and their standard deviations to arrive at a value which tells the researcher the specific likelihood that any differences between the two sets of data are due to chance. The value which is obtained is called the t-statistic.

The t-statistic is given by:

$$t = \frac{\overline{X}_1 - \overline{X}_2}{\sqrt{\left(\frac{(N_1 - 1)s_1^2 + (N_2 - 1)s_2^2}{N_1 + N_2 - 2}\right)\left(\frac{1}{N_1} + \frac{1}{N_2}\right)}}$$

where:

$\acute{X}_1$ = mean of group 1 $\acute{X}_2$ = mean of group 2

S_1 = standard deviation of group 1 S_2 = standard deviation for group 2

N_1 = sample size of group 1 N_2 = sample size of group 2

4.7 Conclusion

In this chapter, the interpretive instrument derived from Bloom's theory, as well as reflections on critical thinking and some principles of hermeneutics, is applied to the analysis of a number of past examination papers set by the ECZ. This chapter also illustrated the way in which the measuring instrument was applied to the analysis and evaluation of all the past examination papers consulted in this investigation. There was a brief discussion of the t-test and how it can be applied to compare two sets of data. This test was used to compare the examination papers in Biology and Geography and determine whether or not there was any significant difference between subjects in terms of testing for critical thinking skills.

Chapter 5

Findings of the Analysis

5.1 Introduction

In the previous chapter, the interpretive instrument derived from Bloom's theory, as well as reflections on critical thinking and some principles of hermeneutics, was applied to the analysis of a number of past exam papers set by the ECZ.

In this chapter, the data findings will be presented together with various graphs and tables showing the distribution of questions by cognitive level. As was discussed in previous chapters, the world economy is rapidly transitioning into a phase known as the knowledge economy from an industrial economy. The only difference may be the degree to which individual countries have changed into knowledge economies. However, notwithstanding the degree to which a country has transitioned into the knowledge economy, critical thinking skills are amongst the most important and sought after skills that are expected by prospective employers from young graduates entering the job market for the first time. This is due to the fact that all companies and organizations in the various knowledge economies are striving to be at the cutting-edge of global competitiveness.

In order for students graduating from our education system to not only fit into the job market but also to participate in the knowledge economy successfully, the system of assessment in our educational system must be revised to incorporate the assessment of critical thinking skills in order to promote the teaching of these skills. It is against this

background that the chapter will present and analyse the data gained through the process of exam item analysis outlined in Chapter 4.

The tool used to evaluate the past question papers is the Bloom's Taxonomy, as developed into an interpretive framework in chapter 3.

5.2   Distribution of Geography Paper 1 Questions by cognitive level

	2009	2010	2011	2012	2013	Total	%
Remembering	23	33	28	22	30	136	54.4
Understanding	16	8	7	8	8	47	18.8
Applying	10	8	10	15	11	54	22.4
Analyzing	0	1	5	5	1	12	4.4
Evaluating	1	0	0	0	0	1	0.4
Creating	0	0	0	0	0	0	0
Total no. of questions	50	50	50	50	50	250	100
Total no. of questions testing CT skills	1	1	5	5	1	13	
%	2	2	10	10	2	5.2	

Table 1. *Distribution of GCE 'O' Level Geography 2218 paper 1 questions by cognitive level for the years 2009-2013*

Table 1 above shows the distribution of questions according to Bloom's Taxonomy for GCE 'O' level Geography 2218 paper 1 set by ECZ for each year from 2009 to 2013. Each exam paper consists of 50 multiple choice questions. Of the 250 questions analysed in total, 136 or 54.4% were at the remembering level, 47 or 18.8% were at the understanding level, 54 or 22.4% were at the application level, 12 or 4.4% were at the analysing level and 1 or 0.4% were at the evaluating level. There were no questions at the level of synthesis or creating. Furthermore, the percentage of questions testing the critical thinking skills of analysis, evaluation or creation were 2% for 2009, 2% for 2010, 10% for the years 2011 and 2012 and 2% for 2013. Out of the 250 questions analysed, only 13 or 5.2% tested for the critical thinking skills of analysis, evaluation or creation.

Figure 6 is a representation of the data in Table 1. It shows that 55% of the questions set in Geography 2218 were at the level of recall, 19% tested understanding, 22% tested application and 4% analysis. Figure 1 shows that more than half of the questions set in

Geography 2218 in the years 2009-2014 required only the memorisation and regurgitation of facts and concepts.

From the foregoing analysis, it can be said that the Geography paper 1 places very little emphasis on testing the critical thinking skills of analysis, evaluation and creation. There is a disproportionately high number of questions requiring only memorisation skills. This, coupled with the extremely low number of questions requiring critical thinking skills shows that the paper does not promote the development critical thinking skills.

The distribution of questions for Geography 2218 paper 1 for all papers in the sample also shows that there is little to no integration of critical thinking skills in the Geography curriculum.
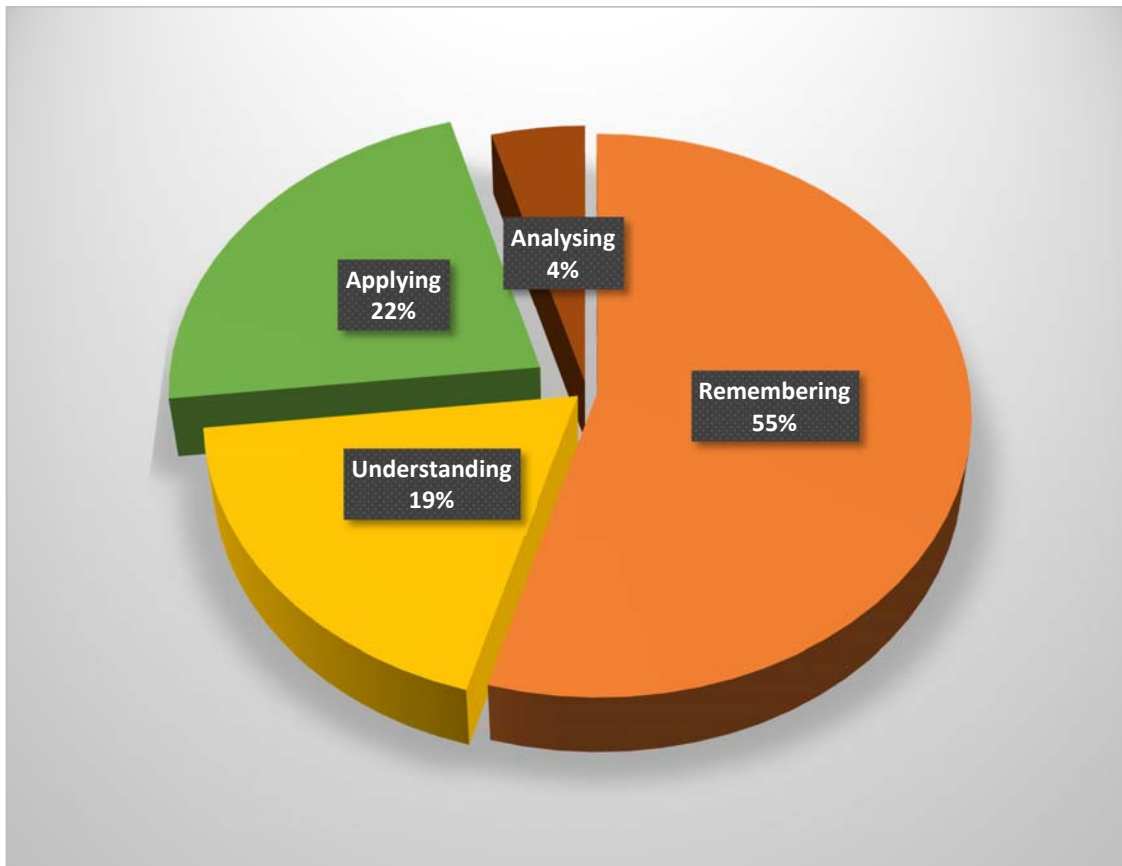

Figure 6 *Distribution of Geography 2218 paper 1 questions by cognitive level*

5.3   Distribution of Geography Paper 2 Questions by cognitive level

	2009	2010	2011	2012	2013	Total	%
Remembering	28	25	34	34	20	141	57.8
Understanding	14	22	20	13	26	95	38.9
Applying	0	0	1	2	1	4	1.6
Analyzing	0	0	1	1	1	3	1.2
Evaluating	1	0	0	0	0	1	0.4
Creating	0	0	0	0	0	0	0
Total no. of questions	43	47	56	50	48	244	100
Total no. of questions testing CT skills	1	0	1	1	1	4	
%	2.3	0	1.8	2	2.1	1.6	

Table 2. *Distribution of GCE 'O' Level Geography 2218 paper 2 questions by cognitive level for the years 2009-2013*

Table 2 shows the distribution of questions by cognitive level for the GCE 'O' level Geography 2218 paper 2 set by ECZ for the years 2009 to 2013. The Geography paper 2 exam paper usually has twelve main questions, each with typically three or four parts. The total number of questions on each exam paper is therefore variable. The paper is divided into four sections and students are required to answer one question from each section. Of the 244 questions analysed in total, 141 or 57.8% were at the remembering level, 95 or 38.9% were at the understanding level, 4 or 1.6% were at the application level, 3 or 1.2% were at the analysing level and 1 or 0.4% were at the evaluating level. There were no questions testing synthesis or creating. Furthermore, the percentage of questions testing the critical thinking skills of analysis, evaluation or creation were 2.3% for 2009, 0% for 2010, 1.8% for 2011 and 2% and 2.1% for the years 2012 and 2013 respectively. Out of the 244 questions analysed, only 4 or 1.6% tested the critical thinking skills of analysis, evaluation or creation.
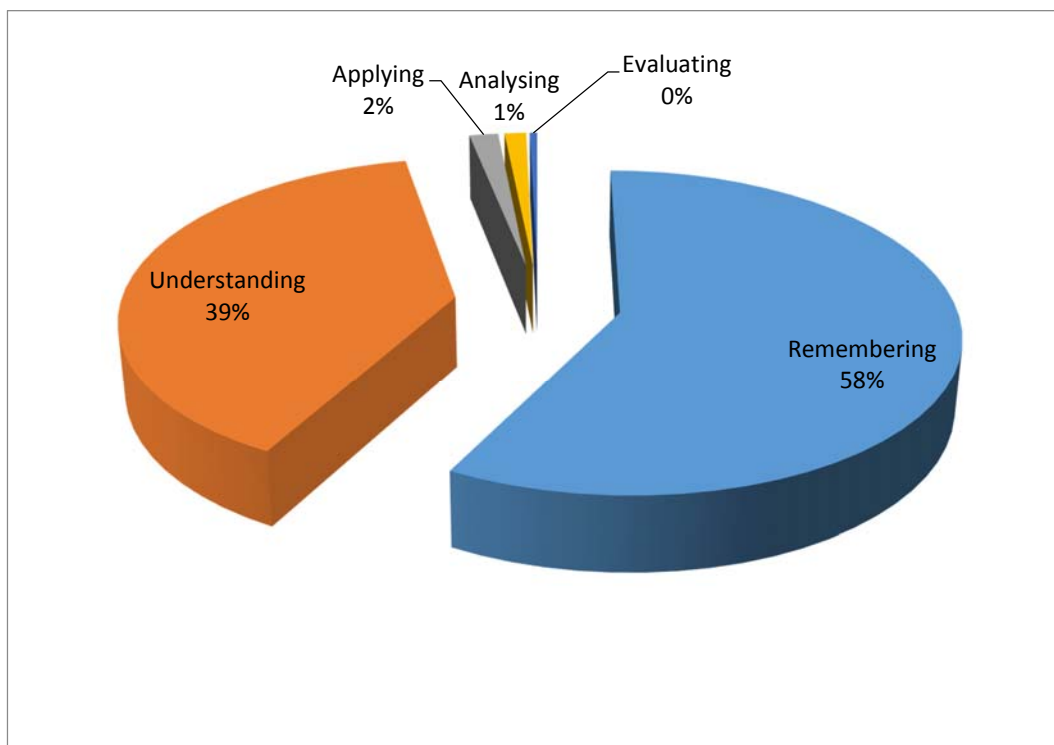
Figure 7: *Distribution of Geography 2218 paper 2 questions by cognitive level*

Figure 7 is a pie chart representing the data in Table 2. It shows that 58% of all the questions set in Geography in the period under review were at the level of recall, 39% required understanding, 2% tested application and 1% analysis. Like for paper 1, the pie chart shows that more than half of the questions set in Geography in the years 2009-2013 required only the memorisation and regurgitation of facts and concepts. Overall, 97% of all the questions sampled required only lower order skills.

From the foregoing analysis, it can be said that the Geography paper 2, like paper 1, placed very little emphasis on the testing of the critical thinking skills of analysis, evaluation and creation. There is again a disproportionately high number of questions requiring only memorisation and regurgitation skills. This, coupled with the extremely low number of questions requiring critical thinking skills of analysis, evaluation and creation, shows that the exam in GCE 'O' level Geography paper 2, like paper 1, does not encourage the use of critical thinking skills.

5.4   Comparison of Geography Papers 1 and 2 using t-test

In order to find out whether or not there was a significant difference between Geography papers 1 and 2 in terms of testing for the critical thinking skills of analysis, evaluation and creation, a t-test was carried out at the 99% significance level. This is shown below.

Year	% of questions testing for CT skills (paper 1)	% of questions testing for CT skills (paper 2)
2009	2	2.3
2010	2	0
2011	10	1.7
2012	10	2
2013	2	2.1

Let μ_1 and μ_2 denote the population mean percentages for papers 1 and 2 respectively.

H_0 : $\mu_1 = \mu_2$ There is essentially no difference between the two papers

H_1 : $\mu_1 \neq \mu_2$ There is a significant difference between the two papers

$\acute{X}_1$ = mean for paper 1 = 5.2

$$s = \sqrt{\frac{\sum_{i=1}^{N}(x_i - \bar{x})^2}{n-1}}$$

$$= \sqrt{\frac{(2-5.2)^2 + (2-5.2)^2 + (10-5.2)^2 + (10-5.2)^2 + (2-5.2)^2}{5-1}}$$

$$= 3.92$$

$\acute{X}_2$ = mean for paper 2 = 1.62

$$= \sqrt{\frac{(2-1.62)^2 + (0-1.62)^2 + (1.7-1.62)^2 + (2-1.62)^2 + (2.1-1.62)^2}{5-1}}$$

$$= 1.77$$

89

$$= \quad \frac{5.2 - 1.62}{\sqrt{\left(\frac{(5-1)3.92^2 + (5-1)1.77^2}{5+5-2}\right)\left(\frac{1}{5}+\frac{1}{5}\right)}}$$

$$= \quad 1.79$$

The p-value is 0.111749.

The decision rule is: accept the null hypothesis if -3.355 < t < 3.355. Reject the null hypothesis otherwise.

For $\alpha = 0.01$, 8 degrees of freedom, the value of t calculated lies within the acceptance region. Since the *p*-value is bigger than the significance level (α), it suggests that the observed data are consistent with the assumption that the null hypothesis is true and thus the hypothesis must not be rejected. Therefore, from the above results, the null hypothesis that there is no significant difference between the two Geography papers in terms of testing for critical thinking skills cannot be rejected. In other words, there is no significant difference between Geography papers 1and 2 in terms of testing for the critical thinking skills of analysis, evaluation and creation.

5.5   Distribution of Geography Papers 1 and 2 questions combined by cognitive level

	2009	2010	2011	2012	2013	Total	%
Remembering	51	58	62	64	50	285	56.7
Understanding	30	28	27	21	34	140	27.8
Applying	10	9	11	17	12	59	11.7
Analyzing	0	2	6	6	2	16	3.2
Evaluating	2	1	0	0	0	3	0.6
Creating	0	0	0	0	0	0	0
Total no. of questions	93	98	106	108	98	503	100
Total no. of questions Testing CT skills	2	3	6	6	2	19	
%	2.2	3.1	5.7	5.6	2	3.8	

Table 3. *Distribution of GCE 'O' Level Geography 2218 papers 1 and 2 questions combined by cognitive level for the years 2009-2013*

Table 3 shows the distribution of questions by cognitive level for the GCE 'O' level Geography 2218 papers 1 and 2 combined for the years 2009 to 2013. Of the 503 questions

analysed in total, 285 or 56.7% were at the remembering level, 140 or 27.8% were at the understanding level, 59 or 11.7% were at the application level, 16 or 3.2% were at the analysing level and 3 or 0.6% were at the evaluating level. There were no questions testing synthesis or creating. Furthermore, the percentage of questions testing the critical thinking skills of analysis, evaluation or creation were 2.2% for 2009, 3.1% for 2010, 5.7% for 2011 and 5.6% and 2% for the years 2012 and 2013 respectively. Out of the 503 questions analysed, only 19 or 3.8% tested for the critical thinking skills of analysis, evaluation or creation.

Figure 8 is a representation of the data in Table 3. It shows that 57% of the questions set in Geography papers 1 and 2 combined were at the level of recall, 28% tested for understanding, 11% tested for application and 3.2% for analysis and 0.6% for evaluation. The pie chart shows that more than half of the all the questions set in Geography papers 1 and 2 in the years 2009-2014 required only the recall of information.
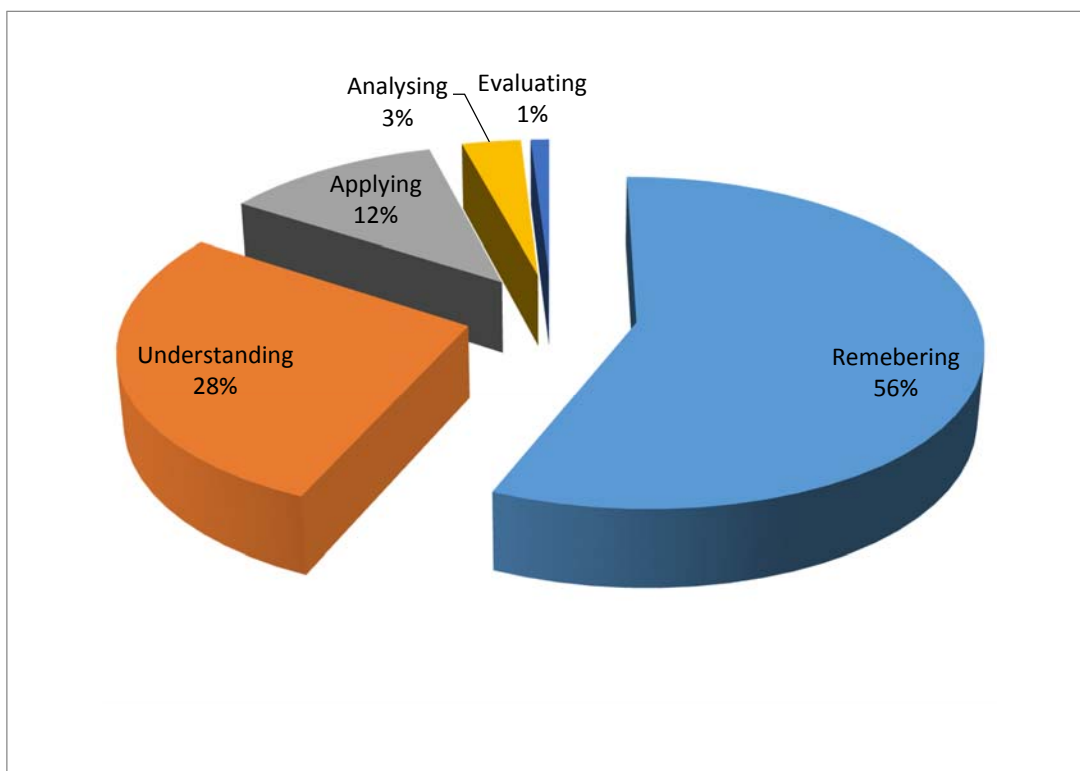

Figure 8 *Distribution of Geography 2218 papers 1 and 2 questions combined by cognitive level*

From the foregoing analysis, it can be said that the questions set in both Geography papers placed more emphasis on the lower-order skills than on higher-order skills. There is a high proportion of questions requiring only memorisation and regurgitation skills. The extremely low number of questions requiring critical thinking skills of analysis, evaluation and creation begs the question: "how can an improvement in critical thinking skills of analysis, evaluation and creation be achieved with such a low proportion of higher order questions?

5.6   Distribution of Biology Paper 1 Questions by cognitive level

	2009	2010	2011	2012	2013	Total	%
Remembering	18	20	23	20	15	96	48
Understanding	8	11	9	12	15	55	27.5
Applying	8	6	7	3	8	32	16
Analyzing	5	3	0	5	2	15	7.5
Evaluating	1	0	1	0	0	2	1
Creating	0	0	0	0	0	0	0
Total no. of questions	40	40	40	40	40	200	100
Total no. of questions testing critical thinking skills	6	3	1	5	2	17	
%	15	7.5	2.5	12.5	5	8.5	

Table 4. *Distribution of GCE 'O' Level Biology 5090 paper 1 questions by cognitive level for the years 2009-2013*

Table 4 shows the distribution of questions by cognitive level for the GCE 'O' level Biology 5090 paper 1 for the years 2009 to 2013. Biology paper 1 consists of 40 multiple-choice questions. Of the 200 questions analysed in total, 96 or 48% were at the remembering level, 55 or 27.5% were at the understanding level, 32 or 16% were at the application level, 15 or 7.52% were at the analysing level and 2 or 1% were at the evaluating level. There were no questions testing synthesis. Additionally, the percentage of questions testing the critical thinking skills of analysis, evaluation or creation were 15% for 2009, 7.5% for 2010, 2.5% for the years 2011, 12.5% 2012 and 5% for the year 2013. Out of the 200 questions analysed, only 17 or 8.5% tested for the critical thinking skills of analysis, evaluation or creation.
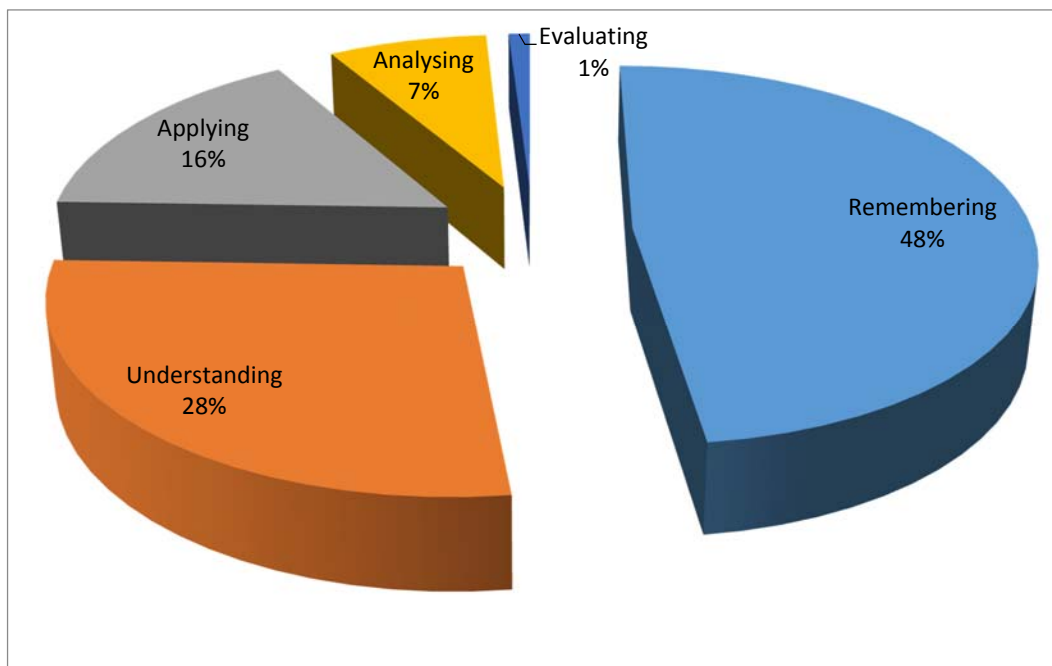
Figure 9. *Distribution of Biology 5090 paper 1 questions by cognitive level*

Distribution of Biology Paper 2 Questions by cognitive level

	2009	2010	2011	2012	2013	Total	%
Remembering	20	19	18	17	13	87	45.3
Understanding	18	8	10	13	15	64	33.3
Applying	2	9	4	1	6	22	11.5
Analyzing	2	1	3	4	2	12	7.5
Evaluating	1	1	0	1	4	7	3.6
Creating	0	0	0	0	0	0	0
Total no. of questions	43	38	35	36	40	192	100
Total no. of questions testing CT skills	3	2	3	5	6	17	
%	7.0	5.3	8.5	13.9	15	8.9	

Table 5 *Distribution of GCE 'O' Level Biology 5090 paper 2 questions by cognitive level for the years 2009-2013*
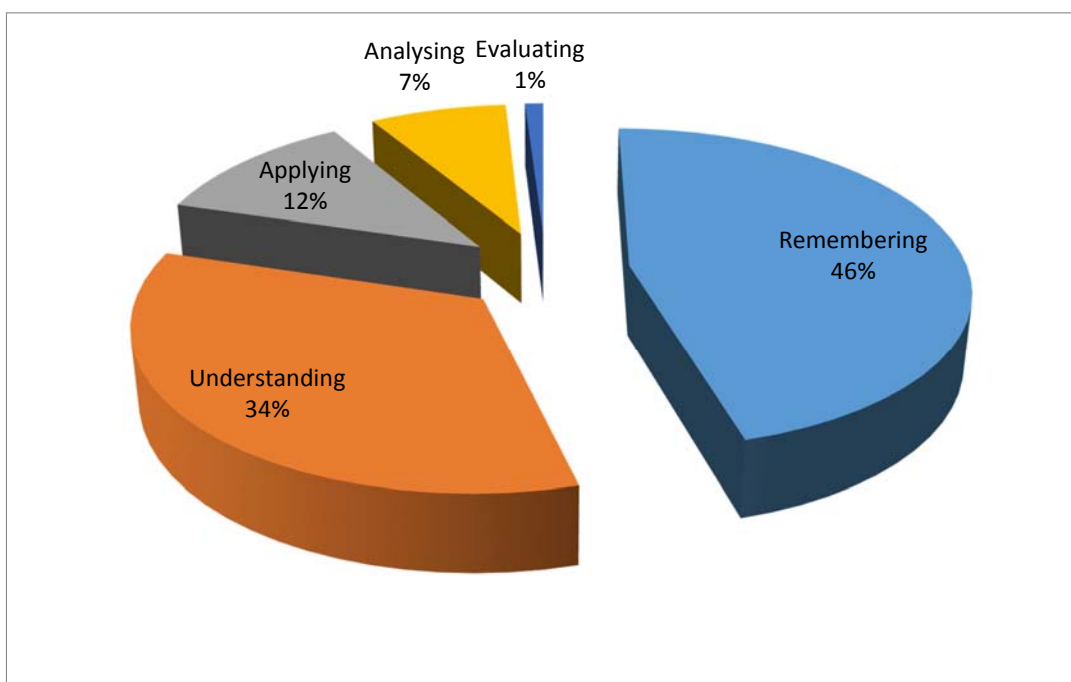
93

Figure 10 *Distribution of Biology 5090 paper 2 questions by cognitive level*

Table 5 shows the distribution of questions by cognitive level for the years 2009 to 2014 for the GCE 'O' level Biology 5090 paper 2.

Biology paper 2 consists of two sections. The first section requires short answers, while the second section requires longer answers. Though the total number of marks for all the Biology paper 2 exams are the same, the total number of questions is variable. Of the total of 192 questions analysed in total, 87 or 45.3% were at the remembering level, 64 or 33.3% were at the understanding level, 22 or 11.5% were at the application level, 12 or 7.5% were at the analysing level and 7 or 3.6% were at the evaluating level. There were no questions testing synthesis.

Additionally, the percentage of questions testing the critical thinking skills of analysis, evaluation or creation were 7.0% for 2009, 5.3% for 2010, 8.6% for 2011, 13.9% for 2012 and 15% for the year 2013. Out of the 192 questions analysed, only 17 or 8.9% tested for the critical thinking skills of analysis, evaluation or creation.

Figure 10 is a summary of the data shown in Table 5. It shows that of the 192 questions examined in total in Biology paper 2, 46% tested remembering of facts and concepts, 34%

tested understanding, 12% tested application, 7% tested analysis and 1% tested evaluation. There were no questions testing creative skills.

The distribution of questions by cognitive level for Biology 5090 paper 2 for all the years sampled shows that there is more emphasis on recall-type questions in the exams than on questions which test the critical thinking skills of analysis, evaluation or creation. Most of the questions require only the memorisation of factual information. This generally correlates with the distribution of questions by cognitive level which shows a very low emphasis on higher order questions.

5.8   Distribution of Biology Paper 3 Questions by cognitive level

	2009	2010	2011	2012	2013	Total	%
Remembering	11	15	12	7	3	48	36.1
Understanding	3	5	10	8	17	43	32.3
Applying	2	2	2	3	8	17	12.8
Analyzing	0	3	0	0	1	4	3
Evaluating	3	9	0	7	0	19	14.3
Creating	1	0	0	1	0	2	1.5
Total no. of questions	20	34	24	26	29	133	100
Total no. of questions testing CT skills	4	12	0	8	1	25	12.8
%	20	35.3	0	30.7	3.4	18.8	

Table 6. *Distribution of GCE 'O' Level Biology 5090 paper 3 questions by cognitive level for the years 2009-2013*

Table 6 shows the distribution of questions by cognitive level for the GCE 'O' level Biology 5090 paper 3 for the years 2009-2013. Biology paper 3 is a practical paper and consists of two questions. Candidates are required to answer both questions and each question contains several parts. Of the total of 133 questions analysed in total, 48 or 36.1% were at the remembering level, 43 or 32.3% were at the understanding level, 17 or 12.8% were at the application level, 4 or 3% were at the analysing level, 19 or 14.3% were at the evaluating level and 2 or 1.5% were at the creating level. Furthermore, the percentage of questions testing the critical thinking skills of analysis, evaluation or creation were 20% for 2009, 35.3% for 2010, 0% for the years 2011, 30.7% 2012 and 3.4% for the year 2013.

Figure 11 represents the data shown in Table 6. It shows that of total of 133 questions analysed, 36% required remembering, 32% required understanding, 13% required application, 3% required analysis, 14% required evaluating skills and 2% required creating.

Compared with papers 1 and 2, paper 3 contains a higher proportion of questions testing the higher order skills of analysing, evaluating and creating. This could be attributed to the nature of paper 3 which seems to demand more reasoning, analysis and evaluation skills. However, there is still a very high proportion of questions (68%) testing lower order skills.
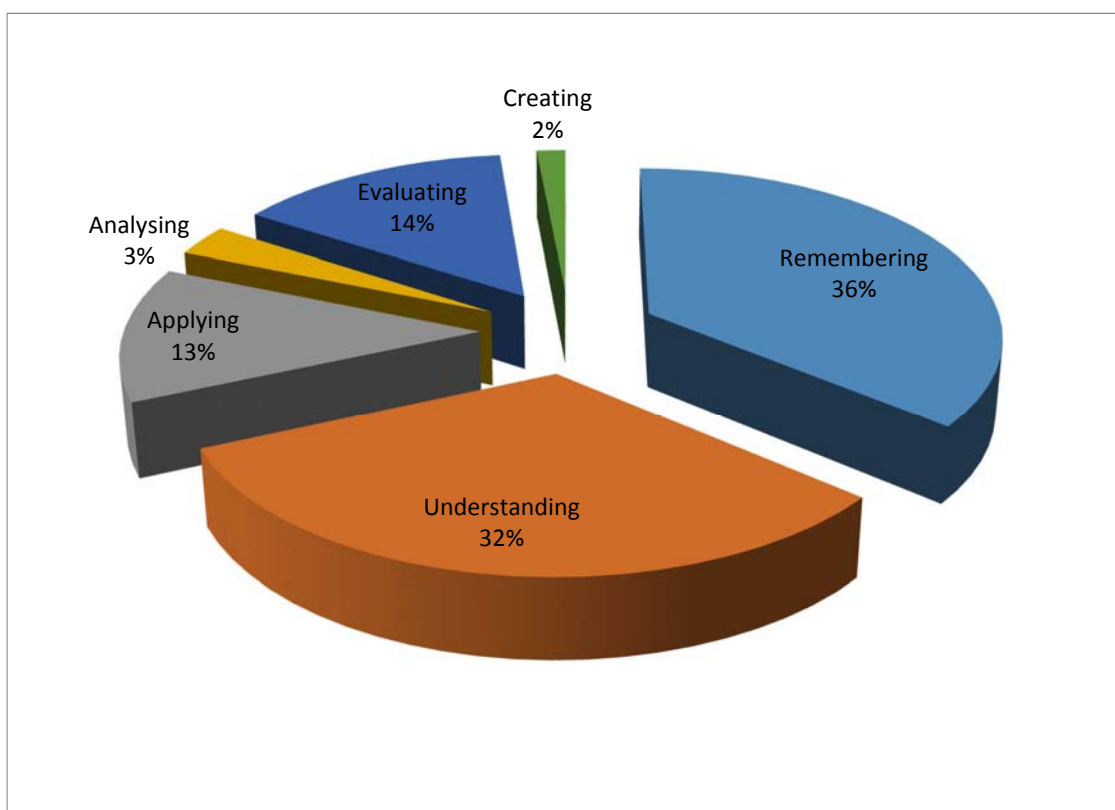

Figure 11. *Distribution of Biology 5090 paper 3 questions by cognitive level*

5.9   Comparison of Biology Papers 1 and 2 using t-test

In order to assess whether or not the theory paper (paper 2) demanded more critical thinking skills than the multiple-choice paper (papers 2), a t-test was carried out. This test is shown below.

Year	% of questions testing for CT skills (paper 1)	% of questions testing for CT skills (paper 2)
2009	15	7
2010	7.5	5.3
2011	2.5	8.6
2012	12.5	13.9
2013	5	15

Let μ_1 and μ_2 denote the population means for papers 1 and 2 respectively.

$H_0 : \mu_1 = \mu_2$ There is no significant difference between the two papers in terms of testing for critical thinking skills

$H_1 : \mu_1 < \mu_2$ Paper 2 demands more critical thinking skills than paper 1.

$\bar{X}_1 =$ mean for paper 1 = 8.5

$$s = \sqrt{\frac{\sum_{i=1}^{N}(x_i - \bar{x})^2}{n-1}}$$

$$= \sqrt{\frac{(15-8.5)^2+(7.5-8.5)^2+(2.5-8.5)^2+(12.5-8.5)^2+(5-8.5)^2}{5-1}}$$

$$= 5.18$$

$\bar{X}_2 =$ mean for paper 2 = 9.96

$$s = \sqrt{\frac{\sum_{i=1}^{N}(x_i - \bar{x})^2}{n-1}}$$

97

$$= \sqrt{\frac{(7-9.96)^2+(5.3-9.96)^2+(8.6-9.96)^2+(13.9-9.96)^2+(15-9.96)^2}{5-1}}$$

$$= 4.28$$

$$t = \frac{\overline{X}_1 - \overline{X}_2}{\sqrt{\left(\frac{(N_1-1)s_1^2 + (N_2-1)s_2^2}{N_1 + N_2 - 2}\right)\left(\frac{1}{N_1} + \frac{1}{N_2}\right)}}$$

$$= \frac{8.5-9.96}{\sqrt{\left(\frac{(5-1)5.18^2+(5-1)4.28^2}{5+5-2}\right)\left(\frac{1}{5}+\frac{1}{5}\right)}}$$

$$= -0.486$$

The p-value is 0.320

The decision rule adopted is: accept the null hypothesis if t < -2.90. Reject the null hypothesis otherwise.

Therefore for $\alpha = 0.01$, the null hypothesis cannot be rejected. Moreover, since the *p*-value is bigger than the significance level (α), it suggests that the observed data are consistent with the assumption that the null hypothesis is true and thus must not be rejected. This means that there is no significant difference between the Biology 5070 multiple-choice paper (paper 1) and the theory paper (paper 2) in terms of testing for the critical thinking skills of analysis, evaluation and creation.

5.10 Comparison of Biology Papers 2 and 3 using t-test

In order to test the hypothesis that the practical exam paper (paper 3) demanded more critical thinking skills than the theory paper (papers 2), a t-test was carried out. This test is shown below.

Year	% of questions testing for CT skills (paper 2)	% of questions testing for CT skills (paper 3)
2009	7	20

2010	5.3	35.3
2011	8.6	0
2012	13.9	30.8
2013	15	3.4

Let μ_1 and μ_2 denote the population mean percentages for papers 2 and 3 respectively.

$H_0 :$ $\mu_1 = \mu_2$ There is essentially no difference between the two papers in terms of testing for critical thinking skills

$H_1 :$ $\mu_1 \neq \mu_2$ There is a significant difference between the two papers in terms of testing for critical thinking skills.

$\bar{X}_1 =$ mean for paper 2 = 9.96

$$s = \sqrt{\frac{\sum_{i=1}^{N}(x_i - \bar{x})^2}{n-1}}$$

$$= \sqrt{\frac{(7-9.96)^2+(5.3-9.96)^2+(8.6-9.96)^2+(13.9-9.96)^2+(15-9.96)^2}{5-1}}$$

$$= 4.28$$

$\bar{X}_2 =$ mean for paper 3 = 22.38

$$s = \sqrt{\frac{\sum_{i=1}^{N}(x_i - \bar{x})^2}{n-1}}$$

$$= \sqrt{\frac{(20-22.38)^2+(35.3-22.38)^2+(0-22.38)^2+(30.8-22.38)^2+(3.4-22.38)^2}{5-1}}$$

$$= 16.62$$

$$t = \frac{\bar{X}_1 - \bar{X}_2}{\sqrt{\left(\frac{(N_1-1)s_1^2 + (N_2-1)s_2^2}{N_1 + N_2 - 2}\right)\left(\frac{1}{N_1} + \frac{1}{N_2}\right)}}$$

$$= \frac{9.96-22.38}{\sqrt{\left(\frac{(5-1)4.38^2+(5-1)16.620^2}{5+5-2}\right)\left(\frac{1}{5}+\frac{1}{5}\right)}}$$

$$= \quad -1.082$$

The p-value is 0.312

The decision rule is: accept the null hypothesis if -3.355 < t < 3.355. Reject the null hypothesis otherwise. Therefore for $\alpha = 0.01$, the null hypothesis cannot be rejected. This means that there is no significant difference between the Biology practical paper (paper 3) and the theory paper (paper 2) in terms of testing for the critical thinking skills of analysis, evaluation and creation. Furthermore, since the p-value is bigger than the significance level (α), it suggests that the observed data are consistent with the assumption that the null hypothesis is true and thus the hypothesis must not be rejected.

5.11 Distribution of Biology Papers 1, 2 and 3 questions combined by cognitive level

	2009	2010	2011	2012	2013	Total	%
Remembering	49	54	53	44	31	231	44
Understanding	29	24	29	33	47	162	30.9
Applying	12	17	13	7	22	71	13.5
Analyzing	7	7	3	9	5	31	5.9
Evaluating	5	10	1	8	4	28	5.3
Creating	1	0	0	1	0	2	0.4
Total no. of questions	103	112	99	102	109	525	100
Total no. of questions testing CT skills	13	17	4	18	9	61	
%	12.6	15.2	4	17.6	8.3	11.6	

Table 7 *Distribution of GCE 'O' Level Biology 5090 papers 1, 2 and 3 questions combined by cognitive level for the years 2009-2013*

Table 7 shows that 44% of all questions set were at the level of remembering, 30.9% were at the level of understanding, 13.5% were at the level of application, 5.9% at the level of analysis, 5.3% were at the level of evaluation and 0.4% were at the level of synthesis.

5.12 Comparison of Biology and Geography Exams using the t-test

In order to find out whether or not there was a significant difference between Biology and Geography in terms of testing for critical thinking skills, a t-test was carried out. This test is shown below.

Year	% of questions testing for CT skills (Biology)	% of questions testing for CT skills (Geography)
2009	12.6	2.2
2010	15.2	3.1
2011	4	5.7
2012	17.6	5.7
2013	8.3	2

Let μ_1 and μ_2 denote the population mean percentages for Biology and Geography respectively.

$H_0 : \mu_1 = \mu_2$ There is essentially no difference between the two subjects

$H_1 : \mu_1 \neq \mu_2$ There is a significant difference between the two subjects

$\acute{X}_1$ = mean for Biology = 11.54

$$s = \sqrt{\frac{\sum_{i=1}^{N}(x_i - \overline{x})^2}{n-1}}$$

$$= \sqrt{\frac{(12.6-11.54)^2+(15.2-11.54)^2+(4-11.54)^2+(17.6-11.54)^2+(8.3-11.54)^2}{5-1}}$$

$$= 5.45$$

$\acute{X}_2$ = mean for Geography = 3.72

$$s = \sqrt{\frac{\sum_{i=1}^{N}(x_i - \overline{x})^2}{n-1}}$$

101

$$= \sqrt{\frac{(2.2-3.72)^2+(3.1-3.72)^2+(5.7-3.72)^2+(5.6-3.72)^2+(2-3.72)^2}{5-1}}$$

$$= 1.81$$

$$t = \frac{11.54-3.72}{\sqrt{\left(\frac{(5-1)5.45^2+(5-1)1.81^2}{5+5-2}\right)\left(\frac{1}{5}+\frac{1}{5}\right)}}$$

$$= 3.0352$$

The p-value is 0.0162.

The decision rule is: accept the null hypothesis if -3.355 < t < 3.355. Reject the null hypothesis otherwise.

For α = 0.01, 8 degrees of freedom, the value of t calculated lies within the acceptance region. Since the *p*-value is bigger than the significance level (α), it suggests that the observed data are consistent with the assumption that the null hypothesis is true and thus the hypothesis must not be rejected. Therefore, from the above results, we accept the null hypothesis that there is no significant difference between the Biology and Geography papers in terms of testing for critical thinking skills.

5.13 Trends in the Proportion of Questions by Cognitive Skill

Since the data collected in this study is longitudinal as it tracks the same type of information at multiple points in time, it was necessary to process it further in order to determine the general trend in the proportions of questions testing the different cognitive skills. Each component paper is considered in turn.

102

5.13.1   Trends in Geography 2218 Paper 1

Category	2009	2010	2011	2012	2013
Remembering	46%	66%	56%	44%	60%
Understanding	32%	16%	14%	16%	16%
Applying	20%	16%	20%	30%	22%
Analysing	0%	2.00%	10%	10%	2.0%
Evaluating	2%	0%	0%	0%	0%
Creating	0%	0%	0%	0%	0%

Table 8: *Proportion of Questions by Cognitive Skill for Geography 2218 Paper 1*
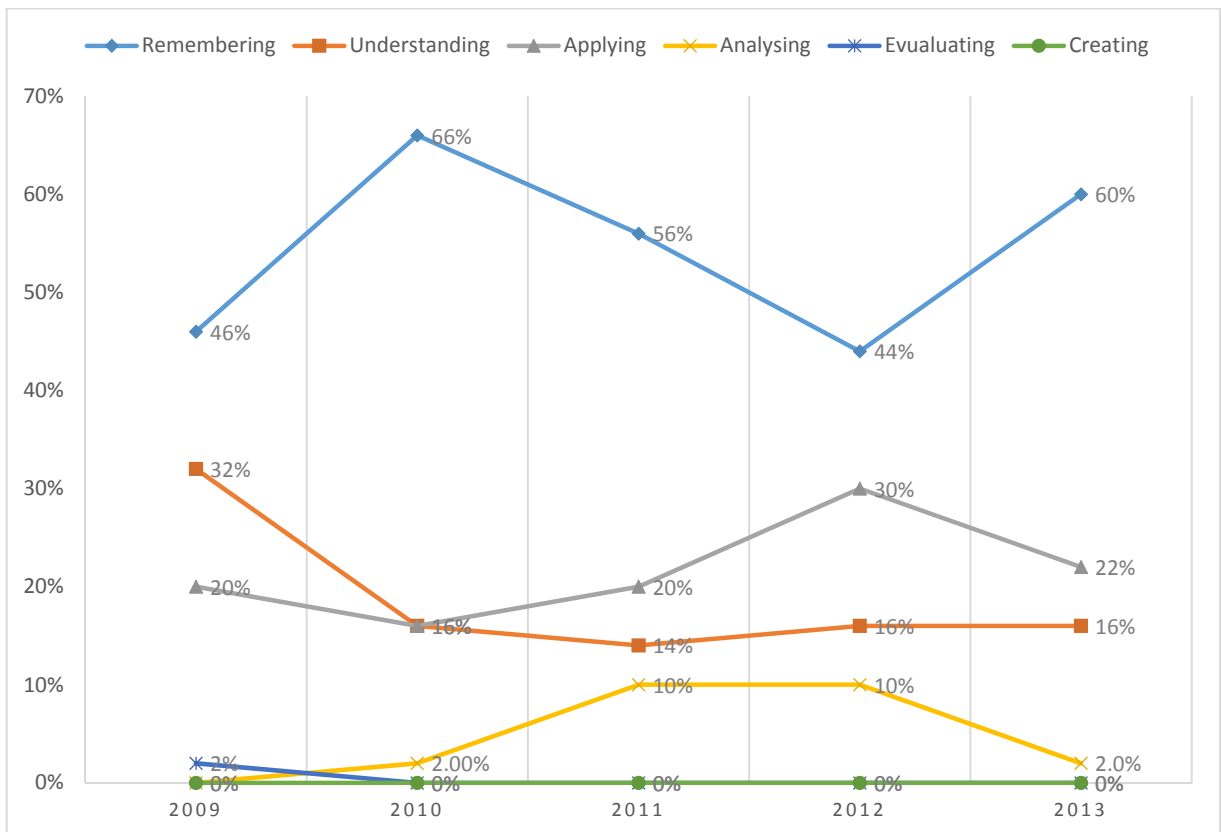
Figure 12: *Trends in the Proportion of Questions by Cognitive Skill for Geography 2218 Paper 1*

An analysis of the graphs in Figure 12 which relate to Geography Paper 1 shows that the proportion of questions testing recall exhibits a general upward trend and has increased

103

from 46% in 2009 to 60% in 2013. However, the increase has not been constant but rather erratic. Similarly, the proportion of questions testing application has shown a general upward trend, increasing from 20 % in 2009 to 22% in 2013. Again, the increase has been not been steady but erratic. By the same token, there has been a general increase in the proportion of questions testing analysis skills from 2009-2013.

However, the proportion of questions testing understanding and evaluation has shown a general downward trend. There has been no change in the proportion of questions testing creation. It has remained constant at 0% meaning that there has been no questions testing creation or synthesis in the period from 2009-2013. This is consistent with the fact that there cannot be questions requiring creation or synthesis in a multiple-choice paper.

5.13.2   Trends in Geography 2218 Paper 2

Category	2009	2010	2011	2012	2013
Remembering	65.1%	53.2%	60.7%	68%	41.7%
Understanding	32.6%	46.8%	35.7%	26%	54.2%
Applying	0%	0%	1.8%	4%	2.1%
Analysing	0%	0%	1.8%	2%	2.1%
Evaluating	2%	0%	0%	0%	0%
Creating	0%	0%	0%	0%	0%

Table 9: *Proportion of Questions by Cognitive Skill for Geography 2218 Paper 2*
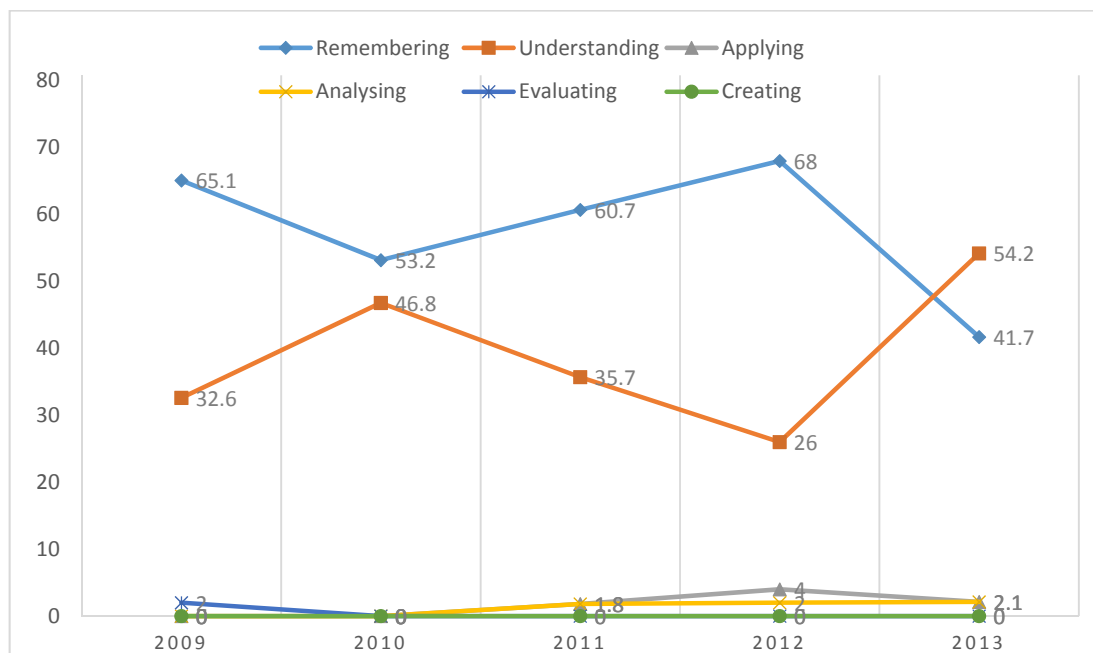
Figure 13: *Trends in the Proportion of Questions by Cognitive Skill for Geography 2218 Paper 2*

An analysis of the graphs in Figure 13 which relate to Geography Paper 2 reveals that the proportion of questions testing recall exhibits fluctuations but has a general downward trend. The proportion of questions testing recall decreased from 65.1% in 2009 to 41.7% in 2013. The change has not been constant or steady but erratic. By contrast, the proportion of questions testing understanding has shown a general upward trend, increasing from 32.6 % in 2009 to 54.2% in 2013. The increase has also not been steady but erratic.

By the same token, there has been a general increase in the proportion of questions testing application skills. Similarly, the proportion of questions testing analysis has also increased very slightly since 2011. However, the proportion of questions testing evaluation skills dropped from 2% in 2009 to 0% in 2010 and has remained at this level up until 2013. There has been no questions testing creation or synthesis in the period from 2009-2013 in Geography 2218 paper 2.

Apart from cyclic and other long-term variations which are normally present in time series data like this, there may be other factors responsible for trends exhibited in the data. The researcher has not determined whether or not there was a deliberate policy by the Ministry of Education to, for example, reduce the proportion of questions testing recall because this is beyond the scope of the current study.

5.13.3   Trends in Biology 5090 Paper 1

Category	2009	2010	2011	2012	2013
Remembering	45%	50%	57.5%	50%	37.5%
Understanding	20%	27.5%	22.5%	30%	37.5%
Applying	20%	15%	17.5%	7.5%	20%
Analysing	12.5%	7.5%	0%	12.5%	5%
Evaluating	2.5%	0%	2.5%	0%	0%
Creating	0%	0%	0%	0%	0%

Table 10: *Proportion of Questions by Cognitive Skill for Biology 5090 Paper 1*
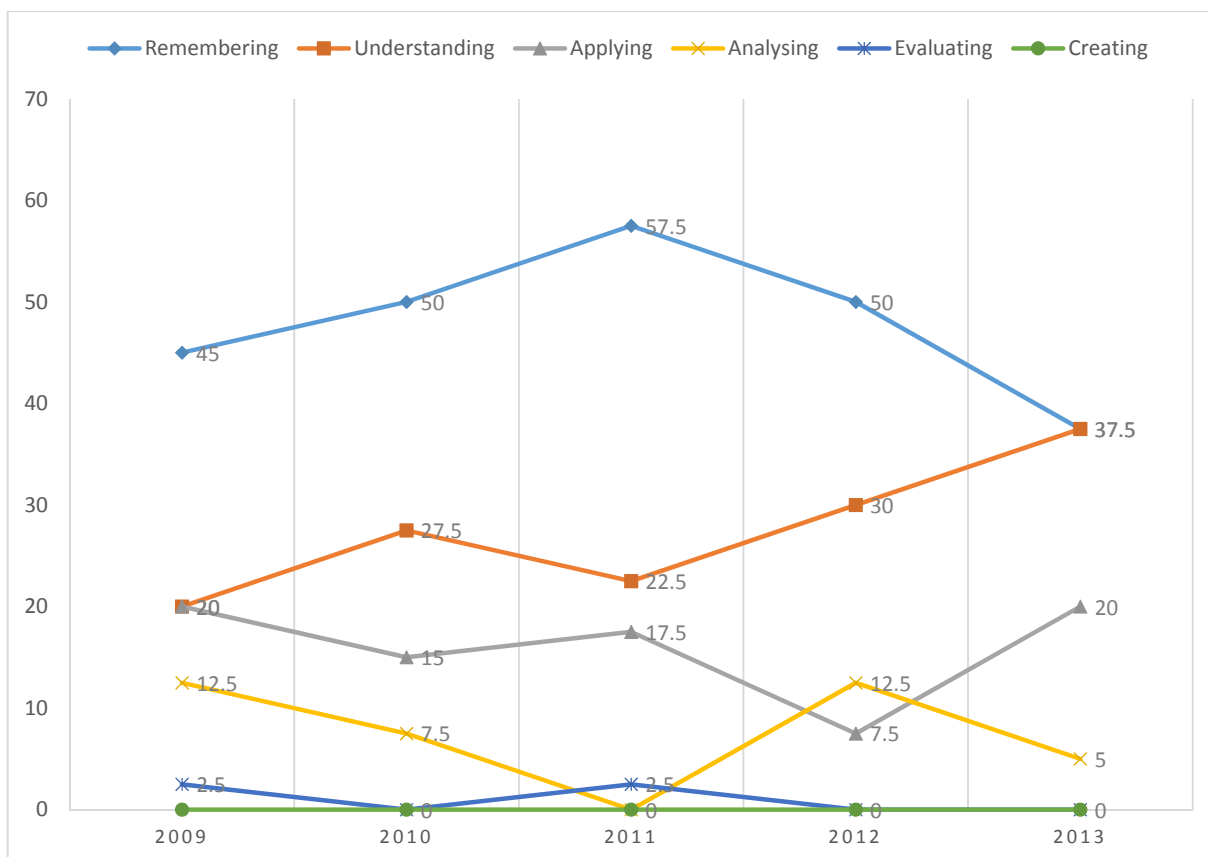
Figure 14: *Trends in the Proportion of Questions by Cognitive Skill for Biology 5090 paper 1*

An analysis of the graphs in Figure 14 relating to Biology Paper 2 shows that the proportion of questions testing recall increased from 45% to 57.5% from 2009-2011 and then decreased fairly steadily from 57.5% to 37.5% from 2011-2013. By contrast, the proportion of questions testing understanding has shown a general upward trend, increasing from 20 % in 2009 to 37.5% in 2013. The increase has also not been steady but inconsistent.

By the same token, there was a general downward trend in the proportion of questions testing application skills until 2012 when it increased sharply from 7.5% to 20%. Similarly, the proportion of questions testing analysis has shown a general downward trend from 2009-2013. The proportion of questions testing evaluation from has fluctuated between 0% and 2.5% from 2009-2013 while the proportion of questions testing creating has remained constant at 0%. This means that there has been no questions testing creation or synthesis in the period from 2009-2013 in Biology 5090 paper 1. This is again consistent with the

fact that there cannot be questions requiring creation or synthesis in a multiple-choice paper.

The researcher did not find out the factors behind the trends exhibited in the data because this was beyond the scope of this study.

5.13.4   Trends in Biology 5090 Paper 2

Category	2009	2010	2011	2012	2013
Remembering	47%	50%	51%	47%	33%
Understanding	42%	21%	29%	36%	38%
Applying	5%	24%	11%	3%	15%
Analyzing	5%	3%	9%	11%	5%
Evaluating	2%	3%	0%	3%	10%
Creating	0%	0%	0%	0%	0%

Table 11: *Proportion of Questions by Cognitive Skill for Biology 5090 Paper 2*
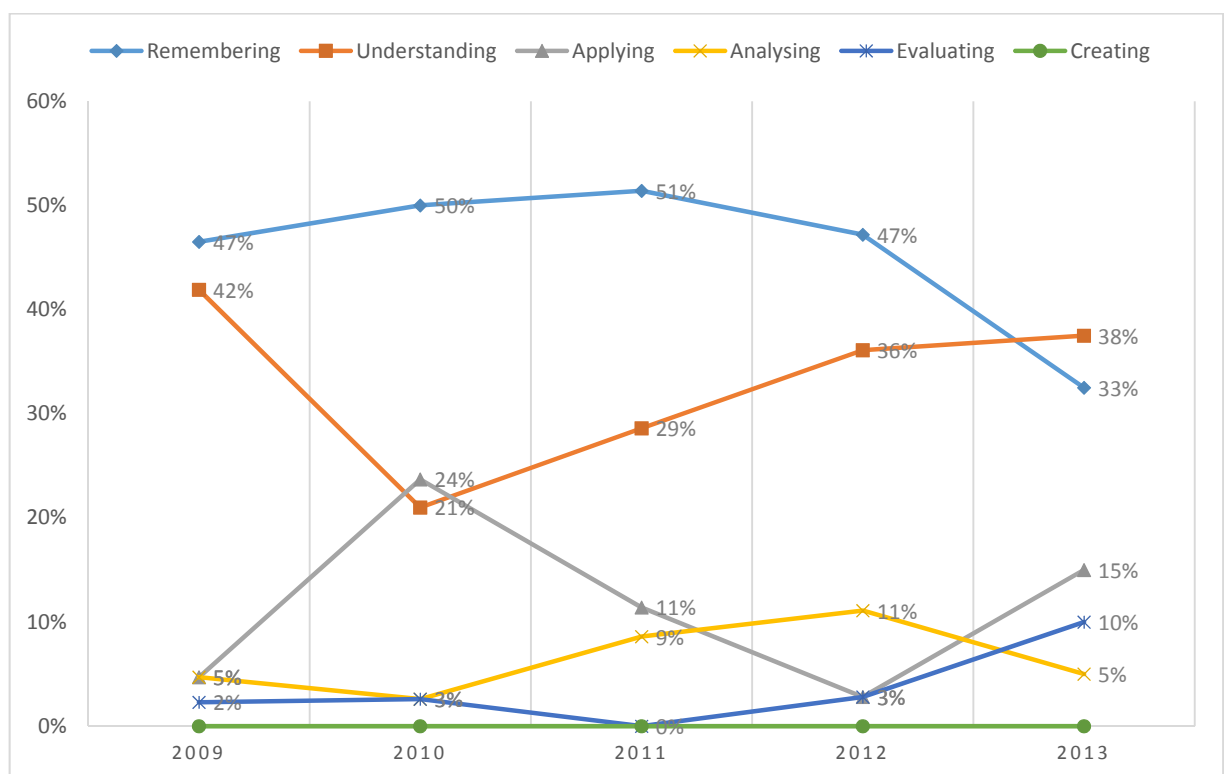

Figure 15: *Trends in the Proportion of Questions by Cognitive Skill for Biology paper 2*

A consideration of the graphs in Figure 15 which relate to Biology Paper 2 shows that the proportion of questions testing recall exhibits an upward trend from 2009 to 2011 and a downward trend from 2011 t0 2013. Similarly, the proportion of questions testing understanding shows a general downward trend, decreasing from 42% in 2009 to 38% in 2013. It can be noted that there was a very sharp decline in the proportion of questions testing understanding from 2009 to 2010.

By contrast, the proportion of questions testing application, analysis and evaluation show a general upward trend in the years 2009-2013. As alluded to earlier, the researcher does not have reasons for shifts in the pattern observed.

5.13.5   Trends in Biology 5090 Paper 3

Category	2009	2010	2011	2012	2013
Remembering	55%	44%	50%	27%	10%
Understanding	15%	15%	42%	31%	59%
Applying	10%	6%	8%	12%	28%
Analysing	0%	8.80%	0%	0%	3.4%
Evaluating	15%	27%	0%	27%	0%
Creating	5%	0%	0%	4%	0%

Table 12*: Proportion of Questions by Cognitive Skill for Biology 5090 Paper 3*

An analysis of the graphs given in Figure 16 (below) shows that the proportion of questions testing memorisation shows a downward trend from 2009-2013, decreasing rather sharply from 55% in 2009 to 10% in 2013. By contrast, the proportion of questions testing understanding has shown a general upward trend, increasing from 15 % in 2009 to 59% in 2013. The increase has not been steady but erratic. Similarly, the proportion of questions testing application skills shows a fairly steady upward trend.

Similarly, the proportion of questions testing analysis has shown a general downward trend from 2009-2013. On the other hand, the proportion of questions testing evaluation has exhibited very wide fluctuations from 2009-2013. Similarly, the proportion of questions testing creating has fluctuated between 0% and 5% from 2009-2013.

The researcher has not investigated the factors behind the trends exhibited in the data for reasons alluded to earlier.
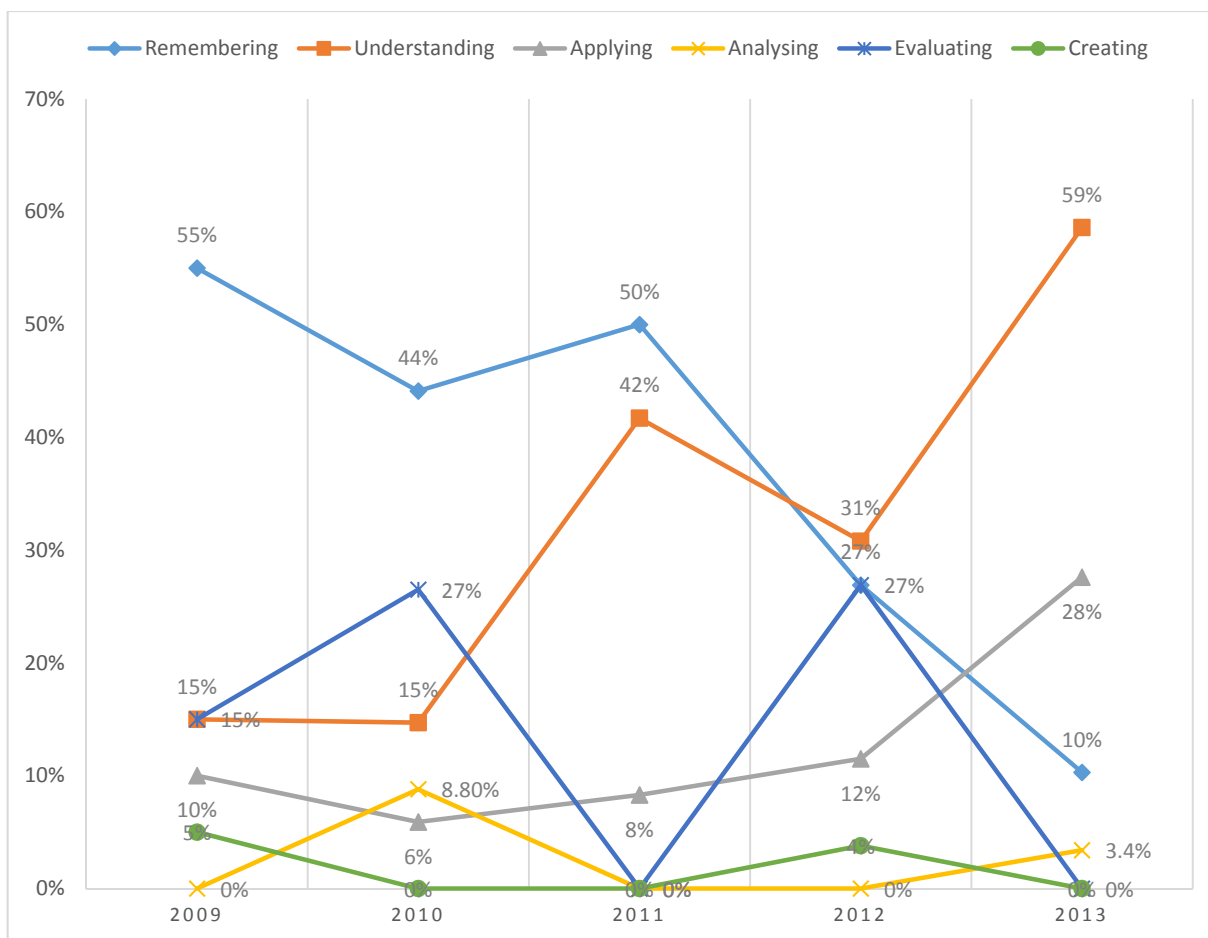
Figure 16: *Trends in the Proportion of Questions by Cognitive Skill for Biology 5090 Paper 3*

5.14 Conclusions

Based on the findings of the analysis of the data collected in this investigation, a number of conclusions were drawn. These are enumerated below.

5.14.1

From the foregoing, it can be said that the findings support the proposition that the Zambian GCE 'O' Level examinations are not supporting the development of the critical thinking skills of analysis, evaluation and creation. In other words, it has been demonstrated that there is very little evidence of critical thinking skills in the analysed assessments. As a consequence, the students leaving the Zambian education system at Grade 12 (or Form 5) level have a below-par competence in critical thinking skills.

5.14.2

Though there are slight differences between Biology and Geography in terms of the distribution of questions by cognitive level, the vast majority of the questions asked in all the components of both the Biology and Geography national examinations require mostly memorization ability. For both subjects, there is an extremely low proportion of questions testing skills like categorizing, comparing and contrasting and other abilities that demand critical thinking skills.

5.14.3

Going through the findings, the distribution of questions by cognitive level for Biology 5090 papers 1, 2 and 3 combined (n = 525) shows that 44% of the questions were at the remembering level and only 11.6% tested the critical thinking skills of analysis, evaluation and creation. Additionally, the total proportion of questions testing remembering and understanding was about 75%. The current Biology syllabus in its Assessment Objectives states that the weighting of questions dealing with "Knowledge with Understanding" (which is equivalent to remembering and understanding) is 40%.[147] Assessment objectives describe the knowledge, skills and abilities which learners are expected to demonstrate at the end of the course, and the assessments are expected to reflect such aims. Clearly, there is a large discrepancy between what the syllabus prescribes and what happens in practice. For Geography 2218 papers 1 and 2 combined (n = 503), findings show that 57% of the questions were at the remembering level of the cognitive domain and only 3.7% tested for the critical thinking skills of analysis, evaluation and creation. It is clear that though Geography 2218 syllabuses places a strong emphasis on the development of higher order skills as indicated by the weighting of assessment objectives,[148] most of the questions in the final examinations were found to focus on lower order cognitive skills.

5.14.4

The distribution of the questions set in GCE 'O' level Geography and Biology shows that the ECZ has placed very little emphasis on questions that engage students in critical

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147   Curriculum Development Centre 2012 Biology High School Syllabus

148   Curriculum Development Centre 2012 Biology High School Syllabus

thinking. This A study by the ECZ reveals that the science and mathematics national examinations at the Junior Secondary School level (i.e. at the end of the first two years of secondary school) have more questions measuring lower level thinking skills than higher order thinking skills.[149] The reason the Grade 9 National Assessment survey was conducted was to evaluate the learning achievements of learners at that level against inputs and processes. The learning achievements focused on learner's mastery of subject content, problem solving and critical thinking skills. The results of the current study shows that the trend continues even at Senior Secondary School. Thus, clearly, ECZ mostly sets lower order examination questions that target rehearsing of facts, and writing, re-writing, memorization and regurgitation of information. In both the Biology and Geography examinations the proportion of questions requiring the use of mental strategies associated with critical thinking is extremely low.

5.15 Chapter Summary

The aim of this chapter was to present and discuss detailed findings of the study regarding the assessment of the critical thinking skills of analysis, evaluation and creation by the ECZ. The data was gained through the process of post-exam item analysis of the GCE 'O' level Biology and Geography past exam papers from 2009-2013 using Bloom's Taxonomy.

The study revealed that, though the test items analysed might have met the acceptable psychometric benchmarks such as the difficulty and discrimination indices, they fell short in terms of integrating questions measuring the critical thinking skill of analysis, evaluation and creation. The study shows that the distribution of questions by cognitive level was biased towards questions testing mostly memorization. This encourages learning by rote. The combined proportion of questions in all Geography papers from 2009-2013 which tested recall was 57%. Only 3.8% tested for analysis and evaluation. Similarly, the combined proportion of questions in all Biology papers from 2009-2013 which tested for recall of information was 44% and 11.6% tested for analysis, evaluation and creation. Though at face value there are some differences between the two subjects in terms of the distribution of questions by cognitive level, the results of the t-test suggest that these

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149   National Assessment of Learning Achievement at Junior Secondary School Level, 2013

differences are not significant. In other words, there is no significant difference between the two subjects in terms of testing for the critical thinking skills of analysis, evaluation and creation. This means that most of the questions set in the two subjects are biased towards testing for recall.

Based on the foregoing, it can be said that the findings support the proposition that there is ineffective assessment of critical thinking skills of analysis, evaluation and creation by ECZ.

In this chapter, data was interpreted and presented using tables and pie charts showing the distribution of questions by cognitive level. The data was generated by the post-exam analysis of test items in the GCE 'O' level Geography 5090 and Biology 5090 exam papers for the years 2009-2013 using Bloom's Taxonomy. The findings of the analysis were then discussed.

A t-test to test the hypothesis that there was no significant difference in terms of testing critical thinking skills between the GCE 'O' Level Geography 2218 and Biology 5090 was carried out at the 99% significant level. It was found that there was no significant difference between the two subjects in terms of testing the critical thinking skills of analysis, evaluation and creation. Another t-test at the 99% significant level revealed that there was no significant difference between GCE 'O' level Geography papers 1 and 2 in terms of testing the critical thinking skills of analysis evaluation and synthesis.

The study showed that the distribution of questions by cognitive level for both subjects was skewed towards questions testing mostly memorization. This encourages learning by rote and does not encourage the development of critical thinking skills. The findings support the proposition that examinations set by the ECZ are not fostering the development of critical thinking skills in Grade 12 school leavers.

Chapter 6

Towards developing Critical Thinking Skills through formal Education

6.1 Introduction

The objective of this study was to establish whether or not examinations in Zambia are supporting the development of the critical thinking skills of analysis, evaluation and creation in Grade 12 school leavers, given the backdrop of the KE. This study was focused on GCE 'O' Level examinations in the Zambian context, with an overview of the impact of examinations on the development of critical thinking in Grade 12 school leavers. In this study, critical thinking skills are related to analysis, evaluation and creation as in the cognitive domain of the Bloom's Taxonomy. In order to achieve the purpose of this study, the researcher conducted a post-examination qualitative item analysis of GCE 'O' Level Biology and Geography past papers for the years 2009-2013 using Bloom's Taxonomy as the measuring instrument. The papers that were analysed were set by the ECZ, the body responsible for administering public examinations in Zambia. Also conducted was an

113

extensive literature review that contributed to building a conceptual framework to define the main concepts that were used during the data collection process. Based on the interpretation and discussion of the data collected, this chapter presents the overall conclusions of this study. Finally, recommendations relating to how to improve the assessment of critical thinking skills in GCE 'O' levels examinations in the Zambian context are outlined.

6.2 Conclusions

As has been noted in this study, our society is moving towards a KE, an economy in which application of knowledge replaces capital, raw materials and labour as the main factors of production. In a KE there are 'knowledge workers' as opposed to 'manual workers.' A knowledge worker works with his or her head to produce ideas, knowledge and information while a manual worker works with his or her hands to produce goods and services.

It has also been noted that the essential ingredient of products and services in the KE is inherent knowledge. The capacity to generate, disseminate and apply new knowledge to achieve improvement and innovation is what constitutes a nation's knowledge productivity. Knowledge productivity will remain the dominant factor in the KE.[150] Knowledge productivity involves indicating, absorbing and processing of relevant information, generating and disseminating new knowledge and applying this knowledge to the improvement of processes, products and services. [151]

In order for one to successfully participate in the processes involved in knowledge productivity, such as creating new knowledge, critical thinking skills are required. This is because one must have the skill to analyse and evaluate reasonings or claims in order to create new knowledge.[152] Critical thinking also empowers one with the ability to solve problems and engage in research. It has also been argued that critical thinking empowers people with the capacity to engage in life-long learning and to adapt to new information and new technologies. This is very essential in the KE which is characterised by rapid

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150 Kessels J W M 2000 *Corporate Curriculum*

151 Kessels J W M 2000 *Corporate Curriculum*

152 Baccerra-Fernandez I et al 2004 Knowledge Management: Challenges, Solutions and Technologies

change. Moreover, it has been established that people with critical thinking skills are more employable.

The type of learning outcomes and learning processes leading to knowledge productivity requires a curriculum which takes a different form from the traditional one which emphasises the development of rote learning and the acquisition of factual content at the expense of the development of thinking skills. Rather, the curriculum for the KE should promote a constructivist approach to teaching whereby students are encouraged to create their own knowledge and apply it to unfamiliar situations.[153] This imparts critical thinking skills to students leaving the educational system who it is assumed will become new entrants into the job sector. As has been alluded to in the foregoing, the curriculum for the KE should focus on the imparting of thinking skills like critical thinking skills.

Hand in hand with a good curriculum is a good assessment system. An effective assessment system must, among other things, support the development of critical thinking skills. Critical thinking can be described as "the intellectually disciplined process of actively and skilfully conceptualizing, applying, analysing, synthesizing, and/or evaluating information gathered from, or generated by, observation, experience, reflection, reasoning, or communication, as a guide to belief and action."[154] Critical thinking skills are needed for one to work successfully in the KE as has been alluded to above. In order for examinations to promote the development of critical thinking skills, they must include more questions that test the higher-order skills in the Bloom's Taxonomy.

Based on a careful analysis of the data, it has been concluded in this study that there is little evidence of critical thinking skills in the Zambian GCE 'O' level examinations. For both Biology 5090 and Geography 2218, the largest proportion of the questions in the sample of question papers analysed tested mostly memorisation and regurgitation of information; this encourages rote learning. For Biology, out of all the questions analysed (n = 525), only 11.6% tested critical thinking skills. For Geography, out of all the questions analysed (n = 503), only 3.8% tested critical thinking skills. In order to determine whether there is a

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153   Hargreaves et al 2000 Learning to Change: Teaching Beyond Subjects and Standards

154   Paul R W and Scriven M 1987 Critical Thinking as Defined by the National Council for Excellence in Critical Thinking

significant difference between the afore-mentioned subjects in terms of testing for critical thinking skills, a t-test was performed. It was found at the 99% confidence level that there was actually no significant difference between the two subjects in terms of testing for critical thinking skills. In general, the GCE 'O' Level examinations set by the ECZ place very little emphasis on critical thinking and do not adequately support its development in Grade 12 school leavers. Education in Zambia is currently characterised by rote-learning and memorisation of knowledge.[155] There is limited focus on critical thinking which enhances learners' thinking, especially at primary and secondary levels.[156] This exacerbated by a formal assessment system that is designed to test mostly memorisation and regurgitation of knowledge. The findings of this study support the argument that the assessment of critical thinking skills by the ECZ is ineffective and does not promote the development of these skills in Grade 12 school leavers in Zambia. One the main reasons for this is that few item writers and test developers seem to have little awareness of centrality of critical thinking skills and the necessity to integrate these into examinations. Assessment and education in Zambia have historically focused on skills and knowledge necessary for academic advancement, rather than social, civic or economic participation.[157]

It is extremely important to ensure that the content of the curriculum that schools offer and the way the content is assessed are relevant to the needs of the students in the contemporary knowledge economy.[158] One of the most certain thing about the world in which today's students will spend their lives is that the pace of change is likely to continue or even increase. Rapid change is in fact a hallmark of today's KE. As was mentioned in chapter 3, in the new Zambian curriculum there is a renewed emphasis on vocational skills which is welcome and appropriate. However, any vocational knowledge and skills acquired may well be out of date by the time the pupil graduates from the educational system. Indeed, in many scientific or technical subjects, what is being taught in schools and universities has

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155 PISA for Development: Capacity Needs Analysis Report: Zambia, 2014

156 www.osisa.org/education/zambia accessed 05/07/2015

157 PISA for Development: Capacity Needs Analysis Report: Zambia, 2014

158 Everard K B & Morris G 1996 Effective School Management.

already been superseded as it is being taught. The future for students graduating from our educational system holds fewer careers of a structured kind. Career 'ladders' have been replaced by 'scrambling nets' or even 'climbing walls'. Using another metaphor, those who are to succeed will have to jump from raft to raft of new skills as their existing skills and knowledge become redundant. This applies as much to the shop assistant or the typist as to the technologist or the teacher, or the lawyer or industrial manager.[159]

Given such a scenario, it follows that the most essential skills of citizens in the KE are not low-level skills like the ability to memorise and regurgitate subject content but life-long skills like critical thinking and learning how to learn alongside academic knowledge and skills.   The goal of education, therefore, is not to memorise and remember facts but to use those facts to solve problems and make decisions. Based on the findings of this research, it can be argued that the Zambian GCE 'O' Level examinations do not encourage the development of these skills. What is promoted and encouraged by these examinations is the teaching of low-order skills like the recall of facts and information.

6.3 Recommendations

The development of critical thinking as part of the so called 21st Century skills is seen by a wide range of countries around the world as an important part of a rounded education for success in the KE.[160] Education in Zambia, as has already been observed, is currently characterised by rote-learning and memorisation.[161] There is very limited focus on critical thinking which enhances students' capacity for life-long learning and gives them problem solving and decision-making skills. This has affected students at both primary and secondary level in Zambia.[162]

The challenge of having Grade 12 school leavers who have below-par critical thinking skills, and are therefore not prepared to participate in the KE, will require a systemic change because it involves the whole educational system. Therefore, it should be tackled at various

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159   Everard K B and Morris G 1996 Effective School Management

160   https://teachers.cie.org.uk/qualifications/academic/uppersec/alevel. 07/07/2015

161   www.osisa.org/education/zambia accessed 05/07/2015

162   www.osisa.org/education/zambia accessed 05/07/2015

levels. It could be tackled at the levels of pre-service and in-service training, curriculum design and assessment.

This research recommends that the MESVTEE must promote and build an awareness of the concept of critical thinking skills through public discourse. More importantly, it must include the teaching of critical thinking skills in both pre-service and in-service training of teachers. The present educator in Zambia has little or no idea about critical thinking skills and their importance in the job sector given the backdrop of the KE.[163] In a national survey to measure the assessment of learning achievement at Junior Secondary School level in Zambia, the teachers who took part in the pre-exam survey showed a below–par competence on items testing thinking skills.[164] There was a correlation between teacher performance and student performance on items testing critical thinking skills, showing that the pedagogical skills of the teachers was a factor in the development of critical thinking skills in students. Based on this, it can be argued that curriculum used in both pre-service and in-service training should be changed to include teaching methodologies that develop critical thinking skills in students. New and diverse methods of teaching have emerged in education. There is a paradigm shift in terms of theories of teaching and pedagogy.[165] The contemporary views on teaching and learning methods are largely based on constructivist theories as opposed to the behavioural theories of teaching. In the constructivist teaching approaches learners are actively engaged in the learning process using their experiences and the knowledge they create or discover, while in the behavioural approach, learning is imparted into passive learners by, presumably, the more knowledgeable teacher. The constructivist theories of teaching promote independent learning, critical thinking and problem solving skills while behaviourism encourages rote learning.[166]

This research also recommends that the Zambian curriculum will have to be transformed

163 National Assessment of Learning Achievement at Junior Secondary Level: Zambia's National Assessment Survey Report: 2013

164 National Assessment of Learning Achievement at Junior Secondary Level: Zambia's National Assessment Survey Report: 2013

165 National Assessment of Learning Achievement at Junior Secondary Level: Zambia's National Assessment Survey Report: 2013

166 Hargreaves A. 2003 Teaching in the Knowledge Society.

in order to promote the development of critical thinking skills as opposed to the acquisition of only factual knowledge. The Zambian curriculum, as was alluded to in chapter 3, has been changed significantly and ICT has been made compulsory. This is a welcome change because it will make students graduating from the educational system more prepared for the KE. Additionally, two learning pathways have been introduced namely vocational and technical. Students who are weaker at academic subjects can now have the opportunity to do practical subjects and gain technical skills which they can deploy when they are not in formal employment. However, there is no mention of imparting to students competencies like critical thinking, which can not only make them more employable, but also innovative and able to participate in the KE successfully. Critical thinking skills are a very strongly linked to creativity. At every level of the school curriculum in Zambia, there needs to be a new focus on teaching/learning creativity and innovation through teaching methodologies that promote critical thinking.

The study, being focussed on improving critical thinking skills in students through assessment, leads us to consider how the challenge of having secondary school leavers with below-par competence in critical thinking skills could be tackled through the avenue of improved examinations. In view of this, this research recommends that GCE 'O' Level examinations should include more items that test critical thinking skills. Incorporating critical thinking in assessment requires more questions that test analysis, evaluation and creation. Both formative and creative assessments need to include more challenging and divergent questions to foster higher-order skills like analysis, synthesis and evaluation. Educationists who practise assessment for critical thinking believe that tasks which focus on the recognition and recall of facts achieve low-level objectives. By contrast, tasks or assessments that promote high-order thinking focus on the ability to apply what is learned. The government, through the Examinations Council of Zambia (ECZ), will have to promote the teaching and learning of critical thinking skills in students by effectively assessing these skills. The national examinations at various points in the school system must gradually include more questions that test the higher-order thinking of analysis, evaluation and creation. Higher-order questions typically require the use of mental strategies that are associated with critical thinking. Higher-order questions encourage learners to locate important information and use it to draw logical conclusions and make

comparisons. These questions are constructed in such a way that the person answering them will need to engage in critical thinking. Learners might use facts and details in the process of answering the question but they must go beyond this and construct the rationale for the answer. With higher-order questions, the person responding is actively asserting some position about causes and relationships. The teaching and incorporation of critical thinking skills in assessments is crucially important if a nation like Zambia is to produce graduates who are innovative and can think creatively. Zambia as a nation will not develop if there is no creativity and innovation. Though there is no metric at present for measuring creativity in the country, it can be said by observation that creativity and innovation are very low. Possible causes include having an education system that does not nurture critical thinking skills and having teachers who not only do not have a mastery of their subject areas but whose critical thinking skills are below expectations.[167] Only about 12 percent of all the teachers in Zambia have degrees.[168]

6.3.1 Recommendations Relating to Geography 2218

It is important to state at the outset that one of the major strengths of the GCE 'O' level Geography 2218 examination is that the questions cover a lot of aspects on Zambia, Central and Southern Africa which makes the exam content relevant and representative.

On the whole, it is important to include more questions in the Geography 2218 exam that test skills like analysis, interpretation and evaluation and creation. In the Geography 2218 exams for the years 2009-2013, there were no questions testing creation or synthesis in either paper 1 or 2, as has been shown in chapter 4. The vast majority of the questions focussed on the memorization of facts, encouraging rote learning. There is, therefore, need to increase the proportion of higher-order questions in the Geography exams. In order to do this, this research recommends that, first and foremost, there should be a revision of the Geography 2218 syllabus in order to bring it more in line with international standards and make it more relevant to the KE.

To begin with, the ECZ should consider introducing a coursework or alternative to

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167 Zambia's National Assessment survey 2013 Report. p. 54

168 Zambia's National Assessment survey 2013 Report. p. 54

coursework component. This will bring the total number of components in the Geography 2218 exam to three. The coursework component could be designated paper 3. The weightings given to each component could be revised to take these changes into account. At present there are two theory papers and these focus mostly on the memorization and regurgitation of facts as demonstrated in chapter 4.

The value of a coursework or alternative to coursework component is that, being a research-oriented paper, it would encourage the development of enquiry skills and techniques which foster higher-order skills. Research skills include such sub-skills as developing hypotheses, planning investigations, locating, organizing and presenting information. These sub-skills would support the development of critical thinking. A range of topics could be form the focus of these researches. Examples of research topics are "Agricultural Patterns within an area" or "The Development of Tourism in an area." Apart from the research sub-skills mentioned earlier, the other sub-skills that would be developed are the analysis of data and formulation of conclusions. These are very important critical thinking skills in today's KE. Thus the coursework or alternative to coursework component could provide complementary assessment to the theory papers with emphasis on research skills and analysis.

Apart from introducing the changes indicated above, the Geography 2218 syllabus could be changed slightly to reduce detailed study of remote countries or regions of the world, like the USA or Canada. This is because, apart from the study of these regions being of lesser relevance to Zambia, such topics encourage mostly the memorization and reciting of information. A current trend is to study topics like mining and include countries like the USA as case studies on these topics. The case study approach supports the development of analytical and decision-making skills among many others.

The research also recommends the strengthening of quality control procedures in order improve the overall quality of the exam papers. While the tests items are generally free from obvious construction errors and meet stringent psychometric benchmarks, the overall quality of the Geography 2218 papers in terms of appearance requires improvement. For instance, some of the resources that are used in the questions lack clarity. In many instances physical sketch maps, for example, have no scale included and are, at times, poorly drawn.

121

In addition, most of the photographs included for use in map reading questions are in black and white. It is important that photographs are in colour in order to enhance their clarity.

The research also recommends that item writers and test developers for Geography need to have training and experience with integrating critical thinking skills in exams. Item writers need to be encouraged to set more questions which test analysis, evaluation and creation.

6.3.2 Recommendations Relating to Biology 5090

Just like for Geography, the research recommends that the item writers for Biology 5090 need to increase the proportion of questions testing analysis, evaluation and creation skills. This will entail that item writers and test developers undergo training and acquire experience with integrating critical thinking skills in exams. Assessment and education in Zambia has historically focused on skills and knowledge necessary for academic advancement, rather than social, civic or economic participation.[169]

This research recommends that the ECZ should consider including questions on the practical examination (paper 3) which require students to evaluate an experimental procedure and suggest how it could be improved. This promotes the use of evaluation which is one of the critical thinking skills. Alternatively, with regard to paper 3 again, ECZ could consider including questions that requires students to plan an experiment and then perform it. This promotes the use of evaluation and analysis.

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169   PISA for Development 2014 Capacity Needs Analysis Report: Zambia

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