The International Journal of Multi-Disciplinary Research
ISSN: 3471-7102

Critical Thinking Skills and Zambian 'O' Level Examinations

(Conference ID: CFP/122/2017)

Joseph Ngungu and Johann Kinghorn
jk@sun.ac.za
Stellenbosch University, South Africa

Abstract

It is generally accepted that the world is moving toward a socio-economic dispensation which is best described as the knowledge economy. Although its contours are still emerging, it is clear that human capital that is rooted in critical thinking skills is the bedrock of the knowledge economy. A country's formal education system plays a pivotal role in developing such critical thinking skills. This paper presents the findings of an analysis of GCE 'O' level examinations in Zambia from the perspective of their focus (or not) on critical thinking skills. For this purpose, the subjects of Biology and Geography were analysed over a 5-year period, starting in 2009. A documentary analysis, based on Bloom's Taxonomy of cognitive learning was done. It was found that the Zambian GCE 'O' level examinations were weak on critical thinking skills in general, and on the skills of analysis, evaluation and synthesis in particular.

1 Critical Thinking Skills in Zambia

It is by now widely accepted that the world is moving into a dispensation which can best be described as the knowledge economy. The dynamics of the knowledge economy are different from the industrial economy. In the knowledge economy resources such as know-how are more critical than other economic resources. The knowledge economy is a multi-faceted phenomenon and its contours are still emerging (Vinnychuk and others, 2014). 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 such societies is the abundance and wide spread of people who command the capacity for critical thinking (OECD 2016, 149).

How well is Zambia doing in this respect? This is, of course, too broad a question to answer definitively. However, by narrowing down appropriately, we can get some "feel" for the situation.

There are a variety of factors that support or inhibit the growth of critical thinking skills in a country. But few would disagree that the formal education system of a country is the major factor in this respect. Indeed, critical thinking skills are not acquired in the ordinary process of life. They are acquired through dedicated intellectual development.

The present study, therefore, focussed on the education system, and in particular on its output at GCE O (school leaving) level. 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 where the thinking skills which are expected to be mediated by the curriculum surface.

The study was further narrowed down to examinations as set by the Examination Council of Zambia. The subjects of Geography and Biology were selected for their central importance in the socio-economic development of modern societies. In each case the examination papers for the period 2009 up to 2013 were subjected to analysis. In all 20 papers were analysed.

2 What is Critical Thinking?

There is no shortage of definitions of critical thinking. Here follows a selection:

Dewey (1910) 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." In other words, critical thinking calls for a persistent effort to examine any belief or supposed form of knowledge in the light of the evidence that supports it. (Glasser, 1941). Critical thinking is an intellectual process which involves applying, analysing, synthesizing and/ or evaluating information as a guide to belief and action. (Scriven and Paul, 1987). Bruner (1973) defined it as the "mental processes and acts of going beyond the information given." Critical thinking has also been defined as "reasonable reflective thinking focused on deciding what to believe or do" (Brookfield, 2000) or "thinking about thinking" (Ennis, 2003). 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." (Raiskums, 2008).

The key word in this context is the word “critical”. It is derived from the Greek verb ‘krino” which means *to decide* or *to choose*. From this is derived the word “crisis” as well, once again implying the urgent need for choosing and deciding. Critical thinking skills are, therefore, the mental and reasoning skills that are required to perform the actions of choosing and deciding optimally. "Critical" in this context does not have connotations of disapproval or negativity. Critical thinking skills manifest themselves in complex problem-solving, complex decisionmaking, and evaluating an argument for its logical acceptability. Without critical thinking skills people are unable to engage in life-long learning and to adopt new knowledge and technologies.

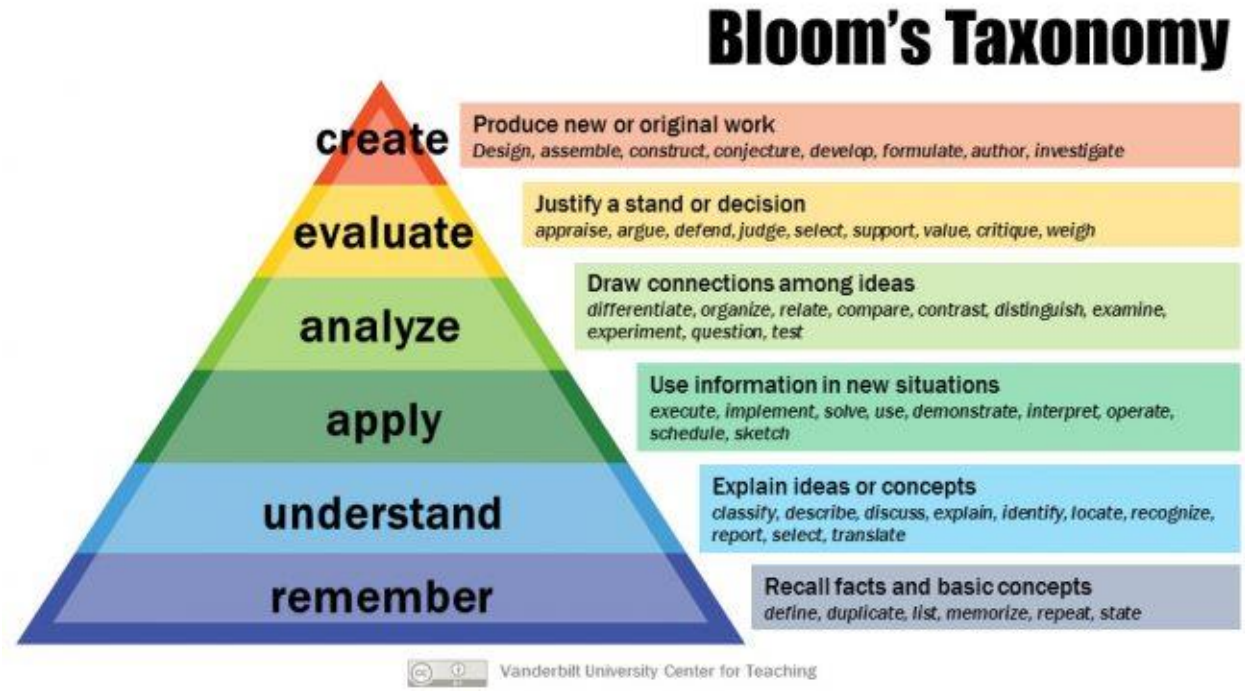
3. Measuring Critical Thinking using Bloom’s Taxonomy

Defining critical thinking is one thing, but “measuring” its manifestations is a different matter. Over the past 4 decades a comprehensive learning model, known as Bloom’s Taxonomy of Learning Domains have come to be accepted by many education systems around the world as a useful way of standardising curriculum content and assessment. For that reason the present study adopted applicable dimensions of the taxonomy as the basis on which the analytical method of the study was developed.

Bloom’s Taxonomy of educational objectives is a classification scheme of learning objectives which was proposed by a committee in the USA under chairmanship of Benjamin Bloom (Bloom, 1956). The taxonomy describes three distinct learning modes, but in practice the cognitive mode has become the dominant feature. In most cases, today, Bloom’s Taxonomy is taken to be synonymous with Bloom’s Taxonomy of the cognitive domain.

It is important to note that the cognitive Taxonomy has undergone fundamental changes in the last two decades. In essence, the changes indicate a shift in the conception of knowledge. Whereas the early taxonomy was satisfied with an understanding of knowledge as *memorising* the advent of the knowledge economy increasingly demonstrated the shortcomings of such a superficial conception. The Revised Taxonomy, consequently, moved from *remembering* to *thinking* as being the essence of cognition. (Leslie, 2016)

The Taxonomy is summarised in the following graphic by Vanderbilt University Center for Teaching according to a Creative Commons Licence:

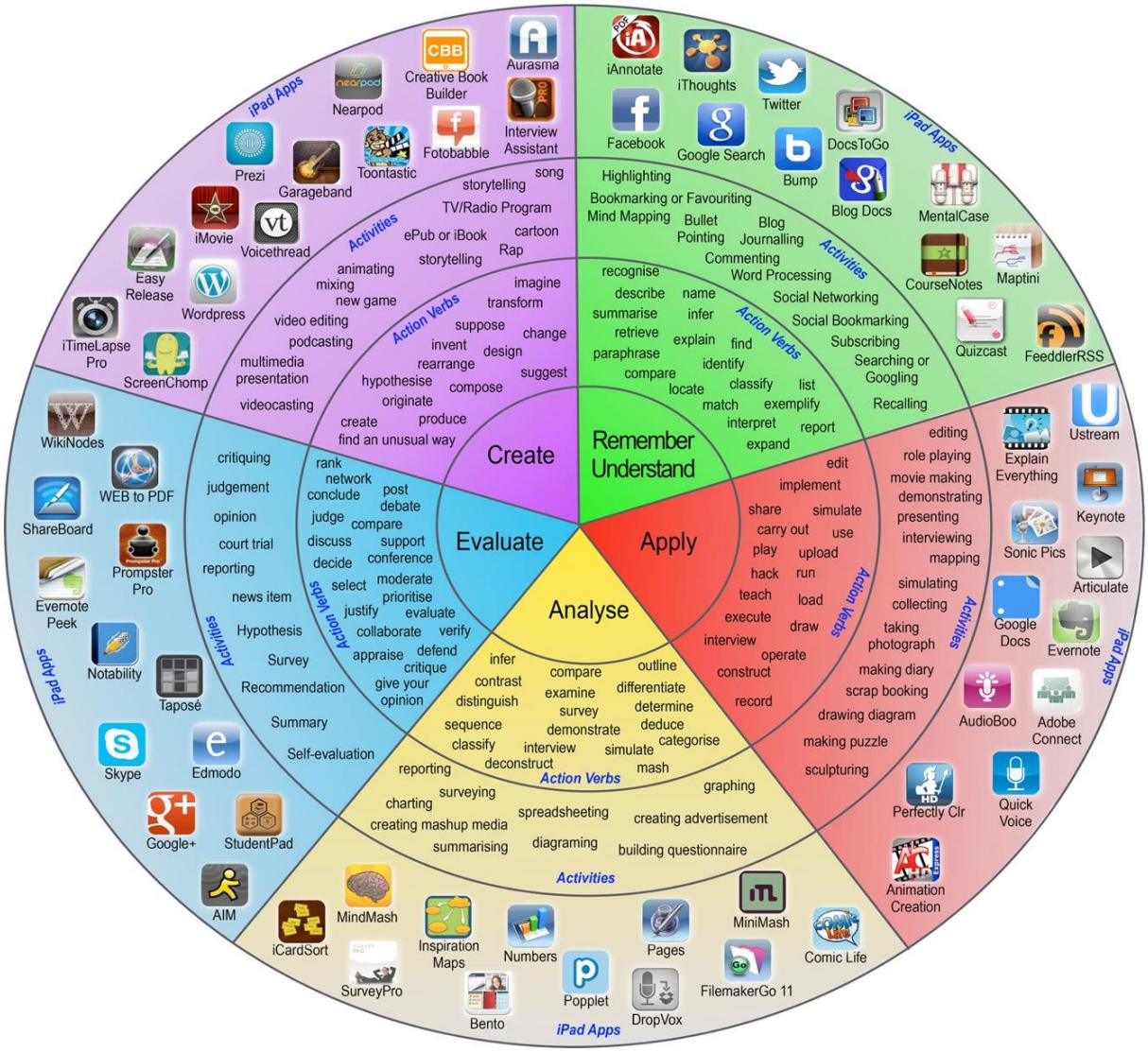


As can be seen, learning objectives are hierarchically organized into six major classes. Intellectual skills are seen as developing from lowest to highest. To remember and understand belong to the basic levels of thinking, while application, analysis, evaluation and creation are truly critical thinking skills.

4 Case study design

4.1 The vocabularisation of Bloom's Taxonomy

Over the years Bloom's Taxonomy has been broadened by developing a secondary level of vocabularies that correspond with the primary 6 concepts. Below is The Padagogy Wheel by Allan Carrington (licensed under a Creative Commons Attribution) which gives a good overview over the extensive vocabulary associated with the Taxonomy. The most recent development also incorporates a classification of apps and technologies to match the 6 underlying concepts. These were, however, not utilised in the study. Only the contents of the second circle of the wheel were used.



The Pedagogy Wheel by Allan Carrington

4.2 Documentary Analysis

The case study focused on two sets of examination papers from the Zambian GCE 'O' Level examinations between 2009 and 2013. The papers were for Biology 5090 and Geography 2218.

The analysis was performed by identifying the task word in each question (that is the active verb). Such words were related to the 6 major categories in Bloom's Taxonomy, with the help of the extended Taxonomy, and in particular the categorisation of the various verbs.

To determine if there was a significant difference between Biology and Geography in terms of testing for critical thinking skills, a t-test was carried out. For $\alpha = 0.01$, 8 degrees of freedom, the value of t calculated lay within the acceptance region. This, coupled with the fact that the p-value is larger than the significance level (α), suggests that the observed data are consistent with the assumption that the null hypothesis is true. It can, therefore, be concluded that there is no significant difference between the Biology and Geography papers

in terms of testing for critical thinking skills.

5 Findings of the Analysis

In this section, the data findings are presented together with various graphs and tables showing the distribution of questions by cognitive level.

5.1 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
Analysing	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
Questions testing CT skills	1	1	5	5	1	13	
CT %	2	2	10	10	2	5.2	

Table 1. *Distribution of GCE 'O' Level Geography 2218 paper 1*

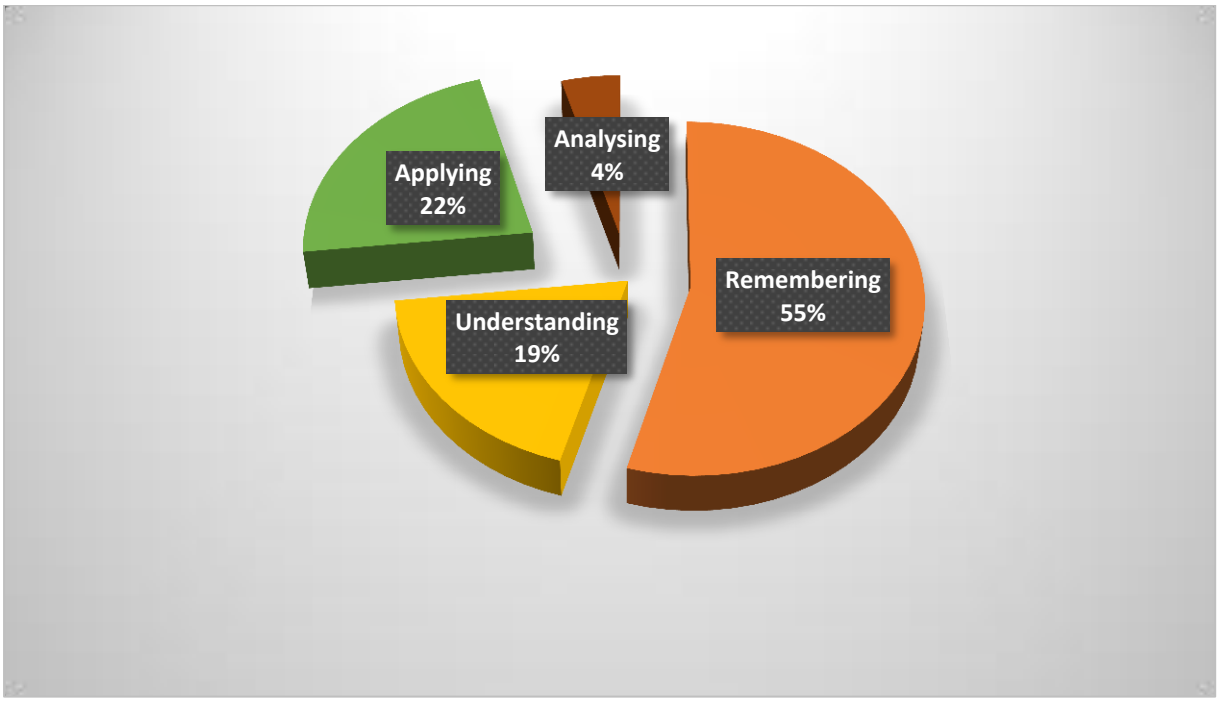


Figure 1 *Distribution of Geography paper 1 questions by cognitive level*

5.2 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
Analysing	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. testing CT skills	1	0	1	1	1	4	
CT %	2.3	0	1.8	2	2.1	1.6	

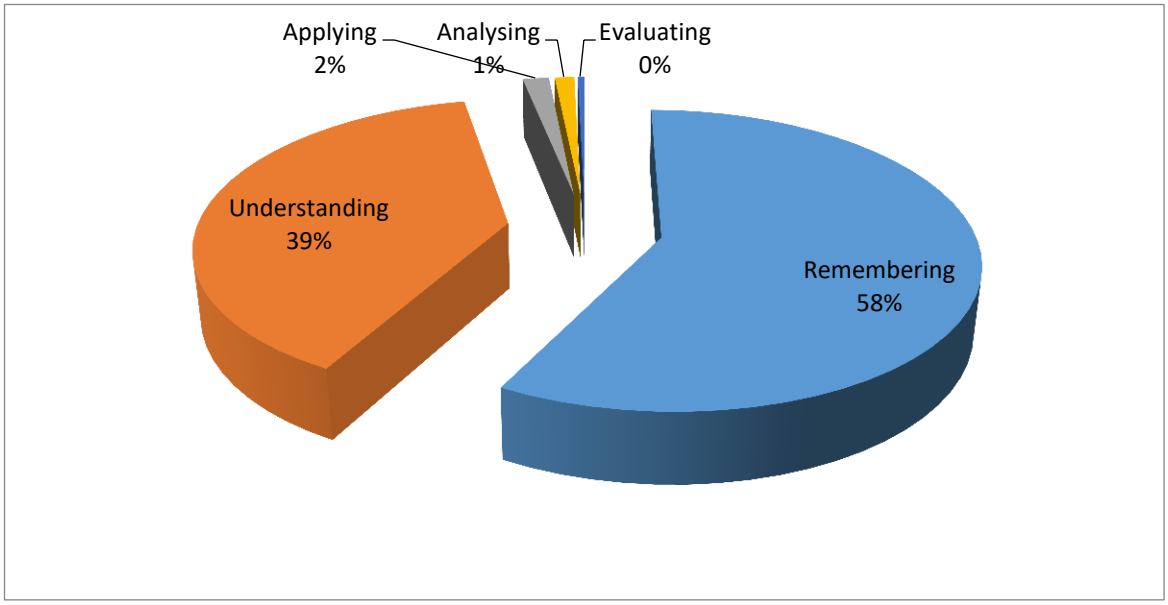


Figure 2 *Distribution of Geography paper 2 questions by cognitive level*

5.3 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. testing CT skills	6	3	1	5	2	17	
CT %	15	7.5	2.5	12.5	5	8.5	

Table 3*. Distribution of GCE 'O' Level Biology 5090 Paper 1*

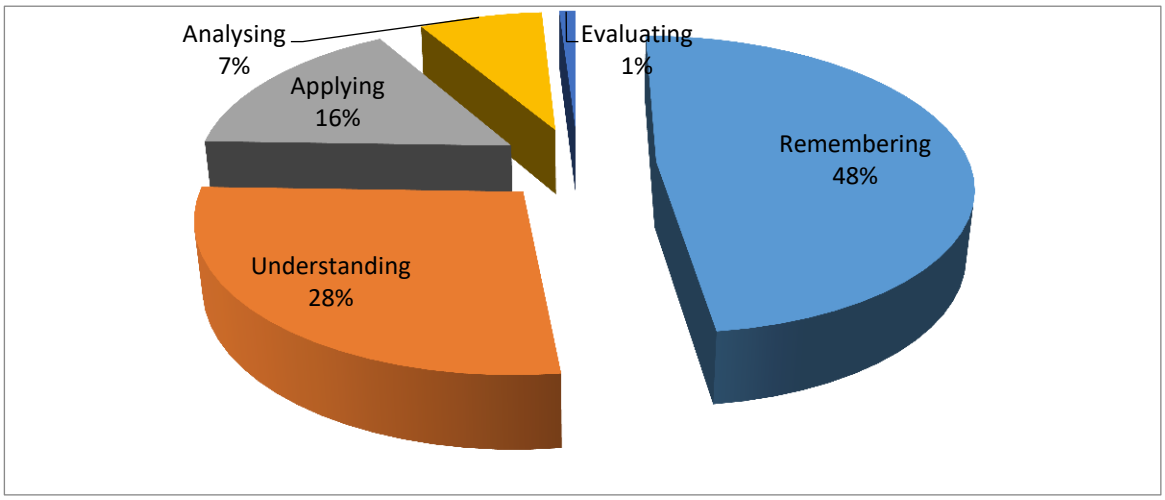


Figure 3. *Distribution of GCE 'O' Level Biology 5090 paper1*

5.4 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**	
CT %	**7.0**	**5.3**	**8.5**	**13.9**	**15**	**8.9**	

Table 4 *Distribution of GCE 'O' Level Biology 5090 paper*

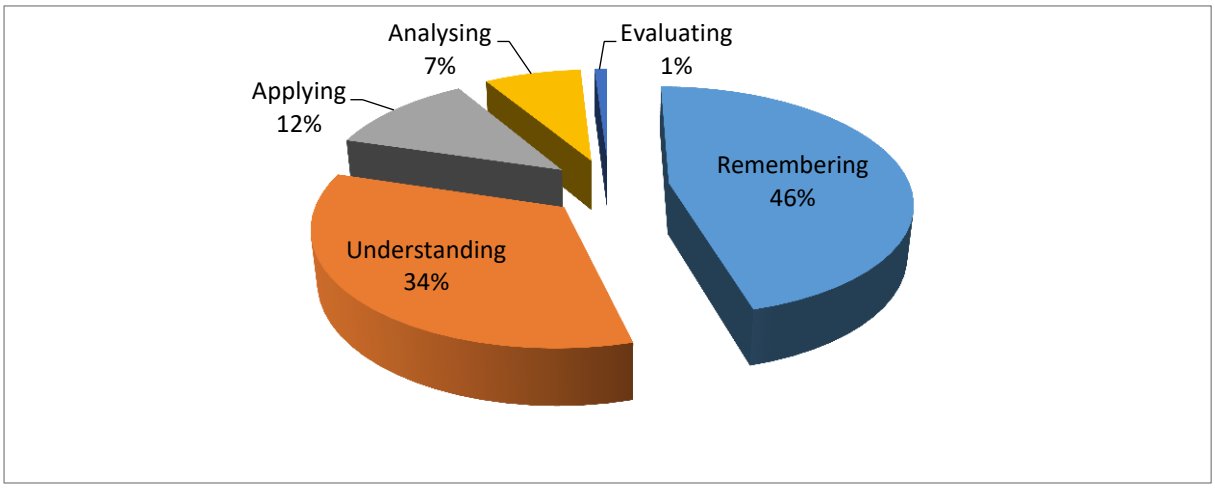


Figure 4 *Distribution of GCE 'O' Level Biology 5090 paper 2 questions by cognitive level*

5.5 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**
CT %	**20**	**35.3**	**0**	**30.7**	**3.4**	**18.8**	

Table 5. *Distribution of GCE 'O' Level Biology 5090 paper 3*

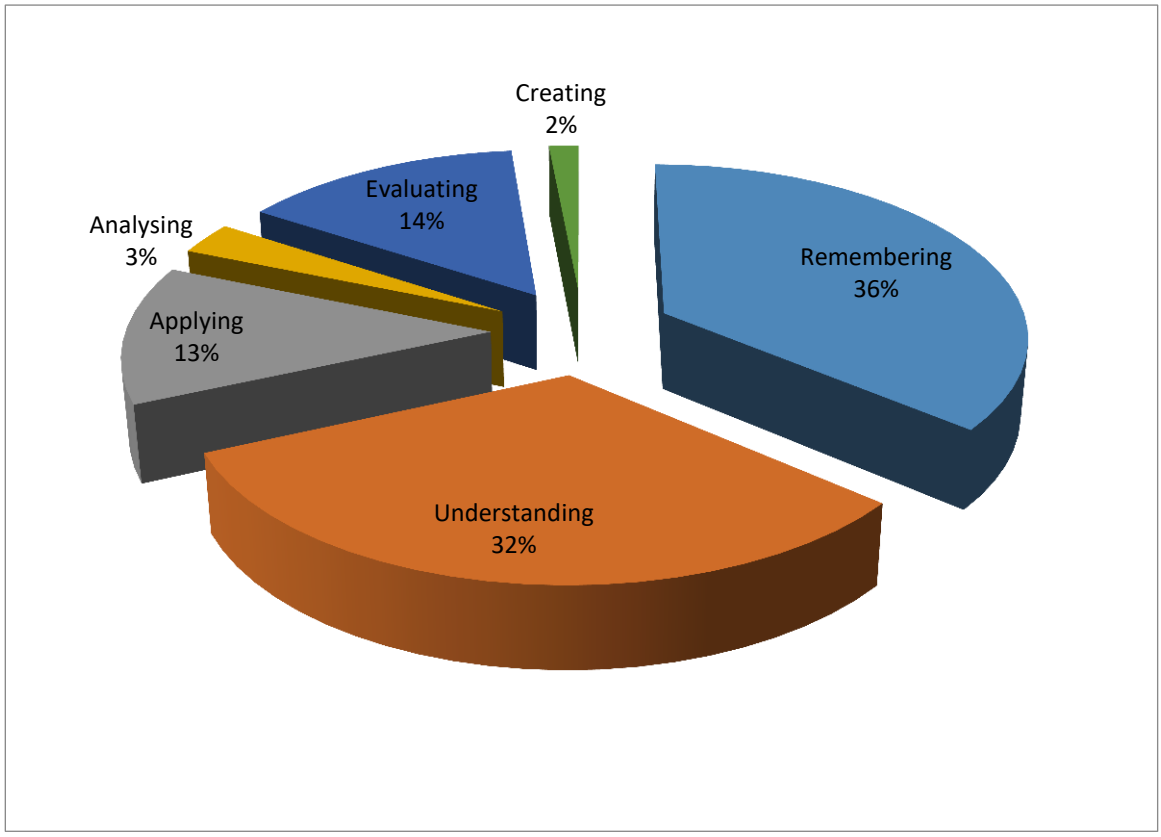


Figure 5*. Distribution of Biology paper 3 questions by cognitive level*

6 Trends in the Proportion of Critical Thinking Skills

The question that arises in light of the foregoing is whether a trend may be identified whereby the critical thinking skills component increased over time. With the general emphasis on knowledge management, and the increasingly ubiquitous notion of the knowledge economy, one would have assumed that by 2013 these would be reflected in the focus of the examination papers. The trends analysis below shows only very marginal changes.

6.1 Trends in Geography 2218 Paper 1

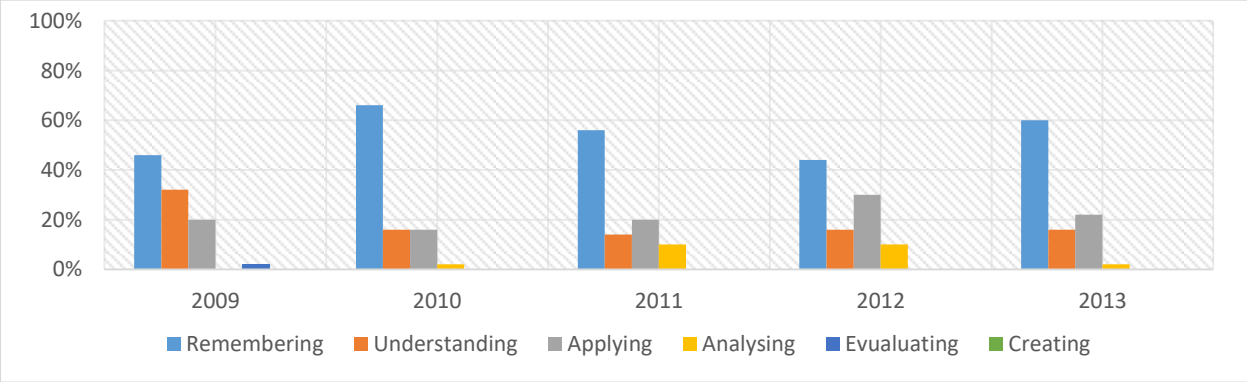


Figure 6: *Trends in Cognitive Skill for Geography Paper 1*

6.2 Trends in Geography 2218 Paper 2

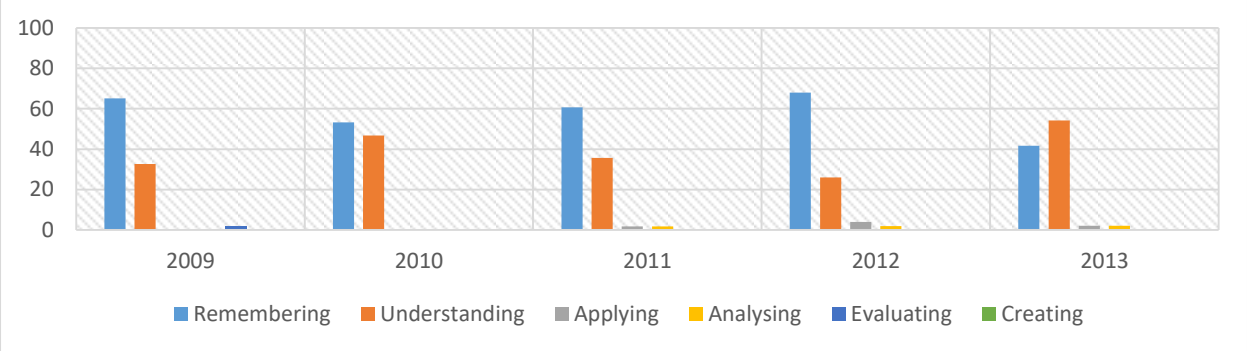


Figure 7: *Trends in Cognitive Skill for Geography Paper 2*

6.3 Trends in Biology 5070 Paper 1

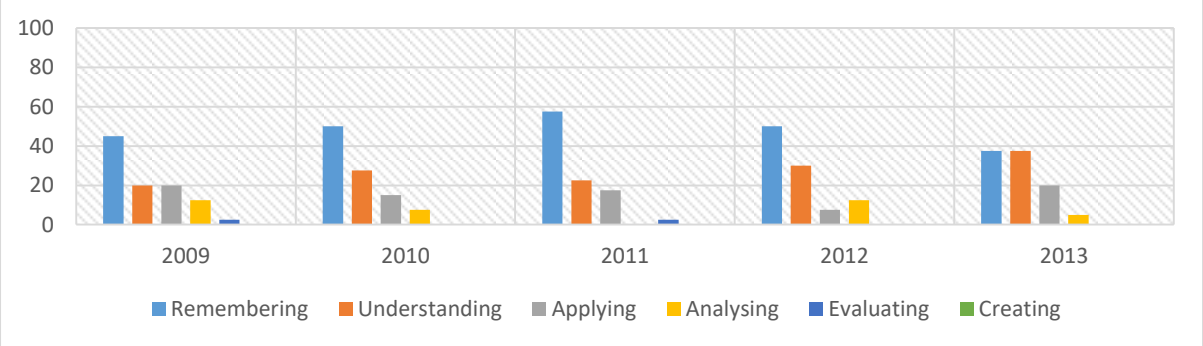


Figure 8: *Trends in Cognitive Skill for Biology paper 1*

6.4 Trends in Biology 5070 Paper 2

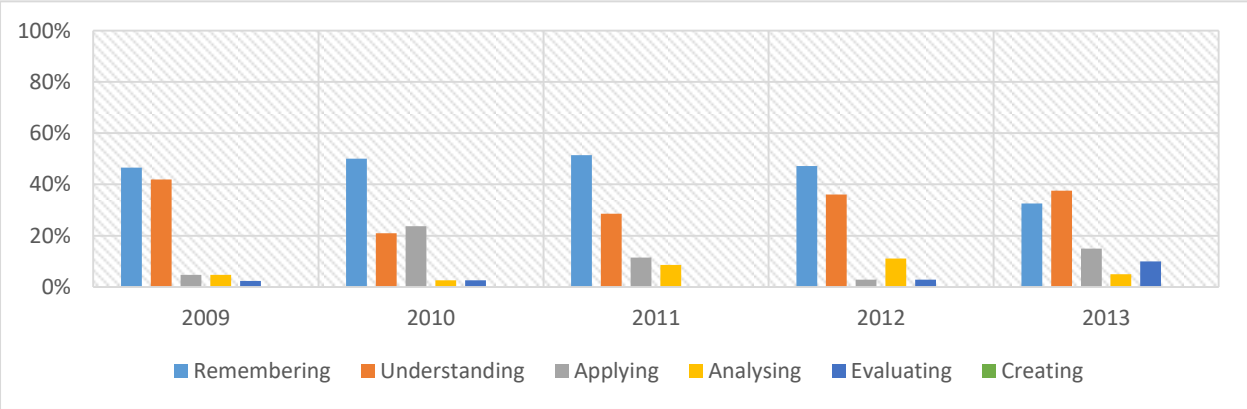


Figure 9: *Trends in Cognitive Skill for Biology paper 2*

6.5 Trends in Biology 5070 Paper 3

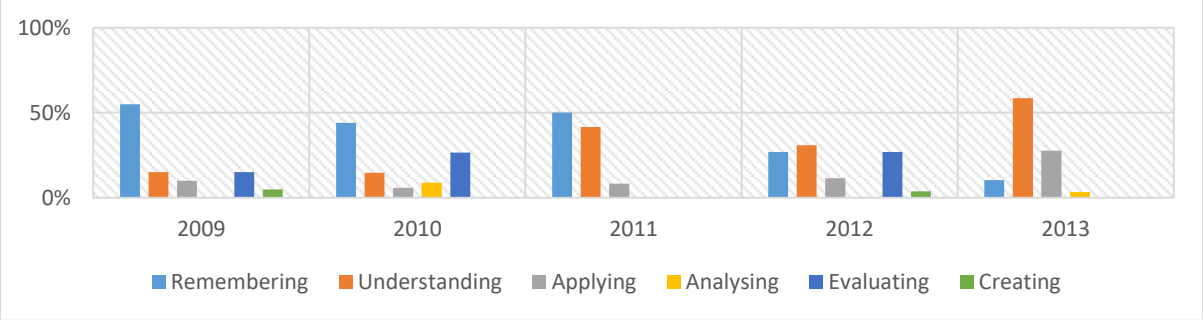


Figure 10: *Trends in Cognitive Skill for Biology Paper 3*

7 Discussion

Since the data collected in this study is longitudinal as it tracks the same variable at different 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 was considered in turn.

An analysis of the graphs in Figure 6 which relates to Geography Paper 1 shows that the proportion of questions testing recall has exhibited some fluctuations. By contrast, the proportion of questions testing application has shown a general upward trend, though there is a drop from 2009 to 2010. 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. The researcher did not probe into the reasons behind these trends as this outside the scope of this study.

A consideration of the graphs in Figure 7 which relates to Geography Paper 2 reveals that the proportion of questions testing recall exhibits a general upward trend. By contrast, the

proportion of questions testing understanding increases from 2009 to 2010 and then decreases steadily over the years 2010 to 2012 before showing an increase. The proportion of questions testing analysis has also increased very slightly since 2011. There have been no questions testing synthesis in the period from 2009-2012 in Geography 2218 paper 2. Again the researcher did not determine the specific factors responsible for the trends exhibited in the data.

An analysis of the Figure 8 which relates to Biology Paper 1 shows that the proportion of questions testing recall a general upward trend before showing a steady decrease. By contrast, the proportion of questions testing understanding has shown a general upward trend. 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%. Again, the factors behind the trends exhibited in the data were not investigated because this was beyond the scope of this study.

A consideration of the graphs in Figure 9 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 to 2013. By contrast, the proportion of questions testing analysis show a roughly upward trend in the years 2009-2013. As alluded to earlier, the researcher does not have reasons for shifts in the pattern observed.

An analysis of the graphs given in Figure 10 shows that the proportion of questions testing memorisation shows a roughly 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. Similarly, the proportion of questions testing application skills shows a fairly steady upward trend. It worth noting that the proportion of questions testing analysis has shown a general downward trend from 2009-2013. The researcher did not investigate the factors behind the trends exhibited in the data for reasons alluded to earlier.

Based on the findings of the analysis of the data collected in this investigation, it was concluded that, though there are slight differences between Biology and Geography GCE 'O' Level examinations in terms of the distribution of questions by cognitive level, the vast majority of the questions asked in all the components of both subjects require mostly the recall of information. For both subjects, there is an extremely low proportion of questions demanding critical thinking skills. The study revealed that, though the test items analysed meet acceptable psychometric benchmarks and are free from obvious construction errors, they fell short in terms of demanding the critical thinking skill of analysis, evaluation and creation

From the foregoing, it can therefore be concluded 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. 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.

8 Towards Developing Critical Thinking Skills through Formal Education

As has been noted in this study, society is moving towards a knowledge economy, an economy in which, among others, application of critical thinking skills replaces raw materials and labour as the main factors of production. 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 knowledge economy (Kessels, 2000).

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 knowledge economy should promote an *interpretivist* approach to teaching whereby students are encouraged to create their own knowledge and apply it to unfamiliar situations (Hargreaves, 2000). This imparts critical thinking skills to students leaving the educational system who, it is assumed, will become new entrants into the job sector. The curriculum for the knowledge economy should focus on the development of such 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 skills are needed for one to work successfully in the knowledge economy 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.

It is extremely important to ensure that the content of the curriculum that schools in Africa offer and the way the content is assessed are relevant to the needs of the students in the contemporary knowledge economy (Everard and Morris, 1996). One of the most certain things 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. Any 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 already been superseded as it is being taught.

The future for students graduating from the educational system holds fewer careers of a structured kind. Those who are to succeed will have to learn new skills continually as their existing skills and knowledge become redundant. This applies as much to the shop assistant as to the technologist or the teacher, or the lawyer or industrial manager (Everard and Morris, 1996).

Given such a scenario, it follows that the most essential skills of citizens in the knowledge economy 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 memorise and remember facts but to use those facts to solve problems and make decisions. This is what will help countries in Africa to achieve sustainable development.

REFERENCES

[1] BLOOM BS *et al*. 1956. *Taxonomy of educational objectives: the classification of educational goals; Handbook I: Cognitive Domain.* Longmans. New York.

[2] BROOKFIELD SD. 2000. *Contesting criticality: Epistemological and practical contradictions in critical reflection* Paper presented at the 41st Annual Adult Education Research Conference Chicago IL

[3] CARRINGTON A. The Pedagogy Wheel. https://designingoutcomes.com/

[4] BRUNER JS. 1973. *Going Beyond the Information Given*. George Allen and Unwin Ltd. London

[5] DEWEY J. 1910. *How We Think*. DC Heath. London

[6] ENNIS RH. 1962. A concept of critical thinking. *Harvard Education Review* 32(1): 81-111

[7] EVERARD KB & MORRIS G. 1996. *Effective School Management.* Paul Chapman Publishing

[8] GLASSER EM. 1941. *An Experiment in the Development of Critical Thinking*. Teacher's College, Columbia University

[9] HARGREAVES A. et al. 2000. *Learning to Change: Teaching Beyond Subjects and Standards.* Jossey-Bass. San Francisco

[10] KESSELS JWM. 2000. Learning in Organisations: A Corporate Curriculum for the Knowledge Economy. *Futures* 33(6): 497-506

[11] LESLIE LO. 2016. *The Second Principle*. https://thesecondprinciple.com/teaching-essentials/beyond-bloom-cognitive-taxonomy-revised/

[12] LIKANDO MK. 2014. Integration of Critical Thinking Items into National Assessment. Paper Presented at the *National Assessment Workshop*. Lusaka Zambia

[13] OECD. 2016. *OECD Science, Technology and Innovation Outlook 2016*. http://www.keepeek.com/Digital-Asset-Management/oecd/science-and-technology/oecd-science-technology-and-innovation-outlook-2016_sti_in_outlook-2016-en#page1

[14] PAUL RW. 1985. *Bloom's Taxonomy and Critical Thinking Instruction*.

[15] RAISKUMS BW. 2008. *An Analysis of the Concept Criticality in Adult Education*

[16] SCRIVEN M & PAUL RW. 1987. Critical Thinking as Defined by the National Council for Excellence in Critical Thinking. Statement presented at the *8th Annual International Conference on Critical Thinking and Education Reform*. Chicago IL. Available at www.criticalthinking.org/aboutCT/define_critical_thinking.cfm (accessed 06/10/2015)

[17] VINNYCHUK O *et al*. 2014. Research of Economic Growth in the Context of Knowledge Economy. *Intellectual Economics* 1(19): 116-127

[18] Wikipedia on Bloom's Taxonomy. https://en.wikipedia.org/wiki/Bloom%27s_taxonomy