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EVALUATING THE ASSESSMENT PROCESS AND ITS IMPLICATIONS ON CANDIDATES' PERFORMANCE IN ORDINARY LEVEL MATHEMATICS AT THE GENERAL CERTIFICATE OF EDUCATION EXAMINATION IN CAMEROON

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Abstract

The study explored the assessment processes and its implications on candidates' performance in Mathematics Ordinary level at the General Certificate of Education examination in the South west region of Cameroon. This study adopted an exploratory design and examined a collection of the mathematics GCE O level national examinations, in particular, the cognitive demands of the examinations made on students. The instrument used to examine the cognitive demands of the test items in this study was an adaptation from the model of Smith et al – the MATH taxonomy, as the descriptors in this model matched with the assessment objectives of the ordinary level mathematics syllabus 570. The instrument included six categories of mathematical knowledge and skills, arranged into three groups A, B, and C, in the MATH taxonomy, assessing students' mathematical understanding. The five assessment objectives for O-level mathematics stated in the GCE Mathematics Ordinary Level Syllabus 570 document were matched with the six categories of cognitive demands in the derived set of assessment standards. The two researchers did the matching independently and afterwards compared their results and differences which they reconciled to come to a common consensus. It was found that all mathematics GCE O-level examinations, analysed in this study were heavily biased towards assessing knowledge and skills in Group A category, with almost 50% or more of the items focusing on (A3) Routine Procedures and 18 - 30% on (A2) Comprehension, though only 9.4% on (A1) Factual Knowledge in the GCE O-level assessments Examination. It was recommended that enough attention should be directed to developing a more balanced assessment that not only includes items that assess the various categories of cognitive demands but also assesses all dimensions of understanding in the different topics.

Keywords:

Assessment processes, performance, Cameroon GCE, Mathematics examination, Evaluation.

Introduction

Mathematics assessment plays a crucial role in determining students' understanding and mastery of mathematical concepts, particularly at the Ordinary Level General Certificate of Education (GCE) examination in Cameroon. The assessment process has significant implications for candidates' performance, as it not only evaluates their knowledge and skills but also influences their future academic and career opportunities. Effective assessment practices are essential to ensure that students receive a comprehensive education and are well-prepared for future challenges.

Research has shown that assessment methods can significantly impact student learning outcomes and motivation [2]. In mathematics education, assessments can either enhance or hinder students' understanding and appreciation of mathematical concepts, depending on the approach used. Therefore, it is essential to evaluate the assessment process and its implications on candidates' performance in Ordinary Level Mathematics at the GCE examination in Cameroon.

This study aims to investigate the assessment process and its implications on candidates' performance in Ordinary Level Mathematics at the GCE examination in Cameroon. Specifically, the study will examine the current assessment practices, identify areas of strength and weakness, and provide recommendations for improving the assessment process to enhance student learning outcomes. By exploring the relationship between assessment and student performance, this study will contribute to the existing body of knowledge on mathematics education and assessment practices in Cameroon. The findings of this study will provide valuable insights for educators, policymakers, and stakeholders to improve the quality of mathematics education and assessment practices in the country.

Understanding the Assessment Process of Candidates' Performance in Ordinary Level Mathematics at The General Certificate of Education Examination in Cameroon.

The conceptual framework for this study illustrated the relationship between the assessment process and candidate performance in Ordinary Level Mathematics at the GCE examination. The framework will consist of the following components:

Assessment Process: This includes the methods, tools, and procedures used to evaluate student learning in mathematics.

Candidate Performance: This refers to the outcomes of the assessment process, including students' scores, grades, and overall achievement in mathematics.

Contextual Factors: This includes factors that may influence the assessment process and candidate performance, such as teacher training, curriculum design, and socio-economic background. By using these theoretical frameworks, the study provided a comprehensive understanding of the assessment process and its implications for candidate performance in Ordinary Level Mathematics at the GCE examination in Cameroon.

It is inherent that evaluation done at different stages of the teaching-learning process gives various educational stakeholders the opportunity to have feedback on the effectiveness of the teaching-learning process. The effectiveness of the teaching-learning can be evaluated after assessments have been administered to the learners. Such assessments can be written tests and quizzes, oral tests and quizzes, end of term examinations or certificate examinations. Educators can appraise performance in their respective subjects by considering the outcomes registered in assessments giving the objectives considered and the education system. The assessment objectives of the Cameroon General Certificate of Education Ordinary Level mathematics are to test candidates' ability to recall, apply and interpret mathematical knowledge in context and everyday situations, do calculations by applying a combination of mathematical skills and techniques, and set out mathematical work in a logical and clear form, organise, interpret and present information accurately in written, tabulated, graphical and diagrammatical forms using mathematical notations and terminology. Many students perform poorly in Mathematics because of lack of interest, phobia, poor instructional strategies, and even poor assessment strategies employed in the subject.

Despite these challenges bordering the teaching and learning of mathematics, it remains a compulsory subject in most educational systems. This is due to the applications of mathematics in all domains of life thus the government in Cameroon gives it the impetus of being one of the compulsory subjects at primary and secondary school levels. Nfon and Ahidjo (2022) asserted that there is a wide application of the skills acquired in the study of mathematics in all spheres of human life. According to Gravemeijer, Stephan, Julie, Lin and Ohtani (2017), mathematics has been designed to equip students to be able to analyse and solve a daily problem which is the reason for making it compulsory. The boasting of the gaining of knowledge in a wide range of mathematics topics should be the intention of mathematics instruction and to enhance the acquisition of mathematical thinking and reasoning skills (MOE, 2012). Five types of abilities have been identified to be imparted on the students when solving real world problems which are: 1) understanding mathematical concepts, 2) calculating fluently, 3) applying mathematical concepts to solve problems, 4) reasoning logically, and 5) involved with mathematics, seeing mathematics as something that makes sense, is useful, and can be done.

Sintha & Mulin (2021) asserted that in a mathematical activity the process of mathematical reasoning using mathematical concepts, procedures, facts, or tools to provide an overview, explanation, and prediction of a phenomenon are involved. According to Österman & Bråting (2019), mathematical literacy is not only imperative in the process of internalising mathematical content, but also there is application of mathematical literacy in the process of skill acquisition like using mathematical reasoning, concepts, and tools in commerce, industries, budgeting at home and attending to some daily needs. Students possessing such Mathematics skills can cope in sectors like commerce, engineering, telecommunication, arts, fashion and other spheres of life. Although mathematics pervades all spheres of life, students' performance in the subject at the ordinary level of the Cameroon General Certificate of Education (G.C.E.) Examination has left educational stakeholders in a fixed. In 2018, 68229 candidates sat for the ordinary level mathematics, 20283 passed, 47946 failed, 2034 got A grade, 2838 got B grade, 15411 got C grade and 32436 got U grade giving a percentage of 47.54% for the U grade.

In 2019, 61283 candidates sat for the ordinary level mathematics examination, 15946 passed with 2146 A grade, 2212 B grade, 11588 C grade and 33934 U grades giving a 55.37% for the U grades. It is worth noting that grades A to C are passed grades with A being the best followed by B then C the lowest pass and the grade U means fail. Some of the possible causes of these massive failures in mathematics have been identified by researcher as being poor instructional strategies employed, insufficient use of instructional materials, students' and teachers' attitudes towards the subject. Researchers have sought to remedy the desperate situation by suggesting some innovative instructional strategies and materials that can rescue the situation. Some of these instructional strategies include collaborative learning, cooperative, problem-solving skills and computer assisted instructions amongst others. These instructional strategies appear to be more theoretical.

According to Tan (2007), mathematics teachers have endeavoured to impact on students' learning by modifying their teaching strategies and moderating assessments, but it has been discovered from studies that students get more interested to acquire the skills that are directed to succeeding in examinations than to consider an in depth learning style, and therefore have a great desire to consider their learning styles and to make all effort possible to register a pass mark in assessment tasks. The tendency is that there would be lapses if the teaching methods are varied without considering the assessment methods, thus it is imperative to examine the quality of the assessment instruments and analyse the content of the assessment to ameliorate and make our instructions better. It is expected that the assessment items should be set within the required mathematical knowledge and skills. There is need to consider the evaluation of the assessment processes and its implications on students' performance.

A lot of attention has been directed toward the instructional strategies and materials and little or no efforts employed to check how well evaluating the assessment processes can have a bearing on students' performance in the Cameroon General Certificate of Education examination. The assessment should include the setting of examination questions, moderation of the examination questions, the writing of the examination, and the marking process which need to be evaluated to ascertain that the student's performance is not jeopardized. The outcomes from these evaluation processes are often carried out in strict confidence such that the results are not always made available to the users of the examination which is not sensible. It is only when teachers and students get to know how some test items are fairing that they can improve on the teaching and learning of some topics, as well as their setting of test items and even the marking of tests and examinations.

A work was done on Taxonomy of Educational Objectives: Cognitive Domain (Bloom et al., 1956) which provided guidelines for an assessment framework. Bloom's classification recognized six levels that can be used to categorize processes for demonstrating students' content knowledge in ascending order as follows: knowledge, comprehension, application, analysis, synthesis, and evaluation. Despite Bloom's effort, findings from some studies carried out to investigate the application of Bloom's taxonomy as a guide in assessing mathematics knowledge have revealed that "Bloom's taxonomy does not provide an accurate model to guide item writers for anticipating the cognitive processes used by students to solve items on an achievement test in mathematics"(Gierl, 1997, p. 26), and that "mathematics teachers have difficulty interpreting the thinking skills in Bloom's taxonomy and creating test items for higher-order thinking" (Thompson, 2008, p. 96). Smith et al. (1996) proposed a modification of Bloom's taxonomy, the MATH taxonomy (Mathematical Assessment Task Hierarchy) for the structuring of assessment tasks. These researchers realized that Bloom's taxonomy could be suitable for structuring assessment tasks, but show some limitations in the mathematical context. Eight categories of mathematical knowledge and skills were identified by these researchers which were arranged into three groups A, B, and C. These eight categories are classified according to the nature, not the difficulty level, of the activity required to complete the task successfully as seen below.

Table 1:

The MATH Taxonomy

GROUP A	GROUP B	GROUP C
(A1) Factual knowledge (A2) Comprehension (A3) Routine Procedures	(B1) Information transfer (B2) Application to new situation	(C1) Justifying and interpreting (C2) Implications, conjectures and comparisons (C3) Evaluation

Source: *The Math Taxonomy (Smith et al., 1996)*

A summary of the descriptors used by Smith et al. (1996) can be seen in figure 2 below. A series of detailed examples to illustrate the list of descriptors was also given by the researchers. Bennie (2005) emphasized that the MATH taxonomy could also be used as a tool in analysing course material in Mathematics. In figure 3, Smith et al. (1996) recommended the use of a grid that matches subject topics with the descriptors of the MATH taxonomy which enables teachers to easily determine how well the assessment tasks are balanced on the paper" (Smith et al., 1996), and they discovered that most of the mathematics examination papers they had analysed had a great bias for group A tasks. In addition, Smith et al. (1996) highlighted a few characteristics of the MATH taxonomy. In the first place, they placed activities that do not require in-depth learning on the left side of the taxonomy, while those that needed a more intense approach were placed on the other side. Secondly, there exist no clear differences between the categories since there are questions that are not directly linked to any category, as well as questions that may link to more than one category. Thirdly, a student's previous learning has a bearing on how the student can perform a task. Lastly, the taxonomy is a representation of the characteristics of the activity and does not consider the difficulty levels in listing the activities.

Table 2:

Descriptors in the MATH taxonomy

Categories	Students can…
(A1) Factual knowledge	recall previously learned information in the original form, for example, a specific formula or definition
(A2) Comprehension	decide whether or not conditions of a simple definition are satisfied, understand the significance of symbols in a formula, show an ability to substitute in a formula, and recognize examples and counterexamples
(A3) Routine procedures	carry out all the steps in a procedure that have been used in drill exercises prior to the assessment, to get the correct answer as long as the procedure is used correctly (although there may be more than one appropriate procedure for a particular problem)
(B1) Information transfer	• transform information from one form to another, for example, verbal to numerical • decide whether the conditions of a conceptual definition are met, where a conceptual definition is one whose understanding requires a significant change in a student's mode of thought or mathematical knowledge • recognize which formula or method is appropriate in a particular context • recognize when a formula or method is inappropriate in a context • summarize in non-technical terms for a different audience

	• construct a mathematical argument from a verbal outline of the method • explain the relationships between parts of the material • explain processes • reassemble the parts of a mathematical argument in a logical order
(B2) Application to new Situation	choose and apply appropriate methods or information in new situations, for example, modelling real life settings, proving a previously unseen theorem (which goes beyond using routine procedures), and choosing and applying appropriate algorithms
(C1) Justifying and Interpreting	justify and/or interpret a given result, for example, proving a theorem to justify a result, finding errors in reasoning, recognizing computational limitations and sources of error, discussing the significance of given examples and counterexamples, recognizing unstated assumptions
(C2) Implications, conjectures and comparisons	draw implications, make conjectures, and prove them
(C3) Evaluation	use set criteria to judge the value of material for a specific purpose, for example, making judgements; selecting for relevance; arguing the merits of an algorithm; using organisational skills; and thinking creatively in restructuring given material to view it in different ways

Table 3:

Grid for MATH taxonomy and subject topics

TOPIC / MATH Taxonomy	TOPIC 1	TOPIC 2	TOPIC 3	TOPIC 4	TOPIC 5
Factual knowledge					
Comprehension					
Routine use of procedures					
Information transfer					
Applications in new situations					
Justifying and interpreting					
Implications, conjectures and comparisons					

The frameworks considered above give guidelines on the ways of assessing various types and levels of knowledge and a standard for examining written assessment items. Specifically, the MATH taxonomy presents both the mathematical knowledge and skills to be learnt, and the cognitive process considered in differentiating the knowledge and skills. This study sought to evaluate the assessment processes and their implications on students' academic performance in the GCE ordinary level mathematics examination.

Theoretical Framework

The study was guided by the following theoretical frameworks:

Social Constructivist Theory: This theory posits that knowledge is constructed through social interactions and experiences. In the context of mathematics education, social constructivism emphasizes the role of assessment in shaping students' understanding and construction of mathematical knowledge.

Assessment for Learning Theory: This theory emphasizes the importance of assessment as a tool for learning, rather than just a measure of student achievement. It highlights the need for assessments to be aligned with learning objectives and to provide feedback that guides student learning.

Curriculum Alignment Theory: This theory emphasizes the importance of aligning assessments with curriculum objectives and standards. It ensures that assessments measure what students are expected to know and be able to do.

Statement of the Problem

The assessment process in Ordinary Level Mathematics at the General Certificate of Education (GCE) examination in Cameroon has been criticized for being inadequate and ineffective in measuring students' true abilities and competencies. Despite the importance of mathematics in various aspects of life, many students continue to struggle with the subject, and their performance in the GCE examination has been unsatisfactory. There is a need to evaluate the assessment process and its implications on candidate performance in Ordinary Level Mathematics to identify areas of strength and weakness and provide recommendations for improvement. This study aims to investigate the assessment process and its impact on candidate performance in Ordinary Level Mathematics at the GCE examination in Cameroon, with a view to informing policy and practice in mathematics education.

Objectives of the study

The general purpose of the study was to evaluate the assessment processes and their implications on students' performance in the GCE ordinary level mathematics examination. Specifically, this study sought to find out:

(1) the types of cognitive demands represented in the GCE ordinary level mathematics examination

(2) the dimensions of understanding represented in the GCE ordinary level mathematics examination

Methodology

This study adopted an exploratory design and examined a collection of the mathematics GCE O level national examinations, in particular, the cognitive demands the examination made on students. The MATH taxonomy provided the set of assessment standards used in the study.

Sample

The General Certificate of Education (GCE) O-level mathematics (syllabus 570) paper set by mathematics O level examiners served as the benchmark paper that constituted the materials to be investigated. In this study, the papers examined from the respective sources will be referred to as the four assessments, and they are from the examinations in the years 2018 and 2019. The mathematics syllabus 570 consists of eleven topics, namely: Numbers, Sets and logic, Mathematical relations, Euclidean geometry, Mensuration, Rectangular coordinate geometry, Algebra and network, Trigonometry, Vectors, Matrices and transformations, Statistics and probability. There are two papers in the written assessment – Paper 1 which consists of 50 multiple choice questions more on the knowledge, comprehension, and application skills of concepts, and Paper 2 consisting of 15 structural and 4 essay questions of varying marks and lengths testing more on higher order thinking skills. Candidates are required to answer all questions in both papers.

Instrument for data collection

The instrument used to examine the cognitive demands of the test items in this study was an adaptation from the model viewed before – the MATH taxonomy (Smith et al., 1996), as the descriptors in this model matched with the assessment objectives of the mathematics syllabus 570. The instrument includes six categories of mathematical knowledge and skills, arranged into three groups A, B, and C, in the MATH taxonomy, assessing students' mathematical understanding. The six categories of cognitive demands are: (A1) Factual Knowledge, (A2) Comprehension, (A3) Routine Procedures, (B1) Information Transfer, (C1) Justifying and Interpreting, and (C2) Implications, Conjectures and Comparisons. The five assessment objectives for O-level mathematics stated in the GCE Mathematics Ordinary Level Syllabus 570 document were matched with the six categories of cognitive demands in the derived set of assessment standards in table 4. The two researchers did the matching independently and afterwards compared their results and differences which they reconciled to come to a common consensus.

***Table 4*:**
Matching of assessment objectives with categories of cognitive demands

Assessment Objectives	Key Words	Cognitive Demands
Understand and apply mathematical concepts and skills in a variety of contexts	Understand	A2
	Apply	A3
	variety of contexts	B1
Organise and analyse data and information; formulate and solve problems; including those in real-world contexts, by selecting and applying appropriate techniques of solution; interpret mathematical results	Organise	A3
	Analyse	B1
	Formulate	A3
	Solve	A3
	Interpret	B1
Solve higher order thinking problems; make inferences; write mathematical explanation and arguments	make inferences	C2
	write explanation and arguments	C1

A grid, that combines item numbers, subject topics, brief description of the content with the categories of the derived set of assessment standards, is used to record the distribution of the codes in each paper of a written assessment.

Results and Discussion

Though there are only about 50 questions in paper 1 and 19 questions in paper two, there are several part questions that allow the testing of a range of cognitive demands in the different dimensions. In this study, the two researchers identified and rated the cognitive demands of the items in the GCE O-level examination independently using the derived set of assessment standards before reconciling to check for the reliability of coding. Out of 138 questions or part questions, the codes for 126 were concurred. The 12 items that had different coding were discussed and arrived at a consensus. Hence it may be said that the intercoder reliability was (126 ÷ 138) × 100% = 91.3%.

Table 6:

Distribution of categories of cognitive demands in the GCE O Level Mathematics examination

Category	Number of questions or part questions (% to one decimal place) *
	GCE O
A1	13 (9.4)
A2	25 (18)
A3	75 (54.5)
B1	12 (14.0)
C1	10 (7.2)
C2	3 (2.2)

Note. A1 = Factual Knowledge; A2 = Comprehension; A3 = Routine Procedures; B1 = Information Transfer; C1 = Justifying and Interpreting; C2 = Implications, Conjectures and Comparisons.
* % is computed as (number of questions or part questions in the category/total number of questions or part questions in the assessment) *100.

Similar to what Smith et al. (1996) found in their study, all mathematics GCE O-level examinations, analysed in this study were heavily biased towards assessing knowledge and skills in Group A category, with almost 50% or more of the items focusing on (A3) Routine Procedures and 18 -30% on (A2) Comprehension, though only 9.4% on (A1) Factual Knowledge in the GCE O-level assessments Examination. In fact, only around 10 - 15% of the items focus on Group B and less than 10% on Group C.

Implications of the study

Students are expected to be attentive to the kind of learning approach they embark on whether it is shallow or in-depth learning depending on the quality and characteristics of the mathematics written assessment they are exposed to (Ramsden, 1992). Obviously, they will consider taking a shallow approach when they are given written assessment which tests a narrow range of skills. D'Souza and Wood (2003) concluded from their research findings that by giving close attention to assessment methods that test a broader range of skills, students' learning can be greatly enhanced. There is a need to critically examine the types and extent of cognitive demands the written assessments make on students. Schools should have as objectives of assessing the knowledge and skills of all six categories in their written assessments, and if possible, in all the eleven topics of the GCE O-level syllabus. The schools could also model their written assessments after the GCE O-level as the distributions of the six categories across the twelve topics in the schools' assessments are in a way similar to those in the GCE O-level. However, the primary objectives of the GCE O-level examination are to evaluate individual student progress and to place students in the appropriate educational level according to their performance in the examination. Thus, teachers are expected to be conscious of the types of cognitive demands solicited from the students as they develop the assessment items in the various topics, so as to design a balanced assessment that offers feedback on the actual learning that takes place rather than only measures the outcomes of that learning (Fong & Kaur, 2015).

Recommendations

It was recommended that enough attention should be directed to developing a more balanced assessment that not only includes items that assess the various categories of cognitive demands but also assesses all dimensions of understanding in the different topics. According to Thompson and Kaur (2011), the entire test results provide only fast feedback on student understanding, which can misdirect the aims of the mathematics curriculum which are to enable students to acquire knowledge and understanding of the nature, reasoning, and purpose of learning mathematics; put mathematical knowledge and skills acquired into use in other disciplines, real-life situations, employment opportunities, and further studies, therefore there is need to assess beyond just their knowledge of skills. Furthermore in the revised Mathematics syllabus, it is stated that: Besides reading, writing, and talking about mathematics in a variety of ways, students should, under the guidance of the teacher, demonstrate the various mathematical approaches to solve problems of all types. Usiskin (2012) recommended that one can be thought of as having a complete understanding of a mathematical concept if that individual can effectively manage the skills and algorithms associated with the concept, with properties and mathematical justifications (proofs) involving the concept, with uses and applications of the concept, with representations and metaphors for the concept.

Conclusion

Assessment is an intriguing aspect of a well-established instructional program for it is meant to offer feedback on how well the instructional objectives have been attained while placing learners at the appropriate level of instruction. Enough attention should be given to the process to ensure it is effectively done by carefully screening the instruments used for assessing learners to meet up with the required standards of the Cameroon educational system. The researchers are not better placed to dictate the mode of distribution of items of a balanced assessment as it is left at the discretion of the class teachers to determine what they consider appropriate depending on the prevailing circumstance. The bottom line is for the teachers and the officials setting assessments in schools or at the national examinations to consider assessments that are of standards and flexible to uphold the excellent standards of the Cameroon educational system.

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