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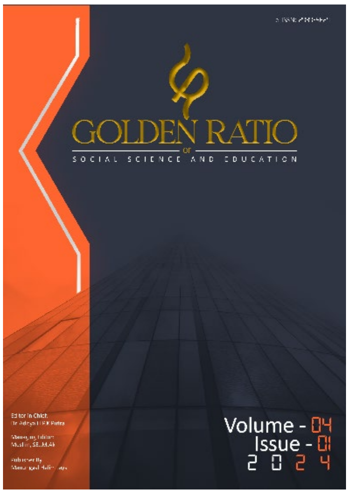

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SOCIAL SCIENCE AND EDUCATION | RESEARCH ARTICLE

An Investigation of The Connection of Bloom's Taxonomy to the Core Mathematics Curriculum for Senior High Schools in Ghana

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Abstract: This paper attempts to preview the connection of Bloom's taxonomy to Ghana's Senior High School mathematics curriculum. Mathematics is a vital tool for economic growth and national development as a STEM subject. Bloom's taxonomy, which presents a hierarchical model, helps educators teach school mathematics to enable students to acquire basic Knowledge known as order thinking (LOT) skills and develop higher-order thinking (HOT) skills. The analysis of the mathematics syllabus concerning Bloom's taxonomy revealed that the syllabus concentrates more on the three fundamental skills in Bloom's hierarchy of teaching and assessment. Remember 18.1%, Understand 33.3%, and Apply 29.8%, totalling 81.2%, leaving only 18.8% for the top three HOT skills. The study recommends that Ghana adopt a curriculum model that focuses on teaching transversal skills that can churn out informed citizens rather than putting students under the shackles of tests.

Keywords: STEM, Curriculum, Syllabus, Revolutionised, Modernization, Globalization, Higher Order Thinking Skills.

1. Introduction

Mathematics is rated as one of the most important subjects within the (Mereku, 2000) foundation subjects that constitute the core curriculum for basic (primary and secondary) education in countries across the world (Martin et al., 2020; Mereku, 2010). As a science, technology, engineering, and mathematics (STEM) subject, it occupies a privileged position in the school curriculum because the ability to cope with more of it improves one's chances of social advancement (Mereku, 2000) and contributes meaningfully to the economic development of a nation. According to Mereku (1992), as cited in (Mereku, 2000), mathematics attained this enviable status when it was made to replace classical languages like Latin or Greek (Mereku, 2000), which were previously used as the screening devices for admission into institutions of higher learning and certain professions.

Today, mathematics is seen as a tool for national development (Abramovich et al., 2019) since it has been the source of many technological advancements and innovations across the globe. The demand for the application of the knowledge of mathematics always continues because mathematics has varied applications. As a result, there is a need to revolutionize the content and focus of school mathematics to reflect changing views about the subject and what is valued globally (Mereku, 2004, 2019). This calls for designing and implementing a critical mathematics curriculum that allows students to take responsibility for their learning (Darder et al., 2003; Giroux, 2020). This kind of instruction enhances student creativity and critical thinking skills and develops specific societal values that make the individual an informed citizen (Bada, 2015; Bruner, 1962; Gruenewald, 2003; Wink, 2005). Mathematics should be craftily rolled out to develop students, tolerance (respect for other people's views), leadership skills, good communication skills, loyalty, collaboration, and problem-solving skills (Ernest, 2018).

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Until recently, the cane was an excellent negative motivational technique in teaching mathematics in Ghana. Mereku (2010) revealed that the cane was used excessively to teach pupils the tables of numbers and measurements and to solve practical problems in measuring, commerce, etc. The teachers forced pupils to use repetitive and rote learning techniques to learn mathematics. However, as Gyang (1979, as cited in Abroampa et al., 2020) observed, this method made many students hate mathematics. The paper noted that school mathematics was characterized by punishment, force, and fear, which forced some students to end their schooling prematurely (Abudu & Mensah, 2016; Mereku, 2019).

The 1987 Educational Reform brought Modern Mathematics, which was developed with a renewed mindset to make the teaching and learning of mathematics meaningful and less computational (Mereku, 2004). However, (Mereku, 2000) asserts that the pupils' achievement in mathematics remained the same, notwithstanding the introduction of new content and modern teaching skills. The 1980 Reform, even though it was greeted with much hope, turned out to be a fiasco because learning and teaching activities that could encourage the use of the new teaching skills and strategies were not included in the curriculum (Mereku, 2010; Santos-Trigo, 2020). It was not surprising that Mereku (2004) reported that Ghanaian students who took part in the international standardized test known as the Trends in International Mathematics and Science Study (TIMSS) 2003 could only answer questions that demanded computational skills and, for that matter, could not perform well. Ghana's continuous abysmal performance in the TIMSS pulled it out after the second unsuccessful attempt in 2007.

Analysis of trends in the performance of senior high students in Ghana's West Africa Senior School Certificate Examination (WASSCE) by Owusu and Amedahe (2018) revealed that poor teaching methods contributed to student failure. Teaching mathematics at the Senior High School only encourages memorization of facts and computational algorithms. Nothing triggers the switch to innovative teaching approaches like problem-solving and inquiry-based learning. This is mainly because the goal of teaching is for students to pass the final examination.

In 1956, one psychologist, Benjamin Bloom, developed a three-domain hierarchy of learning that aims at developing the individual's totality (the Head, the Hand, and the Heart) (Furst, 1981). The focus of the taxonomy is to enrich students with higher order thinking skills that will make them battle-ready to face the challenges posed by modernization, globalization, natural disasters, and socio-cultural dynamics (Aziz & Kharis, 2021; Stinson et al., 2012; Tanujaya et al., 2021). Taxonomy is helpful in education because it helps educators develop critical thinking skills and higher-order cognitive abilities in students (Thompson, 2008; Zhang et al., 2020). It also offers a framework for the organization and classification of classroom objectives based on the level of students. Bloom's taxonomy has been widely harmonized in mathematics curricula across the globe because of its focus on developing higher-order thinking (HOT) skills (Mullis & Martin, 2017; Principles, 2000; Ramírez, 2006). Skills needed in this 21st century to boost industrialization and workforce skills for national security, economic growth, and development.

Statement of the Problem

There have been a lot of curricula reforms in Ghana to position the teaching and learning of school mathematics in its proper perspective and per the international best practices and demands of international assessments (Adu-Gyamfi & Otami, 2020; Akyeampong, 2017; Mereku, 2000). Even though much has been done, as a developing nation, the country has yet to attain much in school mathematics (Byrne & Prendergast, 2020). One would wonder whether the secondary school graduates being churned out have the repertoire of experience and knowledge illustrated in the mathematics curriculum (Dogbey & Dogbey, 2018). As it stands now, the mathematics syllabus stands on Bloom's taxonomy in terms of teaching and assessment. As indicated in the profile dimension (MOE, 2010). Meanwhile, studies have yet to be done to determine the percentage of the various levels of Bloom's taxonomy incorporated in the curriculum in specific objects, content, and assessment. Therefore, this study seeks to show how Bloom's taxonomy regarding percentages has been incorporated into the mathematics curriculum.

Purpose, Objectives, and Research Questions

The study aims to thoroughly investigate how Bloom's taxonomy has been linked to the Ghana mathematics syllabus to promote higher order thinking among students. The study's objectives were

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To find the link between Bloom's taxonomy and the Ghana mathematics curriculum for senior high schools and to investigate the capacity of the Ghana mathematics curriculum to produce critical thinkers. Ghana has not been able to participate in the TIMMS for a long time since their last two unsuccessful attempts in 2003 and 2007, respectively. Meanwhile, there have been many reforms in secondary school mathematics education that are supposed to produce students who can compete internationally. Even so, the student's performance in the final examination conducted by the West Africa Examination Council could be better (Abreh et al., 2018; Amankwah, 2020; Bosson-Amedenu, 2018). There is always the question of whether the curriculum is fit for producing graduates who can face real-life challenges in this technological era. Among the specific research questions are:

1. Is there any link between Bloom's taxonomy and the Ghana mathematics curriculum for senior high schools?
2. Does the current Ghana mathematics curriculum have the capacity to produce students who are critical thinkers?

2. Literature Review

2.1. Mathematics Curriculum in Ghana Before Independence

Ghana's mathematics curriculum at the elementary school level before independence from British rule in 1957 was arithmetic (Mereku, 2010). The traditional school arithmetic taught primarily involved mechanical number facts and tables of measurements. The few foreign books used at the time focused mainly on arithmetic, as their names suggest: Simon and Milliken's Arithmetic' and 'Larcombe's Arithmetic series with accompanying speed tests in mental arithmetic at the Basic Schools. Mathematics had three branches at the senior secondary school and teacher training school levels: arithmetic, algebra, and geometry. They were taught largely using British grammar school textbooks such as 'School Arithmetic' and 'School Algebra' by Channon and Smith (1938, 1948) and 'School Geometry' by Durell (1939) as cited in (Mereku, 2000). Around the 1960s, global mathematics education took a dramatic turn for several reasons. Russia's post-war experience and other discoveries were the main catalysts for a paradigm shift in content and pedagogy in the school mathematics curriculum in the United States and other countries, including Ghana (Principles, 2000). New methods and techniques for solving old and new problems were developed, creating new concepts (Mereku, 2010). These developments led to a careful formulation of ideas and a greater precision of mathematical language. Sets, and to a lesser extent, functions, emerged as unifying concepts (Van der Blij et al., 1981).

2.2. Mathematics Curriculum in Ghana After Independence

The birth of the Africa Mathematics Program (AMP) was a result of a conference of ministers of education in Africa to revitalize and restructure the inherited colonial curriculum to suit the African soil, as documented by UNESCO (1961) cited in Mereku (2010). The AMP blended experience from Africa, Britain, and America to produce mathematics books for smoother African mathematics education, especially in English-speaking countries. The Entebbe Math Series was the first mathematics series produced by the AMP and was later updated and named the Joint School Project (JSP) for secondary schools (Abdul et al., 2015; Mereku, 2000; Wilson, 1982). In Ghana, the JSP was criticized for being foreign, so a few local publishers were tasked to produce local mathematics books that suited Ghanaian culture and practice (Doku, 2003; G. et al., 1976). The project received funding from local and international organizations like the Nuffield Foundation, Centre for Educational Development Overseas and Overseas Development Administration in London, the Mathematical Association of Ghana (MAG), the University of Ghana, and the Ghana Ministry of Education (Mereku, 2010). Some of the books produced were the New Mathematics for Primary Schools (NMPS), Modern Mathematics for Elementary Schools, Book 1 to Book 8, and West African School Mathematics, usually referred to as AWAM, for Middle Forms 3 and 4 (Gibson and Mar dell, 1965) as cited in (Mereku, 2010). The AMP was later developed into West African Regional

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Mathematics Programmes (WARMP) for the three participating countries in West Africa: Ghana, Liberia, and Sierra Leone (Kamara, 2018; A. Williams, 1978). The Ghana Mathematics Series (GMS) textbooks and Teacher's Handbooks, used in the country for three decades, were products of the WARMP (Mereku, 2010).

2.3. The Bloom's Taxonomy

Bloom's taxonomy is a hierarchical model system used to categorize learning objectives into graduated levels of complexity (Krathwohl, 2002). The taxonomy is categorized into various degrees of difficulty, from basic recalling of facts to a higher level of producing new and original knowledge. As an educational psychologist and a chair of the committee of educators at the University of Chicago in the mid-1950s, Benjamin Bloom, in collaboration with Max Englehart, Edward Furst, Walter Hill, and David Krathwohl, was working to devise a system that classified levels of cognitive functioning (Furst, 1981; Ruhl, 2020). He provided a sense of structure for the various mental processes we experience (Armstrong, 2010). After a series of studies focused on student achievement, the team identified factors inside and outside the school environment that affect how children acquire knowledge (Cox & Wildemann, 1970; Krathwohl, 2002; Tabari & Tabari, 2015). It came up that relying upon more than one universal curriculum was not helping many students because of individual differences in learning due to varied cognition levels (Tanujaya et al., 2021). One such factor was the need for more variation in the teaching. In other words, teachers needed to meet each student's needs. To address this issue, the team postulated that if teachers could provide individualized educational plans, students would learn significantly better. This hypothesis formed the basis and motivation for Bloom's taxonomy. The taxonomy was initially published in 1956 but was modified yearly for 16 years before it was revised in 2001 (Krathwohl, 2002). It consists of three learning domains: cognitive, affective, and psychomotor. The cognitive process produces outcomes that focus on knowledge and abilities and require memories, thinking, and reasoning (Abeysekera & Dawson, 2015). Cognitive knowledge is classified into Factual, Conceptual, Procedural, and Metacognitive Knowledge (Artelt & Schneider, 2015; Haberkorn et al., 2014). The practical focus is on learners' feelings, interests, attitudes, dispositions, and emotional states. The psychomotor also develops motor skills and perceptual processes (Furst, 1981; Njura et al., 2021). The hierarchy for cognitive learning, from low-order to higher-order thinking abilities, is Remembering, Understanding, Evaluating, Analyzing, Applying, and Creating (Krathwohl, 2002).

1. Remember, it involves the study of facts, figures, and basic concepts. The action verbs depict remember, list, recite, outline, define, name, match, quote, recall, identify, label, recognize, and others. Putting these action verbs in objectives indicates that students must be able to recall basic information delivered during lessons (Krathwohl, 2002).
2. Understand concerns with the facts productively gathered during the knowledge stage. In this category, learners are expected to describe, explain, paraphrase, restate, give original examples, summarize, contrast, interpret, and discuss (Thompson, 2008).
3. Evaluating is about making judgments or defending opinions. To show evidence of reaching this stage, learners are expected to choose, support, relate, determine, defend, judge, grade, compare, contrast, argue, justify, support, convince, select, and evaluate (Furst, 1981).
4. Analyze is the stage where learners can conclude and establish a relationship between concepts taught. For example, they can design, formulate, build, invent, create, compose, generate, derive, modify, and develop, among other things (Pujawan et al., 2022; Ruhl, 2020).
5. Apply concern with the use of the knowledge acquired to solve real-life problems. In applying the concepts, students are expected to calculate, predict, apply, solve, illustrate, use, demonstrate, determine, model, perform, and present (Thompson, 2008).
6. Create is the last and final stage in the hierarchy, which involves producing new results by planning, designing, developing, and the actual application. Action words associated with this stage are design, build, build, invent, create, compose, generate, derive, modify, and develop (Ruhl, 2021).

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2.4. Affective domain

This domain focuses on how we handle all things related to emotions, such as feelings, values, appreciation, enthusiasm, motivations, and attitudes (Wei et al., 2021). From lowest to highest, with examples included, the five levels are: **Receiving** is about essential awareness. Listen and remember the names of your classmates when you meet them on the first day of school. **Responding** is active participation and reacting to stimuli, focusing on responding, such as participating in a class discussion. **Valuing** is also concerned with the amount of premium put on a particular object or information based on previous experience (Gafoor & Kurukkan, 2015). **Organizing** involves categorizing concepts or objects into priorities and creating a unique value system. The emphasis is always on making comparisons and relating previously identified values. **Characterizing** is about building abstract knowledge based on the knowledge that has been acquired previously.

2.5. The Psychomotor Domain

The third and final domain of Bloom's Taxonomy is the psychomotor domain. The psychomotor model focuses on physical movement, coordination, and anything related to motor skills (Njura et al., 2021). Mastery of these specific skills is marked by speed, precision, and distance. These psychomotor skills range from simple tasks like washing a car to more complex tasks like operating intricate technological equipment.(Muhayimana et al., 2022; Njura et al., 2021) The psychomotor model, as with the cognitive domain, does not come without modifications. This model was first published by Robert Armstrong and colleagues in 1970 and included five levels: imitation, manipulation, precision, articulation, and naturalization (Zhang et al., 2020).

Several theories share the view of Bloom's taxonomy; however, this study discusses only two theories that connect the taxonomy. The first one is Polya's problem-solving approach. The whole Boom's taxonomy is submerged in problem-solving. According to its originator, George Polya, problem-solving has no single definition because it is directly linked to real-life situations (Santos-Trigo, 2020). Real-life situations also come in many forms, and the approach to finding the solution to contextual problems differs. Real-life conditions are faced with many challenges that need innovative approaches to solve, and it is through HOT skills that individuals are challenged to find solutions to real-life issues (Aziz & Kharis, 2021). What the problem-solving approach in learning mathematics seeks to do is to imbibe in the students the ability to reason, think, reason, and communicate mathematically so that they become independent in life and resolute in handling any challenges that arise or may occur in daily life activities (Bhuttah et al., 2019; MOE, 2010; Mullis & Martin, 2017). Studies have shown that the focus of school mathematics has been on for decades in several countries. Realistic Mathematics Education (RME) was primarily borne out of problem-solving (Aksu & Colak, 2021; Arsaythamby & Zubainur, 2014) and has become a household name in mathematics education. Most of the best-performing countries in the TIMSS assessment project have reviewed their mathematics curriculum to absorb the RME (Mullis et al., 2012)

The constructivist theory of learning also links with Bloom's taxonomy since the theory aims to enhance students' knowledge creation based on their previous experience (Adom et al., 2016). For instance, the zone of proximal development (ZPD) asserts that students have basic knowledge and need to reach a certain level of higher thinking order (Lasmawan & Budiarta, 2020). Students can reach this stage through assistance from other capable individuals or through their efforts through the conceptual change model, i.e., Accommodation and assimilation processes (Belbase et al., 2022; Gómez, 2016). The constructivist education theory implies that students must be challenged to take responsibility for their learning (Atta & Brantuo, 2021). Therefore, the teachers should act as coaches, curators, or facilitators to facilitate students' independent learning (Minarni & Napitupulu, 2020). When the student is actively involved in constructing knowledge, it is expected to enhance their chance of utilizing it to solve contextual problems (Atta & Brantuo, 2021).

The concern of Bloom's taxonomy is to help learners acquire knowledge and use the knowledge to solve real problems and create a new situation to improve life (Bermejo et al., 2021). This can be accomplished if the learners apply innovative collaborative and independent creative thinking strategies to solve real-life problems (Adu et al., 2017). Mathematics is a STEM subject, and as a language on its own, it should be taught focusing on not just the acquisition of knowledge but the application of knowledge in creating new knowledge (Diego-Mantecón et al., 2022).

The current mathematics syllabus of Ghana has been built around Bloom's Taxonomy. It fosters the acquisition of lower-order Thinking (LOT) skills such as knowledge and understanding (KA) and Higher Order Thinking (HOT) skills termed Application of Knowledge (AK), which encompasses; "apply," "Evaluate," and Apply and Create (MOE, 2010). The specific objectives are stated using action words regarding Bloom's taxonomy. The syllabus has provided a benchmark of knowledge and understanding of 30% and an Application of Knowledge of 70% for assessment. This guides teachers to plan and deliver appropriate instruction, design valid tasks and assessments, and ensure that such instruction and assessment align with the outlined objectives. The table below shows the scope or content of the core mathematics syllabus. The syllabus consists of thirty topics grouped under seven main learning domains.

Table 1. The Scope of Content for the Core Mathematics Syllabus

Scope	Topics
Numbers and Numeration	Sets and Operations on set Modular arithmetic Number Bases Variation Relations and Functions Real number system Surds Indices and logarithms Number Bases
Plane Geometry	Plane Geometry Plane geometry II (Circle theorems) Constructions
Mensuration	Mensuration I Mensuration II
Algebra	Algebraic expressions Simultaneous linear equation Logical reasoning Quadratic functions Linear equations and inequalities Sequences and Series Ratio and Rates Variation Percentages I Percentages II
Statistics and Probability	Statistics I Statistics II
Trigonometry	Trigonometry I Trigonometry II
Vectors and Transformation in a Plane	Bearing and Vectors in a plane Rigid motion I, Rigid Motion II and Enlargement

Source: (MOE, 2010)

3. Research Method and Materials

The study was a non-experimental survey that focused mainly on the teaching Syllabus for core mathematics for Ghanaian senior High Schools From One to Form Three. The average age range of students in this category is Sixteen years to Eighteen years. The Curriculum Research and Development Division designed the core mathematics syllabus under the Ministry of Education, Ghana, in 2010 (MOE, CRDD, 2010). Since the introduction of the Free Senior High School

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(FSHS) policy, the senior High school has become the termination point for Ghanaian students who wish to exit formal education to enter into their chosen careers and a foundation for those who want to further their education (MOE, 2010) Therefore, choosing this grade level for the study based on the incorporation of Bloom's taxonomy was the best decision. All the action verbs used in the syllabus have been listed and grouped according to Bloom's hierarchy and analyzed based on the frequency at every hierarchy level.

Appendix 1 shows 171 action verbs used in the syllabus regarding objectives, content, and assessment. Fifty-two verbs are used in the objectives section across the hierarchy, with understand having the highest, followed by remember, Apply and Create in that order. The verbs are almost distributed, except that "Create," Evaluate and Analyze are almost missing for assessment. It, therefore, gives credence to the fact that the assessment tools are made to evaluate only the LOT skills, leaving the HOT skills.

4. Results and Discussion

4.1. Result

Table 2 displays the summary of the action verbs used in the syllabus regarding the hierarchy. Remember and understand that the LOT skills cover 51.4% against 48.6% for HOT skills in Objective, content, and Assessment. The syllabus concentrates more on the three skills in terms of assessment. Remember 18.1%, Understand 33.3%, and Apply 29.8%, totalling 81.2%, leaving only 18.8% for the top three HOT skills. It is worth noting that "create" is even missing when it comes to assessment.

Table 2. Statistical Analysis

Bloom's Taxonomy	Objective		Content		T & L		Assessment		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%
Remember	11	6.4%	3	1.8%	10	5.8%	7	4.1%	**31**	18.1%
Understand	17	9.9%	10	5.8%	17	9.9%	13	7.6%	**57**	33.3%
Apply	12	7.0%	12	7.0%	16	9.4%	11	6.4%	**51**	29.8%
Analyze	3	1.8%	4	2.3%	2	1.2%	2	1.2%	**11**	6.4%
Evaluate	3	1.8%	3	1.8%	2	1.2%	1	0.6%	**9**	5.3%
Create	6	3.5%	2	1.2%	4	2.3%	0	0.0%	**12**	7.0%
Total	**52**	30.4%	**34**	19.9%	**51**	29.8%	**34**	19.9%	**171**	100.0%

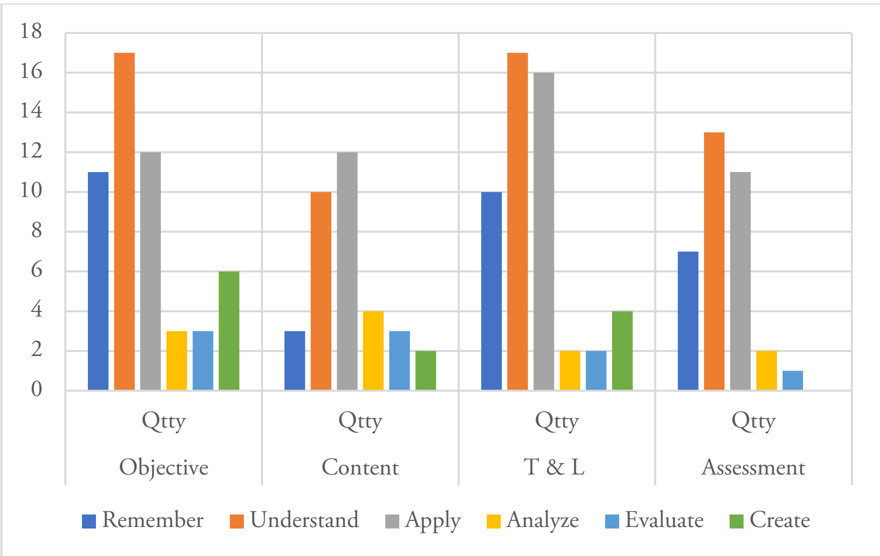

Figure 1. The summary of action verbs used in the syllabus concerning Bloom's taxonomy.

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As observed in Table 2, Figure 1 is pictorial evidence to buttress the discussion. The bar representing "Understand" overshadows all the skills in all the categories, except under content that "Apply" tops all. It is worth noting that, as indicated early on, the three LOT skills stand tall in all categories. The top three HOT skills are not fairly represented except under Objective, where "Create" is quite visible.

4.2. Discussion

The senior high school curriculum encourages memorization and recall of facts. Even though the profile dimension assigns 30% for Remember and Understand, the study revealed that 51.4 % are devoted. For the rest of the percentage, Apply alone constitutes 29.9%. This Apply component in the curriculum is still at a low level and, at best, can be applied to solve some contextual mathematics problems in the classroom but not in real life. It, therefore, confirms the work of Mereku, which indicated that the Ghanaian students who took part in the TIMSS in 2003 and 2007 could only answer the question requiring recall of facts. The TIMSS is a standard test that tests students' ability to apply their knowledge in solving contextual problems (Mereku, 2010). It is no wonder that Ghana, as a middle-income state, still depends on other nations for almost everything since we cannot manufacture or process our products due to a lack of technical know-how and the absence of industries. Even though the mathematics syllabus for senior high school has been designed to help students develop the required mathematical competencies needed to solve real-life problems, it fails to assess students on practical skills like innovativeness, creativity, and problem-solving-oriented tasks needed in real-life activities.

Effective mathematics teaching uses tasks to motivate learning and help students build new mathematical knowledge through problem-solving (Brashier et al., 2014). For students to engage in high-level thinking, the curriculum must be challenging. It should engage the teacher and students in activities promoting reasoning and problem-solving. These tasks will encourage reasoning and access to mathematics through multiple entry points, including using different representations and tools and solving problems through varied solution strategies (Brashier et al., 2014). The mode of assessment at the senior high school, especially the final examination by the West Africa Examination Council (WAEC), has come under several attacks as researchers believe that it only encourages rote learning and its resultant examination malpractices (Abreh et al., 2018; Ashiagbor, 2019). As part of the requirements to enter higher education, students must pass the core mathematics, which creates many avenues for examination malpractice. Paulo Freire's critical pedagogy alludes to the fact that assessing curriculum based on paper and pen tests is not the best and oppresses the students and limits their thinking (Darder et al., 2003; Giroux, 2020). Paulo observed that the more oppressed, the poorer one becomes, and that the mathematics curriculum should train the students in social justice and tolerance to develop informed citizens. A similar study by Olawale, Mncube, and Harber (2021) also indicated that educators and school administrators must make it a duty to cultivate critical teaching and learning experiences that can connect the standardized school curriculum to the reality of learners' everyday lives. The standards for school mathematics across the globe have been changing to conform to the demands of this technological era (Principles, 2000). NCTM recently revised Principles 2000 to Principles to Action to offer students more learning opportunities through problem-solving and problem-based strategies(Baker et al., 2018; Mann, 2014). Apart from being a scientific subject, mathematics is viewed as a tool for social justice and economic emancipation. For the past 20 years, the TIMSS countries have adopted a lot of modern pedagogies and process skills like inquiry-based learning into their curriculum to ensure that their students have what it takes to be generational thinkers and problem solvers.

5. Conclusion

The NCTM's principles of action focus on developing students' mathematical thinking skills through problem-solving to equip learners to be innovative, critical thinkers and problem solvers. For Ghana to move from a knowledge-based economy to a production-based economy, there is a need for a mathematics curriculum that will produce generational thinkers rather than churn out individuals who can only remember. Therefore, the mathematics curriculum should focus more on HOT skills in teaching and assessment. The study results demonstrate that the syllabus focuses on the first three bottom skills in the hierarchy (remember, understand, and apply). These basic skills practically involve the mental faculty (developing the Head). To balance the equation, the syllabus must be able to target the Heart (affective) and the Hand (psychomotor). These can only be achieved if attention is paid to the HOT skills. Suppose students are given the opportunity to discuss, explore, and come up with their findings, observations, and conclusions and put them into action. In that case, it also influences their thinking and reactions. The syllabus must, therefore, be activity-oriented through problem-based and problem-solving strategies.

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Appendix 1. Summary of Action Verbs Used in the Mathematics Curriculum

Bloom's Taxonomy	Objective		Content		Teaching and Learning Outcome		Assessment		Total
Remember	Write	Identify	Draw		read	Sort	Write	Record	
	Read	Recognize	Recognize		write	Map	Read		
	State	Perform	Identify		List	Copy	State		
	Define	Practice			State	Study	List		
	Recall	Select			Draw		Define		
	Draw				Practice		Draw		
	11		3		10		7		31
Understand	Interpret	Factorize	Add	Equate	Interpret	Factorize	Explain	Find	
	Subtract	Find	Subtract		Explain	Find	Interpret	Convert	
	Add	Rationalize	Multiply		add	Rationalize	Approximate	Distinguish	
	Multiply	Share	Approximate		subtract	Share	Subtract	Describe	
	Divide	Construct	Convert		multiply	Perform	Multiply		
	Approximate	Translate	Differentiate		Approximate	Convert	Estimate		
	Convert	Distinguish	Describe		Estimate	Translate	Add		
	Express	Classify	Rationalize		Express	Distinguish	Express		
	Describe		Reverse		Describe		Factorize		
	17		10		17		13		57
Apply	Simplify	Depreciate	Simplify	Operate	Simplify	Compute	round off	Relate	
	Investigate	Use	Round off	Construct	Solve	Discover	Solve	Translate	
	Determine	Relate	Solve	Change	Calculate	Investigate	Simplify	Illustrate	
	Compute	Present	Calculate	Present	Depreciate	Relate	Calculate		
	Apply		Depreciate		Derive	Guide	Use		
	Calculate		Apply		Determine	Plot	Determine		
	Represent		Represent		Construct	Illustrate	Construct		
	Solve		Relate		Use	Represent	Apply		
	12		12		16		11		51

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Appendix 1. Summary of Action Verbs Used in the Mathematics Curriculum (Continue)

Bloom's Taxonomy	Objective		Content		Teaching and Learning Outcome		Assessment		Total
Analyze	Analyze	Order	Examine	order	Order		Order		
	Compare		Check	Compare	Compare		Compare		
	3		4		2		2		11
Evaluate	Verify	Increase	Decrease	Reflect	Measure		Verify		
		Decrease	Increase		Verify				
	3		3		2		1		9
Create	Respond	Develop	Correspond		Revise	Form			
	Create	Undertake	Exchange		Deduce				
	Organize	Form			Develop				
	6		2		4		0		12
Total	52		34		51		34		171