# Boosting the Social Value of Mathematics Education: The way forward

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***Abstract*: Mathematics is a critical subject at the pre-tertiary level. Knowledge in mathematics is believed to be a key to solving societal problems. Many believe that the impact of mathematics is not felt in the society because there has not been much application of acquired knowledge in mathematics in solving societal problems. This paper seeks to throw more light on how to make education useful to society. Importance of mathematics education and the real problem of mathematics in respective to mathematics education as well as the way forward with mathematics education were highlighted.**

***Keywords*: mathematics, performance-based assessment, Education, teaching and learning**

## I. INTRODUCTION

One of the progressive educational programmes that has been adopted and is being pursued in the country in recent times is "functional numeracy"; that is, the ability to count and use number effectively (Ministry of Education [MOE], 2002). All aspects of life base on effective knowledge of mathematics and science as absent mathematics and science knowledge limits development in general. So, a country concerned about her development puts much emphasis mathematical studies (Forman, 2003).

*Importance of mathematics Education*

Mathematics is seen by society as the foundation of scientific and technological knowledge vital in socio-economic development of the nation (Anamuah-Mensah et al., 2005) and its usage permeates almost every field of study including physics, chemistry, geology, engineering and medicine (Roman, 2004). Because of this, Mathematics has remained a compulsory subject at pre-tertiary level in many countries and used as a basic entry requirement into any of the prestigious courses at the tertiary level (Anamuah-Mensah et al., 2005). Kitta (2004) defined mathematics as the language helping to describe ideas and relationships drawn from the environment. Mathematics make the invisible to be visible, thereby solving problems which are impossible otherwise. It is in realization of the vast applications of mathematics that made Eraikhuemen (2003) to posit that a disciplined and ordered pattern of life can only be achieved through the culture of mathematics.

Mathematics help to understand the world around us and at a psychological level, helps in developing an analytic mind to assists in better organization of ideas and accurate expression of thoughts (Adler, 2018). According to Michael (2015), Mathematics makes all invisible to be visible, thereby solves problems that would be impossible otherwise. Again, Mathematics is widely used in various fields and covers a wide range of activities (Zakaria et al., 2010). It is, therefore, critical that the progress of students in mathematics at pre-teriary is monitored. In this regard, failure of students in mathematics is not only worrying to educators but to the student. For instance, the National Education Assessment (NEA) administered in July 2013 by UNICEF in collaboration with the Government of Ghana through the Ministry of Education has shown that children in Ghana have not only struggled to read, but also performance in mathematics has lagged behind grade expectations, with the percentages of primary school pupils (P2, P3 and P6) achieving proficiency in mathematics falling below 20% (Ministry of Education, 2013). Similar results were reported in the 2016 Ghana National Education Assessment (Ministry of Education, 2016). Also, there had been a remarkable drop in the mathematics performance of some Ghanaian students over the last decade in national and international large-scale assessments such as Basic School Certificate Examinations (BECE); West Africa Secondary School Certificate Examinations (WASSCE); and the Trends in International Mathematics and Science Study (TIMSS) (Anamuah-Mensah et al., 2004; Burt, 2017; Butakor, 2016).

Perhaps, mathematics is one subject that has received the greatest attention in the curriculum in our schools. In many countries including Ghana, mathematics has the greatest number of hours per week for instruction (Curriculum Research and Development Division [CRDD], 2007). This is so because sufficient knowledge in mathematics equips the students to fit well into various scientific and technological fields in this modern world. In Ghana education curriculum, mathematics is a core subject that every student is studying at pre-tertiary level. Despite being the core and compulsory subject, students' performance in Mathematics in Ghana had been low for number of years in West Africa Secondary School Certificate Examination (WASSCE). Candidates are reported to exhibit poor understanding of Mathematical concepts and are unable to form the appropriate Mathematical models which could be tackled with the requisite skills" (Chief Examiner's Report, 2007).

*Objectives of mathematics education*

California Department of Education (2013), United States' schools and schools in other parts of the world have now prepared different reforms that details what students

should learn and demonstrate in mathematics as students move through the levels. In Ghana, the profile dimension of mathematics educations is given as 30% for knowledge and understanding and 70% for application of knowledge (Ministry of Education, MOE, 2012). This indicates that ideally mathematics is basically about the application of knowledge. The general objectives of mathematics which set the compass of mathematics education has stated that by the end of students' mathematics experience at the SHS level, the students should be able apply mathematical knowledge in real life situations (MOE, 2012). This implies that mathematics education requires assessment of students to have 70% devoted for application of mathematical knowledge to real life situations (PBA) (MOE, 2012).

The objectives of the current pre-tertiary curriculum of Ghana states among others that, the curriculum would provide broad up-to-date knowledge, skills, values and attitudes in all subjects, and develop in learners the ability to apply what they have learned with confidence and competence in all worlds of work. These two objectives suggest that the prime objective of mathematics education Ghana is make student show evidence of what they have learned in the society.

*Selecting content for mathematics education*

The component of the mathematics curriculum, like every other curriculum includes objectives, content, learning experience and assessment and evaluation practices (NACCA, 2018). One key factor to consider in selecting the objectives is to ensure that the objective is in harmony with content standards of the state (Alvior, 2015). This means that every objective is geared towards the need of the state. *Education devoid of this is useless*. In selecting the actual content to be studies by students, significance (essentiality), validity (connection between content and goals it is intended to serve), relevance (social value of the content) and utility (useful function of the content) are among the factors to consider (Addai-Mununkum, 2020; Murwa, 2018). The educational goals are just a means to an end and not an end in itself. Whatever content students learn should have social value. That is the society should see evidence of the relevance of the content. *Without it, the society sees that content hence the entire mathematics education to be useless*.

*The gap in mathematics education*

Most students do not see the relevance of the concepts they learn. This is because; teachers do not relate the concept to real life situation. Students only consider mathematics as just using a memorize rules to solve some abstract problems. One may ask "what is the use of $A = \pi r^2$?" (formula for calculating area of a circle). Students in schools learn contents like area of rectangle, calculus, and others but cannot tell the relevance of the content or the use of the content in the world of work. This could account for the poor interest and performance of students in mathematics at almost all level of education. This is because if there is no use of a content, then there is no need learning that content.

*The way forward*

According to Gyamfi (2017), mathematics is not all about doing, solving problems, performing algorithms but includes an element of appreciation. Appreciation of mathematics involves having a qualitative comprehension of some of the key concepts of mathematics such as proof and structure. The instructional process of mathematics should not be restricted to only the cognitive and psychomotor domains of learning but to the affective domain as well. That is students should be made to understand the principles of the subject for them to have a rational understanding of the concepts. Student should be provided with opportunity and be taught to apply what they learn in real life situation to solve societal problems. For example, knowledge in area of rectangle could be used to make estimate number of titles needed to tile a room, area of a circle is used to construct and design anything circular, and calculus is used in constructing bridges. These are what society expects from mathematics education. Performance-based assessment is therefore the bedding rock of the way forward in changing the face of mathematics education.

According to National Council of Teachers of Mathematics (2010), assessment that improves learning of mathematics should be a usual part of on-going classroom activity rather than a hiatus. Assessment is a means to an end and "does not simply mark the end of the learning cycle" (Nitko, 2006). Rather, assessment should be fused into the teaching and learning to encourage and support further learning. Naturally, in every lesson, there are opportunities for informal assessment (Rotman, 1993). They are include listening to students as well as observing and making sense of what students say and do in the class. For young children in particular, the observation of students' work brings to bear the qualities of thinking which written or oral activities cannot reveal (Schoenfeld, 2000). Teachers should look out for different assessment opportunities when planning instructions and making decisions about instructions (NCTM, 2010). Questions such as the following should constantly be part of the teachers' planning: "What questions will I ask?" "What will I observe?" "What activities are likely to provide me with information about students' learning?" Gao (2012) stated that "preparation for a formal assessment does not mean regular instruction should pause and resort to teaching to the test" (pg 9). On-going teaching and learning is the best preparation for assessment for students. Similarly, for teachers, the foundation of the best teaching is on-going assessment. This is the way to go with mathematics.

According to the California Department of Education (2013), United States' schools and schools in other parts of the world have now prepared different reforms that details what students should learn and demonstrate in mathematics as students move through the levels. For example, the California Mathematics Framework, the California Mathematics

Standards, and National Council for Teachers of Mathematics have detailed the guidelines and Standards for School Mathematics (California Department of Education, 2013). These documents rally support for assessments that gives attention to students' ability to understand as well as their procedural skills. As detailed in the standards, assessment should measure:

1. "Computational skills as well as the application of these skills in familiar and unfamiliar contexts";
2. "The use of mathematical processes in context";
3. "The use of mathematics to make sense of complex situations";
4. "How well students formulate hypotheses, collect and organize information, and draw conclusions" and
5. "How well students communicate their mathematical reasoning both verbally and in writing" (California Department of Education, 2013.)

Assessments that improve learning of mathematics alongside activities that are consistent to teaching are useful. For example, when students learn by communicating their mathematical ideas through writing, the assessment of their knowledge on that particular concept of mathematics should be done by having them write about their mathematical ideas. If they the concept in groups, the assessment should as well be done in groups. If graphs and calculators are used in teaching, they are to be available for use during assessment. These guidelines are in the domain of performance-based assessment.

Mathematics achievement as a psychological construct makes it difficult to be assessed with only one method. According to Crocker and Algina (2008), assessment of psychological construct is associated with problems such as:

1. Inability of a single approach to measure it,
2. usually based on limited sample of the behaviour,
3. lack a well-defined units of measurement scales
4. constructs cannot be defined in terms of operational definition but must also show relationship to other constructs.

The National Council of Teachers of Mathematics (1995) posited a number of classroom activities are indicators of mathematics learning: oral comments, drawings, models, and other means of representing knowledge. These evidences are useful to the teacher and student, in addition to information from more formal assessment activities, to determine next steps in learning. Activities ranging from scrabbling through to estimating the length of wire for fencing are all evidence of mathematics learning. Continuously assessing the work of the students facilitates their learning, understanding and communication. Moreover, external assessments provide support to the classroom instruction. For classroom work, the teacher's judgments, and students' reflections are considered to be parts of an external assessment. This external assessment enhances students' learning of mathematics. The instructional goals and the assessment are levelled.

*Performance-based assessment and mathematics education*

Hibbard (2017) stated "performance-based instruction and assessment represent a set of activity for the acquisition and application of knowledge, skills and work habits through the performance of tasks that are meaningful to real life situations and engrossing to students". Performance-based instruction and assessment lead to a balanced approach as an extension of the traditional fact-and-skill instruction to real life application of the knowledge acquired. Brennan (2006) stated that with performance assessment, the potential value of the test lies in its closeness to reality and has the feature of different approach to the test hence different correct results. The application of the knowledge is to real life situation. Asamoah-Gyimah and Anane (2018) proposed that performance assessment is effective as a formative assessment. However, Nitko (2004) stated that performance-based assessment could equally be used for summative assessment as in the case of West African Senior Secondary Certificate Examinations (WASSCE).

Performance-based assessment as a contemporary form of assessment is perceived to address many of the challenges associated with the traditional assessment. The focus of performance-based assessment has to do with application of knowledge. According to Nitko (2004), PBA is a form of assessment that presents a hand on task which requires students to perform an activity that calls for application of the knowledge and skills from several learning. It allows students to show how well they have learnt. In its simplest term, a PBA is an assessment which demands students' demonstration of the specific skills and competencies they have mastered by performing or producing something. Ainsworth and Viegut (2006) defined performance assessments as an "activity that requires students to construct a response, create a product, or perform a demonstration" (p.57). Performance assessment deals with the overall experience of a student in performing a learning target through the application of their knowledge and skills from several areas. Performance assessment also lends itself to multiple products to a task therefore resulting in multiple correct responses.

It is observed that the traditional questions students' response to at the SHS have one correct answer and not authentic even though some are performance-based. In view of the strengths of performance-based assessment, Lane and Stone (2006) reported that a well-developed performance-based assessment could reduce examination malpractice The Performance-based assessment unlike the traditional forms of assessment at the senior high school is characterised by multiple correct answers because the approach may differ from one examinee to the other making copying or exchanging of information difficult. It is also not possible for students to utilize information brought to the examination hall because; the process would have to be created right in the

examination hall. As a result, preparing answers beforehand would be difficult.

It is believed that the high incidence of examination practices in the senior high school mathematics could be attributed to the low usage of performance-based assessment. With the developed PBA items which is on-demand, students would have to craft their own unique answers depending on the irrespective approach taken. This will make it difficult for students to copy from each other or teachers solving questions to be sent to students or the invigilators attempting to help individual students.

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