

Analysing Mathematics Performance in Tanzanian Primary Schools through the Lens of Candidate Items Response Analysis Reports

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Abstract

For a long time, mathematics performance in Tanzania, especially in primary and ordinary secondary schools has been deteriorating. The performance rate in the Primary School Leaving Examinations (PSLE) in Mathematics is around 48.7%. The current study analysed the mathematics performance in Tanzanian primary schools through the lens of Candidate Items Response Analysis (CIRA) reports prepared by the National Examinations Council of Tanzania (NECTA) after the release of the PSLE results. The study was guided by three questions which were to analyse content areas students identified as the most challenging over the past decade in PSLE in Mathematics, analyse students' perceptions of the factors influencing their subpar mathematics performance in PSLE over the last decade and analyse the recommendations for enhancing students' mathematics performance in PSLE. Data were collected through document analysis by analysing CIRA reports using a document analysis schedule which consisted of all content areas assessed in each year and a list of perceived reasons for student failure. In each year the frequency of occurrence of contents and reasons for underperformance was recorded. The findings of the study indicate that most students reported Measurements, Algebra, Geometry, Statistics and Integers as the most difficult mathematics learning areas in the last decade. It was also revealed that lack of understanding of the contents, lack of logical and mathematical thinking skills, and lack of understanding of the question requirements were the factors identified by the students for causing underperformance in PSLE for Mathematics subject. Furthermore, NECTA recommends teachers should put more emphasis on teaching challenging topics, provide more mathematics practice problems to students, the government to make sure more competent teachers are employed and use of active-based and collaborative teaching methods which involve real-life situations. The study observes that most of the aforementioned factors may reflect the teacher's capacity in the contents and its respective pedagogy. Therefore, for in-service mathematics teachers, it is recommended that there is a need to strengthen in-school continuous professional development programs (known as MEWAKA) to focus on enhancing teacher's content and pedagogical knowledge in the most challenging topics. Also, for pre-service and in-service teachers, there is a need to strengthen the abilities to use activity-based learning approaches to develop student's logical and mathematical thinking skills and other relevant skills for 21st-century skills.

Keywords: Mathematics performance, Primary School Leaving Examinations, NECTA, Candidate Items Response Analysis, Tanzania

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1. Background

This section discusses the background of mathematics education in primary schools in Tanzania. It covers the provision of primary school mathematics in Tanzania, the role of the National Examinations Council of Tanzania (NECTA) and a review of empirical studies on student's performance in Mathematics.

1.1. Education in Tanzania

Tanzania is one of the member states of the United Nations (UN) committed to implementing the Sustainable Development Goals (SDGs) by integrating them into its main development frameworks (NBS, 2022). In doing so, since 2016 when the SDGs were implemented, Tanzania has made a remarkable achievement in goal 4 which focuses on ensuring inclusive and equitable quality education and promoting lifelong learning opportunities for all.

Education in Tanzania is provided by both the public and private sectors, starting with pre-primary education, followed by primary, ordinary secondary, advanced secondary, and tertiary education levels. According to the Education and Training Policy of 2014, as revised in 2023, the Tanzanian educational system operates on the 1-6-4-2-3 system: 1 year for pre-primary, 6 years for primary school, 4 years for Ordinary secondary school, 2 years of Advanced level and 3+ years for University education.

1.2 Role of the National Examinations Council of Tanzania (NECTA)

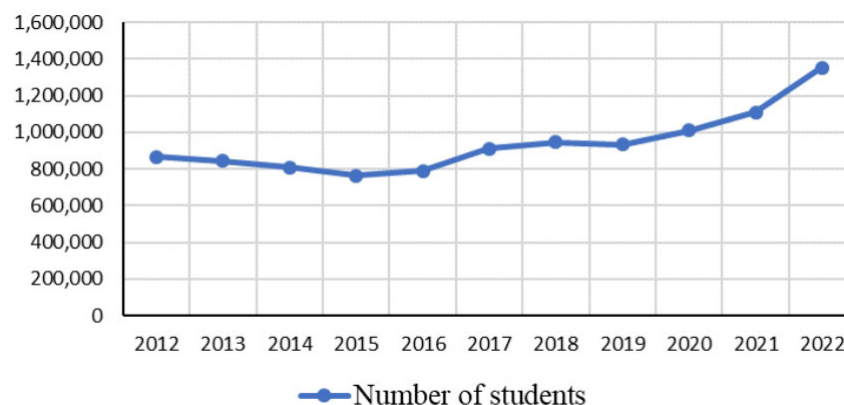
The National Examinations Council of Tanzania (NECTA) is a government institution established by the Parliamentary Act No. 21 of 1973. NECTA is responsible for administering all National Examinations and assessments in Tanzania in primary, secondary and Teacher Education. According to the NECTA (2019), its core functions are to;

- Formulate examination policy in accordance with the principles of education for self-reliance and the education and training policy
- Assume responsibility for examinations within the United Republic of Tanzania and to make provision for places and centres of examinations.
- Receive from other persons or bodies of persons reports or other materials affecting examinations policy and from time to time to consider and review examinations policy as circumstances may require.
- Co-operate with other persons or bodies of persons in the orderly development of an examination system in the United Republic of Tanzania
- Conduct examinations for, and to grant, diplomas, certificates, and other awards of the council.
- Act as the body that shall facilitate, administer, and supervise foreign examinations in Tanzania.

Thus, based on these roles, after the administration of each National examination, NECTA releases the analysis of the student's performance in each subject. The reports are generally referred to as item response analysis reports. The details of the report focused on the analysis of student performance in terms of the percentage by comparing the overall performance of the current and previous year, percentage in terms of the performance in each item, reasons for failure of students in assessed domains, identification of domains in which students have failed and passed the most and recommendations for the improvement of subject achievements to the responsible educational stakeholders. The current study analyses the Candidate's Item Responses Analysis reports for the PSLE in Mathematics from 2012 to 2022 to determine the major causes for the underperformance of pupils in the PSLE in Mathematics in the last decade.

1.3 Primary School Mathematics in Tanzania

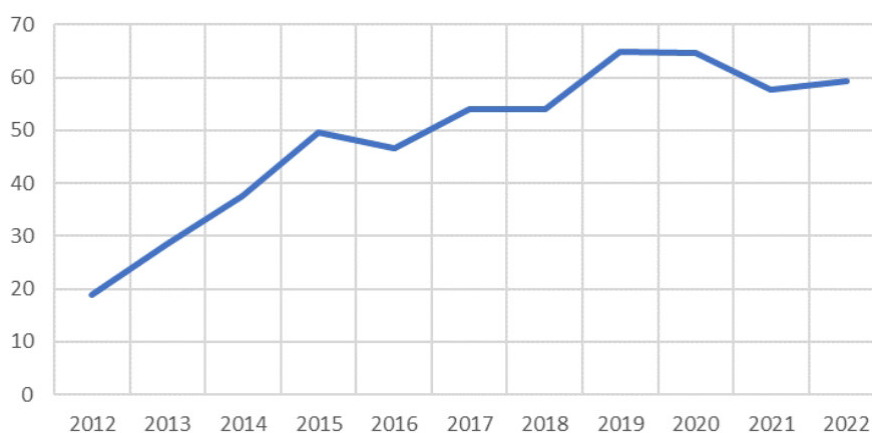
Tanzania, like many other countries, recognizes the role of mathematics in the social and economic activities of its people. In the current Curriculum for primary school, Mathematics is a compulsory subject for all students from standard III to VI (MoEST, 2023). The overall enrolment of primary school students has increased in the last decade (Amani, 2021) which indicates an increase in the number of students studying mathematics in primary schools. For example, Figure 1.1 shows that from 2012 to 2022, the number of students who sat for the PSLE has increased tremendously from around 800,000 to 1.4 million students.



Source: NECTA

Figure 1.1: Trend of the number of students sat for the PSLE in Mathematics from 2012 to 2022

In the last decade, the performance rate of students in the PSLE in Mathematics generally has been increasing but with variations between years as shown in Figure 1.2.



Source: NECTA

Figure 1.2: The trend of student's performance in Mathematics in PSLE 2012-2022

In Figure 1.2, the PSLE student performance in Mathematics has increased from 2012 to 2015, with notable variations from 2016 to 2022. Generally, NECTA reports show that the performance rate of students in PSLE in Mathematics has been increasing in the last decade which is also in line with the enrolment rate and the number of students who have sat for the PSLE in Mathematics as shown in Table 1.1.

Table 1.1: Number of pupils who sat for PSLE in Mathematics from 2012-2022 and their pass rate

Source: CIRA reports by NECTA (2012-2022)

Year	Sat for PSLE	Passed PSLE	% passed
2012	865,221	162,078	18.74
2013	844,706	241,741	28.62
2014	808,085	791,869	37.56
2015	763,493	378,502	49.58
2016	789,404	367,866	46.61
2017	909,888	492,257	54.10
2018	944,151	622,257	54.10
2019	932,136	605,588	64.97
2020	1,009,559	651,703	64.64
2021	1,107,788	638,127	57.63
2022	1,350,784	718,273	59.29
Average	938656	515478	48.7

1.4 Review of empirical studies on mathematics performance in primary schools

Regardless of the increasing overall performance over the last decade, the average performance of the students in PSLE in Mathematics (48.7%) is still below average as shown in Table 1.1, which indicates that more than half of the students in the last decade failed Mathematics in the PSLE. The poor performance of students in PSLE in Mathematics in the last decade has triggered the attention of educational stakeholders, including educational researchers in Tanzania. Mosenda (2022) observes that lack of teacher motivation, negative attitude towards mathematics by both teachers and students, lack of teacher's knowledge of content and methodologies, and effective and relevance of mathematics curriculum are some of the factors hindering better performance of mathematics in primary schools in Tanzania. Teacher's perceptions towards mathematics performance were further explored by Mazana, Montero and Casmir (2020). The study revealed that policy issues, culture and an uncondusive environment for teaching and learning mathematics are some of the major factors towards the low

performance of students in mathematics, particularly in primary school. The study suggests that improving the teaching and learning environment, classroom instructions, teaching and learning skills, and change of mindset on teaching and learning mathematics among the community members can help in improving the academic achievement of students in mathematics. On the other hand, Mussa (2017) studied institutional factors that affect the mathematics performance of students in Morogoro municipality. The study noted that the mathematics performance of students in the Morogoro urban area was largely associated with the lack of mathematics background of the students, lack of teachers and student's motivation, large classes, and few teaching and learning materials. Also, the study revealed that the lecture method was dominant with rare use of group discussions, questioning and problem-solving techniques. The findings are also supported by Michael (2015) who observes that poor working environment, lack of self-study skills, poor background in mathematics among students and lack of managerial skills in the mathematics department are among the factors which affect performance in mathematics among students.

Some other studies in Tanzania have explored specific methods that could be used to teach students with low levels of mathematical skills. For instance, a study by Michael (2013) explored suitable methods for teaching students with low levels of mathematical skills in primary schools in Tanzania. Like many of the other study findings, this study highlights the major drawbacks of teaching mathematics in primary schools which include large class sizes, lack of sufficient teaching and learning resources and lack of variations in the use of teaching methods. The study suggests effective teaching methods such as integrating games, use of real objects, demonstrations, guided participation, error checking and corrective feedback. Gender and ownership of the school have also been studied to determine how they influence mathematics performance in primary schools. Njiku (2019) studied mathematics performance across genders and ownership of the school and reported that private school students perform better than public schools. In general, males perform better than girls, particularly in public schools. The study suggests measures such as more investment in schools, particularly public schools and addressing other in-school factors. Similar findings by Mazana, Montero and Casmir (2020) suggest that gender differences in mathematics performance dominate in primary schools and at all levels of education in Tanzania.

Other empirical studies have explored how teaching and learning instructions among impaired students affect their learning of mathematics in primary schools in Tanzania. For example, a study by Shemndolwa (2016) investigated the factors that affect mathematics performance among students in public and private primary schools with visual impairment in the Tanga region. The study revealed that students with visual impairment need more time for tests and assignments, inappropriate use of teaching methods for visually impaired students, and insufficient teaching and learning materials which are special for visually impaired students.

Examining critically the empirical studies, one can observe that major factors which are associated with the unconducive performance of mathematics in primary schools can be categorised into mathematics teachers' characteristics, students' characteristics, the school's environment and curriculum issues. Teacher's characteristics include negative attitudes and poor motivation, and insufficient knowledge of content and methodologies (Mosenda, 2022 & Mussa, 2017). Students' characteristics include a poor background in mathematics, negative attitudes towards mathematics, lack of study skills, gender and students' special needs (Njiku 2019; Michael 2017; Shemndolwa 2016). Some physical factors include a lack of enough learning facilities, large classes (Njiku 2019 & Mussa 2017) and curriculum factors (Mosenda 2022). However, most of the studies have fallen short of providing an account of the influence of the student's characteristics and its influence on their academic performance in the mathematics PSLE results. While Mabena, Mokgosi and Ramapela (2021) admit that poor academic performance of students in mathematics is a global issue, Iddrisu et al. (2023) note that the attention of the majority of researchers to address this global phenomenon is tackled in a general manner with little attention on the influence of student characteristics. Thus, this study intends to explore perceived students' characteristics based on the CIRA reports that contribute to the poor mathematics academic performance of students in PSLE in Tanzania. Specifically, the study explores content areas which are highly contributing to the poor performance of students in the past 10 years and the reasons towards poor performance in PSLE Mathematics in the last 10 years.

2. Research questions

The following are the main research questions which guided the study:

1. Which content areas have students identified as the most challenging over the past decade in PSLE in Mathematics?
2. How do students perceive the factors influencing their subpar mathematics performance in PSLE over the last decade?
3. What recommendations are there for enhancing students' mathematics performance in PSLE?

3. Methodology

The study employed a document analysis approach where all the CIRA reports from 2012 to 2022 were collected and analysed thematically to determine the frequency of highly reported contents and topics in which students performed poorly and the frequency of the reported reasons for the poor performance of the students in PSLE in the past 10 years. In content analysis, all the topics assessed in each year were listed against the years 2012 to 2022 and tallying was done based on the frequency of a reported topic in which students poorly performed each year. The same was done for the perceived reasons for student's failure each year.

4. Data Presentation and discussion of the findings

The presentation and discussion of the findings focus on the analyzed data from NECTA CIRA reports spanning from 2012 to 2022. The goal is to ascertain student perspectives on content areas frequently reported as the most challenging over the past decade. Additionally, the study aims to identify factors contributing to students' poor mathematics performance in the PSLE during the same period.

4.1 Most challenging content areas for students in PSLE in the last decade

Data from the CIRA reports for 2012 to 2022 were recorded and analysed to determine the attitude of primary school students towards the contents assessed in the PSLE mathematics examinations from 2012 to 2022. The results are summarised in Table 1.2.

Table 1.2: Most reported challenging topics in PSLE in Mathematics from 2012-2022

Content area	f (2012-2022)	%
Measurements	9	90
Algebra	8	80
Geometry	8	80
Statistics	6	60
Positive and negative Numbers	5	50
Money	3	30
Square and square roots	2	20
Percentages	2	20
Coordinate Geometry	2	20
Patterns	2	20

Source: NECTA CIRA Reports 2012-2022

Table 1.2, shows that the measurement topic was highly reported (9 times out of 10), followed by Algebra and Geometry (8 times out of 10). The topic of Statistics was reported 6 times out of 10 and integers was reported 5 times in 10 years. Money appeared 3 times, while square and square roots, percentages, coordinate geometry and patterns appeared 2 times in the last decade. The results show that measurements, algebra, geometry, statistics and integers topics were reported as poorly performed by primary school students in the PSLE for the last decade.

4.2 Students' perspectives on factors affecting mathematics performance in PSLE in the last decade

The study analysed the CIRA reports from 2012 to 2022 to determine the perceived reasons for students underperform in some mathematics content areas identified in Table 1.3.

Table 3. Reasons for the poor underperformance of students in PSLE in mathematics from 2012-2022

Reasons	f (2012-2022)	% (2012-2022)
Lack of knowledge and understanding of the subject matter of specific topics/ assessed domain	10	100
Lack of logical and mathematical thinking skills	8	80
Lack of understanding of the question requirement	4	40

Source: Data from NECTA CIRA Reports 2012-2022

According to the CIRA analysis results in Table 1.3, the major reasons which contributed to the failure of the students in PSLE mathematics results in the last 10 years were the lack of knowledge and understanding of the subject matter which was reported 10 times in 10 years (100%) followed by lack of logical and mathematical thinking skills which was reported 8 times in 10 years (80%) and lack of understanding of the question

requirement which was reported 4 times in all 10 years (40%). The results imply that students in primary schools in the last 10 years lacked a foundation and adequate understanding of mathematical concepts, insufficient mathematical logical and thinking skills.

4.2.1 Lack of knowledge and understanding of the subject matter

One of the challenges in mathematics education is the inadequate conceptual understanding of mathematics concepts which can pose adverse effects on the learning process and its outcomes (Elinda et al, 2023). In the current study, lack of knowledge and understanding of mathematics contents was cited as among the major reasons for the underperformance of students in Mathematics PSLE. During the CIRA analysis, it was observed that topics such as measurements, algebra, statistics and integers were reported frequently each year as the most difficult for students to perform. Other content areas less frequently mentioned were money, square and square roots, percentages, coordinate geometry and patterns. On the other hand findings by Asim et.al (2019) indicated that in the past, Tanzania has struggled to ensure primary school students are equipped with the basic skills of writing, reading and numeracy necessary for post-primary education. While the lack of knowledge in some mathematics contents by primary school students can be associated with the student's own abilities and learning environment, the gap may also reflect the extent of the teacher's capacity in the respective contents and in teaching methodology. Bold et al. (2017) observed that apart from students spending half of the time indicated for learning in the curriculum without teachers, the majority of teachers in the sub-Saharan countries have insufficient knowledge of the curriculum they are supposed to teach their students and a lack of pedagogical knowledge.

4.2.2 Lack of logical and mathematical thinking skills

In recent years, mathematical thinking has been popularly known as mathematical literacy which is the ability to use mathematics in everyday life through its various components of reasoning, modelling, and making connections between ideas (Stacey, 2006). For the last decade, the CIRA reports for PSLE for Mathematics indicate that mathematical literacy was among the major reasons for student's failure in Mathematics. The reports indicated that students had difficulties in formulating equations from word problems and geometrical figures and inadequate use of mathematical operations. In some studies, the inability of the students to develop and use logical and mathematical thinking skills is linked with the teacher's lack of knowledge of the content and pedagogy of the content they are supposed to teach. Hudson, Henderson and Hudson (2015) believe that the effective development of mathematical thinking in primary schools requires teachers with improved subject knowledge, pedagogy, teachers' beliefs and affective dimensions towards students learning. According to the new reformed curriculum for teacher education in Tanzania, primary school teachers will specialize in only two subjects from their combinations in Advanced level and must have passed divisions I to III. This ensures that those who want to join the teaching career in primary education are competent in their subjects and can improve and acquire relevant pedagogical skills. The curricular focus on improving teacher's pedagogical competence ensures that students are offered relevant learning activities which not only stimulate their learning interests but also develop their logical, critical and mathematical thinking skills. Mackenzie, Berger, Thompson, and Holmes (2023) who studied the contribution of students' and teachers' characteristics on the development of mathematical thinking in primary schools reported that while student gender has no effect, student's enjoyment in learning mathematics has a positive relationship with their mathematical thinking.

4.2.3 Lack of understanding of question requirements

Lack of understanding of the question requirement is the inability of the students to determine what they should supply as their responses from a test item. In the last decade, the inability to understand the question requirement was reported in 4 out of 10 years as among the leading reasons for students' underperformance in mathematics in PSLE. The phenomena can be associated with many factors such as difficulties in the language used, lack of mastery of the language of instruction, content incompetency, and fear, among many other reasons. Studies conducted in Mpumalanga province South Africa regarding the factors that affect learner's academic performance in Mathematics, Mabena, Mokgosi and Ramapela (2021) concluded that the language barrier was one of the reasons for the poor academic achievement of learners in mathematics. A lack of understanding of the question requirement can lead to the failure of the students to translate and imagine real-life scenarios into correct mathematical statements. Such findings were revealed by Abdullah, Ahmad, and Nohseth (2020) in their investigation of the student's difficulties in the topic of shapes and spaces concluded that the difficulties in a 3-dimensional stretch of shapes and their drawings were caused by the inability of students to imagine the shape and its stretch.

4.2.4 Recommendations for the improvement of academic performance of pupils in PSLE for Mathematics subject

In each of the CIRA reports, NECTA provides recommendations for the improvement of mathematics performance especially for the forthcoming examination. Most of the recommendations provided are focused on teacher improvement in content and pedagogy, increasing pupil practice in solving mathematics problems and improvement of the working conditions. Table 1.4 provides a summary of the recommendations from the CIRA

Reports.

Table 4. Recommendations for the improvement of Mathematics subject performance of students in PSLE

Recommendations	f (2012-2022)	% (2012-2022)
Putting more emphasis on teaching challenging topics	90	90
Providing enough mathematics practice problems to students	8	80
Ensuring the availability of competent teachers	4	40
Close supervision of teachers by School Quality Assurers	4	40
Ensuring conducive teaching and learning environment for teachers and pupils	2	20
Use of real-life situations and activity-based teaching and learning	2	20
Use collaborative teaching approaches	1	10

Source: NECTA CIRA Reports 2012-2022

Findings in Table 4 show that the most recommended remedy for improving the academic performance of students in primary school mathematics in PSLE is for teachers to put more emphasis on teaching the most identified challenging topics (90%) which was followed by providing many practice problems to students (80%) to develop their competencies in challenging topics. In line with these recommendations, NECTA recommends the insertion of competent teachers in schools (40%) who can facilitate effective teaching and learning of mathematics. It was also recommended that to improve the academic performance of students in subsequent examinations, teachers should employ active-based teaching methods which employ real-life situations (20%) and the use of collaborative teaching approaches (10%).

5. Conclusions

This study analysed primary school students' perspectives on the major reasons for their poor performance in PSLE Mathematics based on the PSLE CIRA reports for Mathematics in the last decade. The study revealed two major factors which contribute to the poor performance of students in PSLE Mathematics. One of the factors is the nature of the contents taught. A review of students' PSLE Mathematics worksheets has revealed that topics such as Algebra, Measurements, Integers, Statistics, and Geometry were not attempted correctly by the majority of students in the last decade. The study also revealed that student's poor performance is also caused by little knowledge of the assessed contents, insufficient logical and mathematical thinking skills, and failure to understand question requirements. The findings indicate a teacher's knowledge gap regarding the mathematics contents they teach and how they facilitate teaching in primary schools in Tanzania. For example, the emphasis on the use of activities in mathematics lessons can ensure the development of various soft skills including logical and mathematical thinking. The findings also necessitate the need to review the language used in setting out mathematics test items in PSLE to ensure items are presented with simple, clear, and familiar language to the students. The current study understands many efforts which have been made by the government including revising the Teacher Education Curricula to allow only students who have passed division I-III at an advanced level to pursue a diploma in primary school teacher education. This will ensure candidates who join the teaching profession are well equipped with the mathematical contents and can learn more conveniently the methodologies in facilitating effective learning of mathematics. Besides, the study recommends the following:

For teachers currently in schools, capacity building in challenging mathematics areas and activity-based teaching of mathematics should be given priority in MEWAKA sessions.

NECTA recommendations in CIRA reports should be analyzed and used by teachers during MEWAKA to determine areas of focus in improving teaching and learning.

Teachers and NECTA examination officers should be capacitated with the best practices for formulating examination items that are clear and concise in terms of the language used.

Preservice teachers should be capacitated with effective methods for teaching challenging topics such as Algebra, Measurements, Integers, and Statistics.

Further empirical studies can be done to evaluate the nature of the language used in teaching and assessing mathematics in primary schools and to determine the level of teachers' efficacy in facilitating mathematics in primary schools.

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