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Assessing the Effectiveness of Mathematics Teacher Training Programs

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Abstract

This study assesses the effectiveness of mathematics teacher training programs in preparing educators with the necessary skills and knowledge for effective teaching. Through the analysis of survey responses from mathematics teachers, the research identifies critical gaps in key areas such as problem-solving techniques and practical applications of mathematics. Many teachers express concerns about inadequate training in problem-solving and a lack of emphasis on connecting mathematical concepts to real-life situations. Additionally, the findings reveal that the curriculum often fails to provide essential mathematical principles and diverse problem sources, leaving teachers feeling unprepared to organize and test mathematical ideas effectively. Furthermore, there are mixed opinions regarding the program's ability to foster student involvement in the learning process. Overall, the study highlights both strengths and weaknesses in the training curriculum, emphasizing the need for significant improvements to better equip teachers for the challenges of modern education.

Key Words Assessing , Effectiveness , Mathematics ,Teacher Training Programs

1. Introduction

The development of teacher knowledge is significantly enhanced by collaborative efforts within the broader school community aimed at improving educators' understanding of mathematics and effective teaching practices (Cobb & McClain, 2001; Sherin, 2002). For teachers to enhance their knowledge, they require material resources, human support, and emotional backing provided by professional development initiatives. Support can also emerge from the collaborative efforts of fellow mathematics teachers within the school (Kazemi, 2008).

Moreover, teachers must genuinely care about their students' engagement (Noddings, 1995) and focus on enhancing students' capacities to think, reason, communicate, and reflect.

The notion of a specialized knowledge base for teaching has been recognized for over twenty years. In 1986, Lee Shulman identified a critical component of effective teaching: pedagogical content knowledge. He defined this as the knowledge and means of "representing and formulating the subject that makes it comprehensible to others" (Shulman, 1986, p. 9). Shulman argued that a pedagogy devoid of content knowledge is problematic for teachers, who rely on their understanding of the subject to deliver instruction effectively and advance student learning.

Teaching mathematics requires a different type of knowledge than that possessed by professionals in other mathematics-related fields (Hill, Ball, & Schilling, 2008).

1.1. Problem Statement

Mathematics is a fundamental subject examined at all levels of education in Somalia, playing a crucial role in shaping careers in business, science, and technology. Despite its significance, there has been a persistent trend of poor performance in mathematics across various educational levels (TPT, 2019-2020). At the Ministry of Education, Culture and Higher Education (MoEC&HE) Teacher Training Institute (TTI), mathematics holds a central position in the curriculum; however,

the effectiveness of its teaching and learning remains questionable. This study aims to investigate the challenges faced by the MoEC&HE TTI in the delivery of mathematics education, including issues related to curriculum implementation, teacher preparedness, resource availability, and student engagement. Understanding these challenges is essential to improving mathematics instruction and ultimately enhancing student performance in this critical subject.

. 1.2. Research Objectives

1. Assess Teaching and Learning Conditions: To determine the teaching and learning conditions of mathematics at the Ministry of Education, Culture and Higher Education (MoEC&HE) Teacher Training Institute (TTI).
2. Identify Lecturer Challenges: To establish the challenges faced by MoEC&HE TTI lecturers when teaching mathematics, including issues related to curriculum, resources, and instructional strategies.
3. Identify Student Challenges: To identify the challenges faced by MoEC&HE TTI students when learning mathematics, focusing on factors such as engagement, comprehension, and support.
4. Evaluate Teacher Satisfaction: To investigate the impact of teachers' satisfaction with the content of the mathematics courses in the teacher training program on their instructional effectiveness.

1.3. Research Questions

1. What conditions exist at MoEC&HE TTI regarding the teaching and learning of mathematics?
2. What challenges do MoEC&HE TTI lecturers face when teaching mathematics?
3. What challenges do MoEC&HE TTI students face when learning mathematics?
4. How does teachers' satisfaction with the content of the mathematics courses in the teacher training program impact their teaching effectiveness?

1.4. Significance of the Study

This study is significant as it provides insights into the teaching and learning dynamics of mathematics at the MoEC&HE Teacher Training Institute in Somalia. By examining the conditions and challenges faced by lecturers and students, the research aims to inform policymakers and educators about necessary improvements. Understanding the factors influencing teacher satisfaction with the mathematics curriculum will help develop more effective training programs.

Ultimately, the findings may enhance mathematics instruction, better prepare teachers, and improve student outcomes, addressing the ongoing issues of poor performance in mathematics across educational levels in Somalia.

2. Related Work

Effective teachers enhance learning by genuinely caring about their students' engagement (Noddings, 1995). They foster relationships that allow students to build their mathematical and cultural identities, maintaining high yet realistic expectations for students' abilities to think critically, reason, communicate, reflect, and evaluate their own practices. Additionally, they encourage students to question the purpose and impact of classroom activities (Watson, 2002).

To achieve a deep understanding of mathematics, it is essential to provide an opportunity to learn (OTL), which encompasses the breadth of the mathematics curriculum, the methods of instruction, and the alignment between

students' existing skills and new material. Research by Husen (1967, 1987) and Schmidt, McKnight, and Raizen (1997) has demonstrated a strong correlation between OTL scores and students' average achievement in mathematics.

Baratz-Snowden (1993) posited that if students are to be held accountable for their learning, schools must also be accountable for providing the necessary opportunities to meet educational standards. Winters et al. (1994) further noted that OTL serves as critical evidence for interpreting student performance.

In this context, Oakes (1989) and Porter (1991) emphasized that test results should be evaluated with careful consideration of students' opportunities to learn. The effectiveness of mathematics programs ultimately hinges on teachers' performance in the classroom (Rukangu, 2000). Qualified teachers employ various instructional methods to improve student outcomes. A study conducted in Nairobi secondary schools by Oseiwu (2013) found that variations in student performance in mathematics were significantly influenced by the teaching methods employed. Hassana noted that many teachers, particularly untrained ones, often lack the patience to address students' questions, possessing subject knowledge without effective teaching methods or the psychological skills needed for mentorship.

Steinberg, Haymore, and Marks (1985) established a positive link between teachers' mathematical knowledge and the quality of lessons delivered. Teachers with a strong conceptual understanding tend to employ more effective teaching strategies, identify connections within and beyond mathematics, and engage students in active problem-solving. Conversely, Leinhardt and Smith (1985) found that teachers' limited exposure to a rich mathematical knowledge base hindered their ability to connect various topics coherently.

Moreover, Grossman et al. (1992) and Thompson (1992) observed that the way a subject is taught is profoundly influenced by the teacher's understanding of that subject. In the Banadir region, the 2019 Teacher Proficiency Testing (TPT) program assessed teachers' mastery of pedagogical techniques and content knowledge across subjects, including Mathematics, Somali Language, Islamic Studies, and English Language. The findings indicate a low capacity among teachers in Somalia, with deficiencies in both pedagogical skills and subject knowledge.

Table 1: Results of 2019 Teacher Proficiency Test

Subject	**Pass Rate**
Pedagogy	17%
Mathematics	37%
Somali Language	95%
Islamic Studies	43%
English Language	36%

The 2019 Teacher Proficiency Testing (TPT) results for the Banaadir region reveal significant disparities in teachers' mastery of various subjects and pedagogical techniques. The findings indicate a severe deficiency in pedagogical skills, with only **17%** of teachers passing this portion of the assessment. In mathematics, the pass rate is similarly low at **37%**, reflecting challenges in teachers' understanding and ability to effectively teach mathematical concepts, which may contribute to ongoing issues of poor student performance in this subject. In contrast, the Somali language shows a high pass rate of **95%**, suggesting that teachers are generally well-equipped to instruct in this area. Meanwhile, Islamic Studies has a moderate pass rate of **43%**, indicating some challenges in teaching effectiveness. The English language also presents difficulties, with a pass rate of **36%**.

Overall, these results highlight a concerning low capacity among teachers in the Banaadir region, particularly in pedagogy and core subjects like mathematics and English, underscoring the urgent need for targeted professional development and training to improve educational quality and student outcomes.

The Early grade math and reading assessments and Early Grade Mathematics Assessment (EGMA and EGRA) were sample student assessments conducted in 2018. A total of 380 grade 5, 6 and 7 students sat the assessment in 22 schools across five states (Banaadir, Galmudug, Hir-Shabelle, South West, and Jubbaland), although the tests are intended to assess grade 4 level competencies.

The assessments identified extremely low learning levels in Somali literacy, English literacy, and, to a lesser

extent, mathematics.[1]

Table 2. Results of 2018 EGRA and EGMA

		Grade 5	Grade 6	Grade 7
EGRA (Somali)	***Overall***	**25.7%**	**27.3%**	**31.1%**
	Females	25.2%	28.3%	28.4%
	Males	26.1%	26.6%	32.5%
EGRA (English	***Overall***	**43.4%**	**47.3%**	**82.1%**
	Females	41.4%	49.2%	78.0%
	Males	45.3%	45.7%	84.2%
EGMA	***Overall***	**63.8%**	**65.5%**	**87.0%**
	Females	62.1%	64.3%	79.3%
	Males	65.4%	66.6%	90.9%

The results from the 2018 Early Grade Reading Assessments (EGRA) and Early Grade Mathematics Assessments (EGMA) reveal concerning levels of literacy and mathematical competencies among grade 5, 6, and 7 students across five states in Somalia: Banaadir, Galmudug, Hir-Shabelle, South West, and Jubbaland. Conducted with a total of 380 students from 22 schools, these assessments aimed to evaluate competencies typically expected at the grade 4 level. In the EGRA for Somali literacy, the overall pass rates are alarmingly low, with only 25.7% of grade 5 students, 27.3% of grade 6 students, and 31.1% of grade 7 students demonstrating the necessary skills. Gender disparities are evident, as female students scored 25.2%, 28.3%, and 28.4%, respectively, which are slightly lower than their male counterparts who scored 26.1%, 26.6%, and 32.5%. In contrast, the EGRA for English literacy shows higher overall performance, with pass rates of 43.4% in grade 5, 47.3% in grade 6, and a significant jump to 82.1% in grade 7. Here, female students scored 41.4%, 49.2%, and 78.0%, while male students outperformed them with scores of 45.3%, 45.7%, and 84.2%. The EGMA results indicate a more promising picture in mathematics, with overall pass rates of 63.8% for grade 5, 65.5% for grade 6, and 87.0% for grade 7. Female students scored 62.1%, 64.3%, and 79.3%, while male students achieved higher scores of 65.4%, 66.6%, and 90.9%, respectively.

3. Methodology

A total of 100 mathematics teachers from public schools in Mogadishu, including primary, middle primary (intermediate), and secondary levels, were selected for the study using a cluster sampling technique from the MoEC&HE Teacher Training Institute.

The selection criteria included having a Bachelor's degree with a major or minor in mathematics, completing a teacher training program with mathematics as an optional subject, and possessing a minimum of six months of teaching experience in public schools.

The sample consisted of 40 teachers for primary classes (20 males and 20 females), 30 for middle classes (20 males and 10 females), and 30 for secondary classes (20 males and 10 females). The researcher developed a questionnaire based on a five-point Likert scale, ranging from strongly agree to strongly disagree. To validate the instrument, it was reviewed by ten experienced mathematics teachers who identified and recommended the removal of five irrelevant statements, resulting in a final version with 12 statements. The reliability of the questionnaire was tested yielding a Cronbach's alpha of 0.64 which is acceptable in social sciences. Data collection involved distributing the questionnaire, accompanied by a covering letter explaining the study's objectives, with assistance from colleagues and friends to ensure clarity about the study's purpose if inquiries arose.

4. Results

[1]All results taken from Wafula and Mulongo, "Are children in South and Central Somalia accessing education, and are they learning? Baseline information", Social *Sciences & Humanities Open*, 2020.

Analysis was conducted to explore the opinion of the teachers about the content of the mathematics courses in the Ministry of Education Culture and Higher Education teacher training programme for male and female teachers. And were divided into three groups (primary teachers, Middle Primary teachers and Secondary B. Ed teachers). See Table 4.

Table 3. opinion of the teachers about the content of the mathematics courses.

		Responses(%)				
Item#	Statement	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
1	Content of mathematics in teacher training program enable the teachers to understand the content of school mathematics.	56	35	4	2	3
2	Content of mathematics in teacher training program prepare them to build on prior skills and knowledge when teaching new content	49	28	13	4	6
3	Content of mathematics in teacher training program trained teachers to link the mathematics with daily life examples.	7	11	8	36	38
4	Content of mathematics in teacher training program train them to make the mathematics of the lesson explicit by using explanations, representations, and/or examples	70	23	3	2	2
5	Content of mathematics in teacher trainingprogram train teachers to provide students strong base foundation in mathematics.	35	38	6	15	6
6	Content of mathematics in teacher training program prepare them to emphasize one solution method to strengthen all students' understanding of the content	19	26	10	29	16
7	Content of mathematics in teacher trainingprogram train teachers for problem solving techniques.	6	5	3	24	62
8	Content of mathematics in teacher training program Have students choose and use appropriate tools when solving a problem	5	4	5	28	58
9	Content of mathematics in teacher training program provide core knowledge, concepts, mathematical principals and their interrelationship.	36	29	13	14	8
10	Content of mathematics in teacher training program train them predominantly use questions and problems that are from the textbook	17	32	7	32	12
11	Content of mathematics in teacher training program train teachers to organize mathematical ideas, test them and fill the gaps for effective teaching of mathematics.	4	4	4	23	65
12	Content of mathematics in teacher training program train teachers to make teaching process effective through involvement of the students.	23	26	10	20	21

The results are particularly concerning regarding problem-solving techniques, with only 6% strongly

agreeing that the program trains them in this area and a substantial 62% disagreeing. Similarly, only 5% strongly agree that the training encourages students to select appropriate tools for problem-solving, with 58% strongly disagreeing, pointing to a lack of focus on practical applications in mathematics.

Regarding the provision of core knowledge and concepts, 36% of teachers strongly agree that the program covers essential mathematical principles, though there remains a notable percentage feeling this aspect is lacking.

When it comes to the curriculum's emphasis on textbook problems, only 17% strongly agree that it trains them predominantly in this area, while 32% disagree, suggesting a need for more diverse problem sources. Moreover, a very small 4% of teachers strongly agree that the program trains them to organize and test mathematical ideas, with 65% strongly disagreeing, indicating a serious shortcoming in this training aspect.

Lastly, 23% of teachers strongly agree that the program fosters effective teaching through student involvement, but 21% strongly disagree, showcasing mixed opinions on this important pedagogical approach. Overall, the table reveals both strengths and weaknesses in the mathematics teacher training program, with broad consensus on areas needing significant improvement, particularly in linking mathematics to real-life contexts, problem-solving techniques, and organizing mathematical ideas.

5. Conclusion

The opinions of teachers regarding the content of the mathematics courses in their training program indicate a mix of strengths and significant weaknesses. While many teachers feel confident in their understanding of school mathematics and the clarity of teaching methods emphasized in the training, there are notable deficiencies in areas such as connecting mathematics to real-life contexts, problem-solving techniques, and organizing mathematical ideas. The feedback suggests that the current curriculum may not adequately prepare teachers to address the diverse needs of their students or to foster effective learning environments.

6. Recommendations

1. Enhance Real-Life Applications: Revise the curriculum to include more training on linking mathematical concepts to everyday life. This can help teachers demonstrate the relevance of mathematics to their students, making the subject more engaging and applicable.
2. Focus on Problem-Solving Skills: Introduce specialized workshops and training sessions dedicated to problem-solving techniques. This should include strategies for encouraging creative thinking and the use of various methods to approach mathematical problems.
3. Diversify Learning Materials: Expand the range of teaching resources beyond textbooks. Provide teachers with access to diverse problem sets and real-world scenarios that can be integrated into lessons, fostering a more dynamic teaching approach.
4. Organizational Strategies for Mathematics: Develop training modules focused on how to effectively organize mathematical concepts and ideas. This can help teachers structure their lessons in a way that promotes understanding and retention of material.
5. Increase Student Involvement: Encourage teaching strategies that actively involve students in the learning process. This can be achieved through collaborative projects, discussions, and hands-on activities that promote student engagement and participation.
6. Regular Feedback and Assessment: Implement a system for regular feedback from teachers regarding the training program. This should include periodic assessments to evaluate the effectiveness of the curriculum and make necessary adjustments based on teacher experiences and student outcomes.

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