# Content Analysis on the Ethiopian Mathematics Textbook for Grade-10 and Teachers' Perspectives: Challenges and Implications to Teachers' Instructional Practices

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**Abstract: The purpose of teaching and learning is to equip students with knowledge, attitude, and skills. It strengthens the overall students' capacity, opens room for students to become competent and problem solvers in the real-world of daily-life activities, if not so it is meaningless and empty. The objective of this study is to identify problems and strengths of grade-10 mathematics textbook, identify factors affecting instructional practices and recommend corrective measures, policy directions, share experiences among teachers, practitioners, policy makers, and the education community. The study employed mixed research approach employing content analysis and conducting survey on grade-10 mathematics teachers from randomly selected schools. Findings indicated that a large number, 35 (55.70%) out of 62 textbook activities are purely assigned for the concept of functions; polynomial, trigonometric, exponential and logarithmic. The geometry part (measurement, coordinate and plane geometry) took a total of 21 (33.87%) activities indicating that little emphasis is given to geometric concepts. The remaining 6 (9.68%) activities are assigned for solving inequalities. Most activities focus on lower-level cognitive objectives (44.83% for remembering). It can be concluded from the findings that the voluminous nature of the textbook (Mean =4.00, S.D.=1.3801), low interest of students towards mathematics learning (Mean=4.6190, S.D.=0.5754) and mathematical misconceptions, high rate of migration (including students and young teachers), lack of continuous training (Mean=3.4762, S.D.=1.4013), lack of parents' support (Mean = 3.7143, S.D.=1.1606) and low living standard of teachers are among the major factors affecting teachers' instructional practices. The bold idea found then is that most teachers have high interest in teaching, but their moral in practice is dead.**

**Keywords:Behaviorism, Cognitive objectives, Constructivism, Content Analysis, Instructional Practices, Mathematics textbook, Misconception.**

## 1. Introduction

Education is a key instrument, especially, for the psychological and social development of citizens and hence for the socio-economic development of a country where mathematics is one of the most important and compulsory subjects of the education system (curriculum) at all levels in many countries including Ethiopia. In the existing Ethiopian Education and Training policy, it is stated that 'The chief goal of the education and training policy is the cultivation of citizens with an all-round education capable of playing conscious and active role in the economic, social, and political life of the country at various levels' (MOE, 2002:15). It is, however. indicated in many official documents of the country (Ethiopia) that the long-standing problems associated with the country's education system were essentially focused on limited and inequitable access, lack of quality and relevance including resources, and continuous decline in quality and standards' (MOE, 2002). \

In general, it has been observed that inadequate infrastructure and facilities such as textbooks, reference books and other teaching materials, absence of interrelated contents and appropriate teaching and learning methodologies, and insufficient training for teachers all indicated the low quality of education in Ethiopia. More specifically, the major problems of the education system are also addressed on the document 'Education and Training Policy and Its Implementation (MOE,2015)' and these are limited access, inequitable distribution of school services, problem of efficiency, lack of quality and relevance, and undemocratic content (for example, in many cases examples and activities presented in the textbooks are not gender sensitive).

Therefore, it required an appropriate direction to set and hence a new education and training policy has been formulated by the Transitional Government of Ethiopia (TGE) in 1994. Theoretically, the policy document encompasses general and specific objectives as well as implementation strategies at all levels. This policy document further emphasized on

the development of problem- solving capacity and culture in the content of education, curriculum structure and approach, focusing on the acquisition of scientific knowledge and practicum. It also incorporated the structure of education in relation to the development of student profile, educational measurement and evaluation, media of instruction and language of teaching at various levels, the recruitment, training, methodology, organization, professional ethics and career development of teachers in general (TGE,1994). Furthermore, the modified existing Ethiopian Education and Training policy states that 'The chief goal of the education and training policy is the cultivation of citizens with an all-rounded education capable of playing conscious and active role in the economic, social, and political life of the country at various levels' (MOE, 2002:15). But all these identified policy issues remained to be more of theoretical that lacked practice. Therefore, in order to achieve these policy goals, among the most important components to be addressed are the preparation of relevant textbooks and the design and implementation of appropriate instructional practices.

### 1.1. Objectives of the study

The specific objectives of this research work are to:

- Identify the major problems and strengths associated with the Ethiopian mathematics textbook for grade-10.
- Investigate the implications of the content and organization of the textbook to teachers' instructional practices.
- Identify and analyze the factors affecting grade-10 mathematics teachers' instructional practices in the selected schools of the Tigray region.
- Recommend possible remedial actions and policy directions related to issues of textbook development and teacher training.

### 1.2. Content Analysis of a Textbook

Content Analysis is a research tool used to determine the presence of certain words, themes, or concepts mostly within some given qualitative data. Using content analysis, researchers can quantify and analyze the presence, meanings, and relationships of such words, themes, or concepts

Mr. Harrison (2023) defines textbook as an embodiment of the syllabus and of all aspects of classroom practices. Textbook has been emphasized to be the most important tool in the teaching-learning process of Mathematics. A well-designed textbook opens the door for better environment in teaching and learning activity. Besides this, it will help students to become competitive, problem solvers and active participants in their daily life. Afolabi Samson Sanday (2014) addressed about a textbook by stating that 'Textbook as an instructional tool is unique among all other instructional media due to possession of certain characteristics. It is durable, permanent (not transient), portable and independent of electricity or electronic device when in use.' So, in order to have quality textbook, continuous analysis on its contents is necessary and practical action should not be left for tomorrow. To do this, the design of the textbook should appropriately address the parameters: learning theories, learning contents (sequence, balance, articulation, continuity and integration) as well as socio-cultural matters.

### 1.3. Methodology

This study has used mixed research approach as recommended by Creswell, J.W. and Creswell, J.D. (2018) employing a critical content analysis of the mathematics textbook for grade-10 both by the candidate for doctor of education (DED) program and the instructor at Mekelle university. The study has integrated results obtained from both the textbook content analysis and survey conducted on a sample of teachers teaching grade-10 mathematics in selected districts and schools of Tigray region Ethiopia.

#### 1.3.1. Data Type, Source and Data Collection Processes

The data type collected were both quantitative and qualitative data. The sources of data for this study were both primary and secondary sources. The main sources of information are mainly grade-10 Mathematics textbook, mathematics teachers from selected schools teaching grade-10 (since, the Ethiopian National Examination at grade-10 is a requirement as an entry gate to the preparatory or pre-university programs), and other high school textbooks that are used as supporting materials. For the purpose of data collection, a critical review of textbook and other instruments including questionnaires consisting of closed-and open-ended items, focus group discussions (FGD) with teachers, and observation on the overall school environment have been conducted. The use of multiple sources and multiple methods have helped to ensure reliability and validity of data.

#### 1.3.2. Data Analysis Approach

The identified, organized themes and observed patterns obtained from the content analysis and responses from the teachers are narrated, sequenced and interpreted using different perspectives and criterion. More specifically, all the chapters (units) and their sub-topics of the textbook have been analyzed in terms of coverage, their vertical and horizontal relationships, integration, and continuity as well as the application of the lower- and higher-level cognitive objectives. In addition, descriptive statistics such as frequencies, percentages, averages (means) and standard deviations are used for the survey data.

## 2. Results and Discussion on Findings from the content analysis

In this manuscript, the authors have reviewed the contents of the Ethiopian mathematics textbook for grade- ten, which has 303 pages. The review is based on the parameters which are identified earlier to analyze whether or not it is up to the required standard to address meaningful instructional practices.

### 2.1. Interpretation of Learning Theories in the Textbook

Learning theories or educational positions are significant when properly implemented in the textbook. From the theory of cognitivist, two major strands of learning theories are wide spread: behaviorism and constructivism, that may be applied in an intention to solving problems by teachers or students given in the form of exercises.

In this regard, even though the problems solved on some pages of the textbook are interesting and encourage learning through assessment that allow practice and repetitions, the behaviorist approach encourages learners to provide proper response to a given stimulus. Of course, behaviorists trust that learning will be enforced when students are engaged in drill practice as initiated by textbook examples as followed by stereotype questions. These trends are observed on examples of most chapters in the textbook. For example, the opening problem on page 2 of chapter 1 addresses the fluctuation on volume of water of a given dam over time 't' may be represented by the function $v(t) = 450 – 170t + 22t^2 – 0.6t^3$. Here, before directly dealing with cubic (degree three) polynomials, it would have been better first to encourage students represent similar realistic word problems in to linear and quadratic functions. The questions on Activity 4.4 (**a** and **b,** p.153) aimed at addressing the relationship between equality of slopes of many pairs of points and parallelism of lines determined by the points. However, the possibility of concurrence of the points is missing because students are guided to focus only on equality of slopes only implies parallelism. Some activities in the textbook (e.g. Q.4 of Activity 7.1 on page 27of chapter 7) presents questions that fully encourage rote memorization or "------ **is called** _____" kind of items which discourage students' higher-order thinking and creativity. Importantly, a number of examples are solved wherein many stereotyped because they call for students' higher-order thinking at some length. It is also observed that some exercises are very similar or direct copies (repetitions) of previous examples. For example, the exercises presented on pages 125 to 126 of chapter 2 are very similar to the solved examples in the previously covered sections and these could not promote students' higher-level thinking.

Generally, in order to achieve the goals of learning, its approach should be developmental that should be built sequentially from simple to complex and from concrete to abstract. There is also a general agreement among mathematicians and educators that too simplistic approach and too problematic is not preferable. Similarly, engaging students directly with challenging questions discourage their progress in learning. In this textbook under consideration (inspection), 1) neither the mathematical knowledge discovery nor the knowledge invention (knowledge construction) is properly addressed. Moreover, in some of the contents, there are no relationships (connections) between simpler problems (e.g., Question 4 on page 126 describing all points in the first quadrant) and more challenging problems (e.g., Question 2 on page 125 requiring to represent the region bounded by three different inequalities) which are presented without having clear goals of how the simple problems would contribute for solving the challenging problems.

Table 1: Number and nature of the activities in the textbook.

| **Unit ($U_i$)** | **Chapter title** | **Number of activities** | **Comments** |
|---|---|---|---|
| 1 | Polynomial function | 13 | Most of the activities emphasize on lower- order thinking. |
| 2 | Exponential and logarithmic function | 10 | Almost all the activities do not promote critical thinking. |
| 3 | Solving inequality | 6 | Some of the activities focus on problem solving approach |
| 4 | Co-ordinate geometry | 8 | Most of the activities are lower-order thinking. |
| 5 | Trigonometric function | 12 | Almost all the activities are not attached with the daily life of learners. |
| 6 | Plane geometry | 8 | Some of the activities emphasize higher- order thinking. |
| 7 | Measurement | 5 | The activities lead to memorize and depend on the formulae. |
| | **Total** | **62** | |

Generally, there is no fucus on one of the learning theories, that is, there is a mix of both the behaviorist and constructivist approaches in treating examples, exercises and activities throughout the textbook.

It is believed that activities would promote the concept of development of mathematical contents. A summary on the number of activities allocated to each chapter and the focus of the activities are provided in Table.1. These data indicated that a large number of activities are purely assigned for the concept of functions, that is, 13 (20.97%) for polynomial

functions, 12 (19.35%) for trigonometric functions, and 10 (15.38%) for exponential and logarithmic functions totaling 35 (55.70%) out of 62 activities (Bansal et al., 2010 & 2015).

On the other hand, the geometry part takes a total of 21 (33.87%) that are distributed as 8 (12.90%) activities for coordinate geometry, 8 (12.90%) for plane geometry and 5 (8.06%) for measurement.

Of course, the remaining 6 (9.68%) activities are assigned for solving inequalities. These data clearly indicated that little emphasis is given to chapters on geometry.

Moreover, most of the activities in the textbook are observed to be focusing on lower-level cognitive objectives (see comments in Table.1), that is; on remembering, comprehension and application and almost ignoring the higher-level objectives (that is; analysis, synthesis and evaluation). To see this, it is sufficient to consider Activity 2.1 on Q.2 (a – l on p.55) questioning students to compute the values of $(-1)^n$ and $(-2)^n$ for n = 1, 2, 3, 4, 5, 6, which is trivial.

So, some data in this textbook review showed that students are not encouraged to be critical thinkers. In addition, it is observed that the repetition of examples, questions, activities and other components make the textbook voluminous. In general, with the exception of some activities, most of them could not fulfill the required standard. For example, the activities in addressing the concept of a plane appears to be challenging for students and some teachers in understanding the concepts such as the difference between an expression and function, a polygon and a region, dimension of objects (e.g. a point, line, polygons, solids, etc.), and perimeter and area.

Also, some activities are observed to irrelevant for the chapter under discussion, for example, Activity 1.2 on the items of Q.3 and Q.4 (items a – d, p.9) have nothing to do with polynomial functions, rather these deal with the distributive and associative properties of real numbers.

In this sense, there are examples and questions in different chapters that do not contribute to the main objectives (big ideas) of the chapters.

**2.1.1. Handling Misconceptions**.

As to the constructivist perspective, handling misconceptions is where students could build on their new learning. Throughout the textbook, there is no indication where students could identify misconceptions and provide corrective treatments to furthering their learning. Instead, there are activities (examples and questions) that are incomplete, unrealistic and without adequate illustrations. Of course, there are many misconceptions committed by students and sometimes by teachers as well. For example, if a student is asked to give examples of plane figures like, rectangle and circle respectively; most of the students' responses are a box for the rectangle and a ball for the circle because they face problems in understanding the definition of figures in the plane and objects in space. Let us consider examples of misconceptions (common errors) in mathematics observed or committed by grade-ten students as presented below:

1) In evaluating the polynomial function given by $x^4 + x^2 = 64$, they try wrongly to answer as follows: $x^4 + x^2 = 64$ implies $x^6 = 64$. Thus, $x = (64)^{1/6} = (2^6)^{1/6} = 2$ which is wrong.

2) In simplifying the exponential expression $(2^3)^2$: $(2^3)^2 = 2^{3.2} = 2^6$ which is correct.

In a similar fashion, the same procedures follow to find the value of $2^{3^2}$: $2^{3^2} = 2^{3.2} = 2^6$ which is not correct since the correct answer is $2^9$.

Even though identifying misconceptions and taking corrective measure is significantly important at least in reducing the difficulties, nothing is addressed in the textbook as a solution.

**2.1.2. Mathematical representations**.

Representations are ways of creating mental images of a mathematical concept through a number of mechanisms that will help one to transcend from simple learning to thinking. The notion of a function can be represented in variety of ways: graphical representations, tabulations, algebraic/symbolic representations, contexts, and word representations (Bansal et al., 2010 & 2015).

Some of these representational methods are utilized in some parts of the textbook in developing the concepts while the relevant others are discarded completely. These representations on the Algebra related chapters, mainly graphical, are focusing more on functions. These, for example, are observed on exponential and logarithmic functions as displayed from pages 85-91, trigonometric functions from pages 173 - 204 as well as on solving inequalities including sign charts presented from pages 128-134. Also, a very good diagrammatical representations in the form of plane figures and solids are used both in chapters 6 (Plane geometry) and chapter 7 on Measurement of the textbook.

**2.2. Interpretation of socio-cultural considerations in the textbook**

The main objective of teaching and learning is to equip students with knowledge, attitude, and skills. It strengthens the overall students' capacity, opens the room for the student to become competent and problem solver in the real world of daily life activities, if not so it is meaningless and empty. So, the activities in the text book should be attached with or should reflect the daily life activities of students. Alan Bishop (Bishop, 1988) argues that regardless of the place they live and the language they speak, all people mathematize – count, play, locate, measure, design, analyze, hypothesize, etc. This has refuted the view that mathematics is universal and culture free discipline rather nowadays constructivists argue that mathematical knowledge is subject to revision and modification. The need to incorporate students' socio-

cultural background in learning materials seems forever increasing, because it helps to recognize mathematics as a subject. In general, mathematics appears to be highly applicable in banking, building construction, trading, farming, industry and so on. However, in this review only few activities and exercises exist related to the socio-cultural issues.

Rooted in socio-cultural philosophy, writing in mathematics has multifaceted benefits (van De Walle, 1998) which enable students receive messages by listening to the class room community, and reading explanation and direction from a number of sources, language development improving metacognition skills and others. The benefits include, (a) understanding the technical vocabulary of mathematics, (b) differentiating between mathematical language and conventional language, (c) comprehending mathematical contents, (d) reading short-hand symbols, numerals, formulas, (e) structuring and linking, to precise, rigorous mathematical statement, (f) expressing mathematical argument, and (g) illustrating mathematical relationship. In this review, it is observed that the activities that aimed to promote student communication is often neglected which in turn affecting the overall instructional process.

**2.2.1. Theoretical Models in Learning Mathematics**

There are many theoretical models significant in mathematical education. Let us look at these three kinds of models: (1) cognitive complexities in educational objectives, (2) level of geometric thinking, and (3) problem solving

1. **Achievement of Educational objectives and Levels of Cognitive Complexities:**

Contents of textbooks are designed to achieve students' learning objectives. Each learning objective specifies a mathematical content and achievement level. For example, if the content is polynomial function; one of the objectives could be, student will be able to draw the graphs of polynomial function. Generally, the achievement level is the cognitive, affective or psychomotor skill. As every educator should the need to understand and able to interpret the levels of Bloom's Taxonomy (Bloom et al.1956) is essential. Lesson objectives should be developed in consideration to what it should the students need to attain at the end; mismatch between what was stated and what was done is common place in mathematics lesson – it is just a contradiction. Although there is no bad or good classification in the taxonomy, the intended end is to attain the higher levels of learning. Table 2 shows the distribution of chapter objectives along the cognitive complexities ranging from remembering to evaluation. Table 2 shows the distribution of chapter objectives along with the cognitive complexities ranging from remembering to evaluation.

Table2, Distribution of the Cognitive objectives (Bloom's Taxonomies) by chapter

| **Taxonomy** | **$U_1$** | **$U_2$** | **$U_3$** | **$U_4$** | **$U_5$** | **$U_6$** | **$U_7$** | **Total** |
|---|---|---|---|---|---|---|---|---|
| Remembering | 1 | 3 | 2 | 1 | 2 | 3 | 1 | 13 |
| Comprehending | 4 | - | - | - | 1 | - | - | 5 |
| Application | - | 1 | 2 | 3 | 1 | 1 | 1 | 9 |
| Analyzing | 1 | - | - | - | - | - | - | 1 |
| Synthesizing | - | - | - | 1 | - | - | - | 1 |
| Evaluation | - | - | - | - | - | - | - | - |
| **Total** | **6** | **4** | **4** | **5** | **4** | **4** | **2** | **29** |

Ui represent the units (Chapters) for i = 1, 2, 3, …, 7

The data in Table 2 shows that most objectives are at the remembering and application levels. The coverage in percentages of objectives along the levels are: 44.83%, 17.24%, 31.03%,3.45%, 3.45 %, and 0% for remembering, comprehending, applying, analyzing, synthesizing, for evaluating; respectively. Clearly, there is imbalance on the educational cognitive objectives in terms of distribution where the higher-level objectives are almost ignored (disused) That is, the textbook has a problem in articulation and balance. Thus, it is believed that addressing these problems is very significant based on critical review of the textbooks.

**2. Level of Geometric thinking**: The word Geometry comes from the Greek word, "Geo" means world and "Metry" means measurement, so equipping student with geometry means enabling student, to measure, to construct predict, and overall skill about the world, applying in his daily life activities and makes life easy in this complex world, that is why geometry as a branch of mathematics is taken from lower level up to higher level. Rooted in Piaget's theory of cognitive development and on the cognitive complexity of Bloom's Taxonomy (on a considerable basis), a geometric thinking advanced by van Hiele is essential to consider. The translation of the theory into classroom practice involves appropriate geometric activities that enable students to transcend from one level of geometric thinking to next higher level. As my concern, the secondary level students are believed to prove mathematical statements assuming that they have properly grown in the previous lower level. They are also expected to analyze mathematical concepts from different axiomatic systems, like viewing the Pythagorean Theorem in relation to different axiomatic systems-Euclidean, vector, analytic, and spherical. The notation of quadrilateral or polyhedral hierarchy could be transformed from 2D or 3D geometry in to analytic geometry of coordinates, or else (van Hiele, 1986). In reviewing the textbook, I found, however, that the authors had little awareness in translating the theory of the geometric thinking into classroom practice. I was not able to see its application in geometry treated in the textbook. Nor is the theory employed in the development of the unifying concept of a function.

**3. Problem Solving**. Unlike textbook exercises, real-life problems are featured with perplexity and puzzlement. A student who is required to determine the measurement of a house having the shape of triangular pyramid and rectangular prism without indication of the dimensions of the solid will be deeply puzzled as compared with a student who is required to determine the measurement of a right rectangular prism or right triangular pyramid, whose measurement formulae were made explicit in the textbook. However, the first is very close to life situations in contrast to the second. Some other problems that are provided with formulas in the textbook could also be more interesting if they were provided in the form of activities wherein students could follow the strict stipulation of Polya's phases of problem solving (Polya, 1947). For example, the items given in example 8 of chapter 1 on p.13 which deals with practical hands-on activity to relate polynomial functions with volume of boxes, Q 2 in exercise 7.3 on p.292 and Q7 in the summary of Chapter 7 on measurement (p.300) asking to derive the general formula for the volume of frustum of a cone and derivation of the formula for the volume of a right circular cone in terms of base radius 'r' and altitude 'h' are very good sample questions that can be approached using the procedures of problem solving. However, there are inadequate number of questions that fulfill problem solving approaches.

**3. Structure and Organizations of Textbook Contents**

The contents of mathematics textbooks are structured both vertically and horizontally. The vertical relationship emphasizes on how topics within a textbook or among curriculum materials are connected developmentally. For example, the topics of grade ten need to be connected vertically with those of contents in grades nine and eleven. Of course, there are always differences in depth of the contents between grade levels which shows the vertical relationship in the mathematics. With regard to chapters for example, 'Exponential function' should be placed before 'Logarithmic function' and this is a horizontal relation within mathematical topics. On the other hand, mathematics is a tool to all subjects (natural sciences such as physics, chemistry, engineering and social sciences) so that it should match with these subjects horizontally. Two benefits seem to generate from the horizontal relationship: 1) real-life problem-solving through the efficient instruction of mathematics lessons in line with the other disciplines and 2) promoting a coordinated endeavor of teachers from different fields for better student learning (Cangelosi, 1996). However, in this voluminous textbook, the opportunity is least practiced which implies the textbook has an integration problem. Few could be cited as good examples from physics and other subjects such as Q.10 of Exercise 1.7 on p.31 which deals with a problem related to a missile launched vertically with height expressed by $h(t) = 100t - 16t^2$ that linked to mathematics lessons. Similarly, Q.14 from review exercises of unit-1 on p.52 deals with profit and loss of a football club where its profit after a takeover is modelled by $p(t) = t^3 - 14t^2 + 20^t + 120$. In addition, Qs 1, 2, 4 on p. 102/3 are related with biology; Q.4 (on compound interest) and Qs. 6 & 7 (Physics related questions) on p.103 are some of the sample practical examples provided in the textbook.

In this review, the results of summarized data showed that the textbook has a good continuity of contents as well as vertical and horizontal relationship within appropriate scope but with considerable sequence and balance problems in relation to the delivery of activities and exercises.

Table. 3. Connection between subtopics of mathematics among grade levels by unit

| **Grade 11 sub-topics (units)** | **Grade 10 units** | **Grade 9 sub-topics (units)** |
|---|---|---|
| 1 and 2. Further on relations and Functions | 1. Polynomial functions | 4.2. Relations and Functions |
| 1 and 2. Further on relations and Functions | 2. Exponential and logarithmic function | 4.2. Relations and Functions |
| 9. Further on Trigonometric functions | 5. Trigonometric function | 4.2. Relations and Functions |
| 3. Coordinate geometry<br>8. Vectors and Transformation of the plane | 6. Plane geometry and<br>4. Coordinate geometry | 5. Geometry and measurement<br>7. Vectors in two dimensions |

**Source:** Mathematics Textbooks for grades 9, 10 and 11. Ministry of Education. Ethiopia

With regard to the problem of sequence for example, it is possible to take the chapter on 'Solving Inequalities' (that is, Chapter.3) which must have been presented before the chapters on polynomial, exponential and logarithmic functions. Because, the chapter on 'Solving inequalities' is a continuation of the chapter on 'Solutions of equations' which is already covered in grade 9. Similarly, some of the units (chapters) contain a lot of questions and others very few items which bring imbalance on the overall presentation of contents among units and/or subunits.

**3.1. Technical considerations of the Textbook**: Technical aspects such as the quality of typology (e.g., spelling, vocabulary, grammar, etc.), gender sensitiveness, ethnicity, technology, and others are unavoidable aspects that a textbook should entail. Meanings should be associated with some of the aspects to express fairness. With regard to this,

the textbook could be featured as well-written, except some elements that need certain emphasis including some editing errors.

In summary, the textbook has sufficient number of activities and exercises for each subtopic of all chapters as well as a good number of review exercises at the end of every chapter. In addition, the values for the trigonometric functions and common logarithms are well addressed in the form of tables at the last pages of the textbook which is very important for students' learning. On the other hand, the textbook does not have reference list and glossary which can be considered as one of its weaknesses.

## 4. Teacher related challenges

### 4.1. Basic Information of Participant Teachers

This subsection presents basic information concerning the grade-10 mathematics teacher respondents. These include among others, respondents' sex, educational status (qualification), teaching experience, address by their zones, average age in years and standard deviation (S.D.), situation of trainings, average class size by gender as well as average weekly teaching load.

Table-4. Demographic characteristics of Grade-10 Mathematics teacher respondents

| No | Observation points | Category | Frequency (Value) | Percent | S.D. |
|---|---|---|---|---|---|
| 1 | Sex | Male | 18 | 85.71 | |
| | | Female | 3 | 14.29 | |
| 2 | Qualification | BSc/Bed. | 18 | 85.71 | |
| | | MSc/Med. | 3 | 14.29 | |
| 3 | Teaching Experience | Above 10 years | 21 (All) | 100 | |
| 4 | Average Age in years | | 44.81 | | 5.77 |
| 5 | Address (Zone) | Central zone | 9 | 42.86 | |
| | | Eastern zone | 5 | 23.81 | |
| | | Mekelle zone | 7 | 33.33 | |
| 6 | Class size (Average) | Male | 33.33 | | 12.50 |
| | | Female | 40.62 | | 16.45 |
| | | Total | 73.95 | | 27.04 |
| 7 | Average Load/Week | Total | 14.67 | | 3.48 |
| 8 | Short-term Trainings | Not at all | 14 | 66.67 | |
| | | Up to three times | 7 | 33.33 | |

From the summarized data collected from three zones (involving a total of thirteen schools) presented in Table-4, among the total 21 respondents only 3 (14.29%) are female teachers teaching grade-10 mathematics in the selected schools, 3 (14.29%) MSc and 18 (85.71%) are BSc holders. All the respondents, 21 (100%) of them, are with teaching experience of more than ten years and the average teaching load is 14.67 periods (contact hours) per week. The average class size is nearly 74 students (Male = 33, Female 41) with standard deviation (SD) equal to 27.04. The large size of the standard deviation shows that there is high variability among schools and/or classes. The average age of the respondents is calculated to be 44.81 years. Most of the respondents, that is, 14 (66.67%) have said that they did not get any short-term training that can improve their profession. From the results, it can be seen that maturity, educational qualification, weekly teaching load, and teaching experience of the teachers may not be problems. Clearly, large class size (nearly 74 students in a class), insufficient professional training, and gender gap on mathematics teachers, where there are more female students than their counterpart males, are among the observed problems.

### 4.2. Additional challenges of teachers in their instructional practices

A significant number of high school mathematics teachers in general and those that are teaching grade-10 mathematics in particular confirmed that the major challenges, among others, they are facing are: 1) low interest of students towards the subject and hence deteriorating trend to attend classes, 2) bulky content of the textbook and the forced accelerated approach to cover the huge volume to compensate the time wasted during destructive war in the region (Tigray), 3) insufficient short-term professional training to teachers,4) critical economic problem of teachers (low living standard)

that is negatively affecting teachers commitment to their teaching profession, 5) lack of support from parents side, 6) shortage of time (allotted periods per week), 7) inconvenient school environment due to the fact that school compounds, buildings and their classrooms are still serving as internally displaced people (IDP) centers (camps) and, at the same time, as teaching classrooms (e.g. Adi-Haqi and Hawelti comprehensive secondary schools at the capital Mekelle, Finote-Berhan comprehensive school at Adigrat, the center of Eastern zone, Nigiste-Saba preparatory and Axum preparatory schools in Adwa and Axum, respectively), and 8) imbalance on the distribution of cognitive objective and activities (that is, most mathematics activities in the textbook focus on lower-level cognitive objectives).

In addition, beyond the misconceptions that are observed on a number of high school students with regard to mathematical concepts, there are also observed misconceptions on some teachers both on cognitive or intellectual values and methodological approaches in their teaching.

These multidimensional problems are some of the major findings that affected the smooth instructional practices of teachers and hence the quality of education in the region and the country as a whole (see Table.5). This in turn leads to low achievement of students and hopelessness in their educational career. As a result of these negative influences, a huge number of young male and female high-school students including some young teachers are dropping out from schools and fleeing the country becoming migrants to Arab and Europe countries. Thus, there is a need to pay due attention and integrated approach among stakeholder to solve the problems strategically.

Again, by conducting continuous on job short-term trainings, there is also a possibility to develop the power of thinking and reasoning in terms of incorporating different methods (e.g. inductive and deductive approaches, problem-solving, project work, etc.), analysis, generalization and judgement of teachers. For example, consider the statement 'The sum of the first **n**-odd natural numbers is equal to $\mathbf{n^2}$.' or given by the formula $1+ 3+ 5+ \ldots + k = k^2$. Note that assuming the formula holds true for n = 1,2, 3, …, k; we need to show that it also holds true for n = k + 1.

Now it is possible to apply induction method to show the equality rather than simply memorizing it. Since any odd natural number can be expressed as 2i – 1 for i = 1, 2, 3, …; it follows that

$\sum_{i=1}^{k+1}(2i-1) = \sum_{i=1}^{k}(2i-1) + 2(k+1) - 1 = k^2 + 2(k+1) - 1$ (by assumption/hypothesis)

$= k^2 + 2k + 1 = (K+1)^2$ and hence it is proved!

Some of the factors affecting teachers' instructional practices are summarized in Table-5 displaying means and standard deviations (SD) computed from the responses of teachers.

Table.5. Summarized results of Teacher respondents on factors affecting their instruction (N = 21)

| **Items** | **Mean** | **SD.** |
|---|---|---|
| Low interest of students | 4.6190 | 0.5754 |
| Bulky content | 4.0000 | 1.3801 |
| Lack of support from parents | 3.7143 | 1.1606 |
| Insufficient training for teachers | 3.4762 | 1.4013 |
| Insufficient periods (time) | 3.4286 | 1.3997 |
| Shortage of teaching aids | 3.2857 | 1.2778 |
| Workload on students | 2.6191 | 0.9989 |

**Note. Strongly agree =5, Agree = 4, Neutral =3, Disagree =2, Strongly disagree =1.**

Accordingly, results indicated that low interest of students towards mathematics learning (Mean = 4.6190, SD = 0.5754), bulky (huge) content of the subject (Mean = 4.000, SD = 1.3801), lack of support from parents (Mean = 3.7143, SD = 1.1606), and insufficient training to teachers (Mean = 3.4762, SD = 1.4013) are among the major problems negatively influencing mathematics teachers' instructional practices.

### 4.3. Application of Teaching strategies

Most of the information indicated that there is no encouraging condition to apply student-centered approach because teachers are required to use the accelerated teaching approach to cover the textbook contents. So mostly, the teaching methods are lecture focused as can be seen from the data presented in Table.6. That is, the teaching approach becomes teacher dominated with the purpose of covering content with insignificant students' participation.

Table. 6. Summarized results of responses on the frequent use of teaching methods (N = 21)

| **Items (Methods)** | **Mean** | **SD.** |
|---|---|---|
| Oral Q-A approach | 3.8571 | 0.9897 |
| Home-work | 3.5238 | 0.8518 |
| Problem-solving Method | 3.1429 | 0.7095 |
| Independent class work | 2.9048 | 0.9712 |
| Doing on assignments | 2.7143 | 0.6999 |
| Group discussion | 2.6191 | 0.8985 |
| Individual presentation by students | 2.2381 | 0.8677 |

**Note.** Always= 5, Most of the time =4, Some-times =3, Very rarely =2, Not at all =1

In parallel to the lecture method, the most frequently applied approaches are oral question and answer (Mean = 3.8571, SD. = 0.9897) and giving home works (Mean = 3.5238, SD = 0.8518). On the other hand, responses showed that the method of individual student presentation is applied rarely (Mean = 2.2381, SD = 0.8677) as compared to the others (see Table-6).

As can be seen from the summarized results displayed in Table-7, correlations of responses for pairs of variables are computed. Accordingly, in an attempt to cover the content, the huge nature of the content showed relatively weak positive correlations with the use of home work as a teaching method (r = 0.3645), problem solving method (r = 0.3404) and group work (r = 0.3456) and slightly negatively correlated with question-answer approach (r = - 0.3486).

Table-7. Correlations (r) between responses of pairs of different variables (N = 21)

| **Variables** | Q-A approach | Problem solving | Group work | Student presentation | Homework |
|---|---|---|---|---|---|
| Huge content | **- 0.3486** | **0.3404** | **0.3456** | 0.0398 | **0.3645** |
| Low student interest | 0.0717 | - 0.09998 | - 0.0044 | **- 0.5814** | - 0.0787 |
| Insufficient training | - 0.0540 | **0.3626** | 0.1441 | **0.3376** | **0.4293** |
| Shortage of time | 0.1817 | 0.0343 | - 0.0974 | 0.1120 | 0.2111 |

Also, responses indicated that the low interest of students towards mathematics versus the application of individual students' presentation are negatively correlated (r = - 0.5814). This means that teachers agree or strongly agree that students have low interest and hence the teachers rarely use the student presentation method. Similarly, the responses regarding problem of teacher training showed weak positive correlations with problem solving method (r = 0.3626), student presentation method (r = 0.3376) and giving home works (r = 0.4293).

### 4.4. Application of Teachers' assessment methods in Mathematics

Due to the overall instructional processes, formal assessment techniques are almost impractical in the classroom. Therefore, teachers and hence all schools focus on summative assessment methods as summarized in Table.8.

Table.8. Summarized results of responses on teachers' assessment methods (N = 21)

| **Items (Strategies)** | **Mean** | **SD.** |
|---|---|---|
| Multiple choice items | 3.6191 | 0.8438 |
| True or False tests | 3.1905 | 1.2196 |
| Short Matching tests | 2.5238 | 1.1800 |
| Self-evaluation | 3.0000 | 1.2344 |
| Peer-evaluation | 2.4286 | 0.8492 |
| Port-Folio Organization | 1.8095 | 1.0057 |
| Provide feed-back to students | 2.8571 | 1.1664 |
| Using Parents' feed-back | 2.0952 | 0.9712 |

` **Note.** Always= 5, Most of the time =4, Some-times =3, Very rarely =2, Not at all =1

Clearly, multiple choice items (Mean = 3.6191, SD = 0.8438) and true or false items (Mean = 3.1905, SD = 1.2196) are the most frequently applied objective type of assessment methods. On the other hand, teachers' responses revealed that organization of portfolio (Mean = 1.8095, SD = 1.0057) and employing parents' feedback (Mean = 2.0952, SD = 0.9712) are least implemented methods.

## 5. Conclusion and recommendation

### 5.1. Conclusion

Generally, it can be concluded that the textbook could be labeled as voluminous. The root cause for this is the bulky nature of information, supposedly many activities, and the stereotype questions throughout the book. The textbook has also some problems related to integration, articulation and balance in using the educational cognitive objectives and representations. Additionally, most of the units in the text book focus on the lower-level cognitive objectives (taxonomies) and does not facilitate the use of analysis, synthesis and evaluation levels as well as the application of inductive-deductive, problem solving, and heuristic approaches for learning. There are only limited number of representations, like graphs, figures, diagrams and charts. Contents are not organized according to the psychological considerations of learners and are not sufficiently linked with day-to day-activities. Even though identifying misconceptions and taking corrective measure is significantly important at least in reducing the difficulties, nothing is addressed in the textbook as a solution. It can also be concluded that low interest of students towards mathematics, lack of continuous training, shortage of time to cover the bulky content, and teachers' low living standard are among the major challenges affecting the overall instructional practices of teachers. As a result of the multifaceted problems and their negative influences, it can be observed that a huge number of young male and female high-school students including some young teachers are dropping out from schools and fleeing the country (Ethiopia) as migrants to Arab and Europe countries. In this regard, a respondent among the teachers expressed his feeling very shortly by saying that

"I have very high interest in teaching, but my moral is dead!" which clearly describes the situation of teachers and education in the Tigray region.

**5.2. Recommendation**

The purpose of content analysis is quite important to transfer relevant and clear information and to lighten the burden of learning and teaching. The criteria selected to make critical analyses of this textbook, among others, are: philosophical (learning theories), psychological, and socio-cultural considerations as well as levels of cognitive complexities. After critical analysis has been made and a survey on mathematics teachers has been conducted, some important results have been obtained as concluding remarks and hence the following recommendations are forwarded.

1. From the detailed analysis, with all of the strengths like vertical relationship among mathematical contents of grade levels on the textbook, there are some weaknesses such as problem of balance and integration. Hence, periodic and continuous review should be carried out so as to ensure the balance and interpretation of the theoretical aspects into practice. In general, it is indicated that there is a need of addressing the imbalance on the allocation of activities to units and the use of cognitive objectives which requires due attention at all levels (including at the school, district, regional and national levels), institutions, and governmental/non-governmental organizations.
2. Even though identifying misconceptions and taking corrective measures is significantly important at least in reducing the difficulties, nothing is addressed in the textbook as a solution for this issue. To alleviate such problems, there must be a mechanism to engage teachers and representatives of local communities during the preparation of textbooks and other educational resources.
3. As the trainings provided to teachers so far are found to be insufficient, the implementation of continuous short-term training programs can be considered as one of the important interventions to alleviate problems associated with teachers' instructional practices.
4. For the benefit of the young generation and hence the whole society, there is a need to strategically engage in awareness creation programs involving all concerned stakeholders including parents. Such long lasting programs can help to divert the migration sentiment of the young generation and focus on their education endeavors.

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