AN ANALYSIS OF THE ETHIOPIAN GENERAL SECONDARY SCHOOLS MATHEMATICS CURRICULUM: EMPHASIS ON THE CURRICULUM COMPONENT DEVELOPMENT

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Abbreviations/Acronyms

AAU: Addis Ababa University

EMPDA/E: Educational Materials Production and Distribution Agency/Enterprise

EPRDF: Ethiopian People Revolutionary Democratic Front

ETP: Education and Training Policy

ICDR: Institute for Curriculum Development and Research

ICS:- International Community School (of Addis Ababa)

ICT: Information Communication Technology

IER: Institute of Educational Research

IGCSE: International General Certificate of Secondary Education

Math/Maths: Mathematics

Ma_1: a group of students (top achievers) learning Mathematics together

Ma_2: a group of students (medium achievers) learning Mathematics together

Ma_3: a group of students (low achievers) learning Mathematics together

MoE: Ministry of Education

TGE: Transitional Government of Ethiopia

TV:- Television

Abstract

The aim of this study was to analyze the appropriateness and adequacy of the current curriculum. The process underwent to bring, the nature of parts, and the comparison with national and international experiences were focal points for the research. In pursuit of these objectives, a mixed research approach was employed with due emphasis to qualitative approach. Data were generated from present and past curriculum materials, pertinent official documents, and from teachers and experts of mathematics. Coding sheets and open-ended interview guide were used to gather and process data. Percentage inter-coder agreement was then calculated to interpret the data found from the coding sheets. Narrative analysis was carried out for some document inspections and interviews. The study revealed that the process under taken to bring the first edition (2001) of the syllabus and the need assessment prior to Plasma TV inauguration were not adequately gone. There is no significant progression of the current curriculum compared to its immediate predecessor. Compared to Sandford and ICS Mathematics curriculum and Mathematics education, individualized and student-centered instruction, intensive learning and assorted instruction and evaluation methods were lacking areas. The harmony of learning objectives, contents, teaching methods and assessment mechanisms is maintained in the current curriculum. However, the levels and types of objectives and methods are not apt to permit students enrich with problem solving, independent thinking, and skill & attitudinal change capabilities. Based on the findings, some suggestions are forwarded.

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Chapter One: Introduction

1.1 Background of the study

Mathematics is invariably identified as the core discipline for scientific and technological careers (Morris, 1985). In Ethiopia, it has been privileged in assuring more places for Mathematics in the time table of the curriculum than any subject except English Language. This much time is allocated as students are in need of being competent in the subject. The following facts are reasons to possess mathematical competence for students. (1) The underpinnings of every day life are mathematical and technological; (2) Mathematics is one of the greatest cultural and intellectual achievements of human kind and appreciation and understanding of that achievement should be developed; (3) The level of mathematical thinking and problem solving skills are needed in the work place; and (4) Although all careers require a foundation of mathematical knowledge, some are mathematics incentive (Brahier, 2005).

Curriculum development can be viewed as a process encompassing curriculum planning, appropriate use of curriculum models with the orientation of educational philosophy, preparation and dissemination of curriculum materials, implementation and evaluation mechanisms. It is also a systematic and rationally planned activity that makes in to consideration the child, the society, subjects, assumptions and philosophies and theories about teaching and learning (Salia-Bao, 1989). Its purpose is 'to make instruction highly effective and efficient' (Pratt, 1980:183).

In the history of Ethiopian curriculum development, because of philosophical view or political contention, curriculum had been revised, reformed and changed. Such decisions, however, required to thoroughly study the gaps existed. A number of broad areas of research can be derived from an examination of the various sub-systems, their relationships and interaction of elements within them. African curriculum experts should research the structure of curriculum proposals, their units of construction, and curriculum materials and so on (Salia-Bao, 1989). In this respect, the overall strategy of the current Education and Training Policy of Ethiopia regards the creating of mechanism by which teachers, beneficiaries, and professionals participate in the evaluation of the curriculum (TGE, 1994:12).

Jackson (1996:130), recommend that 'a number of questions can be asked about curriculum materials [syllabus documents] in the context of evaluation whether they provide a rationale for inclusion of knowledge, contents, skills, and process specified'. Given the importance of published curriculum materials in mathematics teaching and learning, mainly in the form of textbooks, the establishment of an effective method of evaluation of these materials by their potential users is an important goal.

The significant function of evaluation is determining the value of curriculum itself. 'Are the processes themselves valid? Is the curriculum appropriate for the particular group of

students with whom it is being used? Are the instructional models selected the best choices in light of the goals sought? Is the best content selected?'(Saylor et al, 1981:317) These points are concerned with the appropriateness of the curriculum.

The selection of objectives and experiences, the relative emphasis given to different areas of curriculum, and the placement of materials may also be evaluated as appropriate or inappropriate in light of other contextual factors: the philosophy of education of the school, conditions and problems of contemporary life, the nature of the subject matter, and the psychology of learning (Madaus and Kellaghan in Jackson, 1996).

There is a growing movement to assess the effectiveness of Mathematics and Science curricula through various methodologies, including content analysis, comparative studies, case studies, and synthesis studies (Clewell et al, 2005; Walker in Jackson, 1996). In Ethiopia, however, the experience of curriculum evaluation seems far from the above practices. Some engaged in evaluating the process of implementation (Solomon, 2000; Andualem, 2006; Assefa, 2005; & Solomon Deressa, 2004). Others focused on the teachers' perception of the curriculum (Fekadu, 2007), or student achievement cases (Kebede, 2007; Tadesse, 2006). Only limited number of studies intentioned to the document analysis of textbooks (Gizaw, 2001) and the balance of separate variables in the curriculum (Alemayehu, 2001) had been conducted. Ambaye (1999) examined a TTI syllabus against standards and educational policy.

Ding and Guo (2005) viewed the curriculum evaluation in the 20th century as it has been developed from goal-oriented to goal free evaluation; from product to process evaluation; from paying attention to external value of the curriculum to the intrinsic value of the curriculum; from simply examining separate variables to describing and interpreting the context and situations in which the curriculum programs are implemented. The intrinsic

value of the curriculum, development process evaluation of the curriculum, and interpreting the context are all go with the evaluation of the curriculum itself.

1.2. Statement of the problem

In July, 2007, I have been participating a conference held at national level, organized by MoE, via plasma TV; it was recognized and more spelled out that the general secondary education failed in both English and mathematics. Analogously, on October 13, 2008, his excellence Ato Fuad Ibrahim, Vice Minister of the Ministry of Education, has conveyed [to secondary school teachers, via plasma TV] that "…grade ten students, on average, had answered only 31% of the Mathematics National Examination questions by the year 2008, which is the least compared to other subjects" and much less than minimum expectancy (50%). That means, on average, only 31 questions were correctly answered where as 69 questions out of 100 were wrongly answered by students. He also added that "…the current education is getting risk of quality". In line with this claim, some students of AAU, Science faculty, witnessed me that recognized Re-Examination has given in plenty schools of Amhara Regional State (*Machakel*, *Debre Markos*, *Enarjinawga*, *Addiszemen*, *Dessie*, and *Woreelu Woreda*) in August 2008 for detained (more than 60%) grade 9 students of which the failure was severe in Mathematics.

Even the current nation wide School Improvement Program (SIP) which is aimed principally to improve the student's achievement does not cure the problem. On the other hand, the government is highly in need of and plans to produce highly educated human power with firm emphasis of science and technology.

It might pose a question: Is the current curriculum better than the one it has replaced? In this respect, I found some teachers complaining it and not identifying the ideas of the reform made in 2005. It is usual to hear the propaganda: 'the weaknesses are emerged

from the implementation deficiencies not with incompleteness of the policy or the curriculum' on behalf of higher authorities leading the system. This argument has already deemed by Solomon (2007). Solomon had investigated that 'the top-down curriculum development and fidelity implementation approach in Ethiopia have negatively affected the teaching learning practice in secondary schools' (Solomon, 2008:237).

In Ethiopian current Education and Training Policy, students of grades 9 and 10 are expected to consider different areas (fields) in to account for identifying their interest for further education, specific training, and the world of work (TGE, 1994). However, it is at this stage that students heard of the blame of some subjects (for instance phobia of mathematics begins) and inclination to other subjects overtly depicted.

According to Solomon Deressa (2004), 52.81% of the students reported that teaching and learning of the current grade 9 mathematics lessons did not motivate their interest in learning mathematics. The correlation between Mathematics achievement and various dimensions of attitude towards mathematics is positive (Cheung, 1988). If the variables of achievement are malleable and responsive to enhancement, promoting student's attitudes in mathematics and the self, society and creative dimensions is likely to result in an increase in their achievement in Mathematics in schooling. Thus to promote the students' attitude, the need to pre-design would be obvious.

Ambaye (1999) assured that the current Education Policy of Ethiopia stresses the balanced development of the learner in the three domains of behavior. However, Alemayehu (2001) investigated that 91.84% is cognitive, 2.08% is affective and 6.25% is psychomotor for grade 6; and 80.95% is cognitive and 19.04% is psychomotor domain for grade 8 Amhara National Regional States mathematics syllabi.

This limited approach to curriculum evaluation persuades to bounce back to an evaluation of the intended curriculum. Curriculum Evaluation refers to 'the formal determination of the quality, effectiveness, or value of a curriculum' (Worthen *et al* in Sowell, 1996: 257).

The triggering attributes are, therefore, the following. (1) In 2007/08, grades 9 and 10 students obtained very low achievement in Mathematics after School Improvement Program (SIP) had implemented. (2) The availability of researches indicating the attitude of students towards Mathematics education is not positive (Solomon Deressa, 2004; Alemayehu, 2001). (3) I encountered people (especially Mathematics teachers) who complain about the adequacy and appropriateness of the curriculum. (4) Researches conducted on the evaluation of Mathematics Curriculum constituents and processes of development in Ethiopia are not observable.

Aim and Objectives of the Study

The overall aim of the study is to examine Mathematics curriculum of the Ethiopian Secondary schools vis-à-vis appropriateness and adequacy. The specific objectives are:

- To understand the process underwent to bring the current Mathematics curriculum for Ethiopian general secondary schools;
- To examine the nature of objectives, contents, organization of Mathematics curriculum materials for grades 9 and 10 in Ethiopia;
- To examine the current Ethiopian General Secondary Schools Mathematics curriculum of grades 9-10 vis-à-vis international perspectives and experiences.

Research Questions

Hence, my current study will attempt to answer the following research questions.

- How were the current grades 9 and 10 Mathematics Curriculum of Ethiopia developed?
- How are the objectives stated in the current Ethiopian General Secondary School Mathematics Curriculum?
- Are the Ethiopian General Secondary School Mathematics Curriculum objectives and methods in harmony with each other, and with education policy?
- What are the comparative strengths and weaknesses of the current Ethiopian General Secondary Schools Mathematics Curriculum with national and international experiences?

1.3 Significance of the Study

This research could serve as a reflecting mirror for the work of syllabi, text and guide book compiling and editing of practitioners' work. The recommendations of the study may help syllabus developers and textbook writers aware about the problems.

Potentially the study could serve as a reference to understand the real and changing patterns being practiced in Ethiopian Curriculum in general and Mathematics education in particular. Concerned institutions such as the General Education Quality Assurance and Examinations Agency, Ministry of Education and ICDR could get my study insightful for upcoming plans.

A study on mathematics curriculum is not as such exhaustive in Ethiopia. This study will help to add information about the issue, which can serve as source of knowledge especially for candidates for Educational Measurement and Evaluation, Educational Psychology, Subject Methodology (mathematics) and Mathematics Curriculum courses as well as mathematics teachers engaged in the teaching career.

1.4Delimitation of the Study

The components or domains of the Mathematics curriculum chosen for evaluation here include: need assessment, aims and objectives, content selection and organization, teaching methods and assessment mechanisms suggested. The relation between components of curriculum: Objectives and contents, teaching methodology and assessment & evaluation mechanism, learning experiences; the harmony among the policy, mathematics curriculum, and the context of our secondary schools and Ethiopia in general have been examined.

1.5Limitations of the Study

The selection of informants from Addis Ababa City schools made the trial difficult more than I expected. It is connected to the scarcity of the research budget that limited me from interviewing a few very well-versed senior teachers. When I started my interview arrangement from a well recognized secondary school, one senior mathematics teacher told me that I should pay if I extend to more than ten minutes. There were also others whom I lost by their ascribing of unconvincing reasons. Most of my participants were obtained by a big deal.

For sake of security purposes, getting the ICS detail mathematics curriculum at hand, once incorporated as the subject of the study, was an impossible effect. Thus, it obliged me to narrow the comparative aspect of the study.

1.6 **Operational Definition of Terms**

Adequacy of a Curriculum: when the curriculum meets the requirements and purposes it is designed for

Appropriateness of a Curriculum: deals with the worth of objectives, selection of contents, types of learning experiences, selection of teaching methods and evaluation mechanisms; which is developmentally correct,

Coding sheet: a format (as questionnaire is used in Survey) prepared (in content analysis) so that coders express their opinion.

Current Curriculum: the curriculum which is being implemented in the schools

Elements of a Curriculum: the need assessment (context), aims of the curriculum & objectives of learning units, curriculum materials, transactions and outcomes

International Curriculum: a curriculum with international orientation in content, aimed at preparing students for living and working in an international and multicultural context.

International School: a school with a value diversity and internationalization as integral to their education system; internationalization is the incorporation of contents, materials, activities, and understanding in to teaching from the international experiences.

Inter-coder Agreement: the extent to which independent coders evaluate characteristics of a message or content and reach the same conclusion.

Mathematics Curriculum: What the syllabus, textbooks, teacher's guide and Plasma TV Program contain the activities to happen for students

Chapter Two: Review of Related Literature

This chapter is devoted to the overall review and analysis of literatures on: mathematics-education; design, reform, change, and evaluation of school mathematics curriculum.

2.1 Mathematics Education

As the general theory of education goes, the curriculum is one of the means by which the over all aim is translated in to achievement: educated men and women are formed by being introduced to and initiated in to various kinds of knowledge and skill (Moore, 1982). The justification for mathematics education is stretched into the philosophy of education and the philosophy of mathematics. The first vein is for pedagogy while the latter for subject matter itself. From the educational philosophies' perspective, we can talk about what mathematics education [curriculum] look like.

For perennials' educational philosophy, mathematics should be taught for its on sake irrespective of any change in society; education should be stable and its purpose steadily by emphasizing on classical objects and on the desire to make the child literate and moral. It lies on the past agreed on universal truth; education becomes constant and universal.

For essentialists' educational philosophy, mathematics should be taught for use by advocating the perpetuation of mathematics that has proved useful to man's development in the past; there are essentials that each student in school ought to know.

For progressivisms' educational philosophy, mathematics is a medium for teaching process and skills. Change is the essential of reality. Mathematics can be said instrumentally medium for teaching intellectual processes, skills, attitudes, ideas, and appreciations.

As for a curriculum, Re-constructionists had to incorporate strategies for students and teachers to make commitment and actions to problems beyond analysis, interpretation,

and conclusion (Ornstein & Hunkins, 2004). It is necessary but not sufficient to engage in some educational philosophy to develop and lead mathematics curriculum. Understanding of mathematics curriculum itself is vital as well. The emergence of diversified views about the nature of mathematics is such puzzling to rely on one.

2.2 Designing Mathematics Curriculum

Thinking about the design, the arrangement of the parts of the curriculum causes us to reflect on the approaches to curriculum we are contemplating or accepting. Curriculum design, the organization of the components or elements of curriculum, exists along two basic organizational dimensions: horizontal and vertical organizations. It refers to "the placement of the key elements of curriculum and the relationships of these elements one another, a type of mapping of curriculum course of study" (Ornstein & Hunkins, 2004:240-241).

For Shiundu & Omulando (1992), Taba (1962) and Ornstein and Hunkins (2004, p.235), the parts, components, or elements that are arranged in a curriculum design are: (1) aims, goals, and objectives; (2) subject matter; (3) learning experiences; (4) evaluation approaches. Madaus and Kelleghan, quoted in Jackson (1996), identified the major components of curriculum as (1) context (need assessment); (2) general aims of the total curriculum; (3) objectives of specific curricula / learning units; (4) curriculum materials, in which content, subject matter, and skills have been selected and placed in a particular sequence and may take various forms of documentation, including syllabus, teacher's guide, text books, work books, and other materials; (5) transactions, usually in a classroom, in which teachers deliver or teach various aspects of content, subject matter, skills, and values that students are expected to experience, acquire, or learn; and (6) out comes of transaction.

Thus, curriculum design is the actual arrangement of elements of the curriculum and meant for the nature and manner in which they are organized in the curriculum plane comprises. Where as Pratt (1980) used curriculum design and curriculum development interchangeably, Ornstein and Hunkins (2004, p.235) used 'design' and 'organization' equivalently. Pratt agreed that curriculum design is a deliberate processes of devising, planning, and selecting the strategies, techniques, and procedures that constitute same other object.

It is one concern for patterning internal boundary of the curriculum. The concern curriculum design could take different forms vary as the weight given to sources and curriculum components vary.

If the curriculum design is viewed in term of organization, the dimensions could be scope (breadth or depth), sequence, continuity, integration, articulation and balance. If the curriculum is viewed in terms of planning or development, one must be identified with objective or process model of curriculum development.

Elliot (1998), quoted by Derebssa (2004, p. 135-137), presented the objective model in the specification of educational aims followed by content and learning tasks related to it, could then be rationally selected and organized eliciting criterion- referenced test. On the other hand, intrinsically worthwhile content, representing a particular form of knowledge, be selected regardless of organization and matching of contents and learning experiences in process model. Principles and procedures are specified instead of anticipating outcomes (Sali-Bao, 1989).

According to Stenhouse (1975), it is quite possible to evolve principles for the selection of content in the curriculum in terms of criteria which are not dependent on the existence of specific objectives. A process model is characterized by specifying what the teacher is

to do and the concept to be dealt with. Solomon (2007) had suggested as it could be possible for Ethiopian curriculum to adapt the process model. However, either the teacher must to be an expert or he/she must be a learner along with his/her students (Stenhouse, 1975). He/ She must be pedagogically enriched with a lot of experiences of teaching.

2.2.1 Aims, Goals, and Objectives

A Mathematics curriculum is featured by the statement of intentions for the function of providing shape and directions to more specific actions. The philosophical disposition towards educational functioning to serve as a starting point or as a statement of ideas or aspiration of views is about educational aim (Shiundu & Omulando, 1992). 'Aims are broadly phrased in statements and apply to systems rather than individual schools' (Marsh, 1992:85). This is the case when the schools have their own unique curriculum. In Ethiopian context, there is centrally developed curriculum where Mathematics curriculum is one constituent. In most countries, syllabus documents are prepared centrally for the respective schools (Bishop, 1996).

Doll (in Ornstein & Hunkins, 2004:274) and Shiundu & Omulando (1992, p. 44) noted that educational aims should 'address the intellectual or cognitive, the social-personal or affective and productive dimensions'. Intellectual dimension is about the acquisition and comprehension of knowledge, problem solving, and various levels and methods of thinking. Production dimension are concerned with aspects of education that allow the individual to function in the home or job. Aesthetic deals with values and appreciations of the arts. These complementary dimensions could fall under the usual cognitive, affective, or psychomotor domains.

More precise statements of a curriculum intent which gives details of intent and are directed to student achievement are educational goals (Marsh, 1992). When speaking of

goals, we are addressing curriculum goals or desire outcomes for as a result of experiencing the curriculum. Goals are actualized and justified by objectives which implemented and given direction by instructional events and learning outcomes. Learning outcomes that all students must attain to demonstrate learning success are related to standards or competencies.

From Ornstein & Hunkins (2004), Swell's question: What destination do you have in mind for learners as far as a particular curriculum or subject is concerned? (p. 276) and Ornstein's use of program objectives to the level for addressing subjects at a particular grade level (p. 280) are regarded here. *Objectives of Mathematics learning* is used in the current grades 9 and 10 Mathematics syllabus to refer goals (Mathematics Panel (a), 2004)

Of course, the distinction between general objectives and goals is not explicit. Some times general objectives are categorized as non-behavioral objectives in which learning can occur that does not result in obvert, measurable behavior. If general objectives are as broad as goals, the specific ones are equivalent to classroom objectives. Whatever the name given to the different generality levels of intents of the curriculum, the order is aim-goals-general objectives-specific objectives.

■ Guidelines for formulating Educational Objectives

In the process of formulating and stating objectives that could properly guide and direct the ensuing task, proposing tentative ones is the first step. According to McNeil (1985), quoted by Feleke (1990, p. 46), the proposed objectives, before they take their final form, 'must be carefully screened and validated in view of their congruency with values and functions, comprehensiveness, consistency, attainability and feasibility'. In order to choose among objectives, the curriculum worker requires criteria that are understood and

used alike by every one involved in the curriculum construction. Balsara (2006, p.12-13) described that “the sound objectives must be related not only to criteria of human needs, social adequacy; and democratic ideas but also to one another”.

Ornstein and Hunkins (2004, p. 284-285) recognized the factors to be: matching, worth, wording, appropriateness, logical grouping, periodic revision, and legality. Matching refers to the consistency between objectives and goals, where as worth is value to students. Another factor requiring explanation is logical grouping. Objectives should be grouped so as to make sense when units of instruction and evaluation are being determined. Legality is about in harmony with the legal demands made by authorities.

■ Taxonomy of Objectives

The classification of objectives is important to preserve the balance of variables (constituents) in the curriculum and to deduce fair selection and organization of contents, learning experiences, and teaching methods. An assessment scheme cannot be prepared in isolation. Such a taxonomy is to help stimulate the teacher in to asking different sorts of questions and to review assessment tasks.

We can classify learning objectives in to three general objectives by identifying the nature of learning and mental process. Sax, cited by Alemayehu (2001, p.21), noted that it does not mean (imply) that they are completely independent of each other. Alemayehu (2001) added that analyzing and categorizing educational objectives helps to identify and measure the relative emphasis given to each of the domains and there by to observe if reasonable balance among them is achieved. Therefore, the taxonomy of educational objectives influences on curriculum development and teaching methods.

The cognitive domain:- Bloom's taxonomy or classification had a definite influence on curriculum development and teaching methods for it emphasized process rather than content matter and helped determine a proper balance between lower and higher processes (Ornstein & Hunkins, 2004: 285). This domain is about involving thought processes.

Bloom produced list of objectives from simple to complex with the underlying principle that objectives at any one level built up on objectives at lower levels (Parkinson, 1994:201). It comprises six levels knowledge, comprehension, application, analysis, synthesis, and evaluation. (Refer to the Appendix 1).

The affective domain:- Krathwohl's taxonomy is the work of Krathwohl and his associates where by the organizing elements are receiving, responding, valuing, organizing, and characterization (*ibid*). (Refer to the Appendix 1). This domain is about involving attitudes to a task.

The Psychomotor domain:- Simpson's taxonomy is divided in to seven main categories: perception, set (readiness), guided response, mechanism, complex overt response, and adapting and originating (*ibid*). (Refer to the Appendix 1). This domain is about involving co-ordination of the Brain and the muscular activities.

The levels in the three domains are hierarchical and cumulative. That means the levels increase in difficulty and sophistication; each level builds on and subsumes the one below. They can also be classified as lower, middle and higher level categories. Alemayehu (2001) noted that Knowledge and Comprehension from Cognitive domain; Receiving and Responding from Affective domain; and Perception, Set, and Guided response from the psychomotor domain are lower levels. On the other hand, Application from Cognitive domain; Valuing from Affective domain; and Mechanism from

Psychomotor domain are categorized as middle levels. Analysis, Synthesis, and Evaluation of Cognitive objectives; Organization and characterization of Affective objectives; and Complex response, Adaptation and Origination of Psychomotor objectives are all higher order leaning intentions.

2.2.2 Content Selection and Organization

One of the most difficult tasks of curriculum building (construction) is the selection of the subject matter [content] appropriate to the objectives formulated (Balsara, 2006). Change in objectives requires change in content. 'The wisest selection of the subject matter will result from approaching from the problem from the broad principles concerned with the meaning and source of subject matter and the bases of its selection' (*ibid, p.40*).

A preference is made to use the term content than subject matter for this Thesis as the later is broader in scope to the extent of describing the field of studies such as Mathematics. Contents are defined as 'knowledge, skills and values to be learned' (Salia-Bao, 1989: 28). This definition seems confusing to essence of objectives themselves. The content of a curriculum refers to the compendium of information related to facts, laws, theories, and generalizations.

In Mathematics alone, we have a lot of contents or knowledge or accumulated experiences to select from to add to our curriculum and to match with the intended objectives. Only a fraction of the total can be included in the curriculum.

Vashisht (2007) raised the following questions as fundamental.

- Is the content significant to an organized field of knowledge?
- Does the content stand the test of survival?
- Is the content useful?
- Is the content interesting to the students?
- Does the content contribute to the social reconstruction?

Equivalently, Balsara (2006, P. 46) summarized the standards for selection of contents as: 'significant to an organized field of knowledge (if it is thought to be essential to the mastery of the field to which it belongs); stand the test of universal; useful; interesting to the learner; contribute to the growth and development of democratic society'.

Once the contents are selected, a question of how they are arranged and organized follows. According to Marsh (1992, p. 96), 'the methods of organization varies due to organizers' philosophy of education and epistemology'. The dimensions: scope, sequence, continuity, integration, and balance of contents shape the curriculum design.

Scope refers to breadth and depth of contents as well as the varieties and types of educational experiences that are created to engage students in their learning. Sequencing of contents can be addressed by fairly well accepted learning principles: simple to complex, prerequisite learning; whole to part learning; and chronological learning. Continuity deals with the vertical manipulation or repetition of contents. Integration refers to the linkage of all types of knowledge and experiences in the curriculum plan (Ornstein & Hunkins, 2004:242). Marsh (1992, p. 96-97) condensed all the dimensions by two: scope and sequence. And evident as:

> *"Scope refers to the extent and arrangement of curriculum elements that occur across subjects while sequence refers to the organization over a period of time. Approaches to scope or horizontal organization can be by subjects (taught separately); by activity; by core (on the basis of social problems); by correlation (elements from various subjects are interrelated)".*

Perhaps Marsh's discussion could suit to the total curriculum in one, in the Ethiopian context.

2.2.3 Learning Activities and Experiences

If the essence of learning mathematics is the capacity to handle abstract symbols and a system of ideas, learning experiences in mathematics need to be designed to develop this capacity (Taba, 1962). To learn mathematics, students must be engaged in exploring, conjecturing and thinking rather than only in rote learning of rules and procedures. When students construct personal knowledge derived from meaningful experiences, they are much more likely to retain and use what they have learnt (NCTM, 1989, quoted in Assefa, 2005: 6).

Learning experiences are specific kinds of activities by which the content [of mathematics] is learned and as such they are reflected in learners' response- actions and reactions (Feleke, 1990). Learning activity, learning opportunity and learning experience are some times used interchangeably. But, I feel, the later is inclusive of the other two. Opportunity denotes the access to mathematics learning and knowledge; activity refers to the student's involvement; and an experience is about what is gained and practiced.

Hence, learning experience is the interaction between the learner and the conditions with which he/she can react. Salia-Bao (1989, p.27) illustrated it as "the method used to help children learn". Learning is most effective when the learner is actively involved in the learning situation. Shiundu & Omulando (1989) viewed that student's past experiences, attitudes and values; a threat-free atmosphere; and recognition of the purposes of the learner leads to an effective learning situation.

McNeil (1996) has reused the five Tyler's criteria to substantiate his discussion of 'developing and selecting of learning opportunities' as: appropriate practice, satisfaction, success, multiple approaches, and multiple out comes. Appropriate practice if the objective of learning is to develop the skill of problem solving. Activities that offer continuous challenge, social approval, the meeting of physical needs and success itself contributes to students' satisfaction (*ibid*).

A wise way of selecting learning experiences should be accompanied by organization. According to McNeil (1996), the organization can be by two devices: organizing centers and organizing elements. Organizing centers may consist of themes, topics, problems, questions, and projects by their appeal to students. Organizing elements are threads among the centers. Themes and concepts, generalizations, skills and values are organizing elements.

2.2.4 Instructional Methods

Pedagogical knowledge of Mathematics includes "knowledge of approaches to topics within mathematics, different ways of presenting the mathematics, and knowledge of students' strategies and errors" (Haggarty, 1995:9-10). Teaching methods are the means by which the teacher attempts to bring about the desired learning and uses teaching techniques, subject matter, teaching tools, and teaching materials to meet the objectives (Assefa, 2005).

Though there are, and there should be, various teaching methods for mathematics, the two broad categories are teacher centered and student centered approaches. Any type of teaching method could share, at least slightly, some thing common with either and falls under one. The traditional approach may go with the teacher centered where as the

modern approach talks about the active learning and learner centered teaching to ensure learners involvement in the construction and production of knowledge.

There can be many complementary methods under each approach. For instance, lecture and demonstration methods are labeled under the first; discovery, indirect learning, inquiry, problem solving, cooperative learning, and discussion methods are on the other facet of the instructional methods.

The lecture method is one-way flow of ideas; the speaker (teacher) gives ideas and the listeners (students) take them. 'It is relatively passive to explore, to think or interact, to study in depth, for differing responses among students' (Assefa, 2005:23). There are times when most effective and efficient way to teach students for the teacher to present information, skills or concepts in a direct instruction, which is particularly effective for teaching procedural skills (Tamrie in Daniel, 2002: 279-280).

Demonstration, a practical display or exhibition of a process, serves to show or point out clearly the fundamental principles or actions involved. Teaching mathematics consists of reflective presenting and rhetorical presenting (Schoenfeld, 1998: 24). However, Meira in Schoenfeld (1998, p. 16-26) argued that students are mathematicians, engaged in the practice of mathematical sense making, at their own level. They do mathematics, with the same logic of engagement and involvement.

Learning is more meaningful, more thorough and therefore more usable when pupil seeks out and discovers knowledge rather than just being a receiver of knowledge (Lemma, 2006:23). In discovery teaching-learning method students are expected to draw conclusions and generalizations from some form of induction, observation or application of principles. Lemma attempted to convince discovery learning as more satisfying and a potent for the student than any other method. According to Lemma's review on the

concept, inductive methods of teaching and inductive reasoning are inputs to the discovery method.

A revolution is taking place by constructivist theories of learning (Tamrie in Daniel et al, 2002: 283). The idea is the learners must be individually discover and transform complex information if they make it their own. The instructional strategy is student centered instruction. The characteristics of the instruction are: learner at the center of learning process: and teaching for understanding.

Problem solving method of teaching is one of the most important techniques that are used in student centered approach. To apply the method in the mathematics curriculum, specifically in the teacher's guide and/ or students' text book, students must be questioned to persist in their work, and report how they solved the problem. A strategy should be planned to lead teachers to assist students to achieve at. 'The process of solving problems based on evidence, based on facts, based on observation is inquiry' (ibid).

To consume inquiry, problem solving, or discovery methods in structuring the curriculum needs a neat understanding of each for the developer. They seem overlapping. By way of suit for higher order and critical thinking, inquiry method took the lead. The ultimate goal in this method is beyond understanding, generalizing and concluding the content under study.

2.2.5 Assessment and Evaluation Mechanisms

At many points during the instructional process, teachers make decisions about how well their students are learning and how effective their instruction has been. Assessment should be an integral part of teaching and learning; it should be planned in the designing

of curriculum. With out it, we could not be able to determine what the pupils had leaned and would have no clear indication of the effectiveness of teaching.

As to Parkinson (1994, p. 198), assessment should fulfill four mains.

- *It should assist and support pupils in the learning of Mathematics*
- *It should assist in identifying strengths and weaknesses*
- *It should assist Mathematics teachers in evaluating their teaching and learning*
- *It should provide information about progress and achievement of individual pupils for themselves, parents and a range of other people.*

Thus, students' achievement or attainment of the curriculum objectives is always determined after information is collected. The way could be formal (by home works, test, and written reports) or informal (observation and verbal exchange). It should be incorporated in the curriculum development phase.

2.2.6 'The Marks of a Good Curriculum (Plan)'

Defining 'good curriculum' and listing the features of the quality curriculum are difficult tasks. Roughly or by developing rating device, people nearer to the curriculum judge its quality. A 'good' curriculum to some might not induce others. According to Saylor, Alexander and Lewis (1981), there are many questions that need affirmative actions or answers. The largest parts of them are used below.

a) Are the goals sufficiently comprehensive, balanced, and realistic? Is there provision for modifying, dropping and adding goals as need?
b) Do the learning opportunities anticipate a progression… to independent self-directed learning in accordance with the level of learners…? Are all appropriate and feasible types of learning experiences utilized? Do the learning opportunities

seem to be the best possible choice for the learners to achieve the goals set to them?

c) Do learners and teachers [agree] mutually understand the specific plans… which affect them?
d) Does the curriculum provide appropriate leaning engagements in each of the four domains: personal development, social competence, continued learning skills, and specialization?
e) Are any plans developed externally, adapted to the population and facilities of the educational center? Are the provisions made for individual differences of learners?
f) Is the total curriculum plan comprehensive? Does it anticipate instruction and evaluation as well as include goals and designs of learning opportunities?
g) Are the responsible planning groups representative of all persons concerned, including learners, parents, and general public and professional staff?
h) Does the plan have adequate provision of feedback from concerned groups…?
i) Can the plan and each of its parts be explained sufficiently clearly…to be understood?
j) Is flexibility built in to the curriculum plan by adequate provisions for alternative learning opportunities, in structural modes, and learner and teacher options in general?

To come close to specific mathematics, principles that govern curriculum in mathematics are found in Kumar and Ratnalikar (2003).

- ☛ We have to be guided by the utilitarian aspect of mathematics

- For a topic to deserve a place in the curriculum, it must be useful in some other way besides its disciplinary value. Real useful problems train the mind better than unreal formal problems
- Principle of cultural value and community centeredness
- It should train students for life and it should also prepare them for further higher education
- The curriculum is for the child [youth] and the child is not for the curriculum
- The developments in the subject necessitate a change in the curriculum. The curriculum has to be modified and reviewed quite frequently so as to shape it accordingly.
- While framing or revising a curriculum, the views of teachers, who are the real workers, should be sought

Kumar and Ratnalikar are subjective in giving such principles. For instance, the principle that orders to be guided by Utilitarian aspect of mathematics, favors the Essentialists' educational philosophy. Besides, the principle that informs the curriculum as for the child, advocates the child-centered curriculum.

2.3 Reform and Change in Mathematics Curriculum

Scientists who interpret the change process have found it useful to look at five kinds of change (McNeil, 1996). These are: substitution, alteration, perturbations, restructuring changes, and value orientation changes. Substitution is made on one or very few elements of the curriculum. Alteration occurs when a change is introduced in to already existing materials. Perturbations are disruptive to teachers in schedule for teaching. Restructuring changes lead to modification of the system it self. Value orientation changes are shifts in the fundamental value orientation of participants (ibid).

McNeil reviewed these typologies from the perspective of curriculum at departmental level or curriculum at a particular (individual) school level. Substitution, for example, is about improvement, reform amendment on some part of the curriculum in to a modified one. Reforms happened to occur easily and more frequently than changes. If some part of the curriculum is improved, a reform is hold with logical grounds.

2.4 Evaluation of Mathematics Curriculum

Ornstein & Hunkins (2004, p. 332), by quoting Harriet Talmage, posed five types of questions that educators could consider that are pertinent to evaluating curricula. The following table portrayed the questions succinctly.

Table 2.1**:-** Talmage's Questions for curriculum Evaluation

No.	Question	Target features
1	The question of Intrinsic Value	- addresses the goodness and appropriateness of a curriculum -Deals with the curriculum as it is planned & also with the finished curriculum as it is delivered for appropriateness
2	The question of Instrumental value	-Posits: who are the beneficial? Who are its intended audiences? -To link up the curriculum planned with the goals and objectives stated for the program - Deals with the level of attainment of standards or educational policy
3	The question of Comparative Value	-Comparisons between the new curriculum with different curricula in terms of ease of delivery, role, responsiveness to expectations,
4	The question of Idealization Value	- On how the curriculum is working and asking if alternative ways to make the curriculum better. -Requires continued action through out the delivery of the new curriculum to heighten student's achievement
5	The question of Decision Value	-To decide whether to retain, modify, or discard the new curriculum based on evidence addressed by the previous questions

After Ornstein & Hunkins *(2004, p. 332-334)*

The appropriateness of the curriculum in the intrinsic value facet can be reflected by the worth of goals and objectives, appropriateness of contents selected, types of learning

activities or learning experiences organized. It would ask whether the curriculum incorporates the best thinking on the presentation of contents. It would ask whether specialists in mathematics and education give the curriculum planned 'high marks'. The comparative value can be ensured by making the new curriculum compared and contrasted with the preceding ones (changed or reformed out) or other curricula. The instrumental value regards the curriculum with the very existence of the subject at that level.

The questions presented in the table above suggested that evaluation is a process by which data are gathered in order to make decisions.

Chapter Three: Research Design and methodology

Since the aim of the study is to analyze the current mathematics curriculum, the document analysis and interview analysis were employed. This research is mainly a content analysis research. For the purpose of triangulation, interview was conducted.

3.1 The Research Design

The usual approaches to a research are qualitative and quantitative. "Debates about superiority or inferiority of qualitative and/ or quantitative research approaches have been common academic practices" (Solomon Areaya, 2004:1). Since my theme requires determining of the merit, worth and value of the curriculum per se, adhering on the later does not enable to answer the research questions. But, it is not be obsolete. For instance, I quantified the number of occurrences in coding; the reliability index with which I agreed up on calls for number.

Some qualitative research includes limited quantification as Best & Kahn (1999) noted. Such a structure is *Mixed Method Research* approach with emphasis on qualitative approaches. Temechegn (2008) has placed it as one of two types of 'Mixed Researches' in which the other is mixed model research. The difference is that quantitative and qualitative approaches are mixed within or across the stages of the research process in the mixed model research. On the other hand, a qualitative phase and a quantitative phase are included in the overall research study in the mixed methods research. Cleswell & Plano Clarck (2007) used the name 'Mixed Methods Research' for any research type that consumes quantitative and qualitative.

Since the research questions to be answered are qualitative and quantitative in their nature, collecting qualitative data and performing qualitative analysis as well as quantitative analysis characterizes my research. The mixed methods research helps to answer questions that can not be answered by qualitative or quantitative approaches alone

(Cleswell & Plano Clarck, 2007). With regard to its practicality, Cleswell and Plano Clarck viewed the researcher as free to use all possible to address a research problem; to solve problems using numbers and words; to use inductive and deductive thinking; and to employ skills in observing people and recording behaviors.

The use of quantitative and qualitative approaches in combination provides a better understanding of research problems than either approach alone (ibid, 2007). The approach provides strengths that offset the weaknesses of both quantitative and qualitative researches; it provides more comprehensive evidence for studying a research problem than either of the two.

The leading questions of this research: '*How were the current grades 9 and 10 Mathematics Curriculum of Ethiopia developed?'* and *'How are the objectives stated in the current Ethiopian General Secondary School Mathematics Curriculum?'* take qualitative nature. The rest two: *'Are the Ethiopian General Secondary School Mathematics Curriculum objectives and methods in harmony with each other, and with education policy?'* and *'What are the comparative strengths and weaknesses of the current Ethiopian General Secondary Schools Mathematics Curriculum with national and international experiences?'* are of quantitative nature. The data collection techniques: coding and transcribing the interview are quantitative and qualitative methods, respectively. The analysis methods: percentage and narration are quantitative and qualitative methods, respectively. Therefore, my research is processed by mixed methods research approach.

3.2 Data Collection Strategies

Data sources:-The Education and Training Policy (ETP), present and past curriculum materials, grades 9 and 10 Mathematics teachers, pertinent official documents, experts in

the ICDR, international published articles/books are the sources. Much reliance is due on grades 9-10 Mathematics syllabus as it 'represents the curriculum in Ethiopian context' (Alemayehu, 2001:50; Ambaye, 1999).

Instruments

The prominent instrument used was *coding sheet* as it could be suitable for data organization, analysis and conclusion from documents. Hand writing was used to transcribe the interview. Interviewing mathematics teachers was to seek their opinion to the best of their information they have on students' experience and to the knowledge of secondary schools context. Experts were targeted to seek information on the process underwent in designing the curriculum.

Coders and Coding Procedures

I spent much time thinking on who would best code the curriculum materials. I thought high school mathematics teachers; I thought undergraduate senior students of mathematics education of AAU. In due course, first year graduate Mathematics Education students of AAU were found experienced with similar assignment. At the same time, I had no trouble to communicate with most of them. They have been teaching mathematics in secondary schools before they came here at AAU. Ultimately, I selected five who were performing best in their group and those could work together with me. One was reserved to contribute to the evaluation of the pilot study. The rest four were grouped in to two by considering their intimacy and keeping the balance between the groups. A second year graduate student and I were also participated in coding task.

For the process of coding, constructing the categories and coding units or conceptual schemes were developed. Once the classification cues were produced, coding sheets were

prepared. Before the actual work, discussions were made with coders. A ready made print out guide was developed and delivered for each.

Unit Two of grade nine mathematics syllabus was selected randomly to see how the coding sheets would be functional. In the pilot study, I found that there was a high level of inter-coder disagreement in some of the themes. I realized that the coders faced poor operational definitions, categories and insufficient training.

In categorizing educational objectives, it was missed out that the same indicator (key) word (action verb) could refer to different hierarchies of levels of objectives when the total sentence of an objective statement is loosely regarded. It was realized in the trial out work. There were educational statements with different action verb (from the lists given in Appendix 1) to judge of. There were coding sheets with vague instructions. The model I used for classifying Psychomotor Domain in to levels was rather a different one to my coders. Further more, they had proposed Harrow's model to apply. However, Harrow's model was confined to five levels of psychomotor domain. Instead, Simpson's taxonomy is more illustrated with seven hierarchies. On the top of that, it was adapted by Alemayehu (2001). The agreement and disagreement passed on the instructional methods was fifty-fifty (half). It was not attributed to the groups. Somewhat teaching techniques and strategies were encountered along with major teaching methods.

Actual coding was done in two phases after all such shortcomings have been corrected. Phase I: the four coders were engaged for the task from March 12, 2009 through March 20, 2009. I gave them five randomly selected Units from grades 9 and 10 Mathematics Syllabus. Phase II: When sampling of the Units was found unsound, I dealt with one classmate of mine who was waiting for feedback of first draft of his Thesis. Accordingly, from June 04/ 2009 through June 08/ 2009, we independently coded the rest nine Units. Finally, the inter-coder agreement was calculated.

Percentage inter-coder agreement was used as it is easy to calculate on hand. Before applying the index, I developed a rule on how to give points on agreements and disagreements. The two groups of coders were given the same alternatives to rate with. (Refer Appendix 5).

Interviewees and Interviewing Procedures

Selection of most of the teachers is by convenience. Most experienced teachers of Addis Ababa secondary schools have visited at least heard about, different secondary schools of the country by being chief coordinator of the National Examinations in different years. I deemed that they have better awareness of the school context and global development. Besides, the analysis of documents compelled me to devote on materials collection, organization, and interpretation with much time. Interviewing demands enough time, repetitive appointments and close contact, in turn.

Table 3.1 Selection of Interviewees

Area	**Focal Division**	**Interviewee(Respondent)**
Arada sub-city (A.A) *(Nearest)*	Kelemework sec. school *(suggested by Supervisor)*	Two Senior Math. teachers *(volunteers)*
Yeka sub-city (A.A) *(Nearest)*	Kokebe Atsibeha sec. school *(eldest school)*	Two Math. teachers *(accidentally) chosen by the vice director)*
Lideta sub-city (A.A) *(when getting more volunteers was difficult)*	Dej. Balcha Aba Nefso Sec School *(elder secondary Sch.)*	Two Senior Math. teachers *(teacher educators)*
Dejen Woreda, Amhara Region *(accidentally)*	Gojjamber Sec School *(elder Secondary Sch.)*	One Senior Math. Teacher *(experienced)*
International Schools	Sandford International Sch.	Two Math. Teachers
	ICS	One Math. teacher
Institute of Curriculum Development & Research	Academic Subjects Evaluation & Research	One out of two Senior expert *(accidentally)*
	Mathematics Panel	Two out of Three Senior experts (*Experienced*)
	Total	13

At the beginning, I thought that only well experienced teachers could be conveniently selected. But, I found it impractical. So, flexibility was exercised. The criterion used is marked in the bracket following the subjects in Table 3.1 above.

The interviews were conducted from March 21, 2009 through April 04, 2009 and on June 09, 2009 (one expert). The back ground of two Experts who participated in my interview was teaching Secondary School Mathematics. Another Expert of Academic Subjects Evaluation & Research has taught Secondary School English language in Ethiopia. One teacher interviewee has thirty years of experience in teaching; another one has twelve years experience in teaching Mathematics; and three teachers were found having nine years of teaching Mathematics. By the stages of the teachers' Career Structure, all belong to 'senior teacher' provided that Efficiencies are fair. Differently, I took two teachers with two and three Mathematics teaching experiences. This was because they were mathematics educators (they held B. Ed Degree in Mathematics) with academic and professional orientations; they have a notion on how curriculum could be developed and organized.

With regard to interviewing, I used 'hand writing' as a mechanism to transcribe their speech. Soon after the interview ceased, I used to organize the jotted down points with my fullest concentration. Prior to the time my attention has got diverted; I could memorize efficiently what we talked. What if the electronic media had been used? The informants would nurse their words they would spoke out. From the out set, unfortunately, on my first trial to one interviewee to fix the time conducive to him, he requested me if I brought media-to-record so that he would be ready accordingly. On the other hand, I used no media to hear while the first interviewee was speaking; I found insightful information. I understood that the real truths are found under the natural settings. Some of the interviews were conducted in the Lounges and Cafeterias. I was

happy on all the cases. Finally, pseudo-names were used to keep the ethics of the research.

Selection of International Schools

With out comparison, it would be difficult to see, to learn and appreciate the special characteristics of ones own. And comparison can not be based on absolute similarity. Identifying common elements or themes enable us to do the comparison. Good experiences are sought if available in other curricula.

A combination of accessibility and purposive sampling methods is applied to select other countries' curriculum. ICS and Sandford international schools are found in Addis Ababa, Ethiopia. They have been the only international schools, in Ethiopia for many decades. Mainly, they adapt the educational systems of America [USA] and United Kingdom. (Refer to Appendices 4 & 5 for detail). The two countries influenced the history of our curriculum. (Refer to section 4.1).

3.3 Analytical and Interpretive Strategies

Data obtained by coding sheet for comparative study of different mathematics curriculums were processed by developing a comparative unit of analysis and explanation building.

Table 3.2 Models used in the document analysis

No	Theme of coding sheet	Model for categorizing	Remark

1	Taxonomy of objectives	Bloom *et al*	Adopted from Alemayehu (2001)
2	Hierarchy of cognitive domain	Bloom *et al*	
3	Hierarchy of affective domain	Krathwohl *et al*	
4	Hierarchy of psychomotor domain	Simpson	

Educational objectives were seen from different dimensions by different educators. Bloom's taxonomy of objectives was the initial and springboard work for the success of others. Although these models have limitation to fit to implement in the objectives analysis of our Mathematics Syllabus, they are better to be detailed. (Refer Appendix 1).

A narrative way of explaining the historical development of Ethiopian General Secondary Schools mathematics curriculum by looking all accessible pertinent data and interviewing is tempted. A direct interpretation of participants' words i.e., the meaning they talked would have a paramount value in this course of analysis. A narrative analysis method has been employed. Tick description for organizational and harmony issues discussion was made.

I had developed the following model for my document analysis prior to the action.

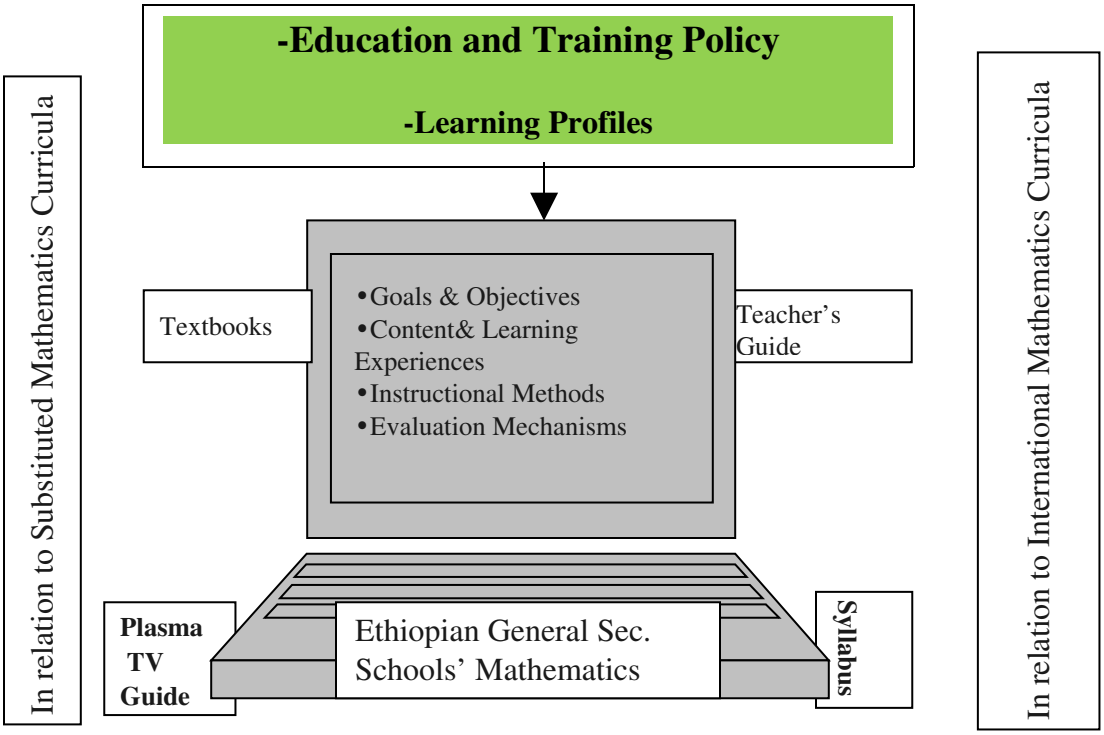




Fig. 3.1 Evaluation of the Documents of Mathematics Curriculum Model

The 'Desk Top' structure is shown in the focal point; the position of other elements has meaning. The idea is elucidated as under.

1) On the Key Board: the Ethiopian General Secondary School Mathematics Curriculum is to be touched and evaluated for this study.
2) On the Display: When I began to study, the curriculum would be seen (reflected) by the constituents (goals & objectives, contents & learning experiences, Instructional Methods, and Evaluation Mechanisms). The questions were: How do they appear? How are the objectives formulated? (The second and third research questions of this study). The intrinsic value of the curriculum would be evaluated. (Refer Chapter Two and Glossary).
3) On the Edges: the supporting blocks were the curriculum materials. The curriculum was concreted and delivered via these materials; they were my data sources. The question was: Do they carry an appropriate and valid curriculum? It is immediate that the type of research is mainly document analysis.
4) On the Top: the Education and Training policy (ETP) and the learning profiles were sources to drive the curriculum. The question was: Do the curriculum match with the

leading ETP and learning profiles? How was the curriculum developed? (The first research question of this study). The instrumental value of the curriculum would be evaluated. (Refer Table 2.1).

5) On the Left Side: the left out Mathematics Curriculums could influence and contributed to the emergence of the current curriculum. There are thoughts that reflect the left out Ethiopian curriculums are recharged again. (Refer Chapter One).The question is: How is the link between the previous and the current curriculums? (The fourth research question of this study). So, the comparative value of the curriculum would be evaluated.
6) On the Right Side: A curriculum is developed by looking at other Nations' Curriculum as well. There exist other Curricula which we think right to follow. The question is: How is the link…? (The fourth research question of this study).

In conclusion, the topic, the research questions, the methods and strategies of the research were all summarized in the model.

Chapter Four: Analysis and Discussion

4.1 The Development of Mathematics Curriculum

The implementation of secondary level curriculum started in the year 1999/2000 beginning from grade nine. According to the curriculum evaluation panel (2004), changing the curriculum was to increase the relevance of education to communities and improving the quality of education were among the major areas of the reform.

To put the background information on the history of mathematics education in Ethiopia and mathematics curriculum development endeavors, I present the following two interview scripts one after the other.

> *"Around the beginning of mathematics education, in Ethiopia, the British 'high way mathematics' was published in the form of Arithmetic 1, 2, 3…in Great Britain and implemented in few schools of Ethiopia. After then, there was a shift to 'Entebee Mathematics series' which published in Uganda. Directly, books from Uganda were imported to Ethiopia. It was America [USA] that took the initiation. Latter on, a contextualized 'Modern Mathematics for Ethiopia' series had been practiced."(Tesfaye Ayele, 24/04/2009).*

To seek full-orientation on the matter, the next script is helpful as well.

> *"…I think Entebee is a place found in Uganda where curriculum materials were prepared…most of the curriculum materials were prepared in Kenya and Uganda under 'Entebee Series', America's initiative of curriculum development for East African countries including Ethiopia. In 1960s, Mathematics panel was launched as one section in this house [ICDR]. The panel began to adapt the Entebee text books by changing examples, names and contexts in the textbooks in to Ethiopian condition; these elements were driven and reflecting Kenya's and Uganda's contexts. …I don't think that there were syllabi in those times. …I learned through the adapted Entebee System. But, the contents of the original Entebee textbooks and the adapted ones were the same. Together with the Curriculum Evaluation and Research Coordination, the panel members had tried to developed syllabus and Curriculum Guides, in 1975E.C [1983], for instance. ….The Mathematics Panel, before it ceased to survive around three years ago, had five members which I was the head. Following the 'BPR' [a similar change like today's Business Processing Re-Engineering] made on that time, the rest four members were assigned to other positions. Now, the number of senior experts like me is increased to three. In the mean time the institution [ICDR] itself has lost its autonomy; it has been self administering organization. Now, it is turned back to its first status at department level under the leadership of the Ministry of Education. " (Tesfaye Ayele, 09/06/09)*

From the above two scripts, it can be inferred that the curriculum development had been changing from total adoption (High Way Mathematics and Entebee Mathematics Series) to adaptation (Modern Mathematics for Ethiopia). For a long period of time, textbook-based instruction featured the curriculum implementation aspect. At present, Curriculum development is the mandate of ICDR under the leadership of Ministry of Education

(MoE). Mathematics Panel, Curriculum evaluation panel, Physics panel and the like were the different sections of ICDR until 2005. At present, the mathematics panel is blocked. Instead, senior experts are appointed for each academic subject. The phase-out mathematics curriculum had tried by its initiative as well as together with the former curriculum evaluation coordination to research out on the substituted Mathematics curriculum.

4.1.1 The Harmony among the Policy Aims, Learning Profiles and the Mathematics Learning Objectives

The emergence of the current ETP) was in 1994. One of the aims of EPRDF when came in to power was to change the ETP (Solomon, 2007). Change of the curriculum and preparation of educational materials accordingly were the special attentions of the education and training policy (TGE, 1994).

Table 4.1: The Harmony among the Policy Aims, Learning Profiles and Goals in the Mathematics Learning

Aims of ETP	*Learning Profiles in Grades 9-10*	*Grades 9 & 10 Mathematics Learning Goals*
1)Develop the physical and mental potential and the problem solving capacity of individuals by expanding education and in particular by providing education for all (Aim 1) *2)Bring up citizens who can take care of and utilize resources*	*1)They can work in areas that do not require special skills of training as they are matured mentally and physically (profile 1)* *2)They are ready for the advanced vocational training owing to their acquisition of general knowledge in which theory is linked with practice*	*1)Appreciate the power, elegance and structure of mathematics (Goal 1)* *2)Use mathematics in environment and social needs (Goal 2)* *3)Understand the essential*

wisely, who are trained in various skills, by raising the private and social benefits of education (Aim 2) *3)Bring up citizens who respect human rights, stand for the well-being of people, as well as for equality, justice and peace, endowed with democratic culture and discipline (Aim 3)* *4)Bring up citizens who differentiate harmful practices from useful ones, who seek and stand for truth, appreciate science and technology in society (Aim 4)* *5) Cultivate the cognitive, creative, productive & appreciative potential of citizens by appropriately relating education to environment (Aim 5). (TGE, 1994: 7-8)*	*(profile 2)* *3)They are conscious of their civic responsibilities and are ready to fight against social ills and mal practices (profile 3)* *4)They are ready for the on-the-job training (profile 4)* *5)They can actively participate in different activities such as social meetings, discussions community development activities (profile 5)* *6)They are ready to acquire practical and theoretical knowledge through continuing education (profile 6) (TGE, 1993:27; Curriculum Evaluation Panel, 2004:154)*	*contribution of mathematics to Engineering, Science, Economics, Agriculture, etc (Goal 3)* *4)Gain Mathematical knowledge and skills to enable them pursue with their further education or future vocational trainings (Goal 4)* *5)Gain satisfaction and enjoyment from learning and applying Mathematics (Goal 5)* *6) Develop their cognitive, creative and appreciative potential by relating mathematics with societal needs (Goal 6) (Mathematics Panel, 2004a:i)*

The elements of the aims are: cognitive, productive, creative and appreciative potentials, problem solving capacity, utilizing resources wisely, and training in various skills, standing for well-being of people, attitude for Science and Technology, and differentiating useful practices.

The elements of the learning profile are about: maturity in mentally and physically for work areas which do not require special skills of training, theory plus practice general knowledge acquisition for advanced vocational training, conscious for civic responsibilities and against mal practices, on-the-job training, participation in social activities, and continuing education for theoretical and practical knowledge acquisition.

These learning objectives comprise of: appreciative value, using mathematics in society and environment, application and integration of mathematics in other subjects, mathematics for further education and training, satisfaction and enjoyment, and cognitive and creative potentials.

The profiles are frame of reference to see how far students collectively advanced in their learning. Of course, these are not known by Mathematics teachers in all of the schools I have visited. In common sense, people, including subject teachers, set their own criterion to judge students' performance. The curriculum evaluation team has used them as one means to assess grades 9 and 10 curriculum in 2004. Moreover, "the grade level subject objectives are derived from them" (Tesfaye Ayele, 31/03/2009).

'Goal 1' (*Appreciate the power, elegance and structure of mathematics*) goes with appreciative potential elements of ETP. Indeed, appreciation might also indicate and could rise from the ability to master on the power, elegance and structure of mathematics. If so, it could contribute to 'profile 1' which states: *the student can work in areas that do not require special skills of training as they are mature mentally and physically.* 'Goal 2' corresponds with 'Aim 2', 'Profile 3' and 'Profile 5'. Thirdly, 'Goal 3' could add a significant aid to the policy intentions that sought *positive attitude to science and technology* and *on-the-job training* elements. Lastly, one purpose of mathematics learning: …*for further education and training*…well addresses 'Profile 2'. Equivalently, goals 5 and 6 are the sufficient conditions to many constituents of ETP aims and profile statements.

The policy aims are hoped to be realized via inclusive efforts of administering mathematics curriculum at different levels. A bit narrowly, learning profiles are outcomes expected at the end of the cycle from all students collectively having taken distinct subjects side by side. As far as mathematics curriculum is one building block, it

extensively considered the plans of the policy and the grade levels learning profiles. But, the extent to which it would be consistent is discussed in sections ahead. However, the mathematics learning (general) objectives ought to be reflected in the units of the syllabi.

4.1.2 Attempts to shape the current grades 9-10 Mathematics Curricula

The production of the first Mathematics Syllabus of grades 9 and 10, after the introduction of the current ETP in 1994, has come on in October, 1995. The implementation had begun in the academic year 1999/2000 for grade 9 and in 2000/01 for grade 10. Theoretically, in the mean time of Syllabus preparation and its implementation tasks such as curriculum materials production, induction to educators and subject teachers, and Trial Out could be exercised. To put insightful points on what was going on, the following interview script is essential.

> *"…There was no different syllabus developed between 1995 and 2005.The time gap was for the preparation of textbooks; textbooks and other curriculum materials like teacher's guide preparation should be given enough time bound. ….There was no pilot study; pilot study is not accustomed to Ethiopian context."(Tesfaye Ayele, 09/06/09).*

Another fact that does not go with logic is that the Mathematics Syllabuses of grade 9 and 10 were printed in 2001(after six years passed since its production and one year passed since its implementation). It could be argued that the Syllabuses were used as draft to prepare textbooks or teacher's guide. The current Mathematics Curriculum, under function/implementation, is the one that was reformed in 2005. When I went to ICDR (the place where the Curriculum /Syllabus development is processed), in 2007, I found only the soft copy of the Syllabuses; I was told that the hard copy was not yet printed.

The Ministry of Education (MoE) has admitted that the curriculum materials of grade 9-12 were not subject to trial (Solomon, 2007). Solomon added that the assumptions

behind is that teachers at this level had all the necessary qualification and expertise to adapt the innovation introduced, as well as be able to identify and rectify any defects in the curricula materials. Unless and other wise it was piloted in sampled schools, the curriculum could not be said sound from the out set.

The current Mathematics Curriculum, under function/implementation, is the one that was reformed in 2005. Tsegaye Ammenu (Academic Subjects Evaluation and Research Senior Expert, ICDR) told me, on 27/03/09, that there was a formative evaluation for three years followed by a summative evaluation for one year on how the 2001 curriculum was being implemented. He commented as well that there is nothing done since the introduction of today's working curriculum by notifying the gap created for the last five years is attributed to the fact that the institution (ICDR) was under organization and disorganization structurally.

Tesfaye Ayele (Senior Expert in ICDR) accounted me the following.

> *"We undertook a focus group discussion by taking sample students from different academic levels. We collected the idea of teachers from the fields we visited. In effect, we recognized irrelevant and inappropriate contents were incorporated in the syllabus."* (On 31/03/2009)

Now, one can realize that there was assessment conducted prior to the emergence of this working Syllabus. It should be, however, criticized that validating contents (relevance and appropriateness) ought to be done early during pilot study.

From the material, Curriculum Evaluation Panel (2004), the evaluation made on the former (2001) edition suggested 26 recommendations among which 25 are in relation to implementation process gaps. Only one was pin pointing a need of thorough revision to undertake. However, it is very hurried to deliver the new curriculum. The

recommendations were sent to Ministry of education (MoE) after March, 2004. It might also take a while until the higher officials, in MoE, endorse and allot budget for it. The next (current) curriculum guide (comprising of the syllabi) was published in May, 2004. We can also think how long it took to type the manuscript before. It is said that the syllabus has got a positive response from regions, as well. It would likely be happened in the mean of March and May. "A number of reforms today employ a complex methodology and are out of a long period of study and preparation; they have led to extensive consultations and the concern the educational system as a whole" (UNESCO, 1981:1). Therefore, it is difficult to take a position on the side that the time spent is enough.

The following is a comparison of the current (2005) with the former (2001) Grade 9 Mathematics Syllabus. General learning objectives of grade 9 and contents covered in an equal number of 36 weeks with in one academic year are presented. Among the common contents, "Set" appeared as a second Unit in the 2001 Syllabus and as first Unit in the 2005 syllabus. I considered it for extracting the Teaching Methods and Assessment Mechanisms so that I could easily delineate the differences made. Key terms entailing the idea are listed or narrated correspondingly.

Table 4.2: Comparison of 2001 and 2005 Grades 9 Mathematics Syllabi

Theme	2001	2005	Remark
Learning Objectives of Grade 9 Mathematics Education (Grade 9 Mathematics General Objectives)	developing a solid Mathematical general education Bringing about (with other subjects) an essential contribution towards the development of a citizen who is conscious of the social, economic, political and cultural realities of	Gain basic knowledge about sets to solve related practical problems. Understand the concepts of binary operations, their properties and apply them. Calculate with real numbers. Express mathematical statements & solve mathematical problems using variables. Develop basic knowledge about relations, functions, inverse relations and their graphs. Use their knowledge of functions to solve different	The description is given beneath the table

	Ethiopia. (ICDR, 2001: 1)	practical problems. Deal with quadratic functions and their basic properties. Gain basic knowledge about trigonometric functions, their graphs and their properties. develop the habit of reading Mathematical Literatures. Develop self confidence in solving mathematical problems independently. Appreciate the application of mathematics in other fields of studies. (Mathematics Panel, 2004a: i-ii)	
Contents	Introduction to Logic; Sets; Numeration Systems; Elementary concepts of Binary operations; Real Numbers; Linear Equations and Inequalities and Systems of Simultaneous Equations; Working with Variables; Quadratic Functions, equations, inequalities and power functions; Some theorems on congruence of Triangles & their proofs; Solid Geometry	Sets; Elementary Concepts on Binary Operations; Real Numbers; Working with Variables ; Linear Equations, Inequalities and Systems of Simultaneous Equations ; Quadratic Equations and Inequalities; Relations and Functions ; Quadratic Functions and Power Functions; Trigonometric Functions	
Teaching Methods	Key phrases: 'Discussing', 'Explaining', 'Solving', 'Defining', 'Strengthening', 'Introducing', 'Using', 'Illustrating', 'Clarifying', 'Checking'	Key phrases: 'Define', 'Giving', 'Help students to…', 'Assist students in…', 'Illustrate', 'Allow students to…', 'Give practical examples', 'Discuss', 'Facilitate group discussion', 'Ask students…'	from the same unit
Evaluation	Classroom activity, Homework, Quiz	'Ask students to illustrate…'; 'Give selected exercises problems'; 'Selected Class & Homework problems'; 'Give exercises on word problems'; 'Test'	-From the same Unit

As depicted in the table above, the objectives in the 2001 mathematics syllabus are too broad and do not presage what contents to select. The harmony between the objectives and the contents could not be determined in the 2001 syllabus. More over, they are not broken down in to specific objectives. The objectives are written explicitly in the 2005

syllabus. Furthermore, they are supported by Unit Objectives; each unit in the 2005 syllabus has its own Unit Objectives.

Among the other common contents included in both syllabuses, 'Set' appeared first in both. By regarding it, the following was obtained. In the 2001 syllabus, the student's role was not marked succinctly. It seems the 'Teacher Dominant' instructional approach was designed. On the contrary, teacher-student centered approach is reflected in the 2005 Syllabus. Teacher-student centered approach is half way in the Teacher centered- student centered continuum. It is characterized by the engagements of the teacher and the student in the instructional process. The evaluation mechanisms in 2001 syllabus were marked specifically. On the other hand, the detailed 2005 syllabus has different alternatives with regard to assessment techniques for the same unit. This would be suitable for beginner or for those teachers whose pedagogical knowledge is not excellent.

4.1.3 Mathematics Teachers' Participation

As I have pointed out in the preceding pages, it was reported that teachers are involved in rating the contents of the curriculum materials. The mathematics teachers who rated the 9th syllabus were counted as 61 up to 63. The number is reduced to 49 up to 51 for 10th syllabus. 100% and 95% of the criterions of the respective syllabi were fulfilled (Curriculum Evaluation Panel, 2004). A little input could be added from these raters to decide to reform the curriculum. On the other hand, two contract coders showed that the syllabi of 9th and 10th mathematics satisfied 46% and 62% respectively of the criterions set. As opposed to the first group, these teachers were given chances to comment on concepts that are not logically sequenced, teaching aids, teaching methods and assessment techniques (ibid).

> *…we had also invited representatives from regional curriculum experts…there is no ground to say the representation made was enough. Among the factors, the question of per-diem can be mentioned for their absenteeism after invited to come. They thought that they could not live with 70 birr per day in Addis Ababa (Tesfaye Ayele, on 31/03/2009)*

It can be inferred that few curriculum experts were participated in the formation of the syllabus. However, an affirmative action or answer whether the responsible planning groups are representative of all persons concerned including learners, parents, and general public and professional staff is required (Saylor, Alexander & Lewis, 1981). Tesfaye Ayele talked to me that the syllabus was sent to regions to get endorsed once the draft was developed in the ICDR.

> *No region refuted to endorse or reported for alternative idea on the constituents of the syllabus (on 31/03/2009).*

Now, we can conclude that mathematics teachers were not involved while they are the agents to pass it to the students. Among the other factors, adequate provision of feedback from concerned groups is one feature of a good curriculum (Saylor, Alexander & Lewis, 1981). If the curriculum is imposed on teachers, their perception is likely to be unexpected one that might in turn affect the success of its practice. The views of teachers, who are the real workers, should be sought (Kumar & Ratnalikar, 2003). Before any new or reformed mathematics curriculum is successfully introduced in to a school, teachers and other concerned bodies should discuss it thoroughly (Dean, 1982:166). Where curriculum developers see little role for teachers' adoptions, they tend to produce what have come to be called 'teacher proof' materials, with extensive and detailed instructions of the form 'use these words', 'hand these out'(Bishop et al, 1996).

4.2 A look at the Pre-1994 Mathematics Curriculum (The Derg Reime)

Without some understanding of the past and current efforts to develop designs more appropriate to the goals and domains of the school curriculum, planners continue to repeat the mistakes they made in the past (Saylor, Alexander and Lewis, 1981:252).

The equivalence educational structure of the then and the current one is as follows. Grades 9-12 of the Derg's time are middle and senior levels of secondary education. Grades 9-10 of the current educational structure are identified by general secondary education. The two are assumed to be equivalent. Analysis of contents and general objectives (aims) are regarded as follows.

From the previous structure, Postulates and Proof (Grade 10); Another look at Proof, Transformation of Plane, Polynomial Functions and Rational Functions (Grade 11); Vectors, Sequence & Series (Grade 12) are absent in the current Grade 9-10 cycle.

Table 4.3: Comparison of Pre- and Post-1994 Secondary Mathematics Curricula Aims

Aims of 1983/84 Mathematics Curriculum (In the Derg Regime)	Aims of 2005 Mathematics Curriculum (in the EPRDF Regime)	Remark
-Demonstrate the knowledge and understanding of Mathematics processes, facts, and concepts and compute with the understanding, accuracy and efficiency -Analyze, attack and solve problems to identify in a problem what is known and thereby translating it in mathematical terms, and to prove and to be able to disprove geometrical problems -Gather (pertaining to social or otherwise), organize and interpret data by statistical methods - Acquire knowledge of general problem solving techniques and use them to solve mathematical problems and real life problems as well	-Appreciate the power, elegance and structure of mathematics. -Use mathematics in their environment and social needs. -Understand the essential contribution of mathematics to Engineering, Science, Economics, Agriculture, etc. -Gain mathematical knowledge and skills to enable them pursue with their further	The sources are Tesfamariam et al (1983, p. 196-197) and Mathematics Panel (2004a, p. i) respectively

-Develop clearness and economy of thought and expression -Demonstrate mathematical utility and power in its interaction with other sciences, be it physical, social or biological -Acquire ample knowledge for exploratory and practical purposes -Introduce mathematical logic: Basic materialist logic in comparison to basic formal logic -Demonstrate understanding of the logical structure of mathematics and the nature of proof -Form general concepts and think in the abstract and in symbols -Recognize both the limitations of deductive and inductive thinking -Develop an attitude of open mindedness and verification of taking things on trust, and of reliance on reason rather than on tradition, authority or humorous -Develop an attitude of self confidence and taking responsibility -Develop habit of reading mathematical literatures -Develop an attitude of socialist attitudes and ideas	education or future vocational trainings. -Gain satisfaction and enjoyment from learning and applying mathematics. -Develop their cognitive, creative and appreciative potential by relating mathematics with societal needs.	

Where as the rest objectives could nearly be match correspondingly, here are the lists of objectives which are peculiar to each. The uncovered mathematics objectives from the Derg's time curriculum include the following.

-analyze attack and solve problems to identify in problem what is known and thereby translating it in to mathematical terms, and prove and to be able to disprove geometrical problems.

-develop clearness and economy of thought and expression

-acquire ample knowledge for exploratory and practical purposes

-recognize the limits of both inductive and deductive thinking

-develop socialist attitude and ideas

The supplemented mathematics objectives in the EPRDF's curriculum include:

- *-gain mathematical knowledge and skills to enable students pursue with their further education or vocational trainings*
- *-gain satisfaction and enjoyment from learning and applying mathematics*
- *-develop their cognitive, creative, and appreciative potential by relating mathematics with societal needs.*

The educational objectives are written no where in the text books of the Derg's regime. Detailed motivational and historical notes, for instance in grade 11 (Ministry of Education, 1980), might contribute to some extent to the affective partition of objectives. The book had been reprinted in 1981 through 1988 once published in1980. The syllabi for each academic subject were produced in 1984. Mathematics contents suggested in the syllabus and books of grade 10 and 11 were identical. Unless the syllabus detailed the teaching methods, assessment mechanisms or learning objectives, where a change be found? Since the books before and after the syllabus were the same, the curriculum guide (1983) and syllabi (1984) were not meaningful.

Roughly speaking, an inclination to consider affective domains in the present plan is comparatively shown. The attention given to skills domain remained minimized. The educational objectives in the turned over curriculum were for contents of 'education for production', 'education for research' and 'education for social consciousness'

The curriculum guide printed in 1983 and the Syllabus printed in 1984 were the only materials available evidences about the Pre-1994 Mathematics Curriculum at the institution, ICDR; have no any prescription about methods of teaching, assessment techniques, and the like. Nothing can be said about the teaching methods and assessment mechanisms, there fore.

4.3 Analysis of the Current (2005) Mathematics Curriculum

4.3.1 Balance among the Cognitive, Affective and Psychomotor Objectives

The three different types of objectives stated in units of the syllabus were organized to find out whether the curriculum intends to emphasize one or two of these behaviors or give appropriate emphasis to each of them.

Table 4.4 Taxonomy of objectives stated in the 2005 Mathematics syllabi

Grade Level	Level of Objectives	Total Number	Domain				Remark
			Cognitive	Affective	Psychomotor	Not Clear	
9	General	11	8(72.73%)	3 (27.27%)	-	-	
10	General	10	7 (70%)	3 (30%)	-	-	
9 & 10	General	21	15 (71.43%)	6 (28.57%)	-	-	
9	Specific	149	127 (85.89%)	1 (0.6%)	38 (25.50%)	1 (0.6%)	*
10	Specific	85	81 (95.29%)	2 (2.35%)	7 (8.24%)	-	**
9 & 10	Specific	234	208 (88.89%)	3 (1.28%)	45 (19.03%)	1	***

**There are 18 specific objectives categorized under cognitive and psychomotor domains.*
***There are 5 specific objectives categorized under cognitive and psychomotor domains.*
****There are 23 specific objectives categorized as cognitive and psychomotor*. Note that the three domains are not expected to be totally disjoint; they are not completely independent of each other.

As shown in the table 4.4, the objectives stated in the syllabus are highly concentrated on the cognitive domain. To the general and specific objectives of this domain, an emphasis of 71.43% and 88.89% much is given, respectively, in both grade levels. Affective domain has given scant place (28.57%) and psychomotor domain had given 1.28% space when stating general objectives. On the contrary, there are about 19.03% (25.50% in grade 9 and 8.24% in grade 10) specific objectives that fall under the psychomotor domain.

It is known that the specific objectives emerge from the general objectives. Goals should have to be broken down in to and reflected on the specific objectives, in turn. Where as, the affective domain appeared insufficiently in the specifics collection, the psychomotor specific objectives have no root. Hence the balance between the three domains of objectives of the syllabus can be said defective. The major cause of the problem of such imbalance is the very low emphasis given to affective and psychomotor domains. Quite the opposite, a very high accent is given to cognitive objectives in the units of the two grade levels.

The development of such attributes as interests, desirable attitudes, appreciation, values, commitment, and empower should be other concerns of a curriculum design. Thus, the identification and stating learning objectives should be an important task. For one reason, they contribute to the enhancement of the building of psychomotor and mental capabilities. For the other reason, disregarding would lead to incomplete behavior building for affective learning is part of the aim of the curriculum.

In relation to this, Alemayehu (2001, p. 80) noted that “even in dealing with cognitive objectives where the success is determined by the students ability to perform a task, the affective behavior is necessary to make the students intrinsically motivated to use their cognitive ability in situations other than the learned one”. He also translated the idea as

the intellectual excellence to be achieved calls for to stimulate the students desire to grasp ideas intuitively.

At grades 9-10 cycle, students are wanted to acquire and develop solid mathematical knowledge, skills and attitudes that significantly contribute to the creation of citizens who are conscious of the social, economic, political and cultural realities of Ethiopia and that can actively and efficiently participate in the ongoing process of development of the country (Mathematics Panel, 2004a). It is also suggested in grade 9 that every thing (task) has to be done to develop personalities, characterized by a specific view of life, high moral qualities and social activities (ibid).

As a final point, each of the three domains has its own importance and contribution to the overall development and life of the learner. The balance made on these domains in ETP (Ambaye, 1999) is not maintained in the grades 9 and 10 Mathematics syllabi. That is, the curriculum under study emphasized the cognitive domain to the impoverishment of the other two.

4.3.2 Levels of Objectives stated in the Syllabus

As depicted in the table 4.5 below, grades 9 and 10 mathematics general cognitive objectives are condensed in three successive levels: comprehension, application and analysis. The marginal levels including synthesis are missed out. It would be fair if all were regarded. Among the other means, complex exercises are included in the curriculum to highly demand mental activities and intensity of thinking for finding out solution procedures independently (Mathematics Panel, 2004a).

At the present discussion, one general objective from grade nine and one from grade ten are offered at the highest hierarchy of affective domain. Receiving and Organization has

got not objective. One objective fall under Responding; two objectives fall under Valuing; and other two are in Characterization. The distribution made on affective domain for the general objectives is comparatively around middle level. Receiving is base for responding and valuing. Since the objectives are hierarchical (Alemayehu, 2001), the attainability of the objectives depends on the inclusion and well foundation of preceding lower level. The affective objectives are scattered in but not fairly distributed to the different levels of this domain.

Table 4.5 Distributions of the levels of Objectives stated in the 2005 Syllabus

Grade	Cognitive								Affective						Psychomotor								Remark
	Knowledge	Comprehension	Application	Analysis	Synthesis	Evaluation	Not Clear*		Receiving	Responding	Valuing	Organization	Characterization	Not clear*	Perception	Set	Guided Response	Mechanism	Complex Response	Adaptation	Originating	Not Clear*	
9	-	1	3	2	-	-	2		-	-	1	-	1	1	-	-	-	-	-	-	-	-	A total of 21 General Objectives
10	-	2	1	1	-	-	3		-	1	1	-	1	-	-	-	-	-	-	-	-	-	
9&10	-	3	4	3	-	-	5		-	1	2	-	2	1	-	-	-	-	-	-	-	-	
9	36	19	43	11	3	1	14		1	-	-	-	-	-	3	7	2	19	-	-	-	3	A total of 234 Specific Objectives
10	23	9	29	3	8	3	6		1	-	-	1	-	-	1	3	2	2	-	-	-	1	
9 & 10	59	28	72	14	11	4	20		2	-	-	1	-	-	4	10	4	21	-	-	-	4	
	(28.37%)	**(13.46%)**	**(34.62%)**	**(6.75%)**	**(5.29%)**	**(1.92%)**	**(9.62%)**								**(9.30%)**	**(23.26%)**	**(9.30%)**	**(48.84%)**					

**'Not clear' is used when the two coders failed to categorize an objective on the same level*

The unevenness distribution is exercised equivalently for specific ones. As it was shown above, the majority of the cognitive objectives are concentrated on the application

hierarchy. A total of 43 out of 127 and 29 out of 81 from the specific cognitive objectives of grade 9 and 10, respectively, are labeled under application category. 59 out of all specific cognitive objectives in the two grades (28.37%) are categorized as knowledge. Where twenty-eight are labeled under comprehension, Analysis, Synthesis and evaluation have got 14, 11 and 4 tallies. Differently, 20 out of 208 total specific objectives are categorized by the coders in any of the six levels of the Cognitive domain and put under 'Not Clear' column. As compared to affective and psychomotor domains, the objectives of the cognitive taxonomy can be said fairly distributed.

As it is observed from the above table, in the psychomotor and affective domains, there are consecutive levels which objectives are left out. Since the objectives are hierarchical, the achievement of each of the medium (middle) and the higher ones depend up on the successful learning of the simpler ones. An association can be made with the stages of the ladder. Thus, the lower steps should have been carefully designed to secure the higher stage. The proportion of the levels could be in a way that the lower levels are greater in number than the next higher one.

Nonetheless, 'the central premise is that the higher level of objectives should be more stressed than the lower' (Alemayehu, 2001:87) so that the ability to think critically and capability of problem solving are fostered. The current ETP was developed to fill the gap in relation to problem solving capacities and higher order thinking. The inclination towards affective domain should have been stressed and maximized. Mathematics learning in grades 9 and 10 has to be in a way that students are ready to take part in constructing the future society (Mathematics Panel, 2004a). It can be fault that leading and guiding affective objectives, that raise and provoke interest, should have been stated and formulated in the specific objectives' collection.

4.3.3 Organization of Contents and Learning Experiences in the Syllabus and Plasma TV Program

This subsection deals with the organization of contents and learning experiences. As far as the definition of the concept 'curriculum' advocated in this thesis is that …represents all the activities engaged in by the students, teachers as well as others; as far as 'curriculum planning' involves the determination of all the means useful for reaching to the ends; Syllabus and Plasma were considered in this study. In fact, Plasma TV program is serving just as a mode of delivery of the curriculum. However, the plasma is source of extra and peculiar examples, exercises, activities and explanations which are not found in the student's textbooks. Among the triggering factors for conducting this research was the unsatisfactory achievements of grade 9 and 10 students on their mathematics education; plasma TV program is part and parcel of it. I am not going to present how the plasma program is running. The investigation is rather focus on and traced back to the inception and development.

The current grades 9 and 10 mathematics curriculum was reformed in 2005 and implemented since 2005/6 academic year. The inclusion of historical facts and examples of applications from different fields such as agriculture, industry, trade, etc in the textbooks' word problem sections could be mentioned for the better understanding of the role mathematics plays.

The inclusion of topics such as logarithmic and trigonometric functions in the syllabus could enable students to cope up problems in Chemistry and Physics. (Refer to Appendix 2 for the list of contents). Yet, the horizontal integration is weak in some cases. As an evidence,

> *"…the same student of ninth grade faces Physics with the consumption of sine and cosine very early before the introduction of these concepts in mathematics"* (Agegnehu Worku, 27/03/09)

These are the concerns of horizontal integration. With regard to the vertical integration, the following is presented. In the same manner, "force decomposition and vector decomposition are arranged in grade 9 Physics prior to the introduction of the idea" (Hailemelekot Gashaw, 24/03/09).

> "*The presentation of 'trigonometric function' at the end of grades 9 and 10 (in two parts) might lead to seriously uncover it. Where as the topic is very significant and the lessons in grade nine are vast, mastering the notion could be impractical. The time bound between the two parts of the topic is almost one year. The students in the second phase would probably forget what they have learned about trigonometric functions"* (Rahimeto Yassin, 28/03/09).

Similarly, though it instigates with revision exercises, the time gap between Power function (the pre requisite) and Exponential functions is long as to Agegnehu Worku.

All of the informant teachers agreed on that the topic 'nested interval theorem' is mistakenly added in grade nine. They thought that the concept needs knowledge of calculus. (I have found teachers who pass over it.) It is psychological disregard too. The theorem is presented below.

Nested Interval Theorem
Theorem 3.3 If $\{[a_n, b_n]\}$ is a nested sequence of closed non empty intervals, the intersection $\bigcap_{n=1}^{\infty}[an, bn]$ contains exactly one number (or point)

(Ministry of Education, 200c:65)

This theorem is included to teach Arithmetic Description of Points on the Number Line. An example to introduce the theorem is:

"Consider the sequence of intervals $\{[\frac{-2}{n}, \frac{5}{n}]\}$, where n is a natural number. If n=1, I_1= [-2, 5]; If n=2, I_2 = [-1, 2.5]; if n =3, $I_3 = [-\frac{2}{3}, \frac{5}{3}]$…; if n= 100, $I_{100} = [-\frac{2}{100}, \frac{5}{100}]$…The sequence of intervals $\{I_1, I_2, I_3, I_4 \ldots\}$ is called a sequence of nested intervals" (ibid, p. 64-65).

Fist of all, the definition of Sequence must be delivered earlier than imposing the theorem. The elementary concepts of Sequence of Numbers, Increasing and Decreasing sequences, etc are presented in grade 12 Mathematics Education. The students are not trained to describe sequences, to use patterns, to find the n^{th} term of even linear sequences.

The topic 'relation and function' had taught in grade 10 before. '…in the reformed syllabus, units are re-arranged. And the plasma instruction of the topic is now given to grade nine students with out any change….' (Samuel Akalu, 21/03/09). Aren't the age difference and grade level the factors? To delineate this talk, Fikremariam's enlightenment, presented subsequently, is helpful.

> *"The plasma program has launched in 1997 E.C [2004/5]. That was to resolve the scarcity of secondary school teachers. When the syllabus is reformed in 1998 E.C [2005/6], what has been done was rearranging the lessons accordingly to go with the new syllabus… we edited the TV teaching CD accordingly…we add some minutes to certain class work questions…this was possible by taking some fraction of minutes from fine points of the instruction…this was because the plasma teachers are South Africans. They could not be available right then... we were ordered to do so."* (Fikremariam Regasa, 31/03/09)

Now, it can be talked that the syllabus and the plasma program should have been developed joint inclusively. Once the syllabus is authorized for implementation, the idea of the plasma TV program is required to persist in. While the TV program was under construction, the syllabus was under formative and summative evaluation. It could not be argued that the drawbacks of the timed out syllabus (curriculum) are founded after the

inauguration of the TV program because the evaluation took at least four years. Or else, the evaluation should have been inclusive of trial out of the TV program.

As well, it could wait until the feedbacks of the program are reported. In connection with this spat, Tesfaye said that:

> *"…our heads told us that we can evaluate the working [*current*] syllabus by sending questionnaires when ICT practitioners went to field…. Out of the 20% returned papers, most were filled out carelessly"* (Tesfaye Ayale, 31/03/09)

To restate the above paragraphs, the arrangement of units and their contents correspond in the syllabus and the TV program. The TV program helped to cover the syllabus. Though, the process of formulation of the syllabus and the plasma TV program is inadequately allied.

4.3.4 Teaching Methods suggested in the Syllabus

The objective of secondary school curriculum focuses at enabling students to solve real life problems and become independent, helpful citizens (Getnet, 2008). The main task of the teacher is selecting and arranging the order of problems, helping and motivating the students to solve problems by themselves in the planned and organized way (Mathematics Panel, 2004a). It is also suggested that the teacher should use his or her creativity or discretion rather than getting a prescription from some one else (Mathematics Panel, 2004b). As a result, it is tried to suggest the procedures for teaching rather than specific teaching methods. The mathematics instruction is towards enabling students solve problems by themselves. But, it can be said as far as the syllabus is more helpful for beginner teachers, letting the choice as to which one, where to use the method on the individual teachers' judgment might insecure the proposal.

Table 4.6 Prevalence of different teaching Methods suggested in the syllabus

Grade	Teaching Methods and Techniques								
	Lecture/ Explanation	Demonstration	Discussion / Question & Answer	Guided Discovery	Problem Solving	Inquiry	Drill or practicing with Exercises	Not Clear	Remark
9	31	18	31	35	9	1	23		
10	14	20	26	18	10	-	11		
9 &10	45	38	57	53	19	1	34		
	18.2%	15.3%	23.1%	21.5%	7.7%	0.4%	13.8%		

Keep in mind that all the frequency indicators shown in table 4.6 above are the coders agreed with. Six types of teaching methods are branded from the syllabus that extends from lecture and explanation up to methods that offer students engagement such as inquiry. Additionally, one category is supplemented under the heading of “Not clear” for other methods. The teaching method that occurred many times in the units is Discussion/ Questions and Answers. It coats 57 out of 247 occurrences (23.1%). In the form of technique, the syllabuses suggested students to practice with various exercises; these techniques cover 13.8% complementary to other methods. Guided Discovery, Lecture or Explanation, and Demonstration are 21.5%, 18.2%, and 15.3% respectively. Methods that good deed students’ engagement (Problem Solving and inquiry) received less emphasis. They cover 7.7% and 0.4% respectively.

The teaching methods rated dominantly, in the table, such as discussion and guided discovery invite participation of the students in the process of learning. It is fair to say that the methods are proposed in response to the objectives nature. Nonetheless, the habit of independent work and problem solving would be best fostered by free discovery methods such as problem solving and inquiry.

4.3.5 The design of Teachers and Students' Role in TV and Classroom Instructions

The higher officials had been strongly arguing that the plasma TV teacher is assistance to the classroom teacher by conferences on ICT. Getnet (2008) evaluated the Government's objectives in introducing the plasma mode of instruction as 'quite attractive on paper'; he shared what was supposed even if he thoroughly blamed the implementation defects and impacts.

> *"In the beginning of 2003, there came a new idea to resolve the shortage of secondary school teachers and the un-coverage of contents at the end of the academic year. The Ministry of Education and the Ministry of Capacity Building agreed to inaugurate Plasma TV program… There was no action on the need assessment rather than bolding the significance….It became instructional. In the Derg's time, there was an 'Education Supported by Television' program. In that time contents to be presented in the Television were selected by teachers and the then educational media agency (today's ICT center) coordinators. The two groups had been preparing it for a period of 20 minutes. However, the accessibility was limited to a few towns. The quality of the broad cast was decreasing as one went far from Addis Ababa. The current broadcast is equally audible and accessible to any corner of Ethiopia*." (Fikremariam Regasa, 31/03/09).

Here, one can conclude that the Plasma TV program is being used as chief instructional means. Teachers would be influenced by 'the Plasma' than the Syllabus and the Teacher's Guides. On the other hand, Solomon (2007, p.100) has found students and teachers still rely heavily on textbooks and printed out media though the shortage of textbooks is a pressing problem.

It is likely that students' role might not be high in the formation and construction of their knowledge. "The classroom teacher is the organic link; the plasma program would be a passive environment otherwise" (Fikremariam Regasa, 31/03/09).

The daily exercises, introductory exercises, miscellaneous exercises, and complex exercises are as means of assessment techniques and techniques of teaching. To this end, among the other tasks, the teacher is requested in unit one of grade 9 to:

- 'Motivate students to give some more examples of their own'
- 'Help them to solve practicable word problems….'
- 'Assist them in illustrating…'
- 'Help them to check the practicability of…'
- 'Allow students to take their own sets and check these laws'
- 'Assist them to solve word problems leading to such set operations' (Ministry of Education, 2005a)

On the other hand, "the plasma teacher used to impart and students are waiting for only exercises. In the mean time of TV broadcast, the students become passive. It does not hold all the fast, medium, and slow learners" (Samuel Akalu, 21/03/09); "the Program is one way transition" (Rahimeto Yassin, 28/03/09). When and how students and the classroom teacher interaction would be maximized? It is heard that a controversial gossip on who is the main and who is the supportive teacher from the two. Most of the interviewees shared a common position that their role is minimized in TV time though they have instances they could intervene during the 30 minutes (Live Transmission time). How could the classroom teacher use variety of methods (the syllabus recommends) to motivate and arise students' interest in the subject?

On the TV lessons, the teacher could use strategies on how the role of students could be increased by: making sure that students are following the lessons properly doing the activities and exercises given by the TV teacher; trying to discuss the core ideas of the lesson; and trying to accommodate for the differences of examples or exercises considering them as extra and additional examples and exercises. (Ministry of Education, 2005b)

The teacher should always make sure that students often get the opportunity to continuously express their opinion (in written form or orally) and explain the solution procedure for a given problem and reason out the ways of the solution (Mathematics Panel, 2004b). This might not be realized. Pedagogically, students' fullest engagement in the mathematics learning and hot teacher-student interaction make the instruction lively.

To close up the dialogue, both the syllabus and 'the plasma' are more helpful for beginner teachers. Experienced teachers might benefit less from the 'the plasma'. Consolidations and recommendations are found in the allocated Chapter, ahead.

4.3.6 Assessment and Evaluation Mechanisms Suggested in the Syllabus

The following table is part of and springboard for the discussion of how the assessment mechanisms are developed in the curriculum guide of mathematics education.

Table 4.7 Distribution of assessment mechanisms Stated in the Syllabus

Grade	Homework	Class work / activity	Oral Questions	Exercises/ Questions & Answers	Test	Observation/ Follow up	Assignment	Project Work	Not Clear	Remark
9	23	37	33	19	3	-	1	-		
10	26	31	23	6	1	3	2	1		
9&10	49	68	56	25	4	3	3	1		
	23.4%	32.5%	26.8%	11.96%	1.9%	1.4%	1.4%	0.47%		

As indicated in the above table, Class activity, Oral questions and Home work took the most rates, 32.5%, 26.8%, and 23.4% respectively. In grade 9 Mathematics Syllabus, class activity was counted thirty seven times out of two hundreds nine tallies. In grade 10, the frequency of class activity is sixty eight times. In grade nine, teachers are advised to provide written exercises. In the time allocation of the curriculum guide, time for classroom tests is not included. Measuring what a pupil knows, understands or can do is not always an easy process. The way we shape or phrase our measuring instrument may affect the response we get from our pupils (Parkinson, 1994: 199).

To enable students solve problems independently, the teacher is given a task to make sure students often get the opportunity to continuously express their opinion in written form and orally explain the solution procedure for a given problem and reason out the ways of solution.

4.4 Comparison with International Schools' Mathematics Curriculum

In this section two international schools' mathematics curriculum and education is reviewed. The two schools are International Community School (ICS) of Addis Ababa and Sandford International School. A summary of the two schools' mathematics curriculum is presented at the end of this section tabulated in the form of comparative approach with the Ethiopian Curriculum.

4.4.1 International Community School Mathematics Curriculum

A Day in the School Compound

Getting the main gate of the school was not an easy task for me. A long thin security '*Habesha*' man was out side the campus in the frontage of the main gate distantly from the entrance. He interrogated me what did I want. I told him the purpose was to undertake a research and to seek good experiences from there. After he read the letter of cooperation, he allowed me to close to the police men to deal. I was out side yet. For that moment, I was afraid as if I was sentenced with a certain crime. Almost twelve minutes were passed until I got the permission of entrance.

Soon after permission, they assigned one police woman to accompany me until the 'Reception Room'. I grasped a temporary guest ID. They hold me with regard, afterwards. I present my letter that inquires about cooperation. I was invited to have a seat till the issue was processed. A black man and a white man were debating around about a day before Champions League contest. The Black man was for Chelsea; the white man was calling Steven Gerard of Liverpool again and again. However, the two clubs were not counterparts of each other on that day's schedule.

Finally, the black man was assigned to guide me to one Mathematics teacher. His badge informed me that he was *Habesha*. He was Mr. Biruk Kebede. We were talking in Amharic as I did with police staffs. While accompanying me, Mr. Biruk was greeting students. On his left hand, he handed a cup of coffee (tea) to drink down the journey. We left back many offices and two buildings.

When we reached at the gate of 8th Mathematics classroom, Mr. Biruk asked one white boy to bring his slip before entering the class. I understand that Mr. Biruk was education facilitator. The boy took out it from his pocket on the shirt. Mr. Biruk transferred it to me. At the back of the slip, I looked at two A-charges. Mr. Biruk told me that those were the boy's performance indicators or marks for the subject Mathematics. Bear in mind that we were still at the gate of the class. The time was

'Break Time' in the morning shift. Then, we entered to the class. Some students were passing the time by discussing about their relatives. Almost half of them were seemingly Africans. In the class, there was a computer at the back, white board on the front wall, a print out curriculum map posted on the back wall. Near the window, a pile of books were stacked. I picked one; it was Pre-Algebra book published in America. Mr. Biruk notified me that it served as a text book. A few of seats were arranged around desks suitable to group work and cooperative learning. I guessed that the number of students, in that class, might not be more than 25. Mr. Biruk asked what they were going to learn. They replied that the subject was Mathematics.

Then, we left out the class to wait for the teacher out side. On the corridor we come across, a bold *Habesha* man coming towards. Mr. Biruk, lead us to set up each other. He was Mr. Teddy Afro, Maths teacher of the class. Mr. Teddy appointed me to return back at 2:00 PM local time for any discussion. Mr. Biruk had already told me that that man had visited many foreign countries. Mr. Biruk was hopeful that we could create an interactive discussion than other foreigner staffs. On the next day, March 12,

When Mr. Biruk and I returned backside to the reception room, I kept quite. For that moment, I was thinking about *Arat Killo (*Science faculty of AAU*)* and ICS simultaneously. I was totally immersed in the comparison. The structure and organization of the compound, the neatness of the ground, etc was very fantastic. I had never seen such a primary and secondary school before.

At 2 o'clock, I got Mr. Teddy having a meal in the same class of morning time. It was Mr. Biruk who accompanied me up to there. Mr. Teddy was free to communicate with me side by side. The first question I raised was about what mathematics contents their students are learning. He began from the pre-University program (grades 11 and 12). According to his illustrations, students are grouped in to three levels. In level 1, there

are a group of students who learn 'Maths studies'. He connected it with our social science stream of our country system. In level 2, there are other students who take 'Math standard level'. These are average students. In level 3, a group of students who are taking 'Math higher level'. These students should have to have a firm background of mathematics and are expected to be such as Scientists, Astronomers, etc

This classification determines what to teach in grades 7, 8, 9, and 10. Mathematics courses are Grade 6 Math, Grade 7 Math, Grade 7 Advanced Math (Pre-Algebra) and, in Grade 8, Pre-Algebra or Algebra 1. In all grades the program is designed to refine computational skills, increase problem-solving abilities, develop mathematical communication skills, and improve reasoning. Frequent use of hands-on activities and projects connect mathematical strands and connect mathematics to other disciplines. The Mathematics curriculum is Summarized and presented in the following table.

Table 4.8 Mathematics taught in ICS

Paths	Grade	Mathematics Education	Pre-University Mathematics Education
one	7	General Maths	Maths Studies (Level 1)
	8	Pre-Algebra	
	9	Algebra 1	
	10	Geometry	
two	7	Pre-Algebra	Math Standard Level (Level 2)
	8	Algebra 1	
	9	Geometry	

	10	Algebra 2	
three	7	Pre-Algebra	Math Higher Level (Level 3)
	8	Algebra 1	
	9	Geometry	
	10	Algebra 2	

(From verbal communication of Mr. Teddy Afro, 11/03/2009)

Students who took General Maths, Pre-Algebra, Algebra 1, and Geometry in grades 7, 8, 9, and 10 respectively are assigned to Maths Studies group in grade 11 and 12. The courses Geometry and Algebra 1 can be given interchangeably. Maths Higher Level and Math Standard Level of grade 11-12 experience the same courses of studies in the lower grade levels, but with different level of complexity. Their achievement in grade 10 mathematics examination is regarded as well. The task of identifying students in to three classes would start early in grade 6. The classroom teacher is requested to suggest. Besides, student's scores are the determining factors for their mathematics capacity. In the later grade levels, if a student shows an out standing grade, he/she could be assigned accordingly.

At the end of grade (year) ten, students sit for international test set by Cambridge University. Unlike the Ethiopians experience, the examination in mathematics is not limited to multiple choice items which are susceptible to chance result and cheating. The international standardized test comprises of short response, extended response as well as skill related skill practice. The consistency of this international test with the classroom tests could enable learner in being all-rounded. One of the targets for mathematics curriculum in ICS is whole learning.

The standardized test practice comprises of short response, multiple choice, extended response and gridded-answer. These are model questions for the international examination they sit for at the end of grade 10 so as to join international Baccalaureate

(IB) program in grade 11-12. Other assessment mechanisms include: quizzes, chapter summary and review, chapter test, and open ended writing.

Where there is an individual difference on students, they are learning according to their pace. The categorizing of students in mathematics and English classes could enable them to dream an area of study very early beginning from grade seven. Even in a mixed ability class, teachers are advised to identify lower, middle, and higher ability students to treat in view of that. Better achieving students must be given more tackling problems and extended learning to facilitate their acquisition of knowledge and skill.

A Mathematics Textbook

In response to my query about curriculum materials, Mr. Teddy lend me Grade 11-12 Mathematics Curriculum map, Pre-Algebra book (which serves as a textbook for grade eight student) and Algebra 1 book (written by Larson and others, 2007).

The 13 chapters of 'Algebra 1' course are organized as follows. The text book is published in a water proof colored print out pages. How the assessment mechanisms or instruments are prescribed is also put as under. The major themes for organization are: pre-requisite skills (Vocabulary check and skill check), big ideas, animated algebra, multiple-step problems, skill practice, multiple representations, guided practice, mixed review of problems solving, extra practice, problem solving workshop and standardized test preparation & practice (Larson and others, 2007).

In each chapter, these themes are frame of references to formulate the contents and mark the learning experiences. Each new topic in each chapter is on track with 'Before', 'Now', and 'Why?' centers. 'Why' questions are to seek students pre-thinking of implications once they are reminded with previous related deals by 'Before'. The element

'Now' gives hint to extend what has been learned before. Animated Algebra provides interactive electronic activities for exploring concepts and their real world applications throughout the course. The word problems are incorporated in between in each section.

Since the organizational themes of 'Algebra 1' text book are related to activity questions and problems, it can be inferred that the learning would be activity based. It goes with process learning and problem based leaning. The multiple-step problems, multiple representations, extra practice questions, mixed review of problem solving work shop questions favor integrated education. On the top of that, an intensive instruction and deep learning could be presented. The inclusion of 'Big Ideas' in each chapter signify the central issue that should be mastered.

4.4.2 Sandford International School Mathematics Curriculum

A Day in Sandford International School

On March 12, 2009, I went to Sandford International School. They were more open as compared to the ICS. One of the elder Guards took me to the office of director of the secondary school. All were *Habesha*. The director was Mr. Resh Ariel. After he listened to my urge, he took me to one Maths teachers.

On our way, he saw three students, in front of us; he greeted them. Soon after they react, they came to draw near enough. The two females set up an introduction of the boy and the director. They told him that boy was on visiting the surrounding being a new comer. It seemed that the school admission of new comers in the second semester (term). Mr. Resh lengthened his hand for introducing him self by saying: 'I am Resh… what is yours…?' Then Resh wished the student a happy time.

When we reached one Maths class, a thin long white man was helping a girl to come up with solution. It was break time in the morning shift. The student was told to return back later on. On the table, I saw a book: New National Framework 9 Mathematics (written by M. J. Tippler and K. M. Vickers). The white man told me that it was a text book for grade nine students who learn mathematics. I asked him which grade levels are considered as secondary level. By notifying UK education system as model system they are following, he identified three:

- Lower Secondary or Key Stage 3 (7-9 years or grades)
- Upper Secondary or Key Stage 4 (10-11 years or grades)
- Pre-University (12-13 years or grades) or IB

After he mentioned *Practical and Investigation tasks* as more features of their school as compared to many African governmental schools, I could not extend the discussion. Either I was frightened on the condition or I was disorganized. Rather, I preferred to receive his e-mail address or to arrange another appointment. He passed me to another Mathematics teacher who was teaching in 'Ma1' class (class of year 10 Mathematics students), on the first floor. We agreed to have another appointment.

We continued to fix the contact time via e-mailing. Her name was Ms. Taba Stenhouse. She convinced me to observe one practical class hopefully that the practical class would exactly inform me what was intended in the curriculum map. I knew that I was not dealing on the curriculum implementation. Finally, she promised to copy the curriculum maps as well and to keep for me.

On March 25, I reached 10 minutes earlier than the appointment time. When she saw me, she pardoned for the power [light] being off to photocopy the hard copies. We went to the class-'Ma_1' which we planned to observe. It was ten minutes past eight

o'clock. The students entered after additional ten minutes. She introduced them that I was from Addis Ababa University appeared there to watch their learning process by adding my name. Some student returned their face to greet me facially. I was back bencher. I liked their frank and free feeling.

She already wrote exercise questions on one of the three white boards. On top of the two, at the front wall, there was a watch hugged over. I counted 17 students with three extra seats. The class is rather a wider one. One of the two notice boards, on the side wall, solutions of home work problems was posted. Any student can correct his home work trials. A collection of books were seen at the back free space. I saw more than three lockers at the back wall. But, I could not guess what available inside was. Perhaps, the electronic machines to display a stretch or any other important aid to facilitate the learning might put in. I saw two on the table. When Ms. Taba begun the lesson, she awaked the students that they would be forced to learn devoid of any electronic means because of absence of power (light).

She seemed in 40's, but has been acting freely as if she was at the beginning of 20's; she moved here and there round the class. Every student was asked one form of question and expected to reason out. Her teaching approach was activity based and process learning. She used inductive approach of teaching and learning method. The total period covered was 80' (eighty minutes). At the end of the period she told me that their learning teaching process is exhaustive and intensive. In the class activity, every student contributed to gear the learning process. And she was restless to check whether every student was engaged. Like in ICS, individual learners were considered. The progress of each student could easily be managed.

In the break time, she told me that the students were higher achiever student collected together to learn Maths. Like in ICS, the selection of the three groups started early in

grade six. At 8th year (grade) they learn on separate classes. 'Ma_1' students are higher achiever 10th students in Maths. 'Ma_2'students are those who are better. 'Ma_3' students are slow learners in Maths. Ma_1 and Ma_2 students take Extended Mathematics education where as Ma_3 students take Core Mathematics education. Extended Maths is inclusive of Core Maths. Only extra topics and activities or problems were added in some of the chapters.

The next coming table is exemplary one. In ICS and here in Sandford International Schools, Mathematics contents to be covered within a year are vast. On the other hand, most of my interviewees were complaining on the enormous contents in grade 9. As compared to these two international curricula, the Ethiopian grade 9 mathematics curriculum can not be said for breadth coverage.

Table 4.9: Core and Supplement Mathematics Contents in Sandford International School for Year Ten, 'Term 1' of 2008/09 Academic Year

Topic	**Core Contents**	**Supplement Contents***
Types of Numbers	Primes, factors, multiples, HCF, LCM; squares, square roots, cubes and cube roots; Rational and Irrational numbers;	Use Language and location of sets, including Venn diagrams
Sequences	Continue and Describe sequences; Use difference patterns; find expressions for the n^{th} term of the linear sequences	Also quadratic Sequences
Estimations, Approximation and Limits of Accuracy	Make estimates of numbers, quantities and lengths; Give approximations using significant figures and decimal places; Give appropriate upper and lower bounds for data given to a specified degree of accuracy	Use these to find appropriate bounds of solutions of problems
Algebraic Representation and Formulae	Use letters to express generalized numbers and express basic arithmetic processes algebraically; substitute in to formulae, including with directed numbers, fraction and decimals; Transform simple formulae	…..more complex formulae
Algebraic Manipulation	Expanding brackets; Extracting common factors	Expanding and factorizing quadratic expressions; Recognizing 'the difference of two squares'; Manipulating

		algebraic fractions
Solutions of Equations and inequalities	Solve simple linear equations in one unknown; Solve simultaneous equations if two unknowns	Solve quadratic equations by factorizing, and either by completing the square or using the quadratic formulae; Solve simple linear inequalities; Solve problems by forming and solving appropriate equations
Geometrical Terms and Relationships	Use and interpret the geometrical terms: point, line, parallel, bearing, right angle, acute, obtuse and reflex angles, perpendicular, similarity, congruence; Use and interpret vocabulary of triangles, quadrilaterals, circles, polygons and simple solid figures including nets	Use the relationships between areas of similar triangles, with corresponding results for similar figures and extension to volumes and surface areas of similar solids
Geometrical Constructions	Measure lines and angles; construct a triangle given three sides, using ruler and compasses; construct angle bisectors, and perpendicular bisectors, using compasses and straight edges; read and make scale drawings	

* Teachers of Ma 2 must gauge, topic by topic, how far it is the supplementary work

(IGCSE Scheme of work by Ms. Taba Stenhouse)

Students may follow either the core or the extended curriculum which involves both the core and supplement. Students aiming for grades A* to C should follow the Extended curriculum. Students in Ma 3 have grades D, E, F, G (Ms.Taba Stenhouse, 25/03/09). At the end of year ten, core examinations (paper 1 and 3) and extended examinations (paper 2 and 4) are prepared accordingly. IGCSE Mathematics textbook is written specifically for students' preparation of the University of Cambridge IGCSE examination; it takes full account of students' needs for this examination (Pimentel & Wall, 1997).

Table 4.10: Comparative Summary of ICS, Sandford, and Ethiopian Secondary Schools' Mathematics Curriculums

Theme	International Community School of Addis Ababa	Sandford International School	Ethiopian General Secondary Schools
Secondary Education	Years 9-10	Years 10-11*	Grades 9-10
	Years 11-12 (Pre-University Level)	Years 12-13 (Pre-University Level)	Grades 11-12 (Pre-University Level)
		Three Terms per Year	Two Semesters per Year
Curriculum Development	Standard Based (adopted standards & Bench marks); Refined yearly by Subject Teachers (Refer Appendix 3)	Standard Based; Refined yearly by subject Teachers (Refer Appendix 3)	Problem Solving approach; Centrally developed (Getnet, 2008); Reformed with Government's Initiations
Mathematics Education	Cyclic Education (Refer Glossary); Three distinct ways to deliver for three different groups of Mathematics (Ma_1, Ma_2 & Ma_3) Students	Core (for Ma_1) and Extended Mathematics (for Ma_2 & Ma_3 students) Curriculums; Examination Oriented	Uniform Curriculum for all schools
Emphasized Areas	Computational Skills; Reasoning skills, Hands on & project related mathematics; Multi-Step Problems; Multiple Representations; Problem Solving Workshop; Guided practices.	Logical thinking; Puzzles to be solved; Overcoming difficult questions to get enjoyment; Thought, Concentration and Determination(Pimentel & Wall, 1997; UCLES, 2008)	Knowledge acquisition as stabilization has central position within Mathematics learning (Mathematics Panel, 2004a).

Instructional (Teaching-Learning) Approach	Student Centered; Interactive; Activity based; encourages Initiative, creative, inquiry and academic achievement (Refer Appendix 3)	Student Centered and Inductive Approach; Activity based; Process Learning; Practical and Investigation Tasks; Exhaustive and Intensive Learning	Student-Teacher Centered; Exercising; Discussion; Guided Discovery; Lecture/ Explanation Methods
	Individual student treatment;	Individual student treatment;	Group of student treatment;
	Mathematical ability grouping	Mathematical ability grouping	Mixed ability grouping
		40 or 80 minutes of class time (Conditional)	42 minutes (of which 30 minutes are for Live Transmission) class time
Teacher's Role	Can improve the curriculum plan in line with Standards set.	Can improve the curriculum plan in line with Standards set.	Implement what is developed from ICDR
Major Evaluation Methods	U.S.A grading level system; Placement Evaluation; Standardized Test Practice	Homework; Regular Tests; Mock (Model) Examinations; Exercises with plenty of practice questions (Pimentel & Wall, 1997)	Class activity; Oral Questions; Homework;

*It is not structurally identical with Ethiopians Grades 9-10 level; there is also Years 7-9 stage of secondary school level. Years 10-11 is the period that determines students' continuing of Pre-University Program like Ethiopian General Secondary Schools Cycle.

In Table 4.10 above, few points are presented correspondingly under ICS, Sandford and Ethiopian Schools Mathematics curriculum. The table is just a summary of Appendix 3, Appendix 3, interview and content analysis tasks. A major difference is seen in the learning approach. In ICS and Sandford Mathematics students are at the center of learning process; individual students are considered; the progress of individual students is regarded and differentiated. Surprisingly, students are treated according to their ability. On the other hand, the provision of a plasma TV broadcasted

from the Capital to almost all governmental secondary school of Ethiopia does not consider such variability. By the theory of Brain-Compatible and Multiple Intelligence learning theories, each student has different and unique ability. Accordingly, slow learners would need a different mode of instruction perhaps characterized by assistance ship. Fast learners could be given more challenging learning opportunities. Learning is most effective when a student is actively involved in the learning situation. Knowledge acquisition is the feature of Ethiopian students' learning design. However, 'learning is more meaningful and more thorough and therefore more usable when pupil seeks out and discovers of knowledge' (Lemma, 2006:23).

Both ICS and Sanford have experience on developing Mathematics Curriculums in to three different level of complexity. There are common contents and activities in which all the students of Ma_1, Ma_2, and Ma_3 classes would take in the form of 'Core Contents'. There are 'Supplementary Contents' for 'Extended Curriculum' candidates. Such a delivery might not be an easy task under the Ethiopian context as it requires facilities and expertise to cope up. However, there is no means practiced on how to handle individual difference in learning except holding all Ethiopian School students in the same frame of mirror. Since the two international schools advocate competency based curriculum, mathematics teachers are let to choose, arrange and develop their own curriculum framework (map). A mathematics teacher in Ethiopian secondary education system is expected to understand and better implement what is developed.

The centrally developed curriculum is being influenced by few individuals at ICDR, MoE and perhaps Regional Bureaus or other organizations. It needs these groups of individuals to be expertise enough. With regard to the training of experts in the ICDR:

> *"There was a chance to proceed in the field of Curriculum; it is blocked now. The nature of Training we have been grasped is On-Job-Training. By self*

initiative, by asking senior experts who held the position prior to our appearance, by browsing other countries' curriculum experiences via Internet….. Much of the experiences we had are our teaching experiences in high school mathematics." (Tesfaye Ayele, 09/06/09)

The curriculum designing task needs the experts and other participants to be enriched with possible trainings in the area of mathematics and pedagogical issues. If experts continued to adapt the experience of those who were pre-engaged on the matter, the likely of replication would persist on. It insists to be concerned and worried about our centrally developed approach. How could one trust that we are out of curriculum 'Vicious Circle' in curriculum development and reforms or curriculum changes?

Chapter Five: Summary, Conclusion, and Recommendations

This chapter deals with summary of major findings, the conclusions reached at and the recommendations forwarded based on the findings.

5.1 Summary

The current grades 9 and 10 mathematics syllabus of the country is being implemented since it was reformed in 2005. The aim of this study was to evaluate its appropriateness, relevance and adequacy. The following four questions led the study.

- How was the current general secondary school mathematics curriculum of Ethiopia developed?
- How are the objectives stated in the current general secondary mathematics curriculum?

- Are the objectives, assessment and teaching methods harmony with each other, with educational policy?
- What are the comparative strengths and weaknesses of the general secondary school curriculum Vis-a-Vis the national and international experiences?

To answer these questions, all units of grades 9 and 10 mathematics syllabi were reviewed by content analysis. For the comparison purpose 1983/1984 Mathematics Curriculum of Ethiopia was available and considered. Sandford International and International Community Schools' Mathematics Curriculum were also purposely selected for comparison. Teacher's guides, student's textbooks and pertinent documents to the secondary school mathematics education were accessed. Three experts and ten teachers of Mathematics were interviewed. Six graduate students of Mathematics Education were selected four of whom were grouped in to two to rate five (out of sixteen) units. One was assisting me in shaping the structure of the coding sheet before coding was conducted. The sixth one and I were also coders to rate the rest units of the mathematics syllabus.

All the qualitative and quantitative data were analyzed qualitatively and quantitatively that features the mixed research approach. Narration overwhelmed the qualitative analysis. Frequency count and percentage were used to quantitatively analyze data.

The data analysis revealed the following major findings of the study.

- There is a harmony among grades 9-10 mathematics learning objectives and the Education and Training Policy aims & the general secondary school student's Learning Profiles.
- The current Mathematics curriculum has reformed following the basic steps; however, the need assessment before it was innovated in 1995 was in short supply. The extent to apply the prior curriculum evaluation findings and recommendations was

inadequate. For example, it was already found out that reference books were not suggested in the 2001's mathematics teacher's guides. The drawback was acknowledged but repeated in 2005's edition.

- The time devoted to reform the current syllabus in the form it took is short while the prior recommendations request exhaustive revision to take place. The experts' recommendation of stipulation was proposed to MoE in March, 2004 to get endorsed. The revised syllabus was published in May, 2004.
- Teachers' involvement in the curriculum reformation was not to a great extent. Even Regions were passive agents to react against or in favor of the frame work of the curriculum. Therefore, there was a tendency of taking little idea and experience from teachers and Regional experts.
- As compared to the Derg's regime mathematics curriculum, a tendency for the psychomotor domain is shown. But, still the domain remained much less than the cognitive domain. The cognitive domain covers 71.43% in general objectives collection; 28.57% are affective general objectives. On the same fashion, 88.89%, 1.28% and 18.38% of the first cycle secondary mathematics specific objectives represent cognitive, affective, and psychomotor domains respectively. That is unfair balance between the three domains.
- The distribution of the levels of general cognitive objectives prevails up to the middle hierarchical arrangement; the objectives mostly fall on the application level. The higher order levels seemed left out. The affective general objectives of the two grades are: one Responding, two Valuing, and two Characterizations. More over, the general objectives are not reflected by specific objectives. Similarly, without any driving general objectives, forty-three (18.38%) specific psychomotor objectives are located over the units of grade 9 and 10. From these much share (48.84%) was at Mechanism level.

- Another important aspect of the study was on the co-existence of syllabus and the Plasma TV program. It is found, from the analysis of interviews and self experience that the plasma program was launched with out deep prior studies or need assessment. Further more, the role of teachers in the time of development was blocked as compared to the Derg's time TV program. The TV program has been used as main instructional purpose as opposed to the view of higher officials, in the MoE, who argued that the program was developed as a supportive means.
- In connection with logical sequence of a topic, "Nested Interval Theorem" needs a conception of Sequence and Patterning. The placement of it under grade 9 is found unfair. Among the most significant chapters, trigonometry is one which presented at the end of grade 9 and at the end of grade 10. This leads to be liable to be uncovered. Horizontal integration is not maintained for such as trigonometric functions across Physics and Mathematics.
- In connection to psychological sequence, the reformation of the mathematics curriculum has drawbacks. When the topics "Relation and Function" and "Set" were rearranged down to 9^{th} grade level, the 10^{th} level TV lessons were adopted directly. That means, the production designed for and given to 10^{th} students is now being provided to 9^{th} students.
- With regard to teaching methodologies suggested in the syllabus, the Discussion and/ or Questioning & Answering are compromising with the overwhelming assessment mechanism Class Activity. Other teaching mechanisms, next to Discussion method, are Guided Discovery, Lecture/Explanation, Demonstration and Giving Exercises for practice. The general approach of the curriculum and ETP was sought to be Problem Solving. However, Problem Solving method of teaching has got scant place. Other means of teaching techniques and evaluation purpose like self study, individual work, group work and project work are not visible. Attention given to promote independent thinking is lesser than it has to be considered.

- In the pre-1994 time, Grade 11 Mathematics Textbook had been reprinted in 1981 through 1988 once published in1980. The syllabi for each academic subject and grade level were produced in 1984. However, the printing of Syllabi must be earlier than the publication of Textbooks and Teacher's guide. The deficit had continued in the post-1994.

- Both ICS and Sanford have experience on developing Mathematics Curriculums in to three different level of complexity (for Ma_1, Ma_2, and Ma_3 students). There are common contents and activities in which all the students of Ma_1, Ma_2, and Ma_3 classes would take in the form of 'Core Contents'. There are 'Supplementary Contents' for 'Extended Curriculum' candidates. Such a delivery might not be an easy task under the Ethiopian context as it requires facilities and expertise to cope up. However, there is no means practiced on how to handle individual difference in learning except holding all Ethiopian School students in the same frame of mirror. The flexibility of the curriculums is also reflected by the teachers' role. Since the two international schools advocate competency based curriculum, mathematics teachers are let to choose, arrange and develop their own curriculum framework (map). A mathematics teacher in Ethiopian secondary education system is expected to understand and better implement what is developed.

The centrally developed curriculum is being influenced by few individuals at ICDR, MoE and perhaps Regional Bureaus or other organizations. It needs these groups of individuals to be expertise enough. With regard to the training of experts in the ICDR:

The curriculum development and designing task needs experts and other participants to be enriched with possible trainings in the area of mathematics and pedagogical issues. If experts continued to adapt the experience of those who were pre-engaged on the matter, the likely of replication would persist on. It insists to be concerned and

worried about our centrally developed approach. How could one trust that we are out of curriculum 'Vicious Circle' in curriculum development and reforms or curriculum changes?

5.2 Conclusion

From the preceding findings, it is possible to arrive at the following conclusions, based on the process how the curriculum was developed; on how the objectives were formulated; on how the objectives, contents, and methods were correlated; and how far advance or lag behind national and international experiences.

How was the current Ethiopian grades 9-10 Mathematics Curriculum developed?

The production of the current Mathematics curriculum had started since 1995 following the policy change made (1994) on education. No evidence found entailing how the stake holders participated in the development. It was first implemented in grade 9 in 1999/2000 with out any trial out. But, there was enough time to do that as the syllabus was developed as of mid of 1990s. The contribution of teachers and regional experts when the curriculum was reformed in 2004/2005 was minimal.

How are the objectives formulated in the current Ethiopian grades 9-10 Mathematics curriculum?

Unless objectives in the lower bases existed enough, the attainment of middle and higher objectives of the current syllabus would likely be impossible. Such premature leap to the central objectives that are not built up on the lower levels and remaining at the central level without going to more complex of learning reflect another problem of balance between depth and breadth (Alemayehu, 2001). A higher level of mental ability,

creativity and cognition from the cognitive domain; the physical and problem solving capabilities of students; and appreciative potential elements of ETP intentions could not be substantiated easily.

Are the Ethiopian General Secondary Schools Mathematics Curriculum objectives, assessment and instructional methods in harmony with each other, with educational policy, and with standard methods?

The Education and Training Policy (ETP) sought to develop citizens who solve problems, think critically, do independently and do in cooperation. There is a harmony between the general objectives of grades 9 and 10 mathematics learning with ETP and the learning profiles. However, the connection between the general objectives and the specific ones is not maintained. For instance, there are general affective and almost no specific affective objectives; there are no psychomotor general objectives even though a lot of specific psychomotor objectives are available.

The general approach of the curriculum is sought to be problem solving based though the place given to problem solving method of instruction is this much. It questions the adequacy of the Mathematics curriculum. Most of the teaching methods and evaluation mechanisms favor students' involvement. The teaching methods and assessment methods do not provoke independent thinking and problem solving.

What are the comparative strengths and weaknesses of the current Ethiopian grades 9-10 Mathematics curricula with national and international experiences?

As compared to the Derg's time mathematics curriculum, the current one has progressed in including affective domain to some extent. The objectives for each of course of study (Units, for instance) are written now. The teaching methods and assessment mechanisms

are given suggestion now. As far as the objectives of the then and the current mathematics curriculum are not departed totally, it is difficult to conclude that the current functioning one is typically novel. The contents that were covered within four years (grades 9 through 12) seemingly squeezed in to two years (grades 9 to 10, general secondary) offering. Besides, the depth of some topics such as trigonometric function, exponential function, quadratic equations and inequalities etc is penetrated to the level of application.

As compared to ICS and Sandford international school mathematics curriculums, the following can be mentioned. The general approach of the two international mathematics curriculums is standard or competency based where as ours virtually based on problem solving approach. The international schools' mathematics curriculum regard the individual difference, ours treat all student almost in the same mood. [Refer Plasma TV connected subsections of this thesis]. There are three types of mathematics curriculums for the same grade level in the two international schools. Students' progress is well differentiated.

The role of teachers is reflected in each year when developing curriculum maps; the teacher is assumed to lead the process learning or activity based learning; the evaluation and assessment methods are varied enough in the two international mathematics curriculums. Student-centered intensive learning characterizes the curriculums. On the other hand, the teacher-student centered approach is designed in our mathematics curriculum. Teachers are assumed to facilitate students' knowledge acquisition. Their role is minimized seriously. The annual and lesson plans might help them to adapt the curriculum.

The broadness of Ethiopian Mathematics Curriculum of 9^{th} grade was commented by most of my interviewee teachers. As compared to the two international mathematics

curriculums, it seems rather tapering. When we consider the number of chapters as a unit measurement, there are 9 chapters for Ethiopian grade 9; 13 chapters of 'Algebra 1' for grade 8 or 9 students of ICS; 21 chapters for year 10 students of Sandford International School.

5.3 Recommendations

Based on the findings and conclusion reached at, some points are forwarded to concerned authorities or individuals who could contribute for.

- The ICDR better train and allow actively engage Mathematics teachers and Regional Education Bureau experts to seek contribution ahead of reform and change of curriculum decisions are passed. The MoE, in turn, better endorse any reform or curriculum change proposals after inspection is made on the process.
- The general and specific objectives in the syllabus need to be reformulated in a manner that affective and psychomotor domains could fairly be treated. As well, the levels of objectives better include all the hierarchies of Cognitive, Psychomotor, and Affective domains. The objectives need to be reformulated to accommodate for more high level of objectives.
- The role of students needs to be increased. The ETP advocates on the teaching methods to provide an opportunity to the student to be involved in. Thus, the curriculum need to be revised in a way that student can be able to engage in things to develop their skills and solve practical problems than the acquisition of knowledge; exercises of the project work type could be integrated.
- The Plasma TV program of Mathematics restricts students not to run according to their pace and potential. Therefore, reducing the Plasma TV broad cast from 30 minutes to 20 minutes would give chance students to highly involve in the

learning process. Or, if additional 18 minutes are added to the usual 42 minutes bounded period, it would be possible to permit students to immerse in learning process with the guidance of the classroom teacher.

- ☛ This research uncovers the evaluation of objectives and contents based on the underlying principles and guidelines on how to select and produce them. Thus, I suggest interested researchers for further investigation.

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Appendix 1: Key Words (Action Verbs) in the Taxonomy of Objectives

	Category	**Key Words**

Cognitive Domain: Bloom's Taxonomy		
	Knowledge: Recall data or information.	defines, describes, identifies, knows, labels, lists, matches, names, outlines, recalls, recognizes, reproduces, selects, states.
	Comprehension: Understand the meaning, translation, interpolation, and interpretation of instructions and problems.	Comprehends converts, defends, distinguishes estimates, explains, extends, generalizes, gives Examples, infers, interprets paraphrases, predicts rewrites, summarizes, and translates.
	Application: Use a concept in a new situation or unprompted use of an abstraction.	applies, changes, computes, constructs, demonstrates, discovers, manipulates, modifies, operates, predicts, prepares, produces, relates, shows, solves, uses.
	Analysis: Separates material or concepts into component parts so that its organizational structure may be understood.	analyzes, breaks down, compares, contrasts, diagrams, deconstructs, differentiates, discriminates, distinguishes, identifies, illustrates, infers, outlines, relates, selects, separates.
	Synthesis: Builds a structure or pattern from diverse elements.	categorizes, combines, compiles, composes, creates, devises, designs, explains, generates, modifies, organizes, plans, rearranges, reconstructs, relates, reorganizes, revises, rewrites, summarizes, tells, writes.
	Evaluation: Make judgments about the value of ideas or materials.	appraises, compares, concludes, contrasts, criticizes, critiques, defends, describes, discriminates, evaluates, explains, interprets, justifies, relates, summarizes, supports.

Affective Domain: Krathwohl 's Taxonomy	**Receiving Phenomena**: Awareness, willingness to hear, selected attention.	asks, chooses, describes, follows, gives, holds, identifies, locates, names, points to, selects, sits, erects, replies, uses.
	Responding to Phenomena: Active participation on the part of the learners.	answers, assists, aids, complies, conforms, discusses, greets, helps, labels, performs, practices, presents, reads, recites, reports, selects, tells, writes.
	Valuing: The worth or value a person attaches to a particular object, phenomenon, or behavior.	completes, demonstrates, differentiates, explains, follows, forms, initiates, invites, joins, justifies, proposes, reads, reports, selects, shares, studies, works.
	Organization: Organizes values into priorities by contrasting different values, resolving conflicts between them, and creating a unique value system.	adheres, alters, arranges, combines, compares, completes, defends, explains, formulates, generalizes, identifies, integrates, modifies, orders, organizes, prepares, relates, synthesizes.
	Internalizing values: Has a value system that controls their behavior.	acts, discriminates, displays, influences, listens, modifies, performs, practices, proposes, qualifies, questions, revises, serves, solves, verifies.

Psychomotor Domain: Simpson's Taxonomy	**Perception**: The ability to use sensory cues to guide motor activity.	chooses, describes, detects, differentiates, distinguishes, identifies, isolates, relates, selects.
	Set: Readiness to act. It includes mental, physical, and emotional sets.	begins, displays, explains, moves, proceeds, reacts, shows, states, volunteers.
	Guided Response: The early stages in learning a complex skill that includes imitation and trial and error.	copies, traces, follows, react, reproduce, responds
	Mechanism: This is the intermediate stage in learning a complex skill.	assembles, calibrates, constructs, dismantles, displays, fastens, fixes, grinds, heats, manipulates, measures, mends, mixes, organizes, sketches.
	Complex Overt Response: The skillful performance of motor acts that involve complex movement patterns. Proficiency is indicated by a quick, accurate, and highly coordinated performance, requiring a minimum of energy.	assembles, builds, calibrates, constructs, dismantles, displays, fastens, fixes, grinds, heats, manipulates, measures, mends, mixes, organizes, sketches. NOTE: The Key Words are the same as Mechanism, but will have adverbs or adjectives that indicate that the performance is quicker, better, more accurate, etc.
	Adaptation: Skills are well developed and the individual can modify movement patterns to fit special requirements.	adapts, alters, changes, rearranges, reorganizes, revises, varies.
	Origination: Creating new movement patterns to fit a particular situation or specific problem.	arranges, builds, combines, composes, constructs, creates, designs, initiate, makes, originates.

http://www.nwlink.com/~Donclark/hrd/bloom.html

Appendix 2: Specific Objectives of Grades 9-10 Mathematics Syllabus

Grade 9

Unit 1 Sets

Students should be able to:

1) define sets
2) define the notions "empty set", "finite sets", "infinite sets", "subsets", "proper subsets" clearly
3) determine the number of subsets and proper subset of a given set
4) differentiate between "Equal" and "Equivalent" sets.
5) use Venn diagrams to illustrate set relations.
6) determine the union of sets.
7) determine the intersection of sets.
8) determine the symmetric difference of sets using their respective symbols.
9) determine the complement of a set.
10) determine the product of sets.
11) use Venn diagrams to illustrate set operations
12) state the properties of set operations
13) state the "Demorgan's Laws"
14) use set operations in solving problems on set operations
15) Solve practical word problems leading to set operations.

Unit 2 Elementary Concepts on Binary Operations

Students should be able to:-

1) determine whether the set under discussion is closed under a given operation.
2) define binary operation
3) determine whether a given binary operation is commutative or not, is associative or not,
4) identify the identity element whenever it exists.
5) identify the inverse of an element whenever it exists.
6) solve problems related to binary operations.

Unit 3 Real Numbers

Students should be able to:

1) describe the laws which are valid for rational numbers.
2) represent rational numbers as decimals and fractions.
3) state and prove the theorem on density of rational numbers
4) explain the development of the number system.
5) define irrational numbers
6) locate some points representing irrational numbers on a number line
7) describe the position of a point using intervals.
8) state the nested interval theorem.
9) classify infinite decimals.
10) show the correspondence between infinite decimals and the number line.

11) define real numbers.
12) state the order relation of real numbers.
13) approximate sum of irrational numbers.
14) explain the properties of addition and multiplic-ation on the set of real numbers.
15) explain the notion "rationalization"
16) identify a 'rationalizing factor' for a given expression
17) simplify expressions involving radicals.

Unit 4 Working With Variables

Students should be able to:

1) interpret the definition of the notion 'variable' in their own words
2) identify the structure of a term or on expression.
3) compute the values of terms or expressions by listing the steps.
4) recognize different approaches necessary for proving statements.
5) apply different approaches for proving mathematical statements.
6) transform terms using the rules for removing braces, by multiplying a sum by a sum.
7) describe the binomial formula and use it for transformation of expressions.
8) identify perfect squares.
9) add and subtract quotients
10) multiply and divide quotients.
11) define power
12) recognize that exponentiation is higher form of operation
13) state the laws for multiplying and dividing powers with positive integral exponents.
14) apply the laws for multiplying and dividing powers with integral exponents.
15) multiply powers with rational exponents.
16) divide powers with rational exponents
17) apply the laws of exponents for computing roots.
18) represent any positive rational number in its standard (scientific) notation.
19) perform calculations using physical quantities.

Unit 5 Linear Equations and Inequalities

Students should be able to:

1) apply the addition, subtraction, and multiplication and division rules to obtain successive
   equivalent equations
2) solve linear equations in one variable.
3) apply the rules to transform a given inequality to an equivalent inequality.
4) mark intervals by inequalities and vice versa.
5) write solution sets of linear inequalities in one variable.
6) check solutions of inequalities.
7) solve word problems leading to linear inequalities in one variables.
8) solve simultaneous equations.
9) identify the three cases of solutions of simultaneous equations (a unique solution, no solution, infinitely many solutions)

10) solve a system of two linear equations in two variables.
11) solve word problems leading to simultaneous equations.
12) interpret the definition of absolute value.
13) solve equations involving absolute value using the definition of absolute value.
14) solve linear inequalities involving absolute value
15) solve problems on linear equations and inequalities independently.

UNIT 6 Quadratic Equations and Quadratic Inequalities

Students should be able to:

1) define quadratic equations
2) factorize quadratic expressions.
3) solve quadratic equations using factorization
4) apply the method of completing the square for solving quadratic equations
5) derive quadratic formula using completing the square method.
6) determine the number of roots of a quadratic equation using the discriminant.
7) solve quadratic equations using the quadratic formula.
8) describe Viete's theorem.
9) apply Viete's theorem to solve related problems
10) Solve word problems related to students' real life and leading to quadratic equations.
11) define quadratic inequalites.
12) solve quadratic inequalities by factorization and product property
13) Solve quadratic inequalities by using sign charts of boundary values.

UNIT 7 Relations and Functions

Students should be able to:

1) determine the product of sets.
2) define the notions “relation”, “domain” and “range”
3) draw graphs of relations
4) use graphs of relations to determine the domain and range.
5) define inverse of a relation.
6) determine /write/ the inverse of a given relation
7) determine the domain and range of the inverse of a given relation.
8) draw the graph of the inverse of a relation using the definition.
9) determine the domain and range of the inverse of a relation from its graph.
10) draw the graph of the inverse of a relation by reflecting the original graph of a relation along the line $y = x$
11) define function
12) determine the domain and range of a given function
13) define “Even”, and “Odd” functions.
14) identify the graphs of "Even" and "Odd" functions
15) explain the symmetry of functions.
16) define "Increasing" and "Decreasing" functions.
17) identify the graphs of "Increasing" and "Decreasing functions.
18) define “one –to – one”, “on to” functions.

19) identify functions as one- to - one or not and as on to or not.
20) determine the inverse of a function.
21) sketch the graph of the inverse of a function.
22) determine the domain and range of the inverse of a given function.
23) determine the sum, difference, product and quotient of functions.
24) determine the relationship between the domains and ranges of functions and that of their sums, differences, products and quotients.
25) define the composition of functions.
26) determine the composite function given the components.
27) determine one of the functions given the composite and the other component function.

Unit 8 Quadratic Functions and Power Functions

1) define quadratic function.
2) graph and describe the specific properties of the quadratic functions of the form $f(x) = ax^2$, $a \neq 0$
3) draw the graphs of the functions of the form $f(x) = ax^2 + c$, $a \neq 0$.
4) list down the common properties of the graphs of the functions $f(x)= ax^2 + c$, $a \neq 0$, for different values of a.
5) sketch the graphs of the functions $f(x) = ax^2 + bx + c$, $a \neq 0$.
6) list down the properties of $f(x) = ax^2 + bx + c$, $a \neq 0$ from the graphs.
7) use completing the square to change $f(x) = ax^2 + bx + c$, $a \neq 0$ to the form $f(x) = a(x + d)^2 + e$, $a \neq 0$.
8) determine the vertex and the axis of symmetry for the graph of quadratic function.
9) define the zero of a function
10) determine the approximate zero(s) of quadratic functions from their graphs.
11) define power functions.
12) draw the graphs of power functions with positive integral exponents and list their common properties.
13) draw the graphs of power functions with negative integral exponents and list their common properties.
14) draw the graphs of power functions with rational exponents of the form $\frac{1}{k}$, $k \neq 0$, and list the common properties.
15) solve word problems leading to quadratic functions and power functions.

Unit 9 Trigonometric Functions

Students should be able to:

1) define an angle
2) identify directions of rotations
3) describe angles in standard positions.
4) determine the coterminal angles of a given angle.
5) express a given angle in terms of degrees, minutes and seconds or degrees in decimal and vice versa.
6) convert angles in degree measures to radian measures and vice-versa.

7) determine the coterminal angles to a given angle in radian measure.
8) define the Sine, Cosine and Tangent functions of an angle in standard position.
9) determine the values of the functions for an angel in standard positions, given the terminal side of that angle.
10) use a unit circle to determine the value of the functions for special angles
11) determine the algebraic signs of the sine, cosine and tangent functions of angles.
12) describe the domain, range and periodicity of the sine, cosine and tangent functions.
13) draw the graph of the sine function f(x) = sin x
14) draw the graph of the cosine function f(x) = cos x
15) sketch the graph of the tangent, function f(x) = tan x
16) define the cosecant function.
17) describe the properties of the cosecant function
18) sketch the graph of f(x) = csc x for different intervals.
19) define the secant function.
20) describe the properties of the secant function
21) sketch the graph of f(x) = sec x for different intervals.
22) define the cotangent function.
23) describe the properties of the cotangent function
24) sketch the graph of f(x) = cot x for different intervals.
25) solve right angled triangles using trigonometric ratios.
26) use trigonometric ratios to solve problems on angles of elevation and angles of depression.

Grade 10

Unit 1. Introductory Logic

Students should be able to

1) recapitulate what they have studied about "statement" and "open statement"
2) explain the difference between "statement" and "open statement"
3) determine the truth value of a statement.
4) describe the rules for each of the five logical connectives.
5) recognize and use the symbols 5, v, w, ⇒and ⇔
6) Determine the truth values of compound statements.

Unit 2. Numeration Systems

Students should be able to:-

1) realize the existence of numeration systems other than the decimal numeration system.
2) express decimal numerals in their standard notations and vice-versa.
3) Convert decimal numerals in to numerals in other bases and vice- versa.
4) carry out the four fundamental operations (Addition, Subtraction, Multiplication and Division) in any base.

Unit 3 Exponential and Logarithmic Functions, Logarithms and their Applications

Students should be able to:-

1) use the definition and the laws of exponents in simplifications and in solving simple exponential equations.
2) realize that the laws of exponents are valid for real exponents.

3) define an exponential function.
4) represent exponential functions graphically.
5) list the properties of exponen-tial functions from their graphs.
6) write the formula of functions from their graphs (in simple cases).
7) Can apply their knowledge of exponential functions to describe some phenomena of practical life (process of growth, work producti-vity, compound interest, etc.)
8) define logarithmic function.
9) determine the logarithm of a given number to a given base.
10) list the properties of logarithmic functions from the graphs
11) recognize that exponential functions and logarithmic functions are inverses of each other.
12) solve problems of exponentiation and finding the logarithm.
13) derive the laws of logarithms from the laws of powers.
14) apply the laws of logarithms in simple problems.
15) compute with logarithms to the base two.
16) recognize the advantage of the logarithmic system to the base ten.
17) identify the characteristic and mantissa of any given common logarithm.
18) recognize the struct-ure of the table of common logarithms.
19) use the table for finding the logarithm of a given positive number.
20) determine the number whose logarithm is given.
21) apply the laws of logarithms in computations with common logarithms
22) apply their knowledge on laws of logarithms and on computations with the help of common logarithms for solving practicable word problems of different fields.
23) realize that there are modern auxiliary means that satisfy science and technology but involve expense.
24) get general idea on the development and use of some modern auxiliary means such as slide rule, calculating machines and computers.

Unit 4. Descriptive Statistics and Introductory Probability

Students should be able to:

1) define descriptive statistics.
2) define the notions "population" and "population functions"
3) make a distribution table for a given population function and draw histograms of given population functions.
4) define mean, mode(s) and median of a population function and determine them for given population functions.
5) realize that mean, mode(s) and median are "measures of central tendency" or "measures of location".
6) identify the properties of the mean of a population function.
7) define "variance", "standard deviation" and "range" and determine these values for a given population function
8) realize standard deviation and range as "measures of spread" or "measures of dispersion" and use them properly.
9) define the notions "experiment" and "possibility set"

10) define "event"
11) make a distinction between an impossible event and a sure event.
12) define "observed relative frequency of an outcome" and compute the value for
13) a given outcome of a given experiment.
14) define "probability"
15) determine the probability of a given event.
16) illustrate their probability by using different means such as tree diagram.
17) state the principles of counting and permutations
18) determine the number of elements in the possibility set and in a given outcome of a given experiment.
19) state the principles of combinations and selections.
20) apply the principles for determining the number of elements in the possibility set and in a certain outcome of a given experiment.
21) state the binomial theorem in their own words
22) apply binomial the theorem for determining the expanded form of a given expression or the coefficient of any given term in the expansion of a given expression.

Unit 5. Congruency and Similarity of Triangles

Students should be able to:

1) define congruence of line segments, angles and triangles.
2) state the Side- Angle -Side congruence postulate for triangles.
3) apply the SAS postulate for proving the congruence of triangles.
4) state and prove the Angle - Angle - Side congruence theorem.
5) state and prove the Side- Side - Side, congruence theorem.
6) Prove Hypotenuse- Leg (RHS), Leg - Leg and Hypotenuse- Acute angle theorems for
7) right angled triangles.
8) state and prove the isosceles triangle theorem and its converse.
9) state and prove the AA, SAS and SSS similarity theorems on triangles.
10) solve practical word problems leading to congruence and similarity of triangles

Unit 6. Solid Geometry

Students should be able to:

1) write formulae for calculating surface areas and volumes of solids such as prisms, cylinders, cones, pyramids, spheres.
2) apply these formulae for calculating surface areas and volumes of these solid figures.
3) define frustum of pyramid and of circular cone, derive formulae for calculating surface areas and volumes of these solids.
4) apply the formulae for calculating surface areas and volumes of frustums of pyramids and circular cones.
5) calculate surface areas and volumes of composed solids and similar solids.
6) solve problems related to volumes and surface area of solids.

Unit 7. Trigonometric Functions

Students should be able to:

1) derive the relations $\sin^2 x + \cos^2 x = 1$ and $\tan x . \cot x = 1$ restricted to $0 \leq x \leq \frac{\Pi}{2}$ and rearrange the equations.
2) state the trigonometric relations of complementary angles.
3) use reduction formulae inorder to find the related angle of any given angles, so that they can give the trigonometric value of any given angle.
4) determine the trigonometric values using tables.
5) describe the properties of triangles.
6) state theorems on right angled triangles.
7) apply the trigonometric ratios to solve right angled triangles; functions with respect to right-angled triangles for determining the length of a side, the measure of an angle, and area of a right angled triangle
8) apply trigonometric ratios functions for determining the side length, measures of angles and areas of isosceles and equilateral triangles.
9) derive and use the formula $A = \frac{1}{2} ab \sin \hat{C}$ for calculating area, side length and angle of a triangle.
10) apply the basic principles, ideas and techniques used for calculations on triangles to quadrilaterals and regular polygons.
11) determine volume, the lateral and total surface areas of cone, pyramid, and sphere using the trigonometric ratios.
12) derive the sine law and use it to solve problems.
13) derive the cosine law
14) apply the laws of sine and cosine for calculating sides, angles and areas of triangles.
15) solve different problems related to the applications of trigonometric relations.

Appendix 3: About International Community School of Addis Ababa

The International Community School of Addis Ababa (ICS) is an independent, non-profit, coeducational school, which offers an educational program form pre kindergarten through to grade 12 for students of all nationalities. 'The school was founded in 1966 and serves approximately 420 students from almost 60 countries', from the school web page.

> *The International Community School of Addis Ababa (ICS) is adapting many experiences from different countries. There are many International community schools in distinct countries. ICS of Addis Ababa is independent of any. It takes*

> *something from United States of America. But, it is more international in regarding the cultures of different countries (*Mr. Teddy Afro., on 11/03/09*).*

Students coming from other US-based programs will generally be placed according to their previous school records unless previous records and testing indicate otherwise. Where national programs in other countries closely correspond to the U.S. grade level system, the main criteria for student's placement will be according to the ICS cut-off age and number of years of school completed unless academic history and/or testing indicate a different placement. Any concerns regarding placement will be evaluated on a case-by-case basis.

The school's curriculum, accredited in the United States, develops the talents and intellects of a multicultural student body using learner-centered, holistic instructional methods, empowering each student to contribute in an evolving world. The Middle States Association of Colleges and School accredit the school.

The International Community School of Addis Ababa promotes an interactive, holistic learning environment which stimulates and encourages inquiry, initiative, creativity and academic achievement. Emphasis is placed on providing students with the knowledge, skills and attitudes necessary to face the challenges of the future.

Each student to contribute in an evolving world, ICS has adopted standards and benchmarks in all curricular areas. The curriculum at ICS is dynamic and able to be adjusted to meet the needs of individual students. These standards and benchmarks guide the teacher's planning, assessment, and materials selection. Each teacher designs a curriculum map to ensure that the instructional activities and their assessments align with the standards and benchmarks. The curriculum maps are revised and refined yearly.

The standards have been selected from a variety of sources. Some are from American professional organizations, such as the National Council of Teachers of Mathematics (NCTM) or the National Association for the Education of Young Children. (From their web page)

Appendix 4: About Sandford International School

The origins of the school can be traced back to the early 1940s when Mrs. Christine Sandford, wanted to establish an English-speaking school for her children. The English –speaking community was very small at the time but the Ethiopian nobility also wanted access to an English education for their children. Christine Sandford was the wife of Colonel Sandford, the Head of British Military Mission to Ethiopia during World War II, who along with Cunningham and Wingate, led the British contingent that was dispatched by the British Government to help Emperor Haile Selassie I and the Ethiopian army reclaim the country from 5 year of Italian occupation under Mussolini's Government.

Both British and Ethiopian interests from the beginning, to serve English-language educational needs in the country in a holistic manner, established Sandford. Its role has been unique in Ethiopia and in Africa. Some say it is the first international school in Africa for both nationals and expatriates learning on an equal basis and catering for the special needs in multi-racial, multi-national education. It grew to include a majority of Ethiopian students and began to recruit teachers from abroad.

The teaching staff was mixed international and national with most expatriates from the UK and from other English-speaking countries. Currently about 73% of the teaching staff of the school are expatriates.

In 2001, Sandford English Community School was re-registered as "Sandford International School" and started to offer the international Baccalaureate (IB) instead of the IGCSE A levels, as its pre-university course for yeas 12 and 13.

The school divided into three sections: - the Primary School from Nursery to Year 6, - the Secondary School from Year 7 to Year 13, - the Adult Evening School. Public examinations offered are the Ethiopian National Examinations at Year 8, and Year 10, the IGCSE at Year 11 and the International Baccalaureate at Year 13.

The School has a student population of about 700 and is drawn from approximately 50 nationalities. A significant percentage of the students are Ethiopian.

The School works closely with various offices including the Ethiopian Ministry of Education, Ministry of labor and social affairs and other agencies. The School is a member of the Association of International Schools in Africa (AISA), and the International Baccalaureate Organization. Mission & Values

The Sandford International School is a co-educational, non-boarding, nursery to pre University institution. To meet the international standards of its programme, the School employs a highly qualified professional staff. It is committed to providing a standard of education that is accepted within Ethiopia and by the international community.

Facilities

The site is located on 27,000 sq. metres. It has mostly purpose-built classrooms, offices and laboratories. The libraries have been increasingly outfitted with computers and CD-ROM's. The specialist facilities include five laboratories, two IT rooms, an Art room, a Music Centre, a Hall with stage and a large Gymnasium. There is a

football pitch and facilities for athletics. The store has appropriate administration and support departments, including a sick bay.

There is a whole school computer network, with high-speed connectivity. Students and staff have access to Internet connectivity.

The school is in the process of an aggressive building and development plan. It is an exciting programme, which will give the school quite a different face.

There has been, and continues to be, significant investment into the up-grading of equipment through-out the School. There is a generous supply of TV-videos, Computers for Staff and Students, over-head projectors, LCD projector etc.

The Secondary School Curriculum

In Grades 7-9 students study an international based curriculum comprised of English, Mathematics, French and Amharic, Science, History, Geography, PE, Information Technology, Dram, Dance, Art and Music. Students study each subject regardless of whether they are national or international. This broad based curriculum facilitates a wide range of choice, when they select their IGCSE Option subjects in the third term of Grade 9.

In English and Mathematics students are taught as a whole year group and set into one or other of three classes. In all other subjects students are taught in their tutor groups, which are mixed ability classes. For those students who may need it, learning support in a particular subject is available, either in class or through a withdrawal system. If necessary learning supports can continue when a student transfers into Grade 10, and starts onto the IGCSE Program.

Ethiopian students sit for the National Examinations in Year 8 and Year 10. Since the National and International curriculums are very different, an additional after school tutorial support programme is offered to those students who require it.

In Years 10 and 11 students follow a two-year course leading to the Cambridge IGCSE Examinations. This is an internationally recognized examination that allows students onto pre university educational programmes, such as the International Baccalaureate Diploma. Students are required to take English Language and Literature, Mathematics, and either French or Amharic. In addition students select four option subjects from History, Geography, Environmental Management, Business Studies, Biology, Chemistry, Physics, Drama, Art PE, Information Technology and Music. All students take the English as a Second Language Paper at the end of Grade 10, and sit the English as a First Language Paper along with all other subjects at the end of Grade 11.

Students whose first Language is other than English, Amharic or French may elect to sit a language paper in their mother tongue, providing that it is offered by the Cambridge Examination Board. The school cannot arrange tuition, but will supply examination syllabuses and past examination papers.

At all stages in a student's education there is an emphasis on the process of learning, and the use of cross-curricular activity based approaches. In Grades 7-9 students are required to do both project and fieldwork, since coursework is an integral component of both IGCSE and IB Examinations.

Assessment, recording, and reporting are integral components of our teaching programmes. Students have a homework timetable that details the subjects in which they will receive homework on a particular day. Teachers will give regular tests as

*units of work are completed. Each student receives two full and one interim report each academic year. (**http://www.sandfordschool.org/**)*

Appendix 5: The System of Calculating the Percentage-Index

If **β** is the number of alternatives in the coding units and **α** is the number of disagreements, then 'one minus **α** over **β**' is the point corresponding to a theme. Example follows on how to give points in coding sheets for three hypothetical objectives of a unit.

Educational Objectives	Domain of Educational Objectives				REMARK	Mark Given out of One
	Cognitive	Affective	Psycho-motor	Vague Objective		
1. The student will…	X		X		Coders of group A	0.75
	X				Coders of group B	
2. The student will…	X				Coders of group A	1
	X				Coders of group B	
3. The student will…		X		X	Coders of group A	0.5
	X	X			Coders of group B	
Total point given to the unit						2.25

In the above table, β is the number of alternative beneath 'Domain of Educational Objectives'. Thus, β is 4. α could vary for each of the educational objective statements. The two coders disagree only for 'Psychomotor Domain' in the first objective. Thus, **α** is 1. In the second objective, **α** is 0. Similarly, the coders have different response for 'cognitive Domain' as well as 'Vague Objective'. So, **α** is 2. Once the points are added to 2.25 (i.e., 0.75 + 1 + 0.5 = 2.25), it will be changed to percentage. There fore, 2.25 times 100% over 3. 3 is the total number of such objectives. It becomes 75% only. That is, $\frac{2.25}{3} \bullet 100\% \rightarrow 75\%$. An appropriate minimum acceptable level of reliability index was decided to be 80% (0.80).

Appendix 6: Coding Sheets

Form I- Category of Educational Objectives in the Current General Secondary Schools Mathematics Syllabus

Chapter: _____ Coding Unit: Objectives

Coder Group: _____

Date of Coding: _____Time of coding: _____to_____

Instruction-Based on the definitions and indicators for each domain and on your judgment, for each objective statement, mark 'X' under the column of the Domain. If you assume the sentence can be assigned to two or three domains, write the 'X's accordingly under the columns. Thank you in advance.

Educational Objectives	Domain of Educational Objectives				REMARK
	Cognitive Domain	Affective Domain	Psycho-motor Domain	Vague Objective	
1.					
2.					
3.					
4.					

Form II- Levels of Educational Objectives in the Current General Secondary Schools Mathematics Syllabus

Chapter: _____ Coding Unit: Objectives
Coder Group: _____
Date of Coding: _____Time of coding:
_____to_____

Instruction- the sentence can Based on the definitions and indicators for each level of objectives and on your judgment, for each sentence, mark 'X' under the column of the Domain. If you assume be assigned to consecutive levels, write the 'X's accordingly.

A) Cognitive Objectives (Bloom's Model)

Cognitive Educational Objectives from form I	Levels of Cognitive Domain						
	Knowledge	Comprehension	Application	Analysis	Synthesis	Evaluation	Vague to identify
1.							
2.							
3.							
4.							
5.							

B) Affective Objectives (Krathwohl's Model)

Affective Educational Objectives from form I	Levels of Affective Domain					
	Receiving	Responding	Valuing	Organizing	Characterizing	Vague to identify
1.						
2.						
3.						
4.						
5.						
6.						

C) Psychomotor Objectives (Simpson's Model)

Psychomotor Educational Objectives from form I	Levels of Psychomotor Domain							
	Perception	Set (Readiness)	Guided Response	Mechanism	Complex-covert Response	Adaptation	Originating	Vague to identify
1.								
2.								
3.								
4.								
5.								
Total								

After Alemayehu (2001)

Form III- Classification of Instructional Methods in the Current General Secondary Schools Mathematics Curriculum

Chapter: _____ Coding Unit: Instructional Methods
Coder Group: _____
Date of Coding: _____
Time of coding: _____to_____

Instruction- Based on the definitions and indicators for each and on your judgment mark 'X' in the cells
for matching of vertical up & horizontal left. Thank you in Advance.

Unit	Sub -Titles	Instructional Methods									Comment
		Lecture/ Explanation	Demonstration	Discussion	Answering Questioning &	Problem Solving	Guided Discovery	Task/ Project Based	Inquiry	Others	
Total											

Form IV: Rating of Assessment and Evaluation Mechanisms in the Current General Secondary Schools Mathematics Curriculum

Chapter: _____ Coding Unit: Assessment and Evaluation Mechanisms
Coder Group: _____ Date of Coding: _____
Time of coding: _____to_____

Instruction- Based on the definitions and indicators for each and on your judgment, for each sub-title, mark 'X' under the Assessment Mechanisms columns.

Number	**Sub-Titles**	Assessment Mechanisms								**Comments**
		Home work	Class Work	Test	Oral Questions	Quiz	Individual Assignment	Group Work	Others	