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Comparative Study on the Senior Secondary School Mathematics Curricula Development in Ethiopia and Australia

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Abstract
The main objective of this study is to compare the process of the senior secondary school mathematics curricula development in Ethiopia and Australia. The study was investigated qualitatively with document analysis and semi-structured interview research methods. The documents were collected from Federal Democratic Republic of Ethiopia Ministry of Education website and Australian curriculum website. The documents were analyzed and supported by interviews. The study was conducted based on four themes needs assessment, developing/writing the curriculum, implementation, and monitoring and evaluation. The study revealed both similarities and differences. The considerable differences in the senior secondary school mathematics curriculum development process are (1) emphasis given to international research results and contemporary issues on mathematics education as inputs for curriculum development (2) the underlying principle of content standard organizations (3) trialing the curriculum before implementation initiated, and (4) monitoring and evaluation strategies. Even though substantial differences exist, the similarities are (1) conducting needs assessment and (2) the adoption of the constructivism approach. Depending on the findings of the study, the suggested recommendations were presented under conclusion section.
Keywords: Ethiopia, Australia, comparative study, senior secondary school curriculum, curriculum development

1. Background of the Study

Every country has its own education policy. This policy could be addressed via advanced school curriculum which is viewed as a foundation for educational reforms aimed at achieving high-quality learning outcomes. One could most likely pose a question what a curriculum mean. In the simplest way, there is no universal definition of the term curriculum. A curriculum has different meaning and explanations that could be conceptualized from different perspectives (UNESCO-IBE, 2013; Areaya, 2008; Kassaye, 2005, 2014). The term curriculum has many definitions ranging from dictionary definition 'course of study' to the knowledge, understanding, skills and attitudes that the students acquired as a result of teaching and learning process. Different definitions were proposed by curriculum theorists and philosophers from different viewpoints. Some of them are different, while some most of them slightly similar. Here are some definitions. UNESCO-International Bureau of Education (2013) defined curriculum in the simplest term as a description of what, why, how and how well students learn efficiently and effectively. Taba defined curriculum in a broad conception as "a plan for learning" (Bloom, 2006). While, Ralph Tyler defined curriculum as the plan of the learning experience in which schools are in charge of its implementations to attain its educational goals (Tyler, 1957). Similarly, Kerr (1968) defined curriculum as "all the learning activities which are planned and guided by the school, whether they are carried out in groups or individually, inside and outside the school" (cited in Subharani et al, 2014; p. 48). The focal point here in these definitions is preparing a program and attaining why it was planned for. Such kind of plan is considered as means to an end (Areaya, 2008). In response to such kind of conception and definitions of curriculum, Stenhouse (1975) defined curriculum as "a curriculum is an attempt to communicate the essential principles and features of an educational proposal in such a form that it is open to critical scrutiny and capable of effective translation into practice" (cite in Areaya, 2008; p. 2). This definition is viewed as an alternative to classical definitions of curriculum those main features are on the preparations of a plan for the students to learn. In such kinds of curriculum, the pupils' role is insignificant both in planning, and teaching and learning process. In contrast, the main feature of Stenhouse definition is the communications on the essential principles of the educational proposal. And curriculum could be open to critical scrutiny.

The International Association for the Evaluation of Educational Achievement (IEA) categorized curriculum into three at system levels: *Intended, Implemented, and Attained curriculum* which, nowadays, is widely used in mathematics education and curriculum development (Zhao, 2016; Cai & Howson, 2013). When one thinks of teaching and learning (of mathematics) what comes to his/her mind is the term curriculum, however, they might not know the differences between these three terms. From the first author's firsthand

experience, most people in Ethiopia are unsatisfied with the current Ethiopian education system. They claim that less students' achievement and less job opportunities and other problems are because of curriculum downsides. However, to most of them, perhaps it means education structures and systems; because, the former education system and structures were changed by the existing government, the Federal Democratic Republic of Ethiopia (FDRE) in 1994 (FDRGE, 1994).

Intended Curriculum refers to the curriculum standards, frameworks or guidelines that delineate what students should learn and attain at different school grade levels (Porter & Smithson, 2001). This implied that implemented curriculum is an official and/or written document for the learning of mathematics. According to Cai & Howson (2013), it includes the "goals and expectations set at the educational system level along with official syllabi or curriculum standards." However, its attainments depend on the implementations at the classroom levels which could more probably altered by different school complexities.

Implemented Curriculum refers to putting the intended mathematics curriculum/syllabus into practice at the classroom level (Cai & Howson, 2013). At this level, teachers, principals, and school administrative staffs are responsible for implementing the intended mathematics curriculum through proposed teaching and learning methodologies described in it and according to their experience and beliefs (UNESCO-IBE, 2013). This shows the operation of the mathematics curriculum at the classroom level. In reality, this level is the level at which, more probably, students acquire their mathematical knowledge and develop positive attitudes towards the subject mathematics. For instance, from the first author firsthand experience, when he was in senior secondary school level, he heard when students saying "I hated mathematics cause of uninviting teaching and learning of mathematics at different grade levels".

Attained Curriculum refers to what is actually learned by students and is attested in students' achievements and attitudes (UNESCO-IBE, 2013). It deals with those aspects of the intended curriculum that are taught by teachers and learned by students (Cai & Howson, 2013). Generally, what can be assessed and demonstrated are the learning outcomes or learned curriculum. This indicates the performance in relation to the objectives and the activities. Thus, it is considered as the product of curriculum development process.

Therefore, the differences between *intended, implemented and attained curriculum* makes *intended curriculum* to be the heart of this study. Thus, the main objective of this study is to compare the process of intended senior secondary school mathematics curriculum development in Ethiopia and Australia. The corresponding research question is what are the similarities and differences in the process of intended senior secondary school mathematics curriculum (hereafter referred by SSSMC) development in Ethiopia and Australia?

Why was Australia chosen? Australia was chosen for three main reasons. These are (1) the first Australian national senior secondary school curriculum was published in 2012; (2) the required documents, from the curriculum design to the published curriculum and others are available on *www.acara.edu.au* and *www.australiancurriculum.edu.au* websites and on free access *www.google.com* website and (3) there are no comparative research conducted on senior secondary school mathematics curriculum, so far, between Ethiopia and Australia.

1.1. Mathematics Curriculum Development in Ethiopia Since 1991

Following the change of government in Ethiopia on 28th May 1991, the education reform took place and the new education and training policy were launched in 1994 (FDRGE, 1994). Based on this policy, the secondary school mathematics curriculum was developed and implementation was started in 1999/2000. This curriculum served as the country's secondary school mathematics curriculum/syllabus up to 2010.

In response to the problems identified by the research conducted by Curriculum Development and Implementation Directorate (CDID), Ministry of Education, the Ethiopian government decided to reform the curriculum and the initiatives started in 2007 (Belayneh, 2012). Thus, based on the stated objectives of the education and training policy (FDRGE, 1994) and the mandates given to the curriculum experts, the mathematics curriculum experts at central, the Ministry of Education developed the drafts of the senior secondary school mathematics curricula/ syllabi. These drafts of the curricula were endorsed in collaboration with regional curriculum experts. Thus, the new Ethiopian intended SSSMC/syllabi were launched in 2010. Since then, it has been in operation.

However, likewise, the former two consecutive regimes in the country, this regime's policy, education system and curriculum were not free of criticism. Most researchers criticize education system and curriculum from different perspectives, for instance, from quality education, academic freedom, curriculum development, and students' achievements (Shishigu, 2015; kassaye, 2014; Areaya, 2008; Telila, 2010; Negash, 1996). According to the study of World Bank (Joshi & Verspoor, 2013), the challenges of secondary education in Ethiopia are low primary education completion rate; inequitable access, with rural populations and girls at a particular disadvantage and student learning achievement that is disappointingly low. The study conducted by Gebremichael (2014) on the relevance of mathematics to other school subjects, pointed out that the students were exposed to the applications of calculus in physics before they learn in mathematics. This provides the highlights

of the mathematics content standard inconsistency of mathematics with other science subjects.

1.2. Overview of Mathematics Curriculum Reform in Australia

The Australian Ministerial Council on Education, Employment, Training and Youth Affairs declared new education goals for young Australians in December 2008. The decree of new education goals for young Australians was in response to the five major changes in the world (MCEETYA, 2008) and better schooling for all young Australians. These major changes were:

- Global integration and international mobility have increased rapidly in the past decade,
- The influence of fast Asian growing countries such as India, China and other Asian countries,
- Globalization and technological are placing greater demands on education and skill development in Australia,
- Complex environment, social and economic pressures such as climate change that extend beyond national borders pose unprecedented challenges and
- Rapid and continuing advances in information and communication technologies (ICT) (p. 4-5).

The Melbourne declaration on educational goals for young Australian, declaration has two major goals. Australian government believed that through commitment and hard work, equity and excellence (Goal-1) will be promoted so that all young Australians become successful learners, confident and creative individuals, and active and informed citizens (Goal-2) (ACARA, 2013a).

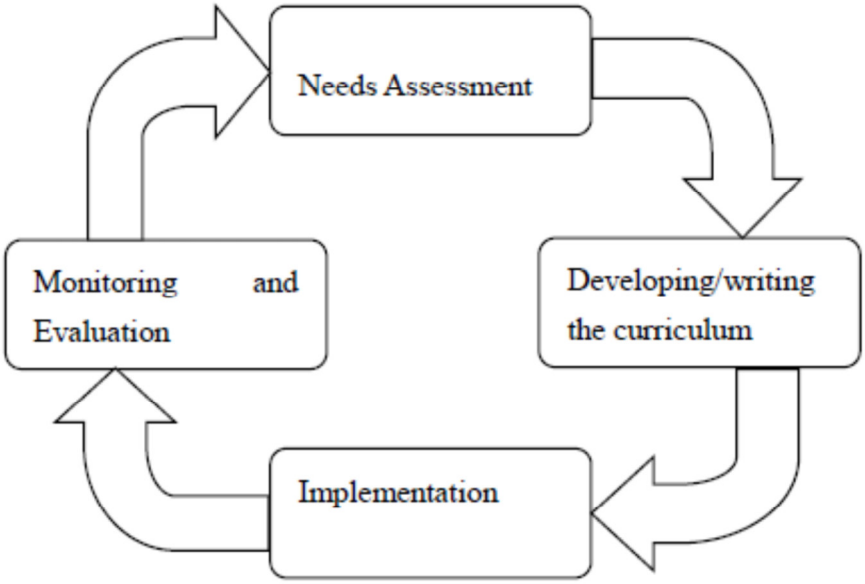
The main emphasis of Melbourne declaration is on the importance of knowledge, understanding and skills of learning areas, general capabilities and cross-curriculum priorities as a basis for a curriculum design to support twenty-first century learning (MCEETYA, 2008). Accordingly, the curriculum was designed to develop successful learners, confident and creative individuals and active and informed citizens (ACARA, 2013a). The Australian curriculum development process, in general, and the intended SSSMC in particular, has passed through the four interrelated phases. These are curriculum shaping, curriculum writing, preparation for implementation and curriculum monitoring, evaluation and review (ACARA, 2012a). After a long process of developing the school curricula, then finally, the Standing Council of Ministers approved the final revised and quality assured senior secondary Australian mathematics curricula in December 2012. The state and territory school and curriculum authorities are responsible for implementing these curricula (ibid). Now this curriculum is available on the Australian Curriculum, Assessment and Reporting Authority (ACARA) website *www.australiancurriculum.edu.au*.

2. Framework of the Study: Process of Curriculum Development

This section addressed the conceptual framework of the study. Intended curriculum development **"**is the process of developing a coherent sequence of learning situations, materials, and student assessment procedures, which has the potential to bring about desired changes in students' learning" Cai & Howson (2013, p. 952). According to this definition, curriculum development is a complex and time-consuming process in nature. The term *process* itself is a sustained phenomenon that needs gradual changes through a series of states. Lunenburg (2011) defined intended curriculum development as the process of planning, implementing, and evaluating curriculum. The intended curriculum development proposal (Malloy, 2006) is started from evaluating the existence curriculum to designing an improved curriculum, to implementing a new curriculum and back to evaluating the revised curriculum. This implied that there are serious of steps, connected to one another, to be followed during curriculum development. These series of steps is called *curriculum model* upon which curriculum planning is build upon (Adeoye, 2006).

A number of curriculum theorist developed different models of curriculum development. Two of them, *objective model* (e.g. Tyler's and Taba's Model) and *process model* (Stenhouse's model), are considered the most dominant models. The main difference between them is the emphasis given to the 'objective' and 'process' by the objective and process model respectively (Areaya, 2008). There is no best model. It depends on upon the fitness for the purposes. All the models have their own pros and cons. What one could understand from them is that curriculum development is time-consuming to create rigorous and realistic curriculum programs that provide opportunities for all students to learn. To investigate this study, the cyclic curriculum development model was adapted from Curriculum Development Handbook (RSD, 2006). As shown in figure 1 below, the model has four interrelated phases: *needs assessment, developing/writing the curriculum, implementation, and monitoring and evaluation*.

Figure 1 the process of curriculum development model



According to this cyclic model, curriculum development is started by assessing the needs and preliminary evaluation of current curriculum, current research, current national and international issues in the particular fields of mathematics education and curriculum development. The next phase is the developing/writing the new curriculum. According to this model, developing/writing the new curriculum could pass through: organizing the curriculum committees, the review needs (review the current research and curriculum guide, and review the current course contents), producing the drafts of the curricula, public consultations, obtaining approval and endorsement. The third is implementations of the new curricula. This is a phase at which the endorsed curricula could be put into practice that is, piloting or trialing the curricula at classroom levels and providing in-service training to teachers and school administrative staffs to make them familiar with the new curricula. The last phase according to this model is monitoring and evaluations. This is the level at which the curricula strengths, weaknesses, needs, preferences for textbooks and other materials, and topics or objectives that do not seem to be working effectively could be studied thoroughly. Therefore, the senior secondary school mathematics curriculum development process undertaken in Ethiopia and Australia were compared based on these four interrelated curriculum development process.

3. Methodology of the Study

The study was conducted qualitatively with document analysis and semi-structured interview research methods. Collecting and analyzing data using more than a single research method, therefore, helps to get a comprehensive and deeper understanding of the problem under study.

The first research method was document analysis. Bowen (2009) defined document analysis as a systematic way of reviewing and evaluating documents (electronic and printed documents). Bowen (2009) argued that "document analysis requires that data be examined and interpreted in order to elicit meaning, gain understanding, and develop empirical knowledge (p. 27)." In this manner, the Ethiopian government curricular documents like education and training policy, senior secondary school syllabuses and textbook were collected from the Ministry of Education *www.moe.edu.et* website. These all documents were analyzed based on the adopted framework of the study. Unlike Australia, it is hardly possible to find the published guiding materials of the Ethiopian curriculum development process and procedures neither on *www.moe.edu.et* website nor in printed form, except the online (*www.moe.edu.et*) published syllabus and textbooks. Therefore, additional documents were collected by the first author from Curriculum Development and Implementation Directorate (CDID), Ministry of Education in electronic and printed form, yet, it was not enough. These were the driving forces to conduct an interview with the (mathematics) curriculum experts, Ministry of Education.

In comparison, required documents pertaining to the Australian intended senior secondary school mathematics curriculum (SSSMC) are available on *www.acara.edu.au, www.australiancurriculum.edu.au* websites, and open access *www.google.com* website. Unlike Ethiopia, the Australian intended SSSMC documents from the initiate of curriculum design to the finally endorsed and published curriculum are available on the *www.acara.edu.au* and *www.australiancurriculum.edu.au* websites. All required documents for this study were downloaded, analyzed, compared and contrasted with Ethiopia based on the adopted framework of the

study.

The second research method was a semi-structured interview. In the semi-structured interview, the interviewer and interviewees engage in a formal interview. One of the advantages of the semi-structured interview is that the informants have freedom to express their feeling and views in their own way (Fraenkel & Wallen, 2009). Concerning the Australian intended SSSMC almost all documents are available on the websites. Even though it seems it was enough to understand the process of Australian intended SSSMC development, the supervisor of the researcher arranged him to interview few of the Australian University teachers, from University of Sydney and Melbourne University. Accordingly, a semi-structured interview was prepared and the interview was conducted with the informants from University of Sydney and Melbourne University.

As discussed above, due to a shortage of online limited access to required Ethiopian (mathematics) curriculum development processes, a semi-structured interview guide was prepared and the interview was conducted with (mathematics) curriculum experts and Addis Ababa University lecturers those who, somehow, have a relationship with curriculum experts, Ministry of Education. Purposive sampling technique was used to select the informants. Because, the information needed for the study directly concerns the curriculum experts, Ministry of Education, Ethiopia.

4. Major Findings of the Study: Results and Discussion

The major findings, results and discussions were described in terms the phases of the adapted curriculum development framework: *needs assessment, developing/writing the curriculum, implementation and monitoring and evaluation*.

4.1. Needs Assessment

The following two subsections describe the needs assessment conducted before the beginnings of writing the senior secondary school mathematics curriculum in Ethiopia and Australia.

4.1.1. Needs Assessment in Ethiopia

According to my interviewees, the senior mathematics curriculum experts (hereafter referred by SMCEs), Ministry of Education, the new intended SSSMC mathematics curriculum development was started by conducting a needs assessment. According to Belayneh (2012), the senior curriculum experts, Ministry of Education teachers', directors', supervisors', and parents' attitudes were collected and analyzed at the preliminary stage of curriculum development. Similarly, the interview results indicated that to some extents, the needs assessment were conducted and analyzed. The document analysis (Belayneh, 2012) indicated that the results obtained from the needs assessment assisted them, the Curriculum Development and Implementation Directorate (CDID), to identify the gap between what existed and what was actually needed, so that, filling that gaps became one of the intentions of the major curriculum development in Ethiopia.

According to my interviewees, the SMCEs, Ministry of Education, the limitations of old SSSMC were summarized as it lacks relevance, less emphasis on problem-solving, content overload, more of theoretical and memorization, less diversified, unattractive layout, difficulties in implementing continuous assessment and student-centered approaches. Thus the intended mathematics curriculum was reformed in response to these limitations and other government strategies such as the Growth and Transformation Plan (GTP), Education Sector Development Plan (ESDP IV), poverty reduction and sustainable development strategies, Education for All (EFA) and Millennium Development Goals (MDGs) (MOE, 2010a).

The informants were asked about the experience of reviewing both national and international research results and other issues on mathematics education. Then, the interview results showed that there was less experience of reviewing national and international research findings on mathematics education and curriculum. This implied that the recent international issues and trends on the (secondary school) mathematics education and curriculum were not addressed at needs assessment stage. Hence, it seems that conducted needs assessment was not exhaustive, because, it fails to address the contemporary issues in mathematics education and curriculum in general.

4.1.2. Needs Assessment in Australia

In comparison, the interview results indicated that the Australian intended curriculum development was started by reviewing the states' and territories' (mathematics) curriculum. Unlike Ethiopia, concerning the national and international research results, the document analysis, *Senior Secondary Mathematics Information Sheet (http://www.acara.edu.au/_resources/Senior_Secondary_Mathematics.pdf*), indicated that at the preliminary stage of the intended curriculum development process, ACARA reviewed both national and international conferences and research results. These are (1) *Foundation Numeracy in Context (*2006) (2) *Maths? Why Not? Final Report prepared for the Department of Education, Employment and Workplace Relations (2008)* (3) *Guidelines for Assessment and Instruction in Statistics Education Project (2004)* and *Teaching Statistics in School-Mathematics- Challenges for Teaching and Teacher Education (2011).*

In addition to these national and international research results, the document analysis, *Senior Secondary*

Mathematics Information Sheet, indicated that ACARA reviewed Finland's, Singapore's, Hong Kong's and United Kingdom's mathematics curricula. These all indicated that, unlike Ethiopia, at the beginnings of senior secondary mathematics curriculum development in Australia, the curriculum developers, the ACARA addressed contemporary issues in mathematics education both nationally and internationally. Similar to Australia, Ethiopian mathematics curriculum developers were assumed to consider various countries mathematics curricula, although these were not explicitly documented.

4.2. Developing/writing the curriculum

The following two subsections describe developing/writings the senior secondary school mathematics curriculum in Ethiopia and Australia.

4.2.1. Developing/writing the curriculum in Ethiopia

According to the Ethiopian Education and Training Policy (FDRGE, 1994), the intended curriculum development was started based on the stated objectives the country's education policy. According to Solomon Belayneh (2012), the senior curriculum expert, Ministry of Education, the major school intended curriculum development process undertaken in Ethiopia has passed through the following steps presented in table 1.

Table 1 steps of the curriculum development process undertaken in Ethiopia

No	Steps of curriculum development process undertaken in Ethiopia	Remark
1.	Established a task force that will conduct and oversee the curriculum development	Needs assessment
2.	Conducted situational analysis through desk research	
3.	Conducted needs assessment	
4.	Developed the national curriculum framework (KG to grade 12)	Developing or writing the curriculum
5.	Developed flowcharts, MLC (minimum learning competency) documents and syllabuses for each subject	
6.	Developed textbooks and teacher guides	
7.	Conducted training of the trainees (TOT) workshops to introduce the curriculum framework and the new curricular materials	Implementation
8.	Began conducting formative evaluation	Monitoring and Evaluation
9.	Planned to conduct summative evaluation by external evaluators	

The steps one through three indicates the preliminary conditions addressed at the needs assessment stage, while, the steps four through six indicates the process of developing the intended curricula (syllabi, textbooks, teachers guide and other materials). Such kind of procedures in intended curriculum development is another broke down of the objective model. This result is similar to the recent research findings of the old curriculum development process and procedures, Areaya (2008).

The interview results indicated that the development of the intended secondary school curricula is the mandate of mathematics curriculum experts at central, Ministry of Education. This indicates that regional education bureaus curriculum experts' participations in the development of the secondary school curriculum are negligible. The result is similar to the recent research findings of Areaya (2008).

The respondents were asked about the participations of (mathematics) teachers in the process of intended mathematics curricula. The informants' response indicated that the teachers' participation in the intended curriculum development in general (preparing the syllabi or textbook) was unsatisfactory. In Ethiopian, the change agent in charge of curriculum implementations, the teachers and principals, lack the sense of ownership of the curriculum because of much less participation in the intended curriculum development process (Areaya, 2008). One could probably think that the less participation of teachers in the first intended curricula development was, probably, because the government's change on 28th May 1991 followed by immediate education reform and curriculum development. Now, if one could pose the question why teachers were not participating in the second intended curriculum development, is a genuine question that supports the findings in the 'needs assessment in Ethiopia' subtitle.

The informants' response to the interview question on time-consumed and number of human recourses indicated that the time taken to develop the syllabuses and number of human resources, as well, were not enough during the intended SSSMC development. One of my interviewees, SMCE, added saying:

> …there are no enough qualified experts at mathematics curriculum expert office, Ministry of Education…there are no continuous training on curriculum development and implementations…most of us who have been working as the curriculum experts are from our personal experiences, we have developed through the years.

It is apparent that the role of highly qualified (mathematics) curriculum expert is vital to produce good curricula/syllabi (Kassaye, 2014). One of my interviewee, from Addis Ababa University, added saying that "there is a shortage of qualified curriculum experts at Ministry of Education…experts should be given

continuous training on the curriculum development in general…highly qualified individuals must be employed there."

The informants were also asked about what kinds of learning theory the curriculum build on. The interviews and document analysis (Belayneh, 2012; MOE, 2010a) indicated that the new (secondary school mathematics) curriculum development was based on *Constructivism theory*. Constructivism is an alternative approach to the traditional mathematics curriculum development and instruction known by *transmission* approach (Clements & Battista, 2009). In this view, students are considered as the passive learner. However, in *constructivist* view, students construct their own knowledge rather than receiving it in finished form from the teacher (ibid). In the philosophy of mathematics education, constructivism is considered as "reconstructing mathematical knowledge" (Ernest, 1991). This viewpoint suggested that in constructivism based teaching and learning process, learners' construct mathematical knowledge through the active learning process. The concept is described in Curriculum Framework for Ethiopian Education (KG – Grade 12) (MOE, 2010a).

> …teachers *do not spend whole lessons talking*, but plan in opportunities for class discussions in which students can exchange ideas, resolve misunderstandings and make sense out of what they are listening to, or engage in a variety of different activities which give them the opportunity to *construct meaning* for themselves out of the information they are receiving (p. 2)

The informants' were asked about the senior secondary mathematics content standard organizations both within the mathematics subjects and across other subjects like physics and chemistry. The interview results indicated that the curricula were organized for the purposes of making good foundations for university courses. This implied that the curricula were organized as lists of topics as introduction to the university courses. However, whatever the purpose was to make good foundations for the university, students need to learn mathematics should be taught at senior secondary levels with strong justifications underlying the subjects.

Concerning the horizontal content organizations of the mathematics syllabuses with other science subjects, the document analysis (Belayneh, 2012) indicated that flowchart and syllabus contents were organized to integrate the contents both vertically and horizontally. However, the results of another document analysis, grade 11 and 12 mathematics, physics, and chemistry syllabi and textbooks, showed that less considerations have taken place while organizing the content standards of the SSSMC in relation to physics and chemistry. The document analysis results are described as follow.

1. Mathematics textbook *grade 11 unit 8 is vectors and transformations* of the plane (MOE, 2009a). While physics student textbook *grade 11 unit 2 is Vector quantities* (MOE, 2008). This indicates that students are exposed to applications of mathematics that demand the mathematics concept first. This result is similar to the earlier findings of Gebremichael (2014).
2. Mathematics textbook *grade 12 units' 2-5 is an introduction to calculus* (MOE, 2009a). While chemistry syllabus grade 11- unit 4 is Chemical Kinetics (MOE, 2009b). This unit requires the prior knowledge of calculus, yet, the students will learn in grade 12.

4.2.2. Developing/writing the curriculum in Australia

Unlike Ethiopia, the documents concerning Australian senior secondary school mathematics curricular developments are available on the *www.acara.edu.au* and *www.australiancurriculum.edu.au* websites. The writing process of the Australian senior secondary mathematics curriculum was commenced in 2009 with reference to Melbourne Declaration on Educational Goals for Young Australian (MCEETYA, 2008), National Mathematics Curriculum: Framing paper (NCB, 2009a), Shape of Australian Curriculum: Mathematics (NCB, 2009b), and the Curriculum Design Paper V2 (ACARA, 2009a). Unlike Ethiopia, the interview result showed that the Australian SSSMC were developed by a group of experts organized by mathematics curriculum experts, pedagogical experts, especial needs experts, information and communication technologies (ICT) experts, indigenous mathematics experts and ethnic experts.

The development was started considering Educational goals for young Australians, key research, learning needs in the 21st century and leading national and international curriculum (ACARA, Infographic, 2016c). Unlike Ethiopia, the writings of the Australian senior secondary mathematics curriculum were started by categorizing the senior mathematics curriculum into four subjects: *Essential Mathematics, General Mathematics, Mathematical Methods and Specialist Mathematics* (ACARA, 2016a). These subjects were developed with the corresponding rationale underlying the subjects. The development passed through four interconnected curriculum development phases (ACARA, 2012a). These are Curriculum shaping, Curriculum writing, Preparation for implementation and Curriculum monitoring, evaluation and review.

In comparison, unlike Ethiopia, the first draft of Australian senior secondary school mathematics curriculum was brought into national consultation in 2010. This first draft has passed through serious public national consultation, stakeholders' feedback, curriculum authorities' consultation and group discussion with professional associations in between June and July 2010 (ACARA, 2016b). In response to these, all feedbacks the writings of the drafts commenced in May 2011 followed by national consultation in August 2011 (ibid). According to the same source, after incorporating all comments gathered from all stakeholders, curriculum

authorities and professional associations the draft presented to national public consultation between May and July 2012. After a long process in developing the senior secondary school curricula, then finally, the Standing Council of Ministers approved the final revised and quality assured senior secondary Australian mathematics curriculum in December 2012. The state and territory school and curriculum authorities are responsible for implementing these curricula (ibid). Now this curriculum is available on the Australian Curriculum, Assessment and Reporting Authority (ACARA) website *www.australiancurriculum.edu.au*.

The Australian Mathematical Sciences Institute (AMSI) believed that without good ground in mathematics, it is hard to achieve good skills in trades such as plumbing, electrical, carpentry, and building (CAG, 2008). Thus to establish good ground in mathematics, *Australian National Statement on Mathematics* (AEC, 1990) suggested *four* mathematics learning principles:

1. Learners *construct their own meanings* from, and for, the ideas, objects, and events which they experience;
2. Learning happens when existing *conceptions are challenged*;
3. Learning requires *action and reflection* on the part of learner;
4. Learning involves taking risks (p. 16–17).

The phrases "construct their own meaning, conceptions are challenged, action and reflection" in the above learning principles indicated that the teaching and learning process should give students to come up with their own constructed understanding in a given lessons. These revealed that the Australian curriculum was developed based on the *constructivist* theory of learning. This finding is similar to the interview results conducted with lectures from University of Sydney and Melbourne University. Therefore it suggests that the foundation of Australian mathematics curriculum is based on constructivism, which is similar to the recent research findings of Zhao (2016).

4.3. Implementation

The following two subsections describe the implementations of the senior secondary school mathematics curriculum in Ethiopia and Australia.

4.3.1. Implementation in Ethiopia

Among the earlier mentioned steps in table 1, in which the Ethiopian curriculum development passed through, steps seven is about implementations of the curricula. The informants were asked about the curricula pilot test before implementations were started. The interview results indicated, in short answer, that it was not pilot-tested. One of my interviewees, the SMCE, Ministry of Education, has the following reasons to justify.

> To be honest, as mathematics curriculum experts we know curricular materials need to be pilot-tested, however, due to the shortage of time, finance, and human resource, we couldn't able to trial the new curricular materials…due to these and other related problems, the curriculum were directly enforced to put into implementations.

Regarding the training, the interview and document analysis (Belayneh, 2012) results revealed that training of the trainees (TOT) was given to the regional representative mathematics teachers. This training was given at central, Ministry of Education level. The responsibility to train the majority of mathematics teachers was given to regional education bureaus. In response to the interview question, did the regional education perform that? The mathematics curriculum experts at Ministry of Education doubt saying that:

> we already gave training of the trainees to the regional representative mathematics teachers…I think the training has not been given to all mathematics teachers due to regional problems like planning, budget, and commitment…this might leads to problems of addressing the objectives why it was revised and difficulties in implementations.

As it has been discussed in 'developing/writing the curriculum' subtitle, the Ethiopian mathematics curriculum was developed based on *Constructivism theory*. However, the implementations of *constructivism* based teaching and learning of (senior school) mathematics in Ethiopia will remain questionable, because, the curricula (syllabus and textbook) has not passed through a pilot test and reliable training was not given to all mathematics teachers, other than, training of trainees (TOT). The document analysis showed that:

> Mathematics teachers said that they need training on how to teach the subject matter and on the contents and concepts, orientation on the new textbooks and the new guides, and training on the new books in general (CDID, 2014, p. 62).

Moreover, the document analysis (CDID, 2014) indicated that "some mathematics teachers expressed that the syllabus is not available in their school; therefore, they have not used it yet."(p. 64). This implied that lots of mathematics teachers do not have curriculum/syllabus at hands. However, it is the syllabi encompassing the objectives of the senior secondary school mathematics, the notions of constructivism, the active learning approaches and assessment methods, like continuous assessments.

4.3.2. Curriculum Implementation in Australia

The response of the informants to the questions about the new curriculum pilot testing indicated that the

Australian senior secondary school curriculum has been pilot tested. Likewise, the document analysis (ACARA, Infographic, 2016c) showed that the curricula were tested at both primary and secondary school classroom levels. This is what, the Ethiopian curriculum developers, Curriculum Development and Implementation Directorate (CDID), need to learn from.

As it has been discussed under 'developing/writing the curriculum in Australia' subtitle, the Australian mathematics curriculum was developed based on *Constructivism theory*. The constructivism based curriculum implementations are the responsibilities of state and territory school and curriculum authorities (ACARA, 2012a). According to the same source, ACARA is responsible for supporting the state and territory school and curriculum authorities for better implementations through "providing briefings, introductory information materials and national facilitation for planning" (p. 6). Unlike Australia, there is hardly existed implementations and reporting framework, as a curriculum package, for secondary schools in Ethiopia.

4.4. Monitoring and Evaluation

The following two subsections describe the monitoring and evaluation of the senior secondary school mathematics curriculum in Ethiopia and Australia.

4.4.1. Monitoring and Evaluation in Ethiopia

Among the earlier mentioned steps in table 1, in which the Ethiopian curriculum development passed through, steps seven is about implementations of the curricula. The interview and document analysis (CDID, 2014) showed since its implementations in 2010, the first evaluation of secondary school curricula were conducted in 2014. According to one of my interviewees, curriculum expert, even though evaluation has been done once, it is not enough. Apparently, it's believed that a single evaluation of the program will not judge the effectiveness of the program.

The informants were also asked about the summative evaluation. According to one of my interviewees, Addis Ababa University lecturer Ministry of Education has missed this research wing. According to Belayneh (2012), the summative evaluation would be conducted by external evaluators within three up to four years from 2012 on. However, now we are at the end of 2016. Until this study's data were collected in July up to 30th of August 2016, there was no result of summative evaluation report at Ministry of Education. The other interviewee, SMCE, Ministry of Education, added saying that recently summative evaluation has never been done. However, the policy advocated that "every five years the quality and relevance of the curriculums at various educational levels will be assessed by a summative evaluation (MOE, 20; p. 45)." This finding highlights the gap between policy and practice. This finding is similar to the recent research findings of Alemu & Schulze (2012).

4.4.2. Monitoring and Evaluation in Australia

In comparison, unlike Ethiopia, Australian Curriculum, Assessment and Reporting Authority (ACARA) developed the Monitoring and evaluation of the Australian curriculum framework in 2013 (ACARA, Monitoring and evaluation of the Australian curriculum, 2013b). ACARA is responsible for providing the monitoring framework, including research questions and associated data gathering while the state and territory school and curriculum authorities are responsible for implementing the monitoring and evaluation strategies.

5. Conclusion

Ethiopia and Australia recently developed the school curricula to address national educational objectives and to get international standards. Taking the case of mathematics curricula, the main objective of this study was to compare the process of the senior secondary school intended mathematics curriculum development in Ethiopia and Australia. According to Bishop as cited in Zhao (2016), we conduct a comparative study in mathematics education when we are interested in the good work of other countries and when we want to adopt good experiences from others. Thus, under this theme, the process of senior secondary school (mathematics) curriculum in Ethiopia and Australia were studied. Both similarities and differences were revealed.

The similarities, in the process of the senior secondary school mathematics curriculum development in Ethiopia and Australia, found in this study are investigations of the needs assessment and adoption of constructivism approaches. Constructivism is an alternative approach to the traditional mathematics curriculum development and instruction known by *transmission* approach (Clements & Battista, 2009). The constructivism based, developed mathematics curriculum let the students construct their own mathematical knowledge. In the philosophy of mathematics education, constructivism is considered as "reconstructing mathematical knowledge" (Ernest, 1991). Thus, the (senior secondary school mathematics) curriculum in Ethiopia and Australia could be considered as the intended curriculum that could able to let the students construct their mathematical knowledge through the active learning process. However, any, even well-prepared, intended curriculum, more probably, could be affected by different variables at implementation classroom levels [teaching and learning process]. For instance, some of the variables are: "inappropriate use of teaching methods and inability to use good constructive questions during teaching and learning process in the classroom (Okogu, 2011, p. 48), "teachers' heavy workloads, learning diversity in class, and teachers' inadequate understanding of the curriculum reform"

(Cheung & Wong, 2012, p. 39). Other factors expected to affect the curriculum at the implementation levels according to Arnott (1994), are the "tight timelines for implementation, as well as challenges such as class size, limited in-service availability, and infrequent networking opportunities" (p. ii).

Even though the substantial similarities exist in the process of intended senior secondary mathematics curriculum development in Ethiopia and Australia, the considerable differences are also revealed. The main differences found in this study are the emphasis given to international research results and contemporary issues in mathematics education as inputs in the process of the intended curriculum development; the rationale of content standards organizations; trialing the curricula before the begging of curriculum implementation, and monitoring and evaluation strategies. These findings could be, in one way or another, considered as those variables hinder the intended (mathematics) curriculum quality and its implementations at classroom levels. Therefore we concluded the study by providing the following recommendations.

- The findings of this research provide insights for the future researchers to conduct (mathematics) curriculum implementations in Ethiopia as well as in Australia.
- For the purpose of better implementations the mathematics curriculum, the curriculum developers should let regional state educations bureaus (mathematics) curriculum experts and ordinary mathematics teachers participate in the process of school mathematics curriculum development.
- To identify the worthiness and effectiveness of the mathematics curriculum and to make the teachers familiar with the mathematics curriculum, mathematics teachers should trial the curriculum at classroom levels. So that decision might be made about the amendment of the mathematics curricula.

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