Fall 1-17-2013

Standards based education in Egypt and Singapore

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El Masri, Dara Akeal. *Standards based education in Egypt and Singapore*. 2013. American University in Cairo, Master's Thesis. *AUC Knowledge Fountain*.
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The American University in Cairo

Graduate School of Education

STANDARDS BASED EDUCATION IN EGYPT & SINGAPORE

A Thesis Submitted to the
Graduate School of Education

In partial fulfillment of the
Requirements for the Degree of Master of Arts in
International and Comparative Education

By
Dara Akeal El Masri

Under the Supervision of
Dr. Peggy Norman
Associate Professor of Practice

December 2012

Acknowledgements

Working on this research has been an overwhelming and challenging learning experience that have benefited me on so many levels and helped me know and understand things that I did not know before.

I am deeply grateful to my advisor Dr. Peggy Norman who has been very supportive and understanding throughout my M.A experience. Working under her guidance has been a real pleasure. She has always been very encouraging and patient. I have to say that I am very lucky and privileged to have had the chance to work and learn from her.

In addition, I am very grateful to both my readers, Dr. Stacie Rissmann-Joyce and Dr. Ted Purinton, who have provided me with insightful and beneficial comments that have added a lot to this research.

I would also like to thank my mother and father for their infinite support throughout everything. Last but not least, I would like to thank my husband and lovely daughter for putting up with 'always-busy' me up until that point, and to my little baby, thank you for not arriving before I was done.

To all my family, *Thank You, I could not have done it without you.*

Abstract

Mathematics education is important for all members of modern societies. In Egypt, the importance of mathematics education needs greater emphasis because of its role in providing job opportunities and helping to understand and build new economies, as well as, reducing the gap between Egypt and other developing countries. In order to know the aspects that need improvement in the Egyptian mathematics educational system, this study analyzed both the national Egyptian and the national Singaporean eighth grade mathematics educational system; mainly the standards, curricula, and textbooks. The analysis of the standards was done by comparing them to the characteristics of high quality standards issued by the Asia Pacific Economic Cooperation (APEC TATF & USAID, 2009), as well as the flaws that should not be part of the standards (Marzano & Haystead, 2008), and whether they incorporate higher order thinking skills or not. The curricula and the textbooks were examined using the content analysis criteria set by Confrey and Stohl (2004). Afterwards, the extent of alignment between the standards, curricula, and textbooks was checked; based on Baker's (2004) alignment analogies. The main results of this study showed that the national Egyptian standards do not fully comply with the six characteristics of high quality standards, are not completely flawless, and need more incorporation of higher order thinking skills. As for the curriculum and the textbook, they need a number of improvements. The problem with the curriculum is that it is very brief and only lists the names of the lessons to be taught and their corresponding dates. As for the textbook, the main aspects that weaken it are that it does not incorporate higher order thinking skills, connections between topics, real world and interdisciplinary connections, and relations to students' previous experiences. Moreover, it has some major spelling mistakes and errors in model answers. As for the national Singaporean curriculum framework, it complies with five of the six characteristics of

high quality standards, is flawless, and is centered around problem solving. When considering

the Singaporean textbook, it has several strengths, the objectives and learning outcomes are

clearly stated, the material is presented in a comprehensive manner, and the exercises and

assessments progress from being simple and direct to hard and challenging. In addition, higher

order thinking skills are incorporated in all aspects of the textbook and no major mistakes were

observed. Another important strength is that real world connections are incorporated in all topics.

A set of recommendations was given at the end of the study based on the results of the national

Singaporean educational system results, with regards to those that need improvement in the

Egyptian eighth grade mathematics educational system.

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Chapter 1: Introduction

Mathematics is essential for members of modern societies; they can use it at work, in financing, for decision making, as it helps in nurturing reasoning and logical thinking skills and even in solving everyday issues. Moreover, mathematics provides the tools for understanding technology, science, engineering, and economics; thus, it is important for national prosperity. Learning mathematics equips students with powerful techniques for describing, analyzing, and solving problems; thinking independently; assessing risks; and much more. What makes it even more important is the fact that it is an international language that is understood in any place in the world. In Egypt, the importance of mathematics education needs greater emphasis because of its role in providing job opportunities and helping to understand and build new economies, as well as, reducing the gap between Egypt and other developing countries; this is especially important with the technological advancements that are taking place at a very fast pace all around the world (The Egyptian Cabinet Information & Decision Support Center, 2010).

When considering Egypt's position regarding the Trends in International Mathematics and Science Study (TIMSS) comprehensive test, unfortunately the results are disappointing (International Association for the Evaluation of Educational Achievement (IEA), 2008). Egyptian schools participated in the test twice in 2003 and 2007. It is administered every four years for students in the fourth and eighth grades, so that the progress of the students who were tested in the fourth grade would be checked again after four years when they are in eighth grade. In 2007, approximately 3% of the Egyptian schools administered the TIMSS, but only for eighth grade students. The test is given in both English and Arabic depending on the language that the school uses to teach mathematics. The TIMSS identifies four benchmark scores for describing students' performance: Advanced (625 and above), high (550-625), intermediate (475-550), and

low (400-475). For Egyptian students, the average mathematics score was 391, lower than the average score achieved in 2003 by 15 points. For the 2007 results, 53% of the students' scores are below the low benchmark, 26% lie in low range, 16% in the intermediate range, 5% in the high range, and 1% in the advanced range. It should be noted that these averages could be misleading because the sample includes students from both public and private schools. The quality of education in private schools is presumably better, when considering the schools' environment, the students' abilities, and their home environment. Accordingly, students who take the test in the English language at private schools tend to score higher (Badr, 2010).

It is worthy to note that the two domains upon which the assessment framework of the TIMSS is based on are the content and the cognitive dimensions (IEA, 2005). The content dimension is concerned with subject matter whose objectives are covered in the curricula of most countries that take the exam. The areas included in the content domain are number and algebra; which each make up 30% of the exam questions and geometry, and data and chance with each making up 20% of the exam questions. On the other hand, the cognitive dimension is concerned with thinking processes, such as knowing, applying, and reasoning. Regarding the knowledge aspect, 35% of the exam questions covers the concepts, facts, and processes that students should know. The application aspect, 40% of the exam questions, takes into consideration the application of the knowledge and the understanding of concepts in order to be able to solve problems. As for the reasoning aspect, 25% of the exam questions, it assesses more complex and unfamiliar situations, as well as, multi-step problems. For the case of Egyptian students, the average score achieved for each area in the content domain is as follows; 393 for number, 409 for algebra, 406 for geometry, and 384 for data and chance. As for the cognitive domain, the

scores' averages are 392 for knowing, 393 for applying, and 396 for reasoning. These average scores are below the TIMSS scale average which is 500 points.

What are the reasons behind this low achievement in mathematics in Egypt? Many factors could be involved, such as the teachers' quality, the school environment, the students' age, gender, and socio-economic background, parents' educational level, students' interest in mathematics, as well as, the curricula and the textbooks used.

In spite of the fact that in 2003 the "National Standards for Education in Egypt" was issued, with a part especially dedicated to curriculum, in 2007 Egyptian students' performance on TIMSS was worse (Mina, 2009). Accordingly, this study will attempt to examine the national standards for mathematics and to determine the extent of their alignment with the national curriculum and textbooks for eighth grade. Furthermore, this study will also examine Singapore's mathematics educational system, because Singapore has always been in the top performing countries in TIMSS; it was the top country in both the 2000 and 2003 TIMSS exams, and came in third place in 2007 with an average score of 593 (IEA, 2008). In 2007, 40% of the Singaporean students were in the advanced range, 30% were in the high range, 18% were in the intermediate range, and 6% were in the low range. As for the content and cognitive domain areas, Singaporean students scored an average of 597 in number, 579 in algebra, 578 in geometry, 574 in data and chance, 581 in knowing, 593 in applying, and 579 in reasoning, which is consistently above the 500 TIMSS average score scale (IEA, 2008). Accordingly, this study will attempt to answer the following questions:

1. How do the national standards of mathematics education in Egypt align with the curriculum and textbook used in eighth grade?

2. How do the national standards of mathematics education in Singapore align with the

curriculum and textbook used in eighth grade?

Chapter 2: Literature Review

One of the major purposes of a country's educational system is to disseminate the

country's culture and traditions. Accordingly, some countries dismiss the idea of international

comparisons of educational systems. This is not the case for mathematics because it is a

universal language that can be understood all around the world regardless of culture and

traditions. For this reason it is important that countries benefit from the experience of high

performing countries by examining their practices, reflecting upon them, and then adapting this

experience to the relevant context (Asia Pacific Economic Cooperation Technical Assistance &

Training Facility (APEC TATF) & United States Agency for International Development

(USAID), 2009). Standards based education reform is one of the most popular attempts at

educational reform in many countries around the world.

Standards based education

Standards based education is comprised of six elements: content standards, student

assessments, performance standards, alignment, decentralization, and accountability (USAID,

2010). Content standards indicate the knowledge that students should know, as well as the skills

that they should acquire and be able to use for each and every subject at each and every grade.

Student assessments include the summative and formative performance assessments that will be

used during the school year to ensure that the students achieve the content standards. On the

other hand, performance standards are the specific levels that evaluate the assessments and thus

categorize the students as either meeting the required standards or exceeding them. Alignment is

the glue that holds the educational system elements together in order to achieve the standards.

These elements include the curriculum, resources, professional development, and assessments. The decentralization component of standards based education reform refers to the responsibility of the districts, as well as the schools, where the decision making process has to be distributed rather than centralized. This will allow for more effective and efficient implementation of the standards. The last element of the standards based education reform is accountability which refers to rewarding or penalizing districts and schools depending on whether they achieve the standards or not. Accordingly, in standards based education, specific performance levels are set relative to the content standards. Assessments are then used to measure the progress made in achieving the content standards. The assessment results are then used for accountability and as a feedback tool for teachers and policy makers (Weiss, Knapp, Hollweg & Burrill, 2001). The two most critical elements that should be present for educational reform to take place are content and performance standards (USAID, 2010).

Based on research done on Asian-Pacific countries that are high performers in mathematics, content standards are the "foundation upon which an entire mathematics program, including materials, assessments, and teacher training, is built" (APEC TATF & USAID, 2009, p.4). Content standards could merely be a list of topics that have to be covered in each grade, or they could be organized as a framework encompassing all the aspects that have to be taken into consideration. In both cases, there should be a philosophy or vision to guide the development of the standards. There are two main reasons for developing standards. The first reason is to raise the level of the students' academic engagement with the subject material (O'Shea, 2005). Secondly, it is to give them the chance to meet the high demands of the 21st century which include reasoning, critical thinking, creativity, problem solving, and other higher order thinking skills (APEC TATF & USAID, 2009).

In order to develop high quality mathematics standards, there are some characteristics that have to be taken into consideration (APEC TATF & USAID, 2009). First, the degree of focus on certain topics depending on grade level, for example, number and operations, geometry and measurement, have to be stressed during the early foundational stages; on the other hand, algebra and data analysis should be focused on during later stages when it is certain that the foundation has been strongly laid. The second characteristic is that topics should be divided into strands, and the sequencing of topics within each strand should be logical. This should be done in order to ensure efficient development of mathematical understanding and knowledge. Thirdly, the progression from topic to topic across each grade should be coherent in the sense that a topic is first introduced to students in a simple manner and then progresses into more complex ways of reasoning thus becoming more competent in that area. The end result in that case should be students that have had extensive practice in that topic so that they move from being novice learners to experts. The fourth characteristic is that standards should incorporate real world connections in order to make the learning experience of the students more meaningful. The fifth characteristic is that standards should be supported by examples of the assessments that the students will undergo. Finally, high quality standards should not only include content but also practices and processes that students should be exposed to and be able to show as long as they are learning mathematics. In other words, they should include the definition of what a mathematically proficient student should be like. This point is made clearer when considering the five elements that define a mathematically proficient student which are, first, conceptual understanding, which means that students should understand mathematical concepts, relations, and operations. The second element is procedural fluency which requires that students have the skill to accomplish procedures in a flexible, accurate, appropriate, and efficient manner. Third is

strategic competence which is defined as students' ability to formulate, represent, and solve

mathematical problems. The fourth element is adaptive reasoning which requires students to

demonstrate the ability to think logically, explain, justify, and reflect. Last is productive

disposition; this element of mathematical proficiency will be acquired when students consider

mathematics as a useful, sensible, and worthwhile subject, and at the same time feel that they are

competent in it (Kilpatrick, Swafford & Findell, 2001, p. 380).

In order for content standards to be efficiently and effectively implemented, two flaws

have to be avoided during development. The first flaw is adding more content than the allocated

time permits which will lead teachers to either choose the topics they want to teach or go over

everything in a quick and shallow manner in order to be able to cover all required content. In

both cases the content standards will not be achieved and the performance standards will not be

reached. The second flaw that should be avoided is the lack of unidimensionality, meaning the

mixing of several dimensions in one statement. In order to be able to assess a standard

effectively, the standard should include one dimension rather than multiple dimensions.

Accordingly, while developing the standards, effective instruction and assessment have to be

kept in mind in order to enhance student achievement. This will prevent having numerous

standards that cannot be reached (Marzano & Haystead, 2008).

Aligning curriculum with standards

Curriculum

A curriculum should be designed based on criteria that are provided by the standards

(Weiss et al., 2001). In other words, standards influence the content taught to students.

Accordingly, the curriculum design, as well as the development and implementation of the

instructional materials and assessments should reflect the content standards. This means that the

curriculum will be aligned to the standards, both content and performance. As a result, standards should be a comprehensive guide for what is to be taught for each subject at each grade as well as be a stimulant for the development or adoption of instructional materials and resources and offer guidance and support for the teachers. An important point that has to be considered when developing textbooks and assessments is that the developers understand the standards thoroughly so that the content and tasks assigned to students reflect the standards. As for case of textbook adoption, certain features have to be taken into consideration, these include an emphasis on inquiry based learning, problem solving, conceptual understanding, and development of skills. Schmidt, Houang, and Cogan (2002) state that high performing countries in mathematics have very well stated clear guidelines in the form of a national curriculum framework. Moreover, they are trained as to how to teach the curriculum, they are offered continuous professional development, and they have the required tools to teach it, teachers' guides, textbooks, and workbooks.

In order for content standards and curricula to be coherent, a set of factors have to be taken into consideration (Schmidt, Houang & Cogan, 2002). First, the sequencing of the topics has to be logical in such a way that it reflects the hierarchy of the content that the subject matter was derived from. Accordingly, the progression of the topics in the content standards has to move from the simple to the deep and more complex structures in the subject. This progression should take place during the school year and across the grade levels. By doing this, students will understand the big ideas as well as the particulars inherent in the subject matter. Second, the content standards and curriculum should be focused, i.e., topics should be covered deeply. Third, the curriculum should be internationally demanding and challenging to students. Last, the implemented curriculum has to be aligned to the national standards. In order for this to take

place, training for teachers, textbooks, workbooks, teachers' guides, diagnostic tests, and assessments have to be provided in order for the teachers to be able to effectively and consistently teach the content.

Furthermore, the Common Core State Standards in Mathematics (CCSSM) (2012) state that there are certain criteria that have to be met in order for focus and coherence to be achieved in mathematics. For focus to be achieved, the number of topics taught each year should be narrowed down so that students delve more deeply in the topics that remain and thus master important mathematical concepts rather than be exposed to a wide variety of topics in a shallow manner. On the other hand, coherence means making sense of the mathematics being taught in such a way that students are able to see the connections between the topics they are learning; mainly vertical connections in the sense that the mathematics taught each year build upon what has been learnt in the previous grades and connect to it. Horizontal connections within a grade improve the focus of the material being taught by making tight linkages between the secondary and major topics. Accordingly, individual topics should not be considered as disconnected events, nor should each individual grade be treated as a separate entity, rather, mathematical topics should be meshed together in such a way that provides students with meaningful content that is focused, coherent, and relates to their previous experiences.

So, how can focus and coherence be achieved in such a way that alignment between standards and the materials being used is maintained? CCSSM (2012) states that this can be accomplished by following certain criteria some of which are considered below:

1. The focus should be on the major mathematics topics, such that most of the time is spent on them rather than the secondary topics. Moreover, these topics should be focused on mainly in the first half of the academic year. The major topics should be highlighted in

the standards. Moreover, these topics should build the students' knowledge in such a way that prepares them for middle school algebra.

2. Arithmetic should be the main focus of the material covered in grades one through five. In order to establish coherence, there are topics that should not be tackled in early grades: probability should not be introduced before seventh grade, statistical distributions should start at sixth grade, geometric transformations, similarity and congruence should be tackled starting grade eight, and symmetry should be introduced at grade four. By doing this, focus on arithmetic which is an important building block for achieving a logical progression between topics is maintained.

3. The progression from grade to grade should be consistent in such a way that when the new academic year begins, the new material is taught directly without wasting time on reviewing topics that have been already covered in previous grades. In spite of that, it is important to relate what is currently being taught to what has been taught before and previous experiences.

4. Connections between the topics being taught in a certain grade should be made by making the learning objectives of each topic clear as well as including activities and exercises that relate more than one topic together.

In order to evaluate whether content in a textbook is focused or not Leinwand and Ginsburg (2007) consider the number of pages of the book, the number of topics introduced, the number of lessons, and, most importantly, the number of pages assigned for each lesson. For a textbook to have greater mathematical focus there should be fewer topics and lessons where each lesson is covered in a substantial amount of pages rather than having many topics and lessons explained briefly.

Another factor that has to be considered is the progression of mathematical topics across grades. This progression can be defined by considering the two main types of curriculum design which are the spiral and strand designs (Snider, 2004). A spiral design is when topics in a curriculum are designed in such a way that they are revisited each and every year. This means that many topics are presented briefly every year, and their coverage becomes more in depth as the grades progress. The organization of mathematical material in this fashion has many disadvantages. First, the topics are only taught in a superficial manner and thus do not allow an in depth mastery of concepts. Second, in a spiral design, each lesson is allocated the same amount of time, irrespective of its level of difficulty. Accordingly, the rate at which new lessons are introduced is either too slow or too fast. This leads to the third disadvantage where the students' academic learning decreases because they are either bored because of the slow pace and repetition or are frustrated with the new difficult content presented to them. The last drawback of spiral design is that it does not give students a chance to review the material that has been already taught that is due to the fact that it will be covered again the next year, so if the students did not understand this time they will probably get it the year after. On the other hand, a strand design is when a lesson is organized in such a way that it incorporates many skills or topics rather than focus only on one skill or topic. This means that these skills and concepts are revisited over a long period of time until fully mastered. When mastering is achieved, new skills and new concepts are introduced. Accordingly, the number of topics introduced in each grade is much less than in a spirally designed curriculum, allowing for more focus on major ideas rather than exposure to many topics in a shallow manner. Furthermore, the rate at which new material is introduced is not preset, but depends on the difficulty of the concepts and skills. As for the academic learning of students, they are not bored because several concepts are introduced in one

lesson, neither are they frustrated because the ideas are presented in a pace that is appropriate for them. Moreover, the strand design provides students with sufficient time for reviewing and practicing to ensure mastery. Very similar to the strand design is mastery learning, where teachers choose major concepts and skills that have to be very well understood and learned and then focus on these topics until they are fully mastered by the students. Students have to go through several levels of activities and assessments in order for the teachers to ensure that the concepts and skills have been very well understood (Guskey, 2010).

Standards based curriculum

A definition that has to be considered at this point is that of a standards based curriculum. A standards based curriculum is one that is aligned to and reflects national content and performance standards (North Central Regional Educational Laboratory (NCREL), 2000). The basis of a standards based curriculum is that it has the same expectations for each and every student. Such a curriculum integrates basic knowledge and skills with higher order thinking skills; it is child centered and relates to the real world. Moreover, it emphasizes problem solving, reasoning, communication, critical thinking, and creativity.

Alignment

Alignment is another important component of standards based reform, because it ensures that the curriculum is coherent, i.e., it has a common framework where curriculum, instruction, and assessments are aligned. Accordingly, alignment is an essential component for developing a successful curriculum. There are two types of alignment, external and internal alignment. External alignment is concerned with aligning the curriculum with content standards and performance standards. On the other hand, internal alignment refers to the alignment of teaching strategies and student assessments to the standards (Drake & Burns, 2004). There are various

metaphors that can help in describing and understanding the extent of alignment within any system (Baker, 2004). First is alignment as congruence; this means that each and every standard is clearly mentioned and assessed in the curriculum without any irrelevancy. This extent of alignment is hard to achieve because sometimes the standards are broad and not specific and, at other times, the standards are just too much to be adequately covered and assessed. Second, there is alignment as a set of correspondences where the standards and curriculum are in harmony and not necessarily congruent. This degree of alignment allows for analogies and functional agreement between standards and curriculum. Third is alignment as a bridge where the bridge is the path that connects the standards to the curriculum. In this case, a strong bridge is a coherent curriculum where the purpose of the standards and the knowledge and skills to be acquired by students are represented concretely and broadly. Last there is alignment as gravitational pull; in this case, the degree of alignment is measured by considering the centralized force that holds process, outcomes, and standards together. In other words, there will be common elements at the center of the system on which alignment would be based. For example, if standards, teaching, and assessments were all aligned together on the basis of higher order thinking skills, then these skills would be the glue that has to be present to keep everything together.

Effect of aligned curriculum on student achievement

When considering the effect of implementing standards based mathematics curriculum on student achievement, Riordan and Noyce (2001) state that the impact is positive and consistent across students of different gender, socio-economic status, and race. Reys, Reys, Lapan, Holliday and Wasman (2003) also state similar results for students who have been taught using standards based curriculum for two consecutive years. Both studies compared standards based curricula to traditional curricula, and in both cases the students' achievement was significantly higher. In the

research synthesis done by Lauer et al. (2005), several studies show that there is a positive impact on student achievement when standards based curricula are used. Some secondary results have to be taken into consideration. First, studies show that the longer the exposure to the curriculum the greater the achievement. This finding shows that the benefit for the students from the standards based curriculum is likely to be maintained and sustained over a long period of time as the teachers become more comfortable and confident with the new material and change of instructional methods. Other studies show that when the curriculum is correctly implemented, the influence on student achievement becomes stronger (as cited in Lauer et al., 2005; Riordan & Noyce, 2001). Another important finding from several studies is that students who are taught using standards based curricula have better problem solving and reasoning capabilities (as cited in Lauer et al., 2005). Overall, the research synthesis done by Lauer et al. (2005) found that all the 17 studies that have been examined showed a positive relationship between a standards based curriculum and student achievement.

Educational Reform in Egypt

Over the last 20 years, education in Egypt, at all levels, has been deteriorating. Several educational reforms and developmental strategies have been introduced but only on paper. Thinkers and educators have concluded that the two major aspects that have to be reformed in Egyptian education are curricula and teaching methods. Other problems that are negatively affecting the educational system include lack of textbooks and resources as well as the absence of appropriate physical space and school facilities. Officials from the Ministry of Education (MOE) believe that the major problem is the increased number of students in classrooms; for that reason they give more priority to building classrooms and schools than to improving curricula

and instruction. Accordingly, the quality of education in both public and private schools is not improving (Korany, 2011).

Based on the national strategic plan for pre-university education reform in Egypt (MOE, 2007), there are six major issues that need to be addressed. First is developing a curriculum framework that is based on the standards with clear objectives and performance measures. The focus on the framework should be on critical thinking, problem solving, creativity, and reasoning skills rather than the traditional rote methods of teaching and learning. Information technology should also be incorporated within this newly developed curriculum. As for assessment, the framework should integrate a comprehensive ongoing assessment system that does not depend only on test grades. The second issue that has to be taken into consideration is the restructuring of the Centre of Curriculum and Instructional Materials Development (CCIMD) so that the curriculum framework that is developed is effective and coherent. Third, textbooks and instructional materials have to be developed in such a way that they are aligned with the curriculum framework. Fourth, for this development to take place, qualified educators have to be trained in order to produce materials that are effective and academically interesting to students. The fifth issue is the review of the printing procedures and processes so that they are delivered in the required time. Last, teachers, supervisors, and school administrators have to be trained in order to be able to implement the new curriculum framework (p. 99-100).

Taking these issues into consideration, the MOE started a wave of reforms in 2006. The first wave was redesigning the primary education curriculum for grades one to three. The new curriculum focused on the three R's, reading, writing, and arithmetic, and emphasized the adoption of a child centered approach to education and comprehensive assessment methods. The second wave was funded by the World Bank where the overall curricula for all grades and all

subjects were revised and new teacher guides and resources were developed. The third wave

involved the reduction of the subjects taught in first secondary to sixteen subjects. The fourth

wave was funded by the Canadian International Development Agency (CIDA) whereby trainings

were provided in standards based education. Fifth, centers for learning by discovery were

established all around Egypt to expose children to experiments that would help them understand

difficult scientific concepts. Last, a High Committee for Curriculum Development (HCCD) was

established by the MOE to evaluate and monitor any new policies or reforms done in curriculum

development. Accordingly, the HCCD will approve the newly development curriculum

framework while the CCIMD will produce resources that align with it (MOE, 2007, p. 100).

The MOE devised a policy framework to ensure that the curriculum reform covers each

and every aspect included in the learning process. This framework includes learning outcomes

and performance standards, curriculum development strategies, the pedagogic model, and the

timeframe of the curriculum reform. The learning outcomes of the reform will include character

education, global citizenship, and 21st century skills. Performance standards will also be part of

the new curriculum. As for the reformation of the curriculum, eight strategies will be taken into

consideration. The first strategy is concerned with the development of a model that integrates

pedagogy and methodology with learning objectives, activities, the use of technology, and

assessments. Second, all the curricula for all subjects will be reviewed for the number of

assigned hours for each topic. Third, the framework should be standards based with information

technology and assessment integrated. Fourth, for each subject, a document will be developed

defining the expected outcomes and performance standards. Fifth, new textbooks that are aligned

with the curriculum framework will be developed with an emphasis on critical thinking, problem

solving, reasoning, and activity based learning. Sixth, two pilot processes for the development of

textbooks will be tested; one where publishers produce the instructional materials, and the other involves the use of multiyear textbooks. Seventh, a professional training program for curriculum designers and instructional material authors will be developed. Finally, an obligatory information technology curriculum for all students will be developed as part of the framework. When considering the pedagogic model, it will be based on four values; first, students will define their learning needs. Second, students will be exposed to learning experiences by exploration and discovery. Third, learning will be related to real life experiences. Fourth, students will be encouraged to reflect on their learning; metacognition will be emphasized. Regarding the scope and timeframe for the curriculum reform, based on the national strategic plan for pre-university education reform in Egypt, it should have been prepared in 2007, and implemented in 2008/09. Grade eight curriculum reforms should have taken place in 2010/11 (MOE, 2007). It is worthy to note that the eighth grade mathematics teacher's guide that was first published in 2009 included the specific standards for mathematics (Gab Allah & Roufael, 2009).

According to Mina (2009), curriculum development of mathematics in Egypt during the past 50 years can be classified into four categories. First is the temporary committees model, where some mathematics professors from universities, mathematics education professors, and mathematics teachers meet together and decide on some changes to the curriculum. They then write a report, submit it to the ministry, and, when the report is accepted, their job is finished. The second model is the Centre of Developing Curricula and Educational Materials (CDCEM); this centre's main job is to issue textbooks. The centre first decides on a scope and sequence of the mathematics topics to be covered from first grade until eighth grade. Afterwards, a team is formulated to start accomplishing the task. An editor revises the textbook and then the team start writing a guide for teachers. Another step that takes place is piloting, where parts of the textbook

are tried in different schools; if necessary, changes are made to both the textbook and teachers' guide. Lastly, a plan is put forth for the introduction of the new textbook and guide to teachers. The third model for curriculum development is national conferences, where university professors, teachers, students, parents, and ministry officials attend. These conferences discuss the development of curricula; for example, there was one for developing the national curriculum for the primary stage and another one a year later for developing the curriculum for the preparatory stage. The fourth model is the educational standards model; in 2003 Egypt issued a three volume book that included six documents, one of which is specifically devoted to curriculum.

Educational Reform in Singapore

Over the past 50 years, the educational system of Singapore has been evolving and improving tremendously to cater to the needs of each and every Singaporean child. This evolution can be broken down into phases, as stated by Yip, Eng, and Yap, and Kaur (as cited in Kaur, 2003). The first phase was from 1946 until 1965; during this period pressure was put to use education as a means for restructuring the economic status of the country and achieving national unity. A specific plan was done to achieve these aims; this plan included the importance of emphasizing mathematics, science, and technical education, as well as an accelerated program for building schools, in order to ensure that each and every child has a place in education. The next phase of educational reform was from 1965 until 1978 when Singapore split from Malaysia to become a separate entity. Again, the main focus of this period was the economy and national cohesion, accordingly, the emphasis focused on technical rather than academic education in order to produce an industrial workforce with a solid educational base. Furthermore, during this period the Singaporean MOE started doing research in order to improve the educational system.

In the following phase, from 1978 until 1984, a New Educational System (NES) was introduced and implemented. This NES was based on the grounds that students have different learning capabilities and capacities; accordingly this system introduced streaming of students based on their abilities. By doing this, the slow paced students were given the chance to develop at their own pace, and those who were not academic still learned basic literacy and numeracy. During the period from 1984 until 1996, three principles were issued by the MOE for guiding educational policies. These principles are that educational policy should be aligned to the economy and society. Second, languages, mathematics, science, and humanities education should be emphasized in such a way that encourages thinking logically and life-long learning. Third, principals and teachers should boost creativity in schools and classrooms. Moreover, during this time some modifications were done to the NES. From 1996 until 2002, the Singaporean MOE wanted to prepare students for the new millennium, with its new circumstances and problems, by ensuring that they can think logically, creatively, and critically, that they have problem solving and reasoning skills, and that they can deal with information technology and its rapid advances. This initiative was known as the Thinking Program. In order to have time for the incorporation of these new skills, the MOE reduced the content of each subject by 10 to 30 percent, while keeping the allocated time the same to allow for the incorporation of the new skills. In 2000, the Thinking Program was substituted by the Project Work program (Wong & Lee, 2009). This program was based on four learning outcomes: the ability to apply knowledge, communicate, collaborate, and learn independently. Teachers were given intensive in-service training in order to be able to modify their current methods and practices. In the phase from 2002 until 2008, the focus of the curriculum became on character education and helping students realize their abilities. Formative assessment also became part of

the educational system, whereby students had an active and reflective role in their learning process. Moreover, the teacher's role became more of a facilitator and co-learner rather than a lecturer, thus the student-teacher relationships and interactions improved. Furthermore, a more holistic approach to education was emphasized (Wong & Lee, 2009).

Singapore's mathematics curriculum has had a major role in the restructuring and development of the economy and progress of the country (Kaur, 2003). The mathematics curriculum is reviewed every ten years to ensure that it is relevant to the students, aligns to the national standards, and prepares the students for the opportunities and challenges ahead of them. Several changes have been made to improve the Singaporean curriculum over the years. First, the content has been trimmed. The rationale behind this trimming is that topics that are trimmed were transferred to the next level in order to maintain the sequence and hierarchy of the learning process. Moreover, the core topics that are essential as a foundation were kept so that they are given more focus and depth. Finally, topics that were abstract and overlapped with other topics in other subjects were removed. After this trimming of the curriculum, it was revised and updated to align with the latest trends and developments in mathematics education. Higher order thinking skills were incorporated in the curriculum, and use of information technology tools in both teaching and learning mathematics were encouraged. In addition, the curriculum was enhanced in such a way to ensure that its content meets the future needs of the country. Furthermore, the examinations were altered so that they aligned with the objectives of the curriculum. It is also important to note that teachers are always monitored in order to ensure that the standards, curriculum, and instruction are aligned.

Mathematics is a compulsory subject in Singaporean education; that is why in the secondary level streaming takes place where students are differentiated based on their

mathematics abilities. Students sit through an exam in order for their level to be determined. All the different tracks learn the same material but the depth and focus on the topics differs from one track to the other (Kaur, 2003).

Chapter 3: Methodology

In this study, I examined the mathematics Egyptian national standards for eighth grade, as well as the national curriculum and textbook. Afterwards, I checked the extent of alignment between the standards and curriculum, as well as how they are translated into the textbook. On the other hand, I also examined the national Singaporean mathematics curriculum framework for eighth grade, as well as the textbook used. Then, I checked the extent of alignment between the framework and the textbook. Finally, after considering the Singaporean mathematics educational system for grade eight, I recommended a list of improvements that the Egyptian mathematics eighth grade educational system can benefit from.

Study Design

This study is an analysis of standards, curricula, and textbooks; accordingly, the main analytic technique used will be content analysis. Based on Confrey and Stohl (2004), when conducting a curricular content analysis the most important aspect that has to be considered is the examination of the materials being used and their relationship with the discipline, the students, and the teachers. Accordingly, Confrey and Stohl state that in order to conduct a content analysis, three dimensions have to be taken into consideration; each dimension is broken down into several aspects. The first dimension has to do with the topics that are covered by the curriculum, disciplinary perspectives. The first aspect that has to be considered within this dimension is the clarity of the objectives and learning outcomes as well as the conceptual ideas behind each topic. The second aspect is comprehensiveness which examines the way that the

topics are structured and well sequenced. The third aspect is accuracy, meaning that the content should be accurate without any errors whatsoever. The fourth aspect includes the depth of mathematical inquiry and mathematical reasoning. Mathematical inquiry has to do with perceptions that help students identify mathematical patterns, conduct simulations, make inferences and conclusions, and have more insight about mathematical ideas. As for mathematical reasoning, it has to do with knowledge of definitions, the ability to prove answers using deductive reasoning techniques, and other methods that would establish rigor, correctness, and precise meanings of patterns discovered through mathematical inquiry. When put into practice, it is important that each topic is presented in such a way that it starts off with mathematical inquiry activities and then moves on to the more complex formalizations of mathematical reasoning. The fifth aspect is the organization of the topics; they should be sequenced logically and coherently to make it easier to move from one topic to the other. The last aspect of this dimension is balance, meaning that the curriculum should be balanced in such a way that accuracy, comprehensiveness, depth of mathematical inquiry and reasoning, clarity, and organization are all attained.

The second dimension of the content analysis is concerned with learner oriented perspectives. The first aspect of this dimension is student engagement. This means that a curriculum should take into consideration student participation by being interesting, relating to students' prior experiences and knowledge, igniting students' curiosity, and motivating them. The second aspect is timeliness and support for diversity. Timeliness is interpreted as pacing and the way the topics progress. As for supporting diversity, it means that the curriculum has to meet the diverse needs of all the students with their different abilities, backgrounds, and cultures. The final aspect of this dimension is assessment. The curriculum should include several types of

assessment, provide summative assessments that are well aligned with the learning outcomes, have assessments that address higher order thinking skills and not only rote memorization, and give advice to teachers on how to improve or change activities based on student results.

The third dimension necessary for conducting a content analysis includes teacher and resources oriented perspectives. The first element of this dimension is pedagogy; the curriculum has to include a part especially for the needs and abilities of teachers. A part should be dedicated to offer advice to teachers as to how to explain each and every topic. The second element is professional development. The curriculum should have a section dedicated to professional development expectations and knowledge that teachers should have before teaching each topic. The third element is resources which have to be clearly indicated in the curriculum.

Data

The data used to conduct this study included standards, curricula, and textbooks.

For the case of Egypt, the documents used were:

1. The national standards for education in Egypt.

   The part considered here is the mathematics national standards for grades seven through nine.

2. The Teachers' Guide for eighth grade mathematics.

   This guide included the specific standards for eighth grade mathematics. Available online (in Arabic only):

   ftp://books-ftp.moe.gov.eg/Prep2/Egy-math-Gabr-TB-G8-new%20book.rar

3. The eighth grade mathematics curriculum

   Available online (in Arabic only): http://manahg.moe.gov.eg/

4. The eighth grade mathematics textbook

Available online:

- First term textbook

 ftp://books-ftp.moe.gov.eg/Prep2/Egy-math-Gabr-SB-G8-V1.rar

- Second term textbook

 ftp://books-ftp.moe.gov.eg/Prep2/prep_math_second_en_t2.rar

For the case of Singapore, the documents used were:

1. The national curriculum framework

   This document included both the standards and the curriculum for eighth grade

   mathematics.

   Available online:

   http://www.moe.gov.sg/education/syllabuses/sciences/files/maths-secondary.pdf

2. The eighth grade mathematics textbook for the normal academic track.

   The book was chosen from the list of approved textbooks.

   The list of approved textbooks is available online: http://atl.moe.gov.sg/

3. The eighth grade mathematics teacher's guide for the normal academic track.

   The teacher's guide for the book that has been chosen from the list of approved

   textbooks.

Choice of data

For the case of Egypt, these are all the resources available for students and teachers.

Accordingly, for the case of Singapore, I chose similar resources in order to examine exactly the

same data for both countries. It is worthy to note that Singapore reinforces the textbook with a

workbook that will not be considered in this study.

Analysis

This study is divided into four phases, as follows:

Phase 1: Examination of standards

Both the Egyptian and Singaporean standards were examined based on the six characteristics of developing high quality standards (APEC TATF & USAID, 2009). These characteristics are the degree of focus on topics, their sequence, the progression from topic to topic, presence or absence of real world connections and experiences, support by example exercises and assessments, and the presence or absence of mathematical proficiency definition. Furthermore, the standards were checked to see whether they have any of the two flaws mentioned by Marzano and Haystead (2008). The final examination criterion was whether the standards for both Egypt and Singapore incorporate higher order thinking skills or not.

Phase 2: Examination of curricula

Both the Egyptian and Singaporean curricula were examined based on the three dimensions of content analysis.

Phase 3: Examination of textbooks

Both the Egyptian and Singaporean textbooks were examined based on the three dimensions of content analysis.

Phase 4: Checking for alignment

This phase examined the extent of alignment between the Egyptian standards, curriculum, and textbook, as well as the extent of alignment between the Singaporean standards, curriculum, and textbook.

Chapter 4: Egypt - Results and Analysis

I. National Mathematics Standards

In order to analyze the Egyptian national standards two documents were examined; the official general national standards document (MOE Egypt, 2003), as well as the specific eighth grade standards listed in the teacher's guide (Gab Allah & Roufael, 2009). Below are the curriculum philosophies that are stated in the introduction of each.

The National Standards Document

This document (MOE Egypt, 2003) covers four levels; first to third grade, fourth to sixth grade, seventh to ninth grade, and tenth to twelfth grade. The philosophy that was adopted when creating this document was that standards should be either content-oriented or process oriented and, in some cases, both content and process oriented. This is to ensure that students get the know-what and the know-how. As for the mathematical skills that have to be focused on, the standards document states the following: first, problem solving where students should be able to use multiple strategies in unfamiliar situations to solve problems that they have not been exposed to before. Furthermore, they should be able to build new mathematical knowledge by solving mathematical and non-mathematical problems. Also, students should be able to solve a variety of problems, such as those with single solutions, or those that can be solved using more than one method, or those with more than one solution and to discover that some problems do not have a solution. The second skill is reasoning and proving which means that students should understand that answering the question "Why?" as well as reasoning and proving are essential components of all branches and activities of mathematics. Moreover, they should be able to smartly speculate and find ways to prove the validity of their speculations and findings. Students should also be able to choose the appropriate proof for the theory or law in question, and to understand that

proving a theory or law can only be achieved by logical reasoning. Third is the communication skill where students are expected to be able to express mathematical ideas in a clear and concise way, both verbally and in written form. Furthermore, they should be able to use the language of numbers, symbols and tables in various mathematical activities. Students should also be able to model life situations, as well as, scientific and social phenomena using equations, or inequalities, or geometric schemes and graphs. In addition, students should be able to translate abstract mathematical situations to verbal language or geometric shapes. The last skill that students should possess is the use of technology, such as calculators and computers, to conduct processes, algorithms, geometrical and graphical constructions while giving them the space to think and be creative. Furthermore, students should understand that technology is not a substitute for understanding and intuition; calculators calculate but human beings think, design, and build.

Specific Eighth Grade Standards – Teacher's Guide

This guide (Gab Allah & Roufael, 2009) starts by stating the philosophy of the eighth grade mathematics curriculum. First, the curriculum should help students gain the appropriate mathematical knowledge, as stated in the standards and benchmarks, in such a way that it relates to students' real world experiences thus satisfying their curiosities and helping to develop their personalities. Second, the curriculum should develop students' different thinking skills, such as critical thinking, creativity, productive thinking, and reflective thinking. Third, it should aid in developing social values that are required for students to live a healthy life; these values include dependence, collaboration, social sensitivity, honesty, using the scientific thinking methods, as well as, the other major humanistic values. Fourth, the curriculum should help students become active and independent when it comes to finding information, gaining skills, forming personal visions and values, as well as, communicating using the mathematical language. Fifth, focusing

on developing skills, this should be done by presenting different methods for learning each skill, as well as, intensive and continuous applications for each and every skill. Last, the curriculum should integrate real life issues and concepts in the form of activities and practical processes.

As for the content of eighth grade mathematics it is organized into four strands as follows: number and operations, algebra, functions and relations, geometry and measurement, and data analysis, statistics, and probability. It is clearly stated in the teacher's guide that the content develops vertically across grades, spirals through each of the strands, and is distributed horizontally across all grades.

The specific eighth grade Egyptian national standards were examined based on three criteria. The first criterion was whether they comply with the six characteristics of developing high quality standards (APEC TATF & USAID, 2009). The second criterion is whether the standards have either of the two flaws mentioned by Marzano and Haystead (2008). The third criterion was whether higher order thinking skills were employed or not. This was examined with reference to Bloom's Revised Taxonomy (Anderson et al., 2001).

1. The characteristics of high quality standards

When examining the Egyptian national eighth grade mathematics standards against the six characteristics that define high quality standards, first, consideration was given to the degree of focus on topics criterion; this characteristic states that number and operations, geometry and measurement have to be stressed during the early foundational stages while algebra and data analysis should be focused on during later stages when it is certain that the foundation has been strongly laid. In order to check whether the Egyptian standards comply with this characteristic or not, the full document of the national standards (MOE Egypt, 2003) was examined and it showed that number and operations, algebra, relations, and functions, geometry, measurement, and

statistics, data analysis, and probability are covered starting in grade one and continuing through grade eight.

Second, regarding the division of topics into strands, and their sequence, the Egyptian standards divide topics into four strands, as follows:

- Number and operations

- Algebra, relations, and functions

- Geometry and measurement

- Statistics, data analysis, and probability

Based on the specific eighth grade standards, the strands alternate throughout the school year as follows: during the first term, they start with numbers and operations, followed by algebra, relations and functions. Afterwards, there is geometry and measurement, followed by statistics, data analysis, and probability. As for the second term, it starts with algebra, relations, and functions, then geometry and measurement, followed by statistics, data analysis, and probability.

As for the third characteristic, the progression proceeds from topic to topic; in order for the progression of topics to be coherent, their introduction should start in a simple manner and then become more complex as time goes by and the easy concepts are fully mastered. In the case of Egypt, almost the same topics are taught every year, in such a way that they become harder and deeper as the grades progress. This shows that topics are arranged in a spiral design (Snider, 2004) which means that the same material is revisited every school year with increasing emphasis and depth. It also means that topics are briefly touched rather than being fully mastered once they are introduced to the students. The fourth characteristic has to do with the presence or absence of real world connections and experiences. In the Egyptian national standards document,

students are encouraged to make interdisciplinary and real world connections through activities that are introduced after all the standards in each strand have been covered; i.e., after the students have totally mastered the topic. Concerning the fifth characteristic, the Egyptian national standards document does not include any example exercises or assessments. Last, the sixth characteristic addresses the presence or absence of mathematical proficiency; the Egyptian national standards cover all five elements except for the reflective part that should be available in the adaptive reasoning element. The first two elements which are conceptual understanding and procedural fluency are included in the standards document in the form of the concepts and skills that have to be learned and acquired by the students. As for the third component, strategic competence is incorporated in certain benchmarks that require students to apply the knowledge and skills that they have acquired and to relate them to real life situations as well as mathematical and non-mathematical problems and interdisciplinary connections. Regarding the fourth component, adaptive reasoning, the standards consist of benchmarks that ask students to give examples, to prove theories, to explain and to discuss, but they are never asked to reflect. For the fifth element, productive disposition, the standards include benchmarks that specifically require students to appreciate mathematical concepts and to understand how they can be used and how they relate to the world they live in.

Based on the above examination, the results have shown that the Egyptian national standards for eighth grade mathematics do not fully comply with the six characteristics of high quality standards. First, in regards to the degree of focus of the topics covered in grades one through eight, the analysis showed lack of focus. In order for a teacher to be able to cover topics from number and operations, algebra, relations and functions, geometry, measurement, and statistics, data analysis, and probability in one school year, it suggests that the topics may be

taught on a superficial level without going into in depth details that would help in building a strong basis for the more advanced mathematical topics ahead. Another issue that should be considered here is the ability of students to comprehend the material presented to them. Second, the topics are categorized into strands; within each strand the material is sequenced in such a way that simple concepts are introduced first and then are built upon. Regarding the third characteristic which involves the progression from topic to topic, the examination showed that the standards are organized in a spiral manner where topics are revisited each and every year. This spiraling could be beneficial if used in an efficient manner in such a way that teachers very briefly review the material that has been already covered the previous year before starting the more in depth material. On the other hand, if the teacher covers the material rapidly without ensuring full understanding of students because they are aware that it will be revisited again the following year, this could lead to serious problems that would show when students are faced with the more advanced topics later on. Concerning the fourth characteristic that has to do with linking content to real world experiences and connections, the Egyptian national mathematics eighth grade standards stress the importance of these linkages, specifically when the topics included in a strand are fully covered. Furthermore, interdisciplinary connections are also encouraged. These connections make mathematical concepts more relevant to the students and their lives. Accordingly, the students become more excited, interested and motivated to learn because they know the meaning of what they are learning and how they can use it. The fifth characteristic is not incorporated in the standards; they do not include any examples of the assessments that the students will go through. This lack of example exercises and/or test questions could leave the door open for teachers or textbook writers to decide on the type of assessments to include or exclude. This could mean that the questions become merely ones that

require rote memorization rather than higher order thinking skills. Accordingly, it is important that at least the type of questions that the students should experience be stated in the standards to guide the teachers and the textbook writers. Last is mathematical proficiency; the examination showed that all aspects of it are available in the standards except for reflection which is a very important skill that students should learn. Reflection is necessary for monitoring one's thinking and being able to know one's self. It should not be ignored because it also helps students know what they understand and the things that they need help in. Overall, Egypt's national mathematics eighth grade standards need several modifications in order to be compliant with the characteristics of high quality standards identified by APEC TATF and USAID (2009).

2. Flaws

Based on Marzano and Haystead (2008) there are two flaws that should not be present in standards. The first flaw is the presence of content that cannot be covered in the allotted time. The second flaw is the lack of unidimensionality; i.e., the mixing of several standards in one statement. The Egyptian standards document showed the following:

a. Content

During the first term; which lasts for three and a half months, 12 standards with 60 benchmarks have to be covered. These benchmarks are divided as follows: 26 for number and operations, six for algebra, relations, and functions; 12 for geometry and measurement; and 16 for data analysis and statistics. As for the second term which lasts for three months, eight standards with 33 benchmarks have to be covered. The benchmarks are divided as follows: 10 for algebra, relations, and functions; 19 for geometry and measurement; and four for data analysis and statistics. It is worthy to note that for the first term, numbers and operations, algebra, relations, and functions, and data

analysis and statistics consume three classroom periods per week, and geometry and measurement consume two classroom periods per week. As for the second term, numbers and operations, algebra, relations, and functions, and data analysis and statistics consume two classroom periods per week, and geometry and measurement consume three classroom periods per week.

For the first term, the above shows that the 48 benchmarks of numbers and operations, algebra, relations, and functions, and data analysis and statistics should be covered in 42 classroom periods. On the other hand, the 12 benchmarks of geometry and measurement should be covered in 28 classroom periods. It is worthy to note that almost each benchmark corresponds to a lesson in the textbook. Assuming that each lesson requires at least one classroom period to be fully covered, this means that the time allocated for the numbers and operations, algebra, relations, and functions, and data analysis and statistics is not sufficient for presenting the material in a focused and deep manner. On the other hand, the time allotted for the geometry and measurement is enough with more than two lessons per benchmark.

For the second term, the above data show that 14 benchmarks for the algebra, relations, and functions, and statistics and data analysis have to be covered in 24 classroom periods, while the 19 benchmarks of geometry and measurement have to be covered in 36 classroom periods. This time allocation is sufficient for covering all the second term material in a deep and well focused manner.

Another important aspect that should be taken into consideration at this point is the time allocated for mathematics education in schools. Based on the National Council of Teachers of Mathematics (NCTM), mathematics classroom periods should be allotted at

least one hour daily throughout the academic year. This increases the time of mathematics instruction by 50 percent, when compared to periods that last for 40 minutes a day. In total, this means that students should receive approximately 180 hours of mathematics education during the academic year (NCTM, 2006). On the other hand, when considering the time allocated by the three top performing countries in the TIMSS, the results for the actual implemented time are as follows: Chinese Taipei allots 158 hours per year, the Republic of Korea 104 hours per year, and Singapore 124 hours per year (IEA, 2008). The actual implemented time for Egypt, as per the IEA (2008) report is 93 hours per year.

b. Unidimensionality

Out of the 60 benchmarks of the first term, 29 are unidimensional. As for the second term, out of the 33 benchmarks, 18 are unidimensional while the rest include several benchmarks in one statement.

The lack of unidimensionality makes it harder for benchmarks to be assessed. Moreover, unidimensionality makes benchmarks easier to achieve and teach. In this case, 47 out of the 93 benchmarks are unidimensional, which leaves 46 benchmarks that need to be made clearer for easier assessing and instruction.

3. Higher order thinking skills

To check whether higher order thinking skills are incorporated into the Egyptian standards, Bloom's revised taxonomy was used as a reference to check the verbs used in stating each standard and its relevant benchmarks. The results are as follows:

Table 1

First Term: Number of Times Bloom's

Revised Taxonomy Verbs are Used in

Egypt's Standards

Verb	Number of Times Used
Remembering	20
Understanding	11
Applying	22
Analyzing	2
Evaluating	3
Creating	2

The above results show that during the first term, the main emphasis is on remembering, understanding, and applying with very minimal weight given to analysis, evaluation, and creation which are very important for improving the thinking skills of students, and preparing them with the 21st century skills required for the developments that are taking place in the world around them.

Table 2

Second Term: Number of Times Bloom's

Revised Taxonomy Verbs are Used in

Egypt's Standards

Verb	Number of Times Used

Remembering	12
Understanding	4
Applying	11
Analyzing	1
Evaluating	3
Creating	0

For the second term, the major weight is also given to remembering and applying with minimal emphasis to understanding, analysis, and evaluation. No importance is given to creativity which is the highest level of thinking.

These results also show that a major part of the benchmarks is dependent on rote memorization, rather than incorporating higher order thinking skills.

II. National Curriculum

There are two documents, one for each term (MOE Egypt, 2011a, 2011b). The format of the document is a simple table that includes the following information. First it gives the months; the first term starts around mid September and ends around mid January, while the second term starts in February and ends in May. Second are the unit names which are further broken down into the lessons within each unit, and classified into either algebra and statistics, or geometry. The third piece of information is the duration for which the unit should be taught. For the first term, the duration dedicated for algebra and statistics is a period and a half per week, while for geometry it is one period per week. Regarding the second term, the duration allotted for algebra and statistics is one period per week, and for geometry it is one and a half period per week. It is worthy to note that a period is an hour and a half, while the duration of one class is forty-five

minutes. Accordingly, one period refers to two classes per week, and a period and a half refers to three classes per week. At the end there is a note that states that revision and assessments should also be considered as part of the curriculum. Confrey and Stohl's (2004) content analysis and its three perspectives could not be applied here because of the format of the document which is very brief with no details.

The curriculum documents should not be used alone but should be complemented with the national standards document and the teacher's guide. Only then will all the information required by teachers be available, because the curriculum documents alone are not sufficient to give teachers what they need.

III. National Textbook

As per the teacher's guide, the content of the textbook takes into consideration all the general and specific objectives of teaching eighth grade mathematics, it is aligned with the standards and benchmarks, and its content is coherent and logical. Moreover, each unit in the textbook starts with an introduction that includes a section for motivating students to explore the lesson, as well as a list of the unit's lessons. As for the lessons, each lesson starts with the main ideas, and it has been taken into consideration that the presentation of the lesson is from easy to hard, simple to complex, and tangible to intangible to abstract. The lessons end with a set of exercises that proceeds from simple to hard and moves from direct questioning to those that require deep thinking and relate mathematics to other sciences. There are also a set of various exploratory activities that relate previous experiences to the new content. Furthermore, the content of each unit includes a set of special features that are closely related, such as real life applications, thinking exercises, reasoning and proving, collaborative work, and critical thinking. At the end of each unit there is a practice test that includes objective questions, essay questions,

and short answer questions. Moreover, at the end of all units there are end of term practice tests that take into consideration the advancement and development in formulating assessments. The textbook also includes shapes and illustrations that relate directly to the content, and the language used in the textbook is appropriate for eighth grade students.

When the Egyptian national eighth grade mathematics textbook (Gaballa, Salah, Rouphaeil, Al Khatieb, & Iskander, 2009a, 2009b) was examined the results were as follows:

Table 3

Egyptian National Eighth Grade Mathematics Textbook Analysis

	First Term	Second Term
Title	Mathematics for Preparatory Year Two	
Authors	Mr. Omar Fouad Gaballa	
	Prof. Dr. Afaf Abo-ElFoutoh Salah	
	Dr. Essam Wasfi Rouphaeil	
	Mr. Mahmoud Yasser Al-khatieb	
	Mr. Serafiem Elias Iskander	
Publisher (Year)	Al-Fostat Modern Presses (2009)	
External Resources	None (Only Student Textbooks & Teacher's Guide – Book & Compact Disc (CD))	
Structural Organization		
Number of Pages	136	118
Number of Units/Topics	4	6
Total Number of Lessons	24	21
Soft Cover/Hard Cover	Soft Cover	Soft Cover

Spiral/Mastery	Spiral	Spiral
Presentation of Content	Each lesson starts with a "Think and Discuss" section, as well as the objectives of the lesson, stated as what the student will learn, and key terms. After that there is a brief explanation of the lesson, followed by examples, and then practice exercises. Moreover, each unit has a test at the end including everything that has been learned before. At the end of each book there are also practice tests that include questions from all previous lessons. It is worthy to note that there are model answers for a selected number of questions.	
Illustrations	Colorful book with mathematical illustrations only (mainly geometrical shapes).	
Worked-out Examples	After each lesson there are a few solved examples.	
Definitions/Rules	Definitions and rules for each lesson are embedded within the text with a list of key terms at the start of each lesson. No glossary. There is a page at the beginning of the book defining the mathematical symbols that will be used.	
Use of Tools	Some exercises require the students to use a calculator to get exact answers. Computer (Microsoft Excel: tells students exactly	

	what to write in each cell or which buttons to click) Geometrical Tools (mainly the compass with illustrations of how to use it).	
Exercises	There are practice exercises after the solved examples, exercises at the end of each lesson, and general exercises after each unit. The majority of the exercises are the same as the worked out examples. Not a lot of variety; most exercises are similar to one another. To the extent that the solved examples, exercises, revision questions, and practice tests all have the same basic idea but with different numbers; sometimes even the same question is repeated once as a solved example and then as an exercise for the students to solve on their own.	
Use of Group Work	One group activity in the statistics unit (Unit 2 Lesson 1).	No group work.
Spelling Mistakes	Yes (Probability written as Pro**P**ability)	No

Note: Analysis criteria adapted from Huntley (2008).

When the textbook was examined based on the content analysis criteria (Confrey &
Stohl, 2004) the results were as follows. First, regarding the disciplinary perspectives which
mainly considers the topics covered by the textbook, when the objectives, learning outcomes,

and conceptual ideas of each topic are examined, it was found that at the start of each lesson there is a section titled "you will learn how", which includes a very brief list of the expected learning outcomes. The wording is clear but not elaborated. This section is complemented with a list of the "key terms" that will be learned during the lesson. As for comprehensiveness which deals with the way the topics are structured and well sequenced, the examination showed that each unit is broken down into a number of short lessons. Each lesson includes a brief presentation of the topic at hand, followed by solved examples and then exercises for the students to solve on their own. These exercises are often similar to the examples that have been solved before. The lessons within each unit are well sequenced, while this is not always the case for the units themselves. For example, the students study real numbers and triangles at the same time without any obvious relationship between them. When it comes to accuracy, the textbook has a major spelling mistake, "Propability" rather than probability. Moreover, the book provides the students with model answers of some exercises and these include several mistakes such as:

- Providing answers to questions that do not exist

- Providing wrong answers

- Wrong numbering of questions

- In the case of multiple choice questions; the given answer is not in the choice list

- Question requires students to draw things that are already drawn, i.e., the answer is illustrated beside the question

It is worthy to note that a few questions were randomly selected and their model answers checked.

Regarding the depth of mathematical inquiry, which has to do with perceptions that help students identify mathematical patterns, conduct simulations, make inferences and conclusions,

and have more insight about mathematical ideas, it was found that the lessons within each unit are built on each other, but the units themselves are mostly separate entities with no obvious relations between them. As for mathematical reasoning which has to do with knowledge of definitions, the ability to prove answers using deductive reasoning techniques and other methods that would establish rigor, correctness, and precise meanings of patterns discovered through mathematical inquiry, each lesson starts with a "Think and Discuss" section that includes activities to make the students curious about what they are about to learn. Afterwards, the lesson is presented, and then worked out examples, followed by exercises for the students to answer on their own. The exercises are very similar to the worked out examples and in some cases are exactly the same as the given examples. Other exercises are labeled "Think" but are direct questions with no space for thinking. The given exercises can be summarized as follows:

- Complete the sentence which requires students to memorize definitions and rules

- Multiple choice questions

- Other questions that mainly start with words like: Find, Write, or Prove

Overall, the variety of the questions is minimal; most exercises are the same. Even the practice tests at the end of the textbook have the same structure of the exercises given at the end of each unit, and the same type of questions that were provided in the solved examples and exercises. In addition, in the questions that involve the use of technology students are guided step by step as what to write and do exactly, with no room for thinking, or trial and error, or creativity.

Considering the organization of the topics which should be sequenced logically and coherently according to the curriculum the topics are divided into two sections taught at the same time; the first section is algebra and statistics, and the second section is geometry. During the

first term, algebra and statistics are taught for a period and a half per week, while geometry is taught for one period only per week. As for the second term, algebra and statistics are taught for a period per week, while geometry is taught for a period and a half per week. Accordingly, students are exposed to lessons from both sections each week, meaning that they alternate algebra and statistics with geometry, with no apparent connection between the topics being taught. In order to examine whether the textbook topics are focused and coherent, the criteria set by CCSSM (2012) and Leinwand and Ginsburg (2007) were considered.

CCSSM (2012) state that content is focused when the most important mathematical topics are highlighted and covered mainly during the first half of the academic year. Moreover, these major topics should be chosen in such a way that they build a strong foundation for the students that prepares them for more advanced algebra. In this textbook, no major topics are highlighted, not even in the standards documents, or curriculum. In addition, the total number of topics taught is 10, for a total of 45 lessons. These topics are to be taught in a period of approximately 30 weeks. The second criterion stated by the CCSSM (2012) is that there are certain topics that should not be tackled in early grades in order for the focus to be on arithmetic and the foundational concepts and skills that the students should master. Moreover, this provides students with a logical progression between topics. For example, probability should not be introduced before seventh grade, statistical distributions should start at sixth grade, geometric transformations, similarity and congruence should be tackled starting grade eight, and symmetry should be introduced at grade four. In order to examine this criterion the topics taught in the national mathematics textbooks for grade one to eight (Abdel-Sattar, 2008a, 2008b, 2009a, 2009b; Gaballa, Salah, Rouphaeil, Al Khatieb, & Iskander, 2009a, 2009b; Mena, Hanna, &

Ahmed, 2008, 2009; Mina & Hanna, 2008a, 2008b, 2008c, 2008d, n.d.a, n.d.b; & Naser &

Ahmed, 2010a, 2010b) were checked and the results were as follows:

- Probability is introduced in second grade.

- Statistical distribution is introduced in seventh grade.

- Geometric transformations, similarity and congruence are introduced in second grade.

- Symmetry is introduced in first grade.

Leinwand and Ginsburg (2007) examine whether a textbook is focused or not by counting the

number of pages of the book, the number of topics introduced, the number of lessons, and most

importantly, the number of pages assigned for each lesson. For a textbook to have greater

mathematical focus there should be fewer topics and lessons where each lesson is covered in a

significant amount of pages rather than having many topics and lessons explained briefly. The

results of this examination are given in Table 4.

Table 4

Egypt's Results of Leinwand & Ginsburg (2007) Textbook Focus Criteria

Criteria	First Term	Second Term	Total
Number of Pages	136	118	254
Number of Units/Topics	4	6	10
Total Number of Lessons	24	21	45
Number of Pages/Lesson:			
Numbers & Algebra	38	26	64
Geometry & Measurement	39	43	82
Data Analysis, Statistics & Probability	12	7	19

Note: The total number of pages per lesson does not include the exercises, general exercises, or
review exercises, or model answers. Only the number of pages dedicated for the lesson itself is

given.

As for the two criteria that CCSSM (2012) take into consideration when examining whether mathematical content is coherent or not, the first is going into new topics directly when the new academic year starts without wasting time reviewing things that have been already covered. The second is concerned with connecting the topics that are taught within the grade by ensuring that the lesson objectives are clear, and including exercises that relate the studied topics together.

In order to examine this first criterion, the topics in the Egyptian national mathematics textbook of seventh grade (Abdel-Sattar, 2008a, 2008b) was checked in order to check whether topics are repeated in the eighth grade textbook or not. The results are shown in the table below.

Table 5

Egypt's Comparison between Seventh & Eighth Grade Topics

Seventh Grade Topics	Eighth Grade Topics
1] Numbers	1] Real Numbers
a. Introduction	a. Revision
b. Rational numbers	b. The cube root of a rational number
c. Comparing and ordering rational numbers	c. The set of irrational numbers (Q')
d. Adding rational numbers	d. Finding the approximate value of an irrational number
e. Properties of the set of rational numbers under addition	e. The set of real numbers (R)
f. The difference of two rational	f. Ordering number at (R)

numbers

g. The product of rational numbers	g. Intervals
h. Properties of the set of rational numbers under multiplication	h. Operation on the real numbers
i. Division of rational numbers	i. Operation on the square roots
j. Repeated multiplication	j. Operation on the cube roots
k. Non-negative Integer powers	k. Applications on the real numbers
l. Negative Integer powers	l. Solving equations and inequalities of first degree in one variable in R
m. Scientific Notation	
n. Order of operations	
o. The square root of a rational number	

2] Statistics	2] Statistics
a. Reading and interpreting data	a. Collecting and organizing data
b. Collecting and organizing data	b. The Ascending and descending cumulative frequency table and their graphical representation
c. Representing data	c. Arithmetic Mean, Median and Mode

3] Geometry and Measurement	3] Geometry
a. Geometrical concepts	a. Parallelogram
b. Geometric constructions	b. The medians of a triangle
c. Pythagoras theorem	c. The Isosceles Triangle

d. Relative positions of two straight lines in space

e. Spatial visualization

f. Congruence

g. Congruent triangles

h. Geometric transformations

i. Reflection

j. Translation

k. Rotation

l. Visual patterns

m. Parallelism

n. Deductive proof

o. Triangle properties

p. The polygon

d. The Isosceles Triangle theorems

e. Corollaries of isosceles triangle theorems

f. Geometric constructions

g. Reflection

h. Translation

i. Rotation

j. Similarity

4] Algebra

a. Algebraic terms and algebraic expressions

b. Like terms

c. Multiplying and dividing algebraic terms

d. Adding and subtracting algebraic expressions

e. Multiplying a monomial by an

4] Factorization

a. Factorizing Trinomials

b. Factorizing the Perfect-Square Trinomials

c. Factorizing the Difference of two Squares

d. Factorizing the Sum and Difference of two Cubes

e. Factorizing by Grouping

algebraic expression

f. Multiplying a binomial by an algebraic expression

f. Factorizing by completing the square

g. Dividing algebraic expression by a monomial

g. Solving Quadratic Equations in one Variable

h. Factorization by taking out the H.C.F.

h. Two Relation Between Two Variables

i. Variable and constant

i. Linear Relation of two variables

j. Linear relationship

j. The Slope of a line and real-life Applications

k. Numerical patterns

l. Equations

m. Solving Equations

n. Applications of solving equations

o. Inequalities

5] Probability and Statistics

a. Samples

b. Systematic Sampling

c. Random Sampling

d. Probability

e. Practical Probability

f. Experimental probability

g. Theoretical Probability

5] Probability

a. Probability

6] Inequality

    a. Inequality

    b. Comparing the measures of the angles of a triangle

    c. Comparing the lengths of sides in a triangle

    d. Triangle Inequality

7] Areas

    a. Equality of the Areas of Two Parallelograms

    b. Equality of the Areas of Two Triangles

    c. Areas of Some geometric figures

8] Projections

    a. Projections

    b. Converse of Pythagoras' Theorem

    c. Euclidean Theorem

    d. Classifying of Triangles according to their Angles

Note: For both grades, the above table combines the topics of the first and second term.

The above comparison shows that mainly the topics in eighth grade build on the topics introduced in seventh grade. In some cases the lessons have the same titles in both grades, as in the case of statistics, but in spite of that the content is different; for example, grade seven organizes data and represents in bar and pie charts while in grade eight the representation is done in the form of a cumulative frequency table and graph. Another example is the topic of reflection in geometry; for seventh grade students are taught to reflect shapes in straight lines while in

grade eight reflection is taught in a coordinate plane. On the other hand, for the case of probability, the material covered in seventh grade seems to be more extensive than that of eighth grade, which is merely a repetition of what had been previously taught.

As for the second coherence criterion, the learning objectives of each topic are clearly and briefly stated at the beginning of each unit. In spite of that, no relation or connections to content that have been previously taught are made. The same is true for the activities and exercises provided in the textbook; with no connections between topics. In some cases, an exercise consists of two parts that are totally unrelated.

An important aspect that has to be considered is whether the textbook content is balanced or not. In order for it to be balanced, clarity, organization, accuracy, comprehensiveness, depth of mathematical inquiry, and depth of mathematical reasoning have to be attained. From the above examination, the Egyptian national eight grade textbook does not fully attain balance as it includes problems in accuracy, lacks mathematical reasoning, is not very focused and has coherence issues.

The second component stated by Confrey and Stohl (2004) has to do with learner oriented perspectives. When it comes to student engagement, participation and relations to students' prior experiences, the textbook only relates to topics that have already been learned by students by providing them with a revision section at the beginning of the book. Otherwise, it does not relate to students' prior experiences and does not relate to real life situations. The "Think and Discuss" section at the beginning of each section supposedly should interest students in the upcoming lesson and ignite their curiosity; however, in some cases the questions are direct and do not require a lot of thinking and researching. It is worthy to note that in some lessons the "Think and Discuss" section only provides a brief revision of something that has been previously

studied by the teachers. As for timeliness and pacing, there is no information in the textbook that indicates the time each unit or lesson is covered. Another factor that should be considered in the textbook is support for student diversity and different ability students; again, there is no mention or consideration of differentiation at all in the student textbook. When considering assessments, the textbook provides a lot of exercises which are mainly complete the sentence, multiple choice questions, and exercises that require direct application of the concepts studied. Accordingly, these assessments mainly require rote memorization with minimal incorporation of higher order thinking skills.

Confrey and Stohl's (2004) third criterion is concerned with teacher and resources oriented perspectives, mainly pedagogy, professional development, and extra resources. The textbook does not provide any information regarding this perspective, but the teacher's guide (Gab Allah & Roufael, 2009) that accompanies the student textbook does and should be considered as a beneficial resource to be used by the teachers. The reason behind its importance is that it includes the following: First, the standards and benchmarks for each and every strand of eighth grade mathematics. Second, it provides the teachers with general teaching strategies that mainly revolve around the constructivism learning theory, where students relate what they are learning to the world they live in and their previous experiences. The suggested strategies include:

- Posing a question, or reciting a historical story at the start of the lesson to ignite the curiosity of the students.
- Giving students a chance for discussion.

- Dividing the given activities between group work and individual work. The group work would allow the students to communicate with each other as well as with the teacher, while the individual work would give each student a chance to think on his/her own.

- At the end of each activity or discussion, the teacher should clearly wrap up everything that has been discussed or solved showing definitions, relationships, theories that have proof, and so on.

- Giving students a chance; either during class time or at home, to explore some properties or relationships alone.

- Encouraging students to give solutions or proofs that are different than the ones provided.

- When teaching any concept or relation between several concepts, examples should be given by the teacher. Moreover, the teacher should ask students to give examples as well.

- Avoiding lecturing and solving exercises on the board all the time without discussions or giving students a chance to solve on their own.

- Using different teaching strategies during class time.

- Giving special care to slow learners during individual and group work, as well as, high achievers.

- Giving students a variety of activities in class and at home, taking into consideration individual differences.

- Setting office hours, other than class time, to provide help for students.

- Helping students feel confident that they can succeed in this curriculum.

Afterwards, for each unit, the teacher is provided with an introductory section where the teacher is reminded with what the students have previously learned and what will be learned during this unit, followed by the objectives of the unit. Moreover, a list of the teaching aids that

can be used is provided, such as the board, colored chalk, three dimensional geometrical shapes, geometrical tools, graph paper and calculators. Furthermore, the teachers are given suggested teaching methods, including group work, lecturing, discussion, brain storming, problem solving, discovery, inductive reasoning, and deductive reasoning. Suggested assessment methods are then presented, such as oral questioning, individual and group written activities during and after the lesson has been presented, and the general test at the end of each unit. Finally, a rubric is provided at the end of each unit to rate the performance of the students.

For each and every lesson, the teacher is provided with a background section, again informing the teacher with what has already been learned, and what should be learned during this lesson, followed by the objectives of the lesson, the key terms that will be used in the lesson, as well as a list of the specific teaching aids that should be used for that lesson. Afterwards, there is a section on how the lesson should proceed. This section shows the teacher exactly how to present and explain the lesson to the students. It also includes answers to some of the textbook exercises, as well as the assessment exercises to be given to students. Moreover, there are extra activities to distinguish between students.

Alignment between the National Standards, the Curriculum, and the Textbook

In order to know the extent of alignment between the Egyptian national mathematics standards, the curriculum, and the textbook, Baker's (2004) alignment analogies were considered. Baker defines four types of alignment; alignment as congruence, alignment as a set of correspondences, alignment as bridge, and alignment as gravitational pull. Alignment as congruence is when the items being checked are perfectly aligned without any irrelevancies. As for alignment as a set of correspondences, it is when the elements are harmonious but not necessarily congruent. On the other hand, alignment as bridge is when there is a connection

linking the items in question together. Finally, alignment as gravitational pull is when there is a central aspect that ensures that all the elements are revolving around it.

1. Curriculum – Textbook Alignment

The type of alignment between the Egyptian national curriculum for eighth grade mathematics and the Egyptian national eighth grade textbook is rather straightforward, as the curriculum is simply a table that includes the names of the subtopics that are to be covered during the two terms of the academic year with no irrelevance whatsoever. These subtopics correspond to the names of the lessons in the textbook. This means that the alignment between the Egyptian national curriculum for eighth grade mathematics and the Egyptian national eighth grade textbook is alignment as congruence.

2. Standards – Curriculum Alignment

When examining the Egyptian national eighth grade mathematics standards against the Egyptian national curriculum for eighth grade mathematics, two types of benchmarks are observed in the standards document. First are declarative benchmarks that directly relate to the content that has to be covered. Second are procedural benchmarks that are more concerned with the application of the knowledge and content to mathematical and non mathematical problems, as well as real life experiences and interdisciplinary situations. The type of alignment between the declarative benchmarks and the curriculum is alignment as a set of correspondences. In other words, the subtopics that are mentioned in the curriculum document have similar counterpart benchmarks in the standards document. As for the procedural benchmarks, there is no mention of these at all in the curriculum document. Accordingly, the overall alignment type could be considered alignment as a set of correspondences because the major part of the Egyptian national

eighth grade mathematics standards is in harmony with the Egyptian national curriculum for eighth grade mathematics.

3. Standards – Textbook Alignment

As a further step, the alignment between the Egyptian national eighth grade mathematics standards and the Egyptian national eighth grade textbook was also examined. The extent of alignment between the textbook content and the benchmarks that are related to knowledge was found to be alignment as congruence. The content benchmarks and the textbook are perfectly aligned to the extent that in most lesson headings the wording used is exactly like the wording used in the content benchmarks. On the other hand, there are exercises in the textbook that barely resemble the knowledge application benchmarks available in the standards document but show little relation to real life experiences and interdisciplinary connections. For instance, some benchmarks require that students be able to give examples of things that they have learned from real life; there are almost no exercises in the textbook that require students to do so. Most exercises tell the students exactly what to do and which method use rather than let them use higher order thinking skills. Accordingly, there is no alignment between the textbook and the knowledge application benchmarks.
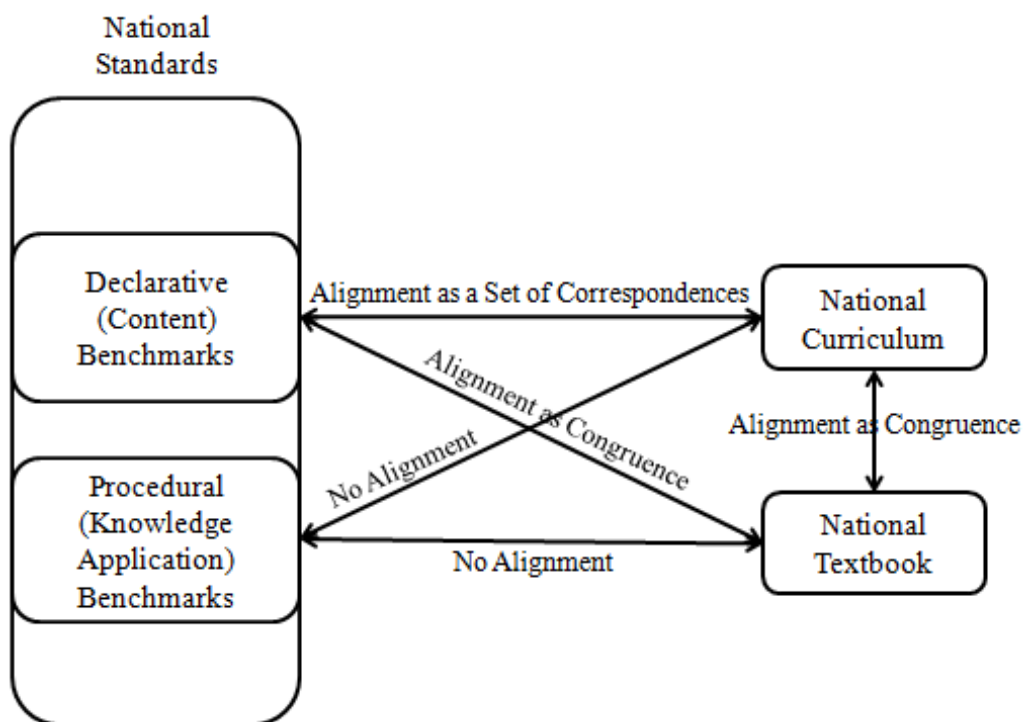
Figure 1. Egypt's National Standards, Curriculum & Textbook Alignment

Chapter 5: Singapore – Results and Analysis

I. The National Curriculum Framework

Singapore's national mathematics standards are organized into an integrated framework (MOE Singapore, 2006b), rather than listed as a standard and benchmarks for each and every topic. This framework includes the principles that the curriculum should encompass in all grades, primary through secondary, and is organized into a pentagon, as shown in the below figure.
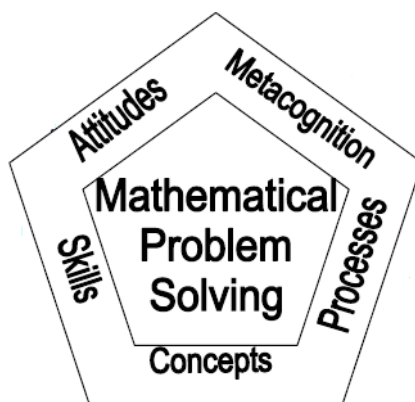
Figure 2. Singapore's National
Curriculum Framework – Pentagon
Model. Adapted from the Ministry of
Education, Singapore (2006)

As shown, mathematical problem solving is the major element required for learning

mathematics. In this framework, problem solving mainly refers to the ability to acquire and apply

mathematical concepts and skills in different situations and under different circumstances. In

order to be able to develop this ability, five interconnected components have to be acquired.

These are concepts, skills, processes, attitudes, and metacognition.

The first component is mathematical concepts which include numbers, algebra, geometry,

statistics, probability and data analysis. It is important for students to deeply acquire and explore

these mathematical ideas, and to understand that they are all interrelated and not be learned in

isolation from each other. Accordingly, the students should be exposed to various learning

experiences in order for them to be able to reach these connections and become more confident

in applying and exploring mathematical ideas. These learning experiences should include

technological aids, hands-on activities, and concrete materials.

The second component is mathematical skills which include calculations, algebraic

manipulation, visualization, analysis, measurement, estimation, and the use of various

mathematical tools. The point that should be emphasized in this component is that students

should first understand the mathematical concepts very well before attempting to be competent in the procedural skills. Moreover, thinking skills, heuristics, and technological skills are important elements that have to be incorporated within the process of developing mathematical skills.

The third component is mathematical processes which include reasoning, communication, connections, thinking skills, heuristics, application, and modeling. Mathematical reasoning means that students should be able to analyze situations and develop logical arguments based on their analysis. This can be achieved by exposing students to mathematical situations in various contexts. As for mathematical communication, it is the students' ability to express mathematics using precise and logical mathematical language. It is important that they be able to do that because it helps them develop and sharpen their understanding of mathematics. Another important knowledge skill that has to be acquired by students is the ability to make mathematical connections which mainly refers to being able to link mathematics and other subjects, as well as mathematics and real life experiences. This skill helps students understand why they are learning mathematics. When it comes to thinking skills and heuristics, they should be incorporated in a variety of ways within the learning experience of the students to aid them in problem solving. Thinking skills mainly include the ability to classify, compare, sequence, analyze, identify patterns and relationships, spatially visualize, induce and deduce. On the other hand, heuristics include representations, guesses, changing the problem, and going through the process. Another important component is mathematical application which refers to the ability of students to apply what they learn, mainly problem solving and reasoning skills, to deal with real world problems. The last component is mathematical modeling where students should be able to use various

models and data representations, and choose the most appropriate methods and tools to tackle real life problems.

The fourth component is attitudes which refer to the affective parts of mathematics learning. These include the students' beliefs about the importance and usefulness of the subject, their interest in it, their enjoyment in learning it, their appreciation of its power, their confidence in using it, and their determination to solve a problem. All these characteristics can only be shaped by the students' learning experience which has to be relevant, positive, fun, and interesting. Moreover, the learning activities have to be designed in such a way to help the students appreciate the subject and feel confident about it.

The last component is metacognition which means that students have to be able to control their thinking process and be aware of it. The development of metacognition is important for improving the problem solving abilities of students, and it can be achieved by exposing students to various problem solving skills, encouraging them to think on their own and use their own methods, providing them with activities that require planning and evaluation, encouraging them to use alternate methods to solve a problem, and giving them the chance to discuss and explain how they will reach their solutions.

The second part of the curriculum framework document includes the topics and subtopics that should be covered within each grade. Specifically, the curriculum is presented in a simple table where each topic is titled followed by its subtopics. Opposite each subtopic is the content to be taught within it. In some cases, examples are given, while in other cases the content section states what should be excluded.

There are three topics, namely numbers and algebra, geometry and measurement, and statistics and probability. The numbers and algebra topic includes five subtopics, while the

geometry and measurement topic includes three subtopics, and the statistics and probability topic

includes two subtopics for a total of 10 subtopics overall.

In order to examine the Singaporean national curriculum framework, the three criteria

that were used are, first: the six characteristics for developing high quality standards (APEC

TATF & USAID, 2009); second, whether the two flaws stated by Marzano and Haystead (2008)

are present or absent; and third, whether higher order thinking skills are incorporated and taken

into consideration within the framework.

1. Characteristics of high quality standards

First, when checking for the degree of focus on certain topics depending on grade level,

the national curriculum framework for primary education (MOE Singapore, 2006a) was

examined; specifically the second part of the document where the topics are listed. The

examination showed that whole numbers, measurement, geometry, and data analysis are covered

in grades one through five. As for grade six, whole numbers are not covered but algebra is

introduced. Starting from grade seven, the three main topics that are covered are numbers and

algebra, geometry and measurement, and statistics and probability. The second characteristic of

high quality standards states that topics should be divided into strands and that they progress in a

logical manner to ensure efficient development of mathematical understanding and knowledge.

As stated before, the topics are divided into three major strands; numbers and algebra, geometry

and measurement, and statistics and probability. During the academic year which is divided into

four terms, these strands progress as follows; during the first term only topics in the numbers and

algebra strand are taught. As for the second term, it starts with topics from the geometry and

measurement section, followed by numbers and algebra. During the third term, topics from

geometry and measurement come first, followed by numbers and algebra, and then data analysis and probability. The fourth term is totally dedicated to data analysis and probability.

Regarding the third characteristic which involves topic progression across grades, based on the curricula for grades one through eight (MOE Singapore, 2006a, 2006b), the topics are introduced in a simple manner in early grades and then become harder as the grades progress. In spite of that, the curriculum is not designed spirally but it has a mastery learning approach (Guskey, 2010), where the number of topics introduced each year is small to ensure full understanding before moving on to the next grade.

The fourth characteristic states that standards should incorporate real world connections in order to make the learning experience of the students more meaningful. As can be seen from all the above components that the curriculum framework is based on, real world connections are incorporated in each and every one of them. Regarding the first component, mathematical concepts, students are encouraged to explore various mathematical ideas and to know that they are all connected. In order for this to be achieved they have to be exposed to different learning experiences which should include experiences and connections from the real world. As for the second component, mathematical skills, these procedural skills also need students to explore and be able to apply what they are learning, which again requires real life and previous experiences. The third component which is mathematical processes includes several subcomponents: Reasoning, communication, connections, thinking skills, heuristics, application and modeling, all of which require real world experiences. For instance, reasoning requires that students be exposed to different situations that allow them to logically analyze situations and develop arguments. These situations have to include real life experiences in order for them to make sense for the students. Another important subcomponent is making connections where students should

be able to see and understand relationships between mathematics and other subjects, interdisciplinary connections, as well as, mathematics and real world experiences. It is also very important for real life experiences and connections to be included in the fourth component, attitudes, because for mathematics to make sense and be relevant to students, it has to be real and related to the students' previous and ongoing experiences. Again, the fifth component, metacognition, requires that students be exposed to real life situations in order to be able to shape their way of thinking and understanding.

Considering the fifth characteristic of high quality standards which states that standards should be complemented with examples of the assessments that the students will be exposed to, there is no mention of the type of exercises or examination questions that the students will undergo in the document. In some topics that are stated in the second part of the curriculum document, examples of what should be taught are given, but otherwise no mention of assessments. When it comes to the sixth characteristic, mathematical proficiency, it is very well covered in the curriculum framework. More specifically, conceptual understanding is stated in the mathematical concepts component. Procedural fluency is complemented with the mathematical skills component. As for strategic competence, it is covered in the mathematical processes subcomponents mentioned in the framework. Adaptive reasoning is clearly articulated in the metacognition component in the curriculum framework. Finally, productive disposition is also covered in the attitudes component.

Examining the above results to check whether Singapore's national curriculum framework complies with the six characteristics of high quality standards (APEC TATF & USAID, 2009), first, when considering the degree of focus of the topics taught in grades one through eight; the examination showed that the material taught in each grade is well focused.

This focus shows in the small number of topics and the relevant subtopics that have to be covered during the academic year for each grade level. Moreover, the more advanced topics are not introduced in early grades, but reserved for later grades. Second, the topics are divided into logical strands that alternate throughout the year such that simple topics are introduced first. As for the third characteristic which has to do with the progression from topic to topic, the Singaporean national curriculum framework ensures that students fully master concepts and skills before moving on to more advanced material. This ensures that students have a strong mathematical foundation and base that would allow them to fully understand and utilize their mathematical capabilities. The fourth characteristic, which is connecting with the real world, is very evident in the curriculum framework components. This helps in making students understand mathematics even more. The Singaporean curriculum framework falls short when it comes to the fifth characteristic, as it does not provide any assessment examples. As for the sixth characteristic, the results show that if the curriculum framework is followed precisely, the students will be mathematically proficient. Overall, the Singaporean national curriculum framework complies with five of the six characteristics of high quality standards (APEC TATF & USAID, 2009).

2. Flaws

The first flaw stated by Marzano and Haystead (2008) is considered with adding more content than the allocated time allows. As per the MOE of Singapore, the school year in Singapore starts in January and is divided into four 10 week terms. This means that the academic school year duration is 40 weeks. During these 40 weeks, the number of topics and subtopics that need to be covered is as follows: Five subtopics for number and algebra, three topics for geometry and measurement, and two topics for statistics and probability. This means that 10

subtopics need to be covered within 40 weeks, approximately four weeks per subtopic. Considering the above data and assuming that each subtopic requires at least one classroom period to be covered, then the time allocated for the material that has to be covered is more than enough.

The second flaw, unidimensionality, is not applicable in the Singaporean situation because the standards are organized into an integrated framework rather than a list of standards and benchmarks.

3. Higher order thinking skills

Higher order thinking skills are incorporated within almost all the components of the curriculum framework. This makes sense as problem solving which is the main characteristic that the whole framework is centered around is a higher order thinking skill.

II. Textbook

When the Singaporean eighth grade mathematics textbook (Keung, 2008c, 2008d) was examined, the results were as follows:

Table 6

Singaporean National Eighth Grade Mathematics Textbook Analysis

	First Term	Second Term
Title	Discovering Mathematics 2A	Discovering Mathematics 2B
Authors	Chow Wai Keung (General Editor: Esther Ng Yoon Cheng & Consultant: Prof. Ling San)	
Publisher (Year)	Star Publishing Pte Ltd (2008)	
External Resources	Workbook (two versions: one for students and one for teachers)	
Structural Organization		

Number of Pages	211	171
Number of Units/Topics	6	5
Total Number of Lessons	25	16
Soft Cover/Hard Cover	Soft cover	Soft cover
Spiral/Mastery	Mastery	Mastery
Presentation of Content	Each unit starts with a chapter opener, followed by the learning objectives. Afterwards comes the lessons which start with an explanation of the subtopic to be covered, then there are class activities, worked out examples, and exercises similar to the examples for the students to try. At the end of the lesson there are exercises that start easy and become harder as they progress. At the end of the lesson there is a revision exercises section. At the end of each unit there is a chapter summary, as well as a question that relates the topic learned to the real world, and a question that requires students to reflect.	
Illustrations	A colorful book with many illustrations:	

A colorful book with many illustrations:

1- When introducing the topic and relating to real world experiences or history

2- Pictures of real things are embedded within the lesson to help in increasing understanding and relate to real life. There are also pictures of famous people.

3- To illustrate a given question

4- Graphs & geometrical drawings

Worked-out Examples	Available after the explanation of each lesson
Definitions/Rules	Definitions and rules are embedded within the lesson and sometimes are written in the review section "in a nutshell" at the end of the unit. No glossary.
Use of Tools	Computer software programs: Microsoft Excel and The Geometer's Sketchpad. Only used in the class activities. Instructions are given to students telling them what to do and which commands to use.
Exercises	Explained in the "Presentation of Content" section above.
Use of Group Work	No exercise asks students to work in groups.
Spelling Mistakes	Nothing evident.

Note: The analysis criteria are adapted from Huntley (2008).

In order to further examine Singapore's textbook, Confrey and Stohl's (2004) content analysis criteria were used. First, when it comes to the disciplinary perspectives section and the topics covered by the textbook, considering the clarity of the learning objectives, each unit starts with a list of learning objectives entitled "Let's learn to …". This list includes brief sentences written in a clear way informing students about what they will be learning from the unit ahead. As for comprehensiveness and the way the topics are structured and sequenced, the textbook is organized as follows. First, at the beginning of each topic there is a chapter opener where the topic is introduced by making connections with the real world or relating it to history. The learning objectives come next. Following that the subtopics are presented in the form of lessons. For each lesson there is a brief explanation of the subtopic being presented .In some lessons, the explanation is followed by class activities. These activities encourage the students to learn by

discovery. In some cases, computer software programs are used to make the students' learning experience more interactive and dynamic. Afterwards, solved examples are demonstrated to help students understand the concepts, as well as show them how they can express their solutions in a correct and precise way; sometimes more than one method for solving the example is presented. Following that there is an exercise named "Try It" for the students to try to solve a problem similar to the one that was just solved to ensure that they have understood the presented concepts. Within each lesson there are small comments for the students to benefit from, these include:

- Remark: Includes information that could be of interest to students

- Recall: Includes definitions or concepts that have already been covered and are related to the new material being presented

- Discuss: Includes discussion questions for the students and teachers to go through

- MathBits: Includes puzzles, or questions, or facts related to mathematics that could be of interest to students

- Go Online: Provides students with websites that could be used as external references to help students better understand the concepts.

At the end of each lesson, there is an exercises section which is categorized into four types of questions ranging from simple and direct to challenging and indirect:

- Basic Practice: This section includes simple and direct questions that require straightforward application of the learned concepts.

- Further Practice: This section includes questions that are more challenging but still require straightforward application.

- Maths@Work: This section requires the students to apply the learned concepts to make real world connections and solve integrated mathematics problems.

- Brainworks: This section includes either open-ended questions, or ones that requires higher order thinking skills, to encourage students to think creatively, critically, analytically, and to come up with answers of their own.

At the end of each topic, there is a summary section named "In a Nutshell" where the important concepts that have been presented in the previous subtopics are summarized for review. Moreover, there is a revision section that includes exercises to help students review the concepts that they have learned; this helps in consolidating the students' learning. Furthermore, there is an "Extend Your Learning Curve" section that encourages students to make connections with the real world as well as further explore concepts that have been learned. Finally, there is a "Write in Your Journal" section where students are encouraged to reflect on what they have learned. Questions are posed to help students in this reflection process. At the very end of the book, there is a "Problem Solving and Heuristics" section that provides students with a step-by-step problem solving process as well as examples to help students understand how they can use this process. Following that section are model answers for the "Try It", end of lesson exercises, and revision exercises.

When it comes to accuracy, no major mistakes were observed. Some exercises were randomly answered and their respective model answers were found to be correct. As for the depth of mathematical inquiry, subtopics within each topic are related to each other and build on each other; however, there is no relation between the topics themselves. Within each topic and its subtopics many relations are made to real world experiences and history. Regarding mathematical reasoning, the end of lesson exercises ensure its development as exercises start off

by being basic, simple, and direct in the basic practice section and move on to being more indirect, challenging and complex in the following sections: further practice, math@works, and brainworks.

Regarding the organization of the topics and the requirement that they be sequenced logically and coherently to make the progression from topic to topic easier, in the Singaporean textbook, topics are arranged in such a way that they alternate between algebra, geometry, data analysis and probability. Each topic is taught as a whole before moving on to a new one. As per the teacher's guide, during the first 10 weeks, i.e., the first term, topics from the numbers and algebra strand should be taught. As for the second term, the topics that should be covered include ones from the geometry and algebra strands. The third term includes topics from the geometry and measurement, numbers, and statistics strands. Finally, the fourth term covers topics from the statistics and probability strand. In order to check if the topics listed in the textbook are focused and coherent, the criteria set by CCSSM (2012) and Leinwand and Ginsburg (2007) were taken into consideration. First, CCSSM (2012) states that focus is achieved when major mathematical topics are made clear and are taught in the first half of the school year; in this case, the first two terms. These major topics should be chosen in such a way that guarantees that students develop a strong basis for moving on to more advanced algebraic topics. No topics are highlighted in this textbook as major or as the most important ones to be covered in the first two terms. Second, the CCSSM (2012) states that for focus to be achieved, there are certain topics that should not be taught in early grades; rather the focus should be on arithmetic and foundational concepts and skills. For example, probability should not be introduced before seventh grade, statistical distributions should start at sixth grade, geometric transformations, similarity and congruence should be tackled starting in grade eight, and symmetry should be introduced at grade four. In

order to examine this criterion the topics that are covered in grades one through eight were checked and the results were as follows:

- Probability is introduced in seventh grade.

- Statistical distribution is introduced in seventh grade.

- Geometric transformations, similarity and congruence are introduced in eighth grade.

- Symmetry is introduced in fourth grade.

As for Leinwand and Ginsburg (2007), a textbook is checked for focus by counting the number of pages of the book, the number of topics introduced, the number of lessons, and most importantly, the number of pages assigned for each lesson. A textbook is said to have more mathematical focus if there is a fewer number of topics, with each subtopic covered in a greater number of pages. The results of this examination gave the following result:

Table 7

Singapore's Results of Leinwand & Ginsburg (2007) Textbook Focus Criteria

Criteria	Textbook 2A	Textbook 2B	Total
Number of Pages	211	171	382
Number of Units/Topics	6	5	11
Total Number of Lessons	25	16	41
Number of Pages/Lesson:			
Numbers & Algebra	91	16	107
Geometry & Measurement	23	33	56
Data Analysis, Statistics & Probability	-	37	37

Note: The total number of pages per lesson does not include the exercises, general exercises, or review exercises, or model answers. Only the number of pages dedicated for the lesson itself is given.

Concerning the two criteria that CCSSM (2012) consider when examining the coherence of mathematics content, these are: first, whether new topics are introduced directly with the beginning of the academic year, or if old topics are reviewed first and then new topics are tackled; and second, the connections made within the covered topics, and whether these are clear in the lesson objectives. Moreover, the second criterion examines if the exercises relate several topics together or not.

In order to check for the first criterion the topics in the seventh and eighth grade Singaporean textbooks (Keung, 2008a, 2008b, 2008c, 2008d) were examined, and the results are shown below.

Table 8

Singapore's Comparison between Seventh & Eighth Grade Topics

Seventh Grade	Eighth Grade
1] Factors and Multiples	1] Expansion and factorization Of Algebraic Expressions
a. Primes, Prime Factorization and Index Notation	a. Expansion of the Products of Algebraic Expressions
b. Highest Common Factor (HCF)	b. Special Products of Algebraic Expressions
c. Lowest Common Multiple (LCM)	c. Factorization by Using Special Products of Algebraic Expressions
d. Square Roots and Cube Roots	d. Factorization of $ax + bx + c$
2] Real Numbers	2] Set Language and Notation
a. Idea of Negative Numbers and the	a. Set Notation

Number Line

b.   Venn Diagrams and Complement of a Set

b.   Addition and Subtraction of Integers

c.   Multiplication, Division and Combined Operations of Integers

c.   Union and Intersection of Sets

d.   Rational Numbers

e.   Real Numbers and Use of Calculators

3] Approximation and Estimation

a.   Rounding Off Numbers to Decimal Places

b.   Rounding Off Numbers to Significant Figures

c.   Estimations and Accuracy of Calculators

3] Proportion

a.   Map Scale and Calculation Of Area

b.   Direct Proportion

c.   Inverse Proportion

4] Introduction to Algebra

a.   The Use of Letters in Algebra

b.   Evaluation of Algebraic Expressions and Formulae

4] Simple Algebraic fractions

a.   Simplifying Simple Algebraic Fractions

b.   Multiplication and Division of Algebraic Fractions

c.   Addition and Subtraction of Algebraic Fractions

d.   More about Formulae Changing the Subject of a Formula

5] Algebraic Manipulation

5] Quadratic Functions and Equations

a. Like Terms and Unlike Terms

b. Addition and Subtraction of Linear Algebraic Expressions

c. Simplification of Linear Algebraic Expressions

d. Factorization by Using Common Factors

e. Factorization by Grouping Terms

a. Graphs of Quadratic Functions

b. Solving Quadratic Equations by Factorization

c. Applications of Quadratic Equations

6] Simple Equations in One Unknown

a. Simple Linear Equations in One Unknown

b. Equations Involving Brackets

c. Simple Fractional Equations

d. Forming Linear Equations to Solve Problems

6] Linear Equations in Two Unknowns

a. Meaning Of Linear Equations In Two Unknowns

b. Solving Simultaneous Linear Equations in Two Unknowns by Graphical Method

c. Solving Simultaneous Linear Equations in Two Unknowns by Substitution Method

d. Solving Simultaneous Linear Equations in Two Unknowns by Elimination Method

e. Solving Problems using Simultaneous Equations

7] Angles and Parallel Lines

    a. Points, Lines and Planes

    b. Angles

    c. Parallel Lines and Transversals

    d. Perpendicular Bisectors and Angle
       Bisectors

8] Triangles and Polygons

    a. Triangles

    b. Quadrilaterals

    c. Polygons

    d. Construction of Triangles and
       Quadrilaterals

7] Pythagoras' Theorem

    a. Pythagoras' Theorem

    b. Applications of Pythagoras' Theorem

    c. Determination of Right-angled
       Triangles

9] Ratio, Rate and Speed

    a. Ratios Involving Rational Numbers

    b. Average Rate

    c. Speed

10] Percentage

    a. Meaning of Percentage

    b. Reverse Percentages

    c. Percentage Increase and Decrease

    d. Discount and GST

11] Number Patterns

a. Number Patterns and Sequences

b. General Term of a Sequence

12] Coordinates and Linear Graphs	8] Congruence and Similarity

12] Coordinates and Linear Graphs

a. Cartesian Coordinate System

b. Linear Graphs

c. Gradients of Linear Graphs

8] Congruence and Similarity

a. Meaning of Congruence

b. Similarity

c. Scale Factors

d. Scale Drawings

13] Simple Inequalities

a. Solving Simple Inequalities

b. Applications of Simple Inequalities

14] Perimeters and Areas of Plane Figures

a. Mensuration of Square, Rectangle,

Triangle and Circle

b. Area of a Parallelogram

c. Area of a Trapezium

d. Perimeters and Areas of Composite

Plane Figures

9] Mensuration of Pyramids, Cones and

Spheres

a. Pyramids

b. Cones

c. Spheres

15] Volumes and Surface Areas of Solids

a. Volumes and Total Surface Areas of a

Cube And a Cuboid

b. Volume and Total Surface Area of a

Prism

c. Volume and Surface Area of a Cylinder

10] Data Analysis

a. Dot Diagrams

b. Stem-and-leaf Diagrams

c. Measure of Central Tendency: Mean

d. Measure of Central Tendency: Median

e. Measure of Central Tendency: Mode

d. Volumes and Surface Areas of

    Composite Solids

16] Data Handling	11] Probability
a. Collection of Data	a. The Meaning of Probability
b. Organization of Data	b. Sample Space
c. Bar Graphs, Pictograms and Line Graphs	
d. Pie Charts	
e. Histograms	

Note: The topics are not arranged in the order in which they should be taught.

After examining the topics that should be covered in both seventh and eighth grade, the results show that there is no repetition between the topics. This means that no time is wasted in reviewing the material that was previously taught. Moreover, the results show that the topics build on each other; as the eighth grade material builds on the topics that have been previously taught.

Regarding the attainment of balance, the Singaporean textbook is very well balanced. From the above results, it is shown that clarity, accuracy, organization, depth of mathematical inquiry and depth of mathematical reasoning are all achieved.

Based on Confrey and Stohl's (2004) content analysis criteria, the second perspective that has to be considered when examining the textbook's content is that of the learners. When considering student engagement, each topic in the textbook starts with a brief introduction that connects it to something in real life, in many cases relating to Singapore. Moreover, embedded within each lesson are small comments for the students to benefit from, ignite their curiosities

and motivate them. These comments are labeled "Remark", "Recall", "Discuss", "MathBits", and "Go Online". Concerning timeliness and pacing, the textbook does not include any timelines that students should be aware of. As for supporting the students' diversity and abilities, the exercises provided in the textbook range from simple and direct to complex, challenging, and indirect. Otherwise, there is not much support for students from different backgrounds and/or cultures. Looking more specifically at the assessments included in the textbook and their incorporation of higher order thinking skills, as mentioned earlier there are different types of assessments given starting from direct questioning to indirect exercises to exercises that do not have one correct answer or one method for answering, as well as questions that incorporate higher order thinking skills and reflection. All these are incorporated in the exercises that are provided at the end of each lesson and include basic practice, further practice, math@works, and brainworks.

The third criterion stated by Confrey and Stohl (2004) is the teacher and resources oriented perspectives which mainly includes pedagogy, professional development, and extra external resources that could be used by the teachers. The textbook does not include any information concerned with this criterion. In spite of that, the teacher's guide (Keung, 2008e) which comes with the textbook does include some beneficial information for the teachers that mainly has to do with pedagogy and resources but does not mention professional development. First, it includes a suggested scheme of work which tells the teacher what to teach each week of the academic year. It is presented in a table format where the following aspects are listed:

a. The term and week number

b. The topic to be taught and its objectives

c. Suggested teaching strategies

d. The activities to be given to students, giving the exact page number in the textbook.

e. The resources that could be used, including chapters from the textbook, specific page numbers and exercises, websites, and the national education messages that the students should learn from this specific topic

f. Extra websites that could help the students understand the topic more

g. An appendix is attached to the suggested scheme of work that lists the national education messages that should be conveyed to the students with each topic as stated in the resources section of the scheme of work table

Second, the guide includes a "Notes On Teaching" section where teachers are given ideas on how to approach the topic that is to be taught. It also includes information on what the students should know, what the teachers should emphasize, misconceptions that the students might have, and mistakes that they could make and how to avoid them. Third, the teachers are provided with fully worked solutions for each and every exercise in the textbook. There are even suggested answers for the problems that have no definite answer but require the students to think.

Alignment between the National Curriculum Framework and the Textbook

Using the alignment analogies stated by Baker (2004), alignment as congruence, alignment as a set of correspondences, alignment as a bridge and alignment as gravitational pull, the extent of alignment between the Singaporean national curriculum framework for eighth grade mathematics, and the Singaporean eighth grade mathematics textbook that is approved by the MOE are examined. The Singaporean national curriculum framework document consists of two sections, the framework and the curriculum; each section was examined as a separate entity.

1. Curriculum – Textbook Alignment

When examining the second part of the Singaporean eighth grade national mathematics curriculum framework, the curriculum, against the Singaporean eighth grade mathematics textbook to check for alignment, the topics stated in the curriculum section were found to be perfectly aligned with the topics in the textbook. Accordingly, the type of alignment is alignment as congruence, as the textbook exactly resembles the curriculum without any irrelevancies.

2. Standards Framework - Curriculum Alignment

The type of alignment between the framework and the curriculum, which are both in one document, was checked by examining the topics in the curriculum against the framework. The curriculum section merely mentioned the concepts and skills that should be covered during the academic year. As for processes, attitudes, and metacognition, there is no mention of them in the curriculum. Accordingly, the alignment is partial and cannot be defined using Baker's (2004) analogies. It is important to note that the framework and the curriculum are both in one document, making it harder to find the extent of alignment.

3. Standards Framework – Textbook Alignment

Regarding the alignment between the framework and the Singaporean eighth grade mathematics textbook, the type of alignment is alignment as gravitational pull. The textbook revolves around the framework components. First, the textbook includes all the concepts and skills that have to be learned by the students. Second, regarding the processes, reasoning, communication and connections, thinking skills and heuristics, applications and modeling, they are all incorporated in the textbook as well. Regarding reasoning, students are encouraged to think and analyze different situations to come up with their own solutions in the "Brainworks" exercise section which is available after each lesson in the textbook. Moreover, students are exposed to several worked out examples in the textbook which helps them see the appropriate

method to communicate their mathematical knowledge. In some cases, more than one method is illustrated in order for students to know that there could be several ways for solving problems and not just one. Furthermore, every unit in the textbook starts with a "Chapter Opener" section that provides students with historical information or real world connections that relate to the topic that will be covered in that unit. As for thinking skills and heuristics, there is a special section at the end of the textbook dedicated solely for explaining problem solving processes and heuristics. This section is also complemented with worked out examples that show the steps that should be followed when approaching any problem. When considering applications and modeling, there are many exercises in the textbook that encourage students to apply the knowledge and concepts that they have learned. These exercises are named "Maths@Work" and "Extend Your Learning Curve"; in them the students are also exposed to real life situations. Third, metacognition is included in the "Write in Your Journal" section at the end of each chapter of the textbook, where students are encouraged to reflect about their learning experience. The last component which is attitudes is reflected in the textbook as well, in the connections and the relationships that are made with real life experiences. These linkages help the students understand why they are learning mathematics and how they can use it in their lives.
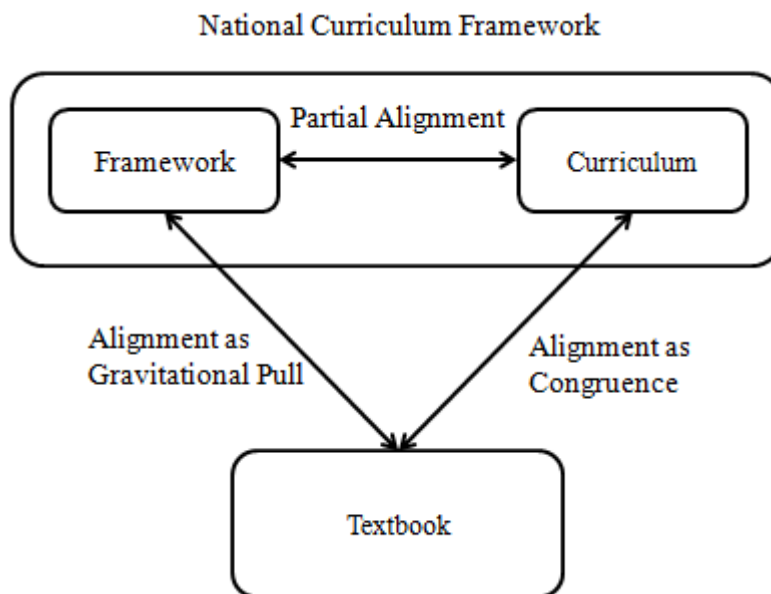
National Curriculum Framework

Figure 3. Singapore's National Curriculum Framework & Textbook Alignment

Chapter 6: Recommendations for Improvement

Based on the above research, several adjustments can be recommended to improve the national eighth grade Egyptian mathematical education system; adjustments in the standards, curriculum, and the textbook.

Considering the standards, first, the degree of focus on topics should be adjusted in such a way that in early grades more emphasis is put on number and operations and geometry and measurement. On the other hand, algebra and data analysis should be postponed to later grades when it is ensured that the foundational knowledge and skills have been strongly laid. Second, the spiral design that is implemented should be changed into either a strand design or a mastery approach. The reason behind this is that spiraling leads to superficial covering of material rather than in depth coverage because teachers are aware that the same material will be reviewed again the following year. This leads to boredom and frustration from the side of students, as they keep learning and reviewing the same material over and over each year. On the other hand, if a strand

design is used mathematical concepts and skills will be taught without introducing any new material, until mastery is achieved. Furthermore, this design entails that several concepts and skills be taught at the same time. In this case, the number of topics introduced should be decreased so that they are covered in depth rather than in a shallow manner. Moreover, the teaching pace will depend on the difficulty or ease of the topics at hand. This ensures that students are not frustrated, because the material is presented at their own pace and nothing new is introduced until the basics are understood. As for boredom, this will not be an issue because students will be introduced to several concepts and skills at the same time. Mastery learning which is very similar to the strand design, is more preferred because it ensures that students fully understand the concepts and master the skills of the material taught without the need to keep revisiting it each and every year. The main difference between the mastery and the strand design is that the mastery approach does not include the incorporation of several concepts and skills at the same time.

Third, the standards should incorporate a reflective dimension that allows students to think about what they are learning and to understand the way they think, as well as appreciate it. As per Betne (2009), one of the problems of a mathematics education that does not involve reflection is that students see it as a set of calculations and formulas that have to be done in order to reach an answer without any relation to the real world. The teaching method is the main contributor to this problem because the only aspects that are emphasized are the procedures and the techniques. In other words, the main focus is on procedural knowledge without giving much attention to its application in real life where a more logical and quantitative analysis is required for solving problems. Accordingly, reflection should help students examine the knowledge and skills they are learning in such a way that they can apply it to real world situations. By doing

this, students will be able to reason logically using their knowledge base, as well as synthesize any information given to them, thus become mathematical thinkers, rather than students who can only calculate and come up with formulas to reach one correct answer. In order for reflection to be beneficial, teachers should pose questions to guide students and lead them to develop greater understanding of the mathematical concepts they are learning as well as how these concepts can be applied in real life. Moreover, reflection should be a continuing process that is part of each and every lesson. Accordingly, the standards for each unit should have a section that ensures that students are asked to examine facts, use their knowledge to answer questions logically, and become skilled in adjusting their understanding and applying it to the real world (Betne, 2009). The fourth recommendation is improving the time allocated for presenting the content that should be covered during the academic year. The other option would be to decrease the number of topics that have to be taught. In both cases, sufficient time should be given for topics to be deeply covered, in such a way that gives students the chance to fully understand the material. Fifth, the standards' benchmarks should be adjusted so that they all become unidimensional; for ease of instruction and assessment. This can be done by "unpacking" the benchmarks such that they do not mix several dimensions in one statement (Marzano & Haystead, 2008). The process of unpacking is beneficial because it shows how much content is actually embedded in the standards and benchmarks. This would also make it easier for teachers by eliminating their need to teach several concepts at the same time instead they would be able to teach one at a time, and to know exactly the required sequence and scope of the material that has to be covered (Marzano & Haystead, 2008).

The last recommendation is the incorporation of higher order thinking skills in the standards. This recommendation is very important because students need these skills in order to

be able to be synchronized with the advancements and developments of the 21st century. As per Pegg (2010) it is difficult for students to learn higher order thinking skills and for teachers to incorporate them while teaching. On the other hand, the Partnership for 21st Century Skills (2011) views mathematics content as inherently aligned with higher order thinking skills. Accordingly, such skills can be easily integrated within mathematics education. For instance, in order to incorporate critical thinking and problem solving, the practices that students should be exposed to include being able to make sense of the problems they are to solve, persevering in finding solutions, reasoning abstractly and logically, applying and modeling using mathematical concepts, and looking for and making use of patterns. As for communication, students should be exposed to exercises that allow them to construct logical arguments, criticize other people's reasoning, and be precise. When it comes to collaboration, students should work in groups, and become members of a team where responsibility is shared. Considering technological literacy, students should be taught how to use the appropriate tools in a strategic manner.

Regarding the curriculum, the national Egyptian mathematics eighth grade curriculum document is content specific; thus, many adjustments could be made to improve it. First, the curriculum document should include a section for curriculum mapping where topics that have been already covered during seventh grade are listed. This is very important because it prevents repetition and wasting time on material that has been already covered. Second, detailed unit descriptions should be included to provide a full picture of the curriculum. These details should incorporate the alignment of each topic with its respective standard(s) and/or benchmark(s), the objectives of the unit, examples of assessments, and the skills that should be integrated within each topic in the curriculum.

As for the textbook, the following recommendations could be made to the national Egyptian eighth grade mathematics textbook in order to improve it. The first recommendation is that the textbook needs to be reviewed for mistakes including spelling mistakes and errors in the given model answers. Since these errors could confuse the students and make them lose confidence in the textbook; the textbook loses its credibility. Second, the exercises provided in the textbook should examine a wider array of students' skills. The exercises that are included in the textbook mainly depend on rote memorization; that is why higher order thinking skills should be incorporated in these assessments so that they include, problem solving, critical thinking, creativity, reflective exercises, and collaboration in the form of group work. Moreover, these practice exercises should progress from simple and direct, to more complex and challenging; by doing this, the different student abilities will be addressed. Furthermore, questions that have more than one correct answer and/or more than one solving methods should be included to allow students to be more creative and to come up with answers of their own rather than being limited to one way of doing things. Third, the textbook should include relations with students' previous knowledge as well as connections with real life. Moreover, the topics taught in the textbook should be related to each other and these relationships should be made clear for the students. Another important factor would be the inclusion of interdisciplinary connections that should also be clarified for students. Incorporating these relations and connections in the textbook would enable the students to understand and appreciate what they are learning and why they are learning it. The fourth recommendation for improving the textbook is that major topics should be given more focus and time allocation. This focus should be emphasized during the first term of the academic year. These major topics should mainly include topics that help students build a strong mathematical foundation that prepares them for the more advanced material in later

grades. Finally, spiraling should be avoided in the textbook; that topics that have been previously taught should not be revisited, but should present new material right away.

Chapter 7: Delimitations and Limitations

The delimitations of this study are mainly concerned with data from the Egyptian educational system. As for the limitations, they are related to data from the Singaporean educational system.

The delimitations of this research can be divided into three categories; curriculum-related, teacher-related, and assessment-related. Regarding the curriculum-related category, the main delimitation is that this research does not include how the curriculum is actually implemented in Egyptian classrooms and whether it is fully or partially covered. As for the teacher-related delimitation, several main factors were not taken into consideration in this research. First is how the Egyptian teachers are prepared in order to teach the curriculum. The second factor is the degree of their familiarity with the standards, curriculum, and the textbook, and whether they have had any previous experience teaching the same material before. The third factor has to do with the teaching methods used in the classroom which differ from one teacher to the other. Finally is information about whether the teachers make use of the teacher's guide or not. Considering the assessment-related delimitation, this research does not include any information about how students in Egypt are actually assessed. Moreover, there is no mention of the type of assessments that they undergo, how they are set, and by whom.

Regarding the limitations of this research, they can be divided into four categories; curriculum-related, teacher-related, assessment-related, and textbook-related. The first three categories are the same as the delimitations mentioned above but for the Singaporean educational system. As for the fourth limitation, the textbook-related one, it mainly has to do with the

Singaporean textbook. There were many other textbooks that could have been used in this research, but the one chosen was the only one that could be accessed. One extra limitation that has to be taken into consideration is that this study is based on the results of the TIMSS (IEA, 2008) which is the only available international exam that students from both Egypt and Singapore undergo.

Chapter 8: Conclusion

The aim of this study was to examine the national Egyptian eighth grade educational system, namely the mathematics standards, curriculum and the textbook. Furthermore, the national Singaporean eighth grade mathematics educational system was to be examined as well. This was done in order to try to reach a set of recommendations for improving Egyptian mathematics, as international tests have identified Singaporean students as high achievers in mathematics. Moreover, the study aimed at finding the weak points in the standards, curriculum and textbook of Egypt, as well as the strong points in the curriculum framework and textbook of Singapore in order to analyze if any lessons could be learned from them and be adapted to the Egyptian case.

Based on the characteristics of high quality standards (APEC TATF & USAID, 2009), the main strengths of the Egyptian national standards are that they categorize the topics into strands and for each strand the benchmarks are divided into declarative and procedural benchmarks. The declarative benchmarks mainly list the concepts and skills that the students should acquire, while the procedural benchmarks require that students be exposed to real life experiences to learn how mathematics is applied in the real world and thus appreciate it more. On the other hand, the Egyptian standards are weak when it comes to the degree of focus of the topics presented, the progression from topic to topic, the lack of variety in assessments and

higher order thinking skills, and unidimensionality. Moreover, the content that has to be covered is more than the time allotted permits.

The national Egyptian eighth grade mathematics textbook has some strong points and some weak ones. The main strong points are the clarity of the objectives and learning outcomes, the presentation of the content, and the teacher's guide that accompanies the textbook. On the other hand, the weak points mainly include the lack of higher order thinking skills, connections between topics, real world and interdisciplinary connections, and relations to students' previous experiences. Furthermore, the variety of the exercises provided is very limiting, direct, and dependent on memorization; i.e., complete the sentence, multiple choice, and exercises that require students to find, or write, or prove rather than explore, reflect, analyze, and so on. Another major weakness is that the textbook has many mistakes, spelling mistakes and errors in the model answers provided at the end of the book. Finally, the textbook does not support students' diverse cultures, backgrounds, or abilities.

The national Singaporean curriculum framework has several strong points; the topics are focused, divided into strands, and their progression is coherent and are covered using a mastery learning approach to guarantee full understanding. Moreover, real world connections are incorporated in each and every component of the framework to ensure that mathematics makes sense to the students. Another major strength is that the framework components ensure that students become mathematically proficient. As for the time allotted for material coverage it is quite sufficient with four weeks per subtopic. Regarding the incorporation of higher order thinking skills, the whole framework is centered around problem solving which ensures that each and every component is based upon higher order thinking skills. The only identified weakness

that the Singaporean curriculum framework has is that it does not give any examples of the anticipated assessments.

The Singaporean eighth grade mathematics textbook has many strong aspects. Most importantly, the objectives and learning outcomes are clearly stated, the material is presented in a comprehensive manner, and the exercises and assessments progress from being simple and direct to hard and challenging. This ensures that students of different abilities are supported. Moreover, higher order thinking skills are incorporated in all aspects of the textbook. Furthermore, there are no major mistakes in the textbook. Another important strength is that real world connections are incorporated at the start of each topic. Finally, the teacher's guide is a very beneficial resource that complements the student textbook. The major textbook weakness is that there are no apparent connections between the topics that are covered.

Standards based education reform in Egypt is a good initiative that still requires improvements and adjustments so that all its components can be strongly founded and all its weak points eliminated. Furthermore, the alignment of these components has to be taken into consideration. This alignment does not necessarily have to be exact but should be harmonious and centered around one big idea. However, this is only the first step towards a good mathematical education in Egypt. The second step, which is the most important, is ensuring that the components of this educational system are actually followed and implemented in schools. Without proper implementation the well founded standards based education components would be meaningless.

A set of questions that should be considered at this point are: Will this well founded standards based educational system ensure that Egyptian students become high achievers in mathematics? Will these students start to compete with Singaporean and other top students? How

can teachers be prepared to teach mathematics now that the practices that they have been using will need to be changed and/or adjusted? What type of professional development will they need? Who will supervise the schools and the teachers to ensure that this new system is actually followed and implemented in a proper manner? All these and many more questions need to be taken into account in the effort to improve the components of the standards based mathematics education in Egypt and ensure that it will have a positive effect on the achievement of students.

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Appendix

Summary of Results

Criteria	Egypt	Singapore
I. Standards/Curriculum framework	Organized into a list of standards and benchmarks.	Organized into an integrated framework that is centered around problem solving
A. The six characteristic of high quality standards	The national standards do not fully comply with the six characteristics of high quality standards.	The national curriculum framework complies with five of the six characteristics of high quality standards.
1. Degree of focus	- Lacks focus as number and operations, algebra, relations, and functions, geometry, measurement, and statistics, data analysis, and probability are covered starting grade one through eight.	- Focused to a great extent as whole numbers, measurement, geometry, and data analysis are covered in grades one through five. As for grade six, whole numbers are not covered but algebra is introduced. Starting from grade seven, the three main topics that are covered are numbers and algebra, geometry and

		measurement, and statistics and probability.
2. Division into strands and their sequence	- Topics are divided into four strands; number and operations, algebra, relations, and functions, geometry and measurement, and statistics, data analysis, and probability. - The strands alternate throughout the school year.	- Topics are divided into three major strands; numbers and algebra, geometry and measurement, and statistics and probability. - The strands alternate throughout the school year.
3. Progression from topic to topic	- Topics are organized into a spiral design where same material is revisited every school year with increasing emphasis and depth.	- Topics are covered in a mastery learning approach method; where the number of topics introduced each year is small to ensure full understanding before moving on to the next grade.
4. Incorporation of real world connections	- Students are encouraged to make interdisciplinary and real world	- The components that the curriculum framework is based on incorporate real

		connections through activities that are introduced after all the standards in each strand have been covered.	world connections in each and every one of them.
5.	Support by assessment examples	- No examples are given of exercises or assessments that students will undergo.	- There is no mention of the type of exercises, or examination questions that the students will undergo.
6.	Inclusion of mathematical proficiency criteria	- Conceptual understanding, procedural fluency, strategic competence, and productive disposition are all included. - The reflection-related aspect of adaptive reasoning is not included, but all other aspects are; giving examples, proving theories, and discussing concepts and results.	- All aspects of mathematical proficiency are covered in the curriculum framework components.

B. Flaws

1.	Time allotted for covering	For the first term:	- There are 10 subtopics that need to be

required content

- There are 48 benchmarks related to numbers and operations, algebra, relations, and functions, and data analysis and statistics should be covered in 42 classroom periods.

- There are 12 benchmarks for geometry and measurement that should be covered in 28 classroom periods.

For the second term:

- There are 14 benchmarks for the algebra, relations, and functions, and statistics and data analysis have to be covered in 24 classroom periods.

- There are 19 benchmarks related to geometry and measurement that have to be covered in 36 classroom periods.

covered within 40 weeks; approximately four weeks per subtopic.

2. Unidimensionality	- Almost half of the benchmarks are not unidimensional; i.e., include mixed statements.	- Not applicable in the Singaporean situation because the standards are organized into an integrated framework rather than a list of standards and benchmarks.
C. Higher order thinking skills	For the first term: - The main emphasis is on remembering, understanding, and applying with very minimal weight given to analysis, evaluation, and creation. For the second term: - The major weight is given to remembering and applying with minimal emphasis to understanding, analysis, and evaluation.	- Incorporated within almost all the components of the curriculum framework which revolves around problem solving.

	- No importance is given to creativity which is the highest level of thinking.	
II. Curriculum	- There are two documents one for each term. - The format of the document is a simple table that includes the following information: a. The months. b. The unit names. c. The lessons within each unit; broken down into either algebra & statistics, or geometry. d. The duration through which the unit should be taught. For the first term, the duration dedicated for algebra and statistics is a period and a half per	- The second part of the curriculum framework document includes the topics and subtopics that should be covered within each grade. - The curriculum is presented in a simple table where each topic is titled followed by its subtopics. - Opposite each subtopic is the content to be taught within it. - In some cases, examples are given, while in other cases the content section states what material should be excluded.

week, while for geometry it is one

period per week. As for the second

term, the duration allotted for algebra

and statistics is one period per week,

and for geometry it is one and a half

period per week.

III. Textbook

1. Disciplinary perspective

| a. Objectives and learning outcomes | - At the start of each lesson there is a section titled "you will learn how", which includes a very brief list of the expected learning outcomes. | - Each unit starts with a list of learning objectives entitled "Let's learn to …".
 - This list includes brief sentences written in a clear way informing students about what they will be learning from the unit ahead. |
| b. Comprehensiveness | - Each unit is broken down into a number of short lessons. | - At the beginning of each topic there is a chapter opener where the topic is |

- Each lesson includes a brief presentation of the topic to be covered, followed by worked out examples and then exercises for the students to solve on their own. These exercises are often similar to the examples that have been solved before.

- At the end of each unit there is a general exercises section.

- At the end of the textbook there are practice tests for the students to solve.

- The lessons within each unit are well sequenced, while this is not always the case for the units themselves.

introduced by making connections with the real world or relating it to history.

- The learning objectives come next.

- The subtopics are presented in the form of lessons that are briefly explained.

- The explanation is followed by class activities, solved examples, exercises similar to worked out examples.

- At the end of each lesson, there is an exercises section which is categorized into four types of questions ranging from simple and direct to challenging and indirect.

- At the end of each topic, there is a summary section named "In a Nutshell" where the important concepts are

summarized for review.

- There is a revision section that includes

exercises to help students review the

concepts that they have learned.

- There is an "Extend Your Learning

Curve" section that encourages students

to make connections with the real world.

- There is a "Write in Your Journal"

section where students are encouraged to

reflect on what they have learned.

- At the very end of the book, there is a

"Problem Solving and Heuristics"

section that provides students with a

step-by-step problem solving process as

well as examples to help students

understand how they can use this

		process.
c. Accuracy	- Probability is spelled wrong; pro**p**ability.	- No major mistakes were observed.
	- Other mistakes in model answers include:	- Some exercises were randomly answered
	▪ Providing answers to questions that do not exist.	and their respective model answers were found to be correct.
	▪ Providing wrong answers.	
	▪ Wrong numbering of questions.	
	▪ In case of multiple choice questions; the given answer is not in the choice list.	
	▪ Question requires students to draw things that are already drawn.	
d. Depth of mathematical inquiry and reasoning	- The lessons within each unit are built on each other, but the units themselves are mostly separate entities with no obvious connections between them.	- Subtopics within each topic are related to each other and build on each other; however, there is no connection between the topics themselves.

- Each lesson starts with a "Think and Discuss" section that includes activities to make the students curious about what they are about to learn. Afterwards, the lesson is presented, and then solved examples, followed by exercises for the students to answer on their own. The exercises are very similar to the worked out examples and in some cases are exactly the same as the given examples. Other exercises are labeled "Think" but are direct questions with no space for thinking. The given exercises can be summarized as follows:

  ▪ Complete the sentence which requires students to memorize definitions and

- Within the each topic and its subtopics many relations are made to real world experiences and history.

- The end of lesson exercises start off by being simple, direct and basic; in the basic practice section, and move on to being more indirect, challenging and complex in the following sections; further practice, math@works, and brainworks.

	rules	
	▪ Multiple choice questions	
	▪ Other questions that mainly start with words like: Find, Write, or Prove	
e. Organization of topics	- Algebra and statistics are taught for a period and a half per week. - Geometry is taught for one period only per week. - Students are exposed to lessons from both sections each week, meaning that they alternate algebra and statistics with geometry, with no apparent connection between the topics being taught.	- The topics are arranged in such a way that they alternate between algebra, geometry, data analysis and probability. -Each topic is taught as a whole before moving on to a new one.
2. Learner perspective		
a. Student engagement	- The textbook only relates to topics that have already been learned by students by	- Each topic in the textbook starts with a brief introduction that connects it to

	providing them with a revision section at the beginning of the book. Otherwise, it does not relate to students' prior experiences, and does not relate to real life situations. - The "Think and Discuss" section at the beginning of each section supposedly should interest students in the upcoming lesson and ignite their curiosity, although in some cases the questions are direct and do not require a lot of thinking and researching.	something in real life; in many cases relating to Singapore. - Embedded within each lesson are small comments for the students to benefit from, ignite their curiosities and motivate them.
b. Timeliness and support for diversity	- There is no information in the textbook that indicates the time each unit or lesson is covered. - There is no mention or consideration of	- The textbook does not include any timelines that students should be aware of. - There is not much support for students from different backgrounds, and/or

	differentiation at all in the student textbook.	cultures. - As for students with different abilities, the exercises provided in the textbook range from simple and direct to complex, challenging, and indirect.
c. Assessment	- The textbook provides a lot of exercises; mainly complete the sentence, multiple choice questions, and exercises that require direct application of the concepts studied.	- There are different types of assessments given starting from direct questioning to indirect exercises, to exercises that do not have one correct answer or one method for answering, as well as questions that incorporate higher order thinking skills and reflection.
3. Teacher perspective a. Pedagogy	Provided in teacher's guide - The teacher's guide includes general teaching strategies, as well as, specific teaching methods for each lesson in the	Provided in teacher's guide - The teacher's guide includes a suggested scheme of work which tells the teacher what to teach each week of the academic

	textbook.	year.
		- A "Notes On Teaching" section is included where teachers are given ideas on how to approach the topic that is to be taught.
		- It also includes information on what the students should know, what the teachers should emphasize, misconceptions that the students might have, and mistakes that they could do and how to avoid them.
b. Professional development	- No mention of professional development in teacher's guide.	- No mention of professional development in teacher's guide.
c. Resources	- The only external resource is a Compact Disc (CD) that accompanies the teacher's guide.	- The external resources that are provided are the workbooks; one for the students and one for the teachers.
Alignment between standards,	- Curriculum and textbook: Alignment as	- Curriculum and textbook: Alignment as

curriculum and textbook	congruence	congruence.
	- Standards and curriculum:	- Standards framework and curriculum:
	▪ Content benchmarks and curriculum: Alignment as set of correspondences	Partial alignment
		- Standards framework and textbook:
	▪ Knowledge application benchmarks and curriculum: No alignment	Alignment as gravitational pull.
	- Standards and textbook	
	▪ Content benchmarks and textbook: Alignment as congruence	
	▪ Knowledge application benchmarks and textbook: No alignment	