APPRAISAL OF MATHEMATICS CURRICULUM 2006

By
Alyas Qadeer Tahir[*]

Abstract

The selected themes, content standards and expected learning outcomes stipulated in the intended National Curriculum 2006 for grade I-XII provided the basis of the framework for reviewing the mathematics curriculum. Current international thrusts in mathematics education such as the focus on problem solving, emphasis on the development of thinking skills and positive dispositions, use of technology whenever it is appropriate and available, and research on how students learn mathematics are considered in this study. The findings of the study are mainly focused on the data collected on the subject where opinion of mathematics curriculum experts was solicited. The framework and analysis of the intended mathematics curriculum show at a glance what the curriculum possesses, what the curriculum should consider as valuable for the students to learn, what they should learn and how they should learn them effectively. The results of the study loudly speak of an enlightened vision of development efforts and identify some deficiencies in problem-solving, communication and disconnection of mathematical approach towards daily life of Pakistani society. This paper also presents guidelines, synthesises, findings and recommends some key elements for further development and improvement of mathematics curriculum in Pakistan and countries around the region.

Keywords: Appraisal, Mathematics Curriculum, Themes, Content, Standards, Learning Outcomes

Introduction

Mathematics is an obligatory subject up to secondary level in Pakistan. According to the Scheme of Studies (Govt. of Pakistan, 2006), the total numbers of periods per week in a school are 40 and the periods allocated to mathematics per week are 6 which is 15% of the total school work load. The number of school

[*] Director, National Institute of Science and Technical Education, Ministry of Education, Islamabad.

days will be now 210 in an academic year and an average school day is of six hours in Pakistan. "This time is more viable as compared to the developed countries such as U.S.A., Germany and Japan whose school days in a year range from 175 to 220. The average length of school stay in these countries varies from 5 to 8 hours per day (Coupland, 2006)".

According to a study at NISTE (2001), "the mathematics curriculum for secondary level has gone through a number of revisions since the creation of Pakistan. The first change in mathematics curriculum was initiated during 1968. This change was termed as modernization of curriculum and included drastic changes in mathematics subject matter, textbooks and teacher training. The 'Sets' were introduced first time in Pakistan at secondary level. The greater emphasis was placed on the practical and scientific application of mathematics" (Government of Pakistan, 1968). Accordingly, "a massive revision of secondary school mathematics was carried out during 1972-73 (Government of Pakistan, 1972). In this revision, the content was made concept oriented. In addition to this, deductive and inductive approaches were adopted for teaching mathematics to the students of secondary classes. The textbooks were implemented from year 1977. Secondary school mathematics curriculum was also revised in 1986 but only a few and minor changes were made in the pervious curriculum (Government of Pakistan, 1986). This curriculum was implemented in the year 1988.

A unified curriculum was developed in 1994 as part of a breakthrough in the history of development of mathematics curriculum for secondary level in Pakistan. This curriculum was developed for all the students opting general as well as elective group (Government of Pakistan, 1994). This curriculum was comprised of four major categories viz: Sets and Numbers, Geometry, Algebra, Information handling and Trigonometry. This curriculum was introduced in 1995. Accordingly, "the curriculum was implemented without any planning and strategy especially towards the delivery of mathematics and in the face of shortage of mathematics teachers, which has always existed in Pakistan". The findings of an evaluation study conducted at NISTE (2000), on this curriculum revealed that "most of the portion of this curriculum was taken from the earlier curriculum made for the students of elective group. The clientele of general group had no option but to study this curriculum. Moreover, the teachers who had been teaching general mathematics, had to teach this course without any preparation. Most of the teachers especially the female teachers did not prove capable of teaching. The comparison of curriculum of 1994 with that of 1986 reveals that it is quite close to

that of the 1986 curriculum. However, the only significant change introduced in the curriculum of 1994 was the inclusion of "information handling".

This situation affected the achievement of students in the examination. According to the results of Federal Board of Intermediate and Secondary Education, Islamabad for the year 2008, "75% of the failing total students failed due to the failure in the subject of secondary school mathematics" (FBISE, 2008). Similarly, in BISE, Rawalpindi, "80% of the unsuccessful students failed in the Secondary School Examination due to failure in mathematics in the year 2009" (BISE, 2009).

The Punjab Education Department developed the science and mathematics curriculum for Classes I-XII in 2000 to overcome the weaknesses of the previous curriculum (Government of Pakistan, 2000). This curriculum was implemented from academic year 2003 throughout the country. The analysis of mathematics curriculum 2000 for Classes IX-X when compared with curriculum of 1994 revealed that "no crucial change was introduced in this curriculum rather this was closer to the curriculum of 1986 (NISTE, 2000). Nevertheless, the sequence of some of the topics in a few chapters of this curriculum was different, whereas, chapter such as 'information handling' was heavily extended. However, the most important among the salient features of this curriculum is the grass root changes towards the delivery approach of mathematics. The main thrust of this curriculum of mathematics was the acquisition of information and skills necessary to become sensible and responsible individuals in highly technological society of the 21st century. This curriculum has been in practice till year 2010. The curriculum 2006, about which this papers is presented, is scheduled to be implemented throughout Pakistan from the academic year, 2011.

Review of Literature

The traditional theories of mathematics have now been changed with the advent of the electronic computer. The mathematics researchers have now adopted paradigms from basic learning theories of psychology, sociology and anthropology for the reason that there is no single agreed upon paradigm is presently available in mathematics education research. According to Anna Sfard (1996) "there are two contrasting views of learning labelled as 'acquisitive' and 'participatory' models. The acquisitive model is mainly based on information processing through which knowledge is acquired as a result of understanding the concepts and acquisition of mathematical skills. In 'participatory' model,

knowledge is taken as social construct which includes: physical and social classroom conditions, teacher's behavior and learning environment, etc. Testing of Trends in International Mathematics and Science Study (Martin, Mullius, Ganzles and Chrowstoski, 2004) was carried out in 46 countries of the world. The test was based on intended, implemented and attained curricula of mathematics. The results of eighth grade mathematics tests 2002/3 show that students of Singapore excelled in scoring higher than all other students of other countries. As a consequence, "the mathematics curricula of Singapore and Hong Kong have come up as better arrangements of courses as witnessed from this study and the Program for International Student Assessment (PISA, 2004a)". According to Wirth & Fleischer (2006) "the analysis of students of mathematics achievements in Germany, Japan, USA, and Netherlands from the PISA, students with higher overall mathematics performance did not necessarily perform better in problem solving while lower overall performing students often showed higher problem-solving skills".

In Singapore, there is a diverse scheme of mathematics curriculum. The students are offered courses keeping in view their capabilities, needs and performance. There was an extensive review of Upper Secondary Education in year 2002 in Singapore where newly introduced curriculum of Junior college level was comparatively broader and more flexible (MOE, 2006). The structural procedures have uplifted the standards and achievements among students of mathematics upto the level that students from Singapore have come up as the highest achievers in competition of 46 countries around the world.

In Hong Kong, new curriculum and assessment framework for all subjects are being developed. There are drastic changes found in new Senior Secondary mathematics curriculum structures of Hong Kong. Mathematics consists of a Compulsory part and an Extended Part which consists of two modules: Module 1 – Calculus and Statistics and Module 2- Algebra and Calculus. The time allocated for teaching is approximately 270 – 338 hours (CDC and HKEAA, 2006). According to the Board of Studies, (NSW, 2006c) Australia, "the level of compulsory mathematics in Hong Kong is more advanced and algebra based whereas in Australia it is 'pure mathematics' flavour".

England is famous for innovations in the subject of mathematics but still there is a big concern in England "about large numbers of students not studying mathematics of any kind after the compulsory years of schooling. This trend has

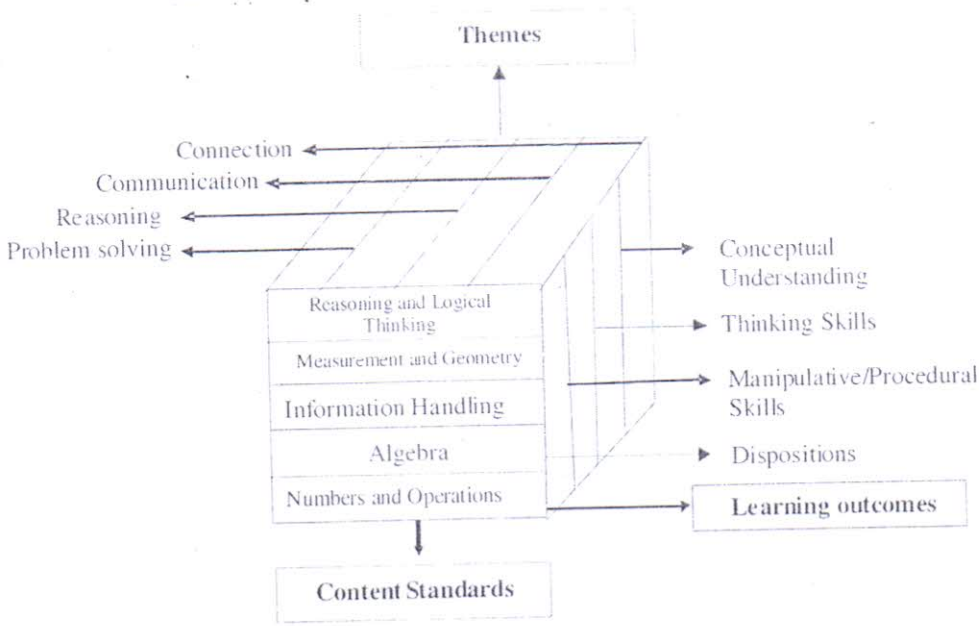
led to the introduction of Free- standing mathematics qualifications which have been designed to meet the needs of the students. The big issue for England is to struggle with the challenge of participation rates in mathematics. Some new innovations likewise 'the AS subjects and ESMQ' have not been universally successful to date" (QCA, 2006b).

"The high school mathematics curriculum in the USA is a unique curriculum. Through this scheme of mathematics curricula, "one year is spending on each of the areas Algebra, Geometry, Algebra and Trigonometry and Pre-Calculus" (NCTM, 1992). The main concern about the USA high school mathematics curriculum is not the availability of various integrated schemes but, lack of cohesiveness among these. According to Stacey (1998), "Calculus is not a mainstream subject in most high schools in the USA".

The Mathematics Curriculum Framework

The new intended curriculum 2006 for the subject of mathematics from grade I-XII claimed to be "more vibrant and more responsive to the modern, socio-economic, technical, professional and labour market needs of the country" (Govt. of Pakistan, 2006). The whole curriculum is based on five Content Standards which are further elaborated through benchmarks in each of the Standard. The guiding principle is that students learn mathematics in a better way when they are confidently engaged and are provided opportunities in applying or doing mathematics. This implies that in all content areas, the themes that should cut across are: problem solving, reasoning, communication, and connection. All these themes require the active involvement of students in generating mathematical ideas and transferring them to new contexts. The standards of mathematic curriculum 2006 comprised of Numbers and Operations, Algebra, Measurements and Geometry, Information Handling and Reasoning and Logical Thinking. These standards are elaborated in greater depth and complexity as the class level increases. The learning outcomes put equal importance to conceptual understanding, development of thinking skills and manipulative/ procedural skills, and acquisition of positive dispositions. The three dimensional model presented in Figure-1 depicts the framework of new mathematics curriculum 2006. The dimensions interact in ways that, as students learn any content; they experience all the themes, which should result in the attainment of the learning outcomes.

Figure 1: Framework for Reviewing Mathematics Curriculum



Content Standards

Numbers and Operations

This standard includes: i) identification of numbers with their representations and operations in different situations. ii) computation of fractions, percents and decimals and, iii) manipulation of different types of sequence and applying operations on matrices.

Algebra

This standard describes: i) analysing number pattern and interpreting mathematical solutions by manipulating algebraic expressions and relations, ii) modelling and solving contextualized problems and iii) interpreting functions, calculating rate of change of function, integrating analytically and numerically, determining orthogonal trajectories of a family of curves and solving non-linear equations numerically.

Measurement and Geometry

According to curriculum 2006 (Govt. of Pakistan, 2006) "this standard includes: i) identifying measurable attributes of objects, construct angles, and two dimensional figures, ii) analysing characteristics and properties of geometric shapes and developing arguments about their geometric relationships and iii) recognizing trigonometric identities, analysing conic sections, drawing and interpreting graphs of functions".

Information Handling

This standard comprised of collecting, organizing, analysing, displaying and interpreting data/information.

Reasoning and Logical Thinking

Accordingly, "this standard includes: i) using patterns, knowing facts, properties and relationships to analyse mathematical situations and ii) examining real life situations by identifying, mathematically valid arguments and drawing conclusion to enhance their mathematical skills (Govt. of Pakistan, 2006)".

Themes

The themes are described in detail in as much as these are usually not consciously and consistently given the needed attention that they deserve in the curriculum.

Problem Solving

The main method as well as the purpose of mathematics teaching should be to develop students' ability to solve problems. The students acquire this ability in their daily life if opportunities are provided for them to experience the following:

i. how mathematical concepts and skills are developed in the contexts of problem situations?
ii. how newly learned concepts and skills may be useful in solving problems with the same structure or may be transferred to accommodate novel situations? and
iii. how specific strategies may be applied to solve problems?

Furthermore, problem solving can be viewed in three ways. One way is teaching and learning mathematics through problem solving. This view uses real life situations or mathematical problems to develop the concepts or topics and skills to be learned. Another way is teaching and learning mathematics for problem solving. In this view, the concepts, skills, and processes are first taught

and then learned by the students to equip themselves to solve mathematical problems related to practical life. The third way is pertaining to knowing about how to teach and learn about mathematical problem solving. In this view, the students are taught the different steps in solving a problem and the strategies for coming up with the solution.

Reasoning

Based on the mathematical relationships that they observe, students should have knowledge of making, verifying and justifying conjectures. Likewise, they should have the ability to provide convincing arguments or counter examples to support the claims that they make. Moreover, the students should be able to make generalizations on the basis of patterns that they discover.

Communication

The students should be able to understand and represent the meaning of a mathematical idea expressed in different forms, for example the geometric interpretation of algebraic formulas. They should be able to explain their ideas logically, clearly, concisely and accurately using concrete objects such as models or semi-concrete objects such as pictures or diagrams, in words verbally or in writing, and symbolically such as using graphs or equations.

Connection

The students should be able to link and connect what they have learned from topics within mathematics and also of disciplines other than mathematics, beyond particular class level and across different class levels. They should also have the ability to apply their knowledge of mathematics and competencies in solving problems related to daily life. Also, they need to be capable and confident in using technology to solve problems and verify if their solutions are reasonable.

Learning Outcomes

According to curriculum documents of Govt. of Pakistan (2006), "Learning outcomes are the learning statements, specifically describing what students are supposed to learn and able to do at each grade level in order to achieve the specified benchmarks for every grade-cluster. In a way, these are the incremental steps towards accomplishment of benchmarks, which are organized around the standards and listed for each grade level as students advance in their knowledge, skills, attitude, and applications".

Conceptual understanding

It is important that students understand a concept thoroughly and this can be ensured partly by their consciously monitoring their own learning. For

instance, when students forget mathematical rules or procedures, they can always rely on their clear understanding of concepts to help them reconstruct these rules or procedures.

Thinking Skills

In the process of doing mathematics, students use different thinking skills. The 2003 Assessment Framework of the Trends in International Mathematics and Science Study (Martin et. al., 2004) categorizes the cognitive domain into four categories, which includes various thinking skills. These categories provide a useful scheme that encompasses the different levels of thinking. Some examples of these thinking skills are: classifying, representing, formulating, interpreting, applying, verifying, making conjectures, predicting, analysing, generalizing, connecting, synthesizing/integrating, and justifying/proving.

Manipulative/Procedural Skills

Using mathematics instruments for measuring, calculating, and constructing geometric figures; Arithmetic, algebraic and statistical manipulations and calculations and geometric constructions

Dispositions

As the students do mathematics, the following dispositions should be developed: curiosity (spirit of discovery and exploration), interest/appreciation, confidence and perseverance.

Methodology

The appraisal of mathematics curriculum 2006 was carried out with the purpose to seek opinion of curriculum experts, mathematicians, educationists and working school teachers in the field. For this purpose, a two days study workshop was organized where respondent were briefed about the new mathematics curriculum and the curriculum development process followed by National Curriculum Council. The experts were given a list of focusing areas identified and considered by the mathematics Curriculum Development Committee. These include: problem solving, reasoning, connections, use of technology, thinking skills and disposition and contents.

The team of expert discussed at length the various approaches and working strategies for the appraisal of the mathematics curriculum. It was agreed after a thought evoking process to evolve and adopt an analytical-cum judgmental approach and to come up with combined findings and recommendations for the appraisal of mathematics curriculum.

Findings and Recommendations

Using the framework of mathematics curriculum, curriculum guidelines and experience in the field, the expert team came up with the following findings and recommendations on appraisal of new mathematics curriculum 2006.

Problem Solving

Findings

Real life situations apparently referred to as word problems in the curriculum are not explicitly required to introduce concepts or skills even when these can naturally and logically be done. Most of the uses of problem solving in the curriculum appear to be teaching and learning for problem solving. Thus, the kind of problems can expectedly be just the routine ones, those that are similar to what will be presented in the textbook or taken up in class. As such, the learners will already know the procedures for obtaining the solutions or answers.

Recommendations

The curriculum should offer a full range of problem solving experiences. Teaching through problem solving will provide the students opportunities to contend with non-routine problems. These are unfamiliar situations needing solutions for which students do not have readily available algorithms or prescribed procedures to use.

With such situation, the potential for the development of high-level thinking is great. Computational exercises or manipulation of symbols should be related to real life problems and situations so that the students will find learning mathematics meaningful and relevant. Students will see that school mathematics is related to the outside school mathematics.

Reasoning

Findings

The basis of a procedure or rule and the reasons why a procedure or rule works are not required. And so, the approaches to teaching and learning that rely primarily on the textbooks which are based on the curriculum may likely be very mechanical, conducive to memorization and imitation, and characterized by superficial understanding. Rote learning does not encourage critical thinking.

Recommendation

The curriculum should require that underlying reasons for commonly accepted mathematical procedures or relationships expressed in formulas be explained adequately and clearly.

Connection

Findings

There are gaps as well as overlaps in the topics introduced within a class level and across different class levels. Sometimes a topic is presented without the necessary required knowledge or skills. There are also instances when a comprehensively developed prior knowledge or skill is not at all used in subsequent topics. Some topics are developed in higher class levels as if the students are encountering them for the first time when in fact they have been just as well introduced in the lower class levels.

Recommendation

Strengthen the vertical and horizontal articulation of the topics in the curriculum.

Use of Technology

Finding

Using calculators when they are available and needed is not at all mentioned in the curriculum. The power of this technology in aiding student investigation of mathematical relationships such as number patterns or in enhancing their reasoning skills when they make estimates are not taken advantage of.

Recommendation

Provide for the appropriate use of calculators (and if possible, even of computers) if such technology is available.

Thinking Skills and Dispositions

Findings

No where in the curriculum is there any mention of the importance to develop among students thinking skills such as making conjectures and predictions, generalizing, and justifying. Likewise, there is no reference at all of

the need to develop student's dispositions such as interest in mathematics and confidence in doing it.

Recommendation

The curriculum should explicitly mention as part of its objectives, the development of thinking skills and desirable dispositions among students. In this way, textbook authors and teachers will be aware that this is just as important as students' learning mathematical content. Hopefully, they will exert efforts to make this happen.

Content

Findings

Certain topics, which are covered in the curriculum of countries like Singapore and the United States of America, are not found in the curriculum. These include problem solving strategies such as guess and check, working backwards, simplifying a problem, symmetry, number patterns, geometric patterns, and concepts of chance or probability.

Recommendation

The curriculum should consider including topics such as problem solving strategies, symmetry, number patterns, geometric patterns, and probability.

Results and Discussion

The Mathematics curriculum for classes VI to XII does not make a clear and specific reference to problem solving as its main focus. It mentioned in its learning outcomes "acquaintance with problem-solving strategies", "solve mathematical problems which have a practical value in real life situations" and "acquire understanding of concepts of mathematics and to apply them to the problems in the world they live in". But such references to problem solving are not sufficient to stress the importance of problem solving. The students in Pakistan may face the situation likewise as mentioned by Wirth and Fleischer (2006) regarding PISA study where "students with higher overall mathematics performance did not perform better in problem-solving while lower overall performing students often showed higher problem-solving skills". Three issues that emerged in the findings concerning problem solving are that in this curriculum priority needs to be given to algorithms and mathematical problems, and using mathematics to solve daily life problems and to develop thinking skills. While algorithms have their legitimate place in the mathematics curriculum as found by Nazir (2001) in his study on comparison of mathematics curriculum of Pakistan with South Asian Countries. He recommended that algorithms should be

dealt with proper balance and not at the expense of problem solving. Resnick (1987) described "the discrepancies which exist between the algorithmic approaches taught in schools and the 'invented' strategies which most people use in the workforce in order to solve practical problems which do not always fit neatly into a taught algorithm". As she says, "most people have developed 'rules of thumb' for calculating, for example, quantities, discounts or the amount of change they should give, and these rarely involve standard algorithms. Training in problem-solving techniques equips people more readily with the ability to adapt to such situations". Problem solving is important because it has practical life applications and develops thinking skills as suggested in content standards of NCTM (1992).

Some Units include many mathematical procedures, rules and formulas for which underlying reasons, justifications or derivations are mostly not provided. Apparently, students are expected to "learn" them without having to learn why and how they came about. The curriculum should require the provision of reasons for steps in procedures, justification for rules, and derivation of formulas. If these cannot be provided, then it is better to introduce them in higher class levels when the mathematical requirements are already available to do so. Otherwise, at least, reference can be made on which class levels they will be taken up. The theorems and their proofs are spread from class VIII to class XI in this curriculum which is a wise decision because a certain degree of student mathematical maturity is needed to prove theorems. By doing so, students will have a gradual exposure to reasoning involved in proofs and so they are more likely to apply logical reasoning than memorizing the content.

Connections have several ways in relation to the curriculum as reviewed in COMPASS (2007). One is the vertical articulation of topics. Since the curriculum is supposed to be integrated and spiral, the topics are expected to be presented with greater depth and complexity as the class levels get higher. However, every time a topic is revised, it is presented as if it is being introduced for the first time. So there are overlaps in the curriculum. Another aspect of vertical articulation involves proper sequencing of a topic across the different grade levels and the adequacy of treatment of said topic at each grade level. The expert recommended that Cartesian Coordinate System be moved from grade *IX* to grade VIII. Cartesian product, binary relation and types of functions (one-to-one, onto, and into) may be taken up in a higher grade and not in grade IX. Instead of using this very formal approach of functions, the Hero's formula and more difficult constructions may also be included at higher grade level. The geometric proofs may be spread in several grade levels. The discussion may also

be included on "Methods to Prove Theorems". The Fundamental Concepts of Geometry may be explained in teacher's guide.

The development of thinking skills and desirable dispositions are addressed in the curriculum of grades IX and X but, in the curriculum of grade VI to VIII, there is less emphasis on these important outcomes since the curriculum is mainly a listing of contents and learning outcomes so there is a great likelihood that this may just be left to chance to happen. According to the experts' opinion, the curriculum of grade I to XII does not fully cover the focus on the development of thinking skills. It is therefore recommended that in the curricula of mathematics at all grade levels the development of thinking skills and positive attitudes may be given due weightage and these should be explicitly stated in the curriculum. It is further recommended that the curriculum should be expressed in terms of learning competences.

Conclusion

The mathematics curriculum 2006 may have its merits and inadequacies but the main challenge is now to translate the content standards, themes and learning outcomes into their real sense while developing textbooks. Moreover expressing the curriculum in terms of learning competencies of mathematics is required while developing the textbooks.

Overlaps in the contents can be avoided if instead of repeating the contents for the revision purpose, only the question involving important concepts are given.

The content standards of various levels intend to develop mathematical concepts and skills through problem solving; there need to be an element of unfamiliarity in the opportunity to engage in high level thinking. Otherwise, they will just be dealing with routine problem solving of carrying out prescribed methods of finding answers to problems. For this to happen, the curriculum should explicitly state the role that problem solving plays in mathematics teaching and learning, whereas, in the textbooks some different ways of solving a problem and evaluation of their merits may be given.

The enlightened vision of development of mathematics' curriculum would therefore be, to cite the connection between seemingly unrelated mathematical concepts and skills explicitly in order to deepen and broaden the student mathematical knowledge and understanding real life examples from Pakistan and regional environment could be given in the textbooks to exemplify the applications with in real life situation.

BIBLIOGRAPHY

Board of Intermediate and Secondary Education (2002). *Gazette notification.* Islamabad: (unpublished).

Board of Intermediate and Secondary Education (2003). *Gazette notification.* Rawalpindi (unpublished).

Board of Studies NSW. (2006c). *Studying for the NSW higher school certificate – An information booklet for Year 10 Students, 2006.* Retrieved 23 rd September from http://www.boardof studies.nsw.edu.au/schoolcertificate/ index.html#studying_hsc

Curriculum Development Council and the Hong Kong Examinations and Assessment Authority. (2006*). Mathematics education key learning area: new secondary school curriculum and assessment guide (secondary 4-6)* mathematics. (Provisional Final Draft). Retrieved 3rd October from http://www.emb.gov.hk/index.aspx?langno=1&nodeID=5594.

Curricular Options in Mathematics Programs for All Secondary Students. (2007). *Math connections: a secondary mathematics core curriculum.* Retrieved April 25, 2007 http://www.ithaca.edu/compass/conx.htm

Coupland, M. (2006). *A critical analysis of selected Australian and international mathematics syllabuses for the post-compulsory years of secondary schooling (unpublished).* Sydney, Australia: Department of Mathematical Sciences, University of Technology.

Government of Pakistan. (1968). *National curriculum in mathematics.* Islamabad: Ministry of Education.

Government of Pakistan. (1972). *National curriculum in mathematics.* Islamabad: Ministry of Education.

Government of Pakistan, (1986). *National curriculum in mathematics.* Islamabad: Ministry of Education.

Government of Pakistan. (1994). *National curriculum in mathematics.* Islamabad: Ministry of Education.

Government of Pakistan. (2000). *National curriculum in mathematics.* Islamabad: Ministry of Education.

Govt. of Pakistan. (2000). *National curriculum for mathematics classes I –XII.* Ministry of Education. Islamabad: National Book Foundation.

Govt. of Pakistan. (2006). *National curriculum for mathematics grades I–XII*, Ministry of Education. Islamabad: National Book Foundation.

Martin, M.Q., Mullis, I.U.S., Gonzalez and Chrostowski, S.J. (2004). *TIMSS 2003 International Science Report: findings from IEA's trends in internationa mathematics and science study at the eighth and fourth grades.* Chestnu Hill, MA: Boston College.

MOE. (2006). Ministry of Education. Singapore. http://www.moe.gov.sg/

National Council for Teachers of Mathematics. (1992). *Curriculum an evaluation standards for school mathematics*. Reston: NCTM. Val.

Nazir, Mohammad. (2001). Comparison of Pakistan secondary scho mathematics with South Asian countries. *Journal of Science a Technology*. 12 (3): 62-68.

National Institute of Science and Technology Education. (2000). *Evaluation science curriculum 2000, developed by PED.* Islamabad: Ministry Education.

National Institute of Science and Technology Education. (2001). *An apprai Study of curriculum.* Islamabad: Ministry of Education.

PISA. (2004). *Learning for tomorrow's world: first result from PISA 2* (OECD Publication No.53799, 2004). Paris, France: Organization Economic Co-operation and Development.

QCA (2006). *A new GCE AS use of mathematics*. Accessed 6th Octobe http://www.qca.org.uk/12041_2495.html. Research Wing, 2004. Fed Board of Intermediate and Secondary Education, SSC-II

Resnick, L. B. (1987). Learning in school and out. *Educational Researcher* 13-20. Sfard, A. (1996). On acquisition metaphor and participa metaphor for mathematics learning. In C. Alsina, J. Alverez, B. Hodg C. Laborde, & A.Perez (Eds.). *Selected lecturers from the 8th internati congress on Mathematics Education*. Seville, 1996 (pp.397-411). Se S.A.E.M. "THALES".

Stacey, K., Dowsey, J. McCrae, B., & Stephens, M. (1998). *Review of s secondary mathematics curriculum.* Sydney: NSW Board of Studies.

Wirth, J. & Fleischer, J. (2006). *A closer look at mathematical literacy problem-solving competence*. Paper presented at the Annual Meeti American Research Association, San.Francisco, CA.