
Twenty Fourth
J. E. Jayasuriya Memorial Lecture
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Mathematics Education – Past, Present and Future

By

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Professor J. E. Jayasuriya Memorial Lecture, 2014

1. Introduction

I first knew the name J. E. Jayasuriya when I was probably 3 or 4 years old. I continued to hear that name in my household, always associated with three Sinhala medium books ගණිත නවෝදය (*Ganitha Navodaya*), වීජ ගණිතය (*Veeja Ganithaya*) and සීග්‍ර ජ්‍යාමිතිය (*Seegra Jyamithiya*), on a regular basis for many more years before I comprehended who that person was. That happened when I progressed to Grade 6 at school and I inherited some of these books from my seven older siblings who had used them one after another. Needless to say, when they reached me, the books were in a very poor condition with sheets torn, pages loose and the binding worn out. By the time I started Grade 6, J. E. Jayasuriya's books were no longer in use at the school for any Grade and instead we had some other prescribed textbooks for Mathematics. However, from this point onwards until I finished General Certificate of Education (Ordinary Level) (GCE (O/L)) Examination my primary source of learning Mathematics was not the textbooks recommended by the school but the treasured *Veeja Ganithaya* and *Seegra Jyamithiya* books passed on to me by elder brothers. Even though the physical condition of the books I possessed was not very attractive to the eye, they were inspiring to read and had questions carefully arranged in increasing level of difficulty. That made me comfortable in learning concepts and was sufficiently challenging in for solving problems by myself as a child.

My experience of becoming interested in Mathematics as a young student due to the influence of popular J. E. Jayasuriya's books would be similar to that of many others. Several generations of students have benefited directly from his contribution as writer of affordably priced mathematics textbooks in the Sinhala medium for the junior school grades. He was able to fill the void regarding the availability of textbooks on the subject when English was replaced as the medium of

instruction, in the junior grades, in the nineteen fifties. These remained the most widely used mathematics books in schools until the government started producing textbooks under the guidance of the Ministry of Education.

It is interesting to note that almost every subsequent Sinhala school textbook in Mathematics was either written by teams of authors or were translations of English books. The current situation in the school is that even though a textbook is available to each student it is hardly used by the teachers or students for the purpose of teaching or learning mathematics in the classroom, which in turn tends to imply that the recent textbooks have failed to accommodate children's needs. On the other hand, even today, we can see some teachers, still using some of J. E. Jayasuriya's books – written close to half a century back– to bridge the competency gap in students who are in transit having done GCE (O/L) Examination and awaiting the commencement of General Certificate of Education (Advanced Level) (GCE (A/L)) classes in Mathematics. The teachers are of the view that solving problems in those books would help bring underprepared students to expected skill competency levels of Mathematics in order to succeed in current GCE (A/L) Mathematics.

It is believed that a good textbook in mathematics must meet pedagogical, psychological, scientific, social and aesthetical requirements. Thus the success of a mathematics textbook is measured against the requirements in appearance, style and language, editing, approach and contents material. Prof. J. E. Jayasuriya with extremely rare training he had received, the combination of expertise in Mathematics Education and Educational Psychology, was able to find ways to present challenging concepts in simpler terms to suit the young minds in his books. His textbooks which facilitate teaching and learning of what was considered a difficult subject remain unmatched by those of any other author to date. In all Prof. Jayasuriya has produced 12 Sinhala medium textbooks in mathematics for the benefit of students and teachers. One retired mathematics education official with several years of experience once requested me to initiate a study to find out if

there has been any other University Professor who has contributed directly to a secondary school level subject comparable to the efforts of Prof. Jayasuriya.

I did not have the privilege of being one of his pupils or even to meet and get to know him. But from what I gathered, Prof. Jayasuriya was a versatile person of many parts. In addition to being the author of textbooks I mentioned earlier, he was an exemplary teacher, educational administrator, researcher and policy maker, international consultant and a devoted family man. Prof. Jayasuriya has published over 150 Research papers on various aspects of education. Twelve of his Education related books are listed in the famous Amazon.com, the world's largest online bookstore, at this very moment. Those eminent people who have preceded me in delivering twenty three memorial lectures, perhaps with first-hand experience, would surely have spoken more eloquently than I am able to do on Prof. Jayasuriya and his great contribution to education in our country.

However, let me seize this opportunity to thank the J.E. Jayasuriya Memorial Foundation for giving me the opportunity of addressing this distinguished audience today. I am greatly honoured and indeed deeply humbled to have been invited to deliver this twenty fourth memorial lecture.

There are so many in my generation, now living all over the world, that I know of, who have studied in Sinhala Medium schools and have become successful professionals due to their strong mathematics background cultivated during school days. I am sure they all would be proud to say, as I did, that they are direct beneficiaries of Prof. Jayasuriya's legendary contribution to secondary level Mathematics. I would like to think that I represent that group today in paying tribute to this eminent Sri Lankan educationist of international repute, who left behind an indelible mark in the field of education in the country.

When the invitation to deliver the Twenty Fourth J. E. Jayasuriya Memorial Lecture was extended to me, I was informed that so far a Mathematics related topic has never been chosen for the occasion. On

that basis and in keeping with my forte I have chosen the topic “Mathematics Education – Past, Present and Future” for today’s lecture.

At the very outset, I wish to define each term in my topic for the sake of clarity:

The scope of Mathematics Education in this lecture will be limited to Secondary School level typically taught in School Years 6 to 11 in the present day context. Since the General Education is presently governed by the provisions of the Education Ordinance, No.31 of 1939 as well as certain other laws enacted thereafter, I will not go back in history beyond 1939 when I refer to the `Past`. I have chosen 1980 as the starting point of the `Present` period due to certain reasons that would be clarified as I progress. The periods I delimit as the `Past` and `Present` in the context of this lecture are the outcome of a literature survey on chronological history of mathematics education carried out by me during past eight months. The `Future` that I refer to here is a much more virtual timeframe which I shall represent by a set of recommendations formulated on the basis of the development of mathematics education in other countries together with my own experiences in the local arena. Education authorities may consider `this recommended future` in formulating any forthcoming reforms related to Mathematics. Some of the recommendations have already been included in previous reports submitted by various committees in which I was a member.

2. Mathematics Education – Past

By the year 1939 there were three types of schools, classified on the basis of the medium of instructions, in the country then known as Ceylon; Vernacular schools, Bilingual schools and English schools. There were noticeable wide disparities in both educational standards and facilities between the Vernacular schools and English schools. But as per the Education Department publication “The Scheme of Studies and Syllabuses for Ceylon Schools” published in December, 1928 the

same curriculum was prescribed for Grades 1 to 8 in both types of schools.

Students in English schools went on to complete their education by passing the Cambridge Senior (CS) or the London Matriculation (LM) examination while pupils in other schools attempted the local Senior School Certificate (SSC) examination conducted by the Department of Education. Bilingual school students had the option of doing SSC in the English medium while the others sat the examination in the Sinhala or the Tamil medium.

Classification of schools by educational level was done as follows;

- Primary schools (a six year course from Kindergarten to Standard V),
- Junior Secondary schools (a nine or ten year course from Kindergarten to the local Junior School Certification examination),
- Senior secondary schools (an eleven or twelve year course leading up to the CS or the LM in the case of English schools, SSC (English medium) in the case of bilingual schools and the local SSC (Sinhala or Tamil medium) in case of Vernacular schools.)
- Collegiate schools were all English schools with facilities to study Science subjects up to CS or LM.

During this period, in primary schools Numbers were taught and at the post-primary level students were able to learn Arithmetic. This was replaced by “The Revised Scheme of Studies and Syllabuses” issued by the Education Department in 1940 in that Arithmetic was made compulsory in all grades from 1 to 8. Mathematics was included as a separate optional subject for post-primary classes.

1940s was a very significant era in the country’s education history. As Minister of Education in the State Council, the late Dr. C. W. W. Kannangara introduced extensive reforms to the education system throughout the decade starting with the setting up of Central School

scheme in 1940 by establishing high quality secondary schools in rural areas of the country. Then came the 1943 publication “Select Committee Report on Education in Ceylon” as the outcome of a special committee appointed by him. Education experts believe this report is “the result of the only complete and comprehensive investigation of all aspects of education undertaken during a hundred and fifty years of British rule in Ceylon”

Among the recommendations for providing “lasting value to the nation” given in the report:

- Education should be free from the Kindergarten to the University.
- The mother tongue should be used as the medium of instruction in the Primary Schools.
- English should be taught in all schools from standard III.
- A curriculum for the child which would develop its "head, heart and hands" should be introduced. In other words, the education of the emotions is as necessary as the education of the intellect and practical ability for the well-being of the child.

Sinhala and Tamil replaced English as the medium of instructions in grade 1 in 1945 and was progressively carried through. During this period the following Mathematics related subjects were available for Junior Secondary students with the indicated formats of examination:

1) Elementary Mathematics (Ordinary), 2) Elementary Mathematics (Special), 3) Pure Mathematics, 4) Arithmetic, 5) Commercial Arithmetic, 6) Advanced Mathematics and 7) Applied Mathematics.

Students in the Science stream followed either 1) or 2) as a requirement.

The curricula for above subjects had been determined by examinations and the curriculum activities led by the Ministry officials. There has not been any evidence to suggest the existence of any institutionalized framework for curriculum activities at the period of time.

With the start of the Second World War, there was a logistic issue in sending LM examination papers and answer scripts of students to and from Ceylon. An agreement was reached between the Education Department of Ceylon and University of London, with effect from December 1941, to hold a special SSC examination (English) on the same syllabus as that for the LM examination as a war time emergency measure. Question papers were prepared and answer scripts were graded by local examiners. In the meantime, the usual SSC exam (English medium) continued. Local authorities took steps in 1942 to develop syllabuses in line with LM that would help do away with the need to hold two examinations based on two syllabuses, starting from December 1944. The agreed syllabuses applied only to the examination in the English medium. SSC was continued to be held in Sinhala & Tamil media under different syllabuses. This situation was corrected in 1948 by making the agreed syllabuses applicable to these two media as well.

Long before Sinhala became the official language of the country, the educationist D. F. E. Panagoda was developing the teaching of algebra, geometry and arithmetic in Sinhala by writing many accessible mathematics textbooks in Sinhala and he published his first book in 1941. His collection of books included '*Senior School Algebra*', '*Senior School Arithmetic*', '*Teaching of Arithmetic*', '*Delight in Numbers*' (Books 1 to 5). They were used widely in schools until 1960.

Establishment of two important education institutes marked the beginning of the next decade. In November, 1950 the Educational Publication Board was set up. Its activities included the selection of books for school use. This Board still continues as the Educational Publication Advisory Board. Then in 1951, Ceylon Examination Department was established. It started conducting the examinations in July 1953. According to records available, within one year after its formation, the Ceylon Examination Department had conducted 8 local examinations and 27 foreign examinations.

A White Paper, passed by the Parliament on 13 February 1951 titled the Education (Amendment) Act, No. 5 of 1951, secondary schools were classified as follows;

- (a) Junior Secondary, comprising Standards VI, VII and VIII and
- (b) Senior Secondary, comprising either two standards beyond standards VIII or four standards beyond Standard VIII. In the latter case, the schools were called Colleges. The examination at the end of two standards beyond standard VIII was SSC; and the further two year course in colleges led to Higher Secondary Certificate (HSC).

Following Mathematics related subjects were available for Senior Secondary students' from 1953 onwards:

- 1) Elementary Mathematics, 2) Pure Mathematics, 3) Arithmetic, 4) Commercial Arithmetic, 5) Advanced Mathematics and 6) Applied Mathematics

Examination papers for subjects 1), 2), 5) and 6) were available only in the English Medium. But candidates were free to choose the medium of examination in the case of 3) and 4). Subjects 5) and 6) were optional and those wishing to enter the Mathematics stream of HSC could choose to do either one or both of subjects.

Even though systematic curriculum development activities were being undertaken by the Ministry of Education from about the late 1950s, syllabuses of different Mathematics subjects remained closely modelled on, and in some instances were perhaps translations of, respective foreign syllabuses.

Another significant event that took place in the decade was the abolition of LM examinations by the University of London in 1951 and the introduction of the General Certificate of Education (GCE) at two levels known as the Ordinary Level (O/L) and the Advanced Level (A/L). Out of these two, only the A/L examination was held in Ceylon. Ceylonese

students were able to combine Ceylon SSC and GCE (A/L) examination of University of London in order to proceed for further education.

Education authorities also soon followed the United Kingdom model and replaced SSC by General Certificate of Education (Ordinary Level) from December 1952. The academic standard and the syllabuses of the GCE (O/L) Examination remained the same as those of SSC Examination. SSC too however continued to be awarded on the same basis as before. In December 1960 the practice of issuing SSC was discontinued.

Change in the medium of instructions from English to Sinhala and Tamil, that began in 1945, reached grade 10 gradually for most schools by 1954 and all schools in all subjects except Science and Mathematics by 1957. In the case of Science and Mathematics, which included all 6 Mathematics related subjects listed above, each school was given the option of choosing the medium convenient to the school. So from 1958 onward the school decided whether its students will be taught and examined at GCE (O/L) in Sinhala, Tamil or English. No time limit was imposed for ending the option.

In January 1955, the Minister of Education tabled in parliament a “Statement of Government Policy on Swabasha as Media of Instructions and Administration” and consequently on 15th June 1955, Swabasha Textbook Production Unit as a wing of the Official Language Department under the Special Commissioner for Language Affairs was set up. The main functions of this Unit were the preparation of glossaries of scientific and technical terms and the compilation and translation of books in the sciences and in mathematics.

As the practice of learning Mathematics in Sinhala was spreading rapidly in the country, the Educational Publication Board took steps to translate the following English Medium books into Sinhala; *School Algebra* by H.S. Hall, *Geometry* by Dural and *School Geometry* by Bernard & Child. As these books were direct translations, both the depth of the subject and the language used were unfamiliar to average students.

'ගණිත නවෝදය' (*Ganitha Navodaya*), 'වීජ ගණිතය' (*Veeja Ganithaya*) and 'සීඝ්‍ර ජ්‍යාමිතිය' (*Seegra Jyamithiya*), form a series of textbooks authored by J. E. Jayasuriya. These books, written in simple and easy to understand language, were first published in 1955 at a time when the medium of instruction of Mathematics in schools was English. He also had the courage and wisdom to slightly change the sequence of some Geometry concepts of Euclid (often referred to as the "*Father of Geometry*") to suit the thinking of average local students and thus enabling them to easily understand the respective topics. For many years J. E. Jayasuriya's books were the prescribed textbooks by the Educational Publication Board for classroom use in schools. Even though the school curriculum has systematically curtailed the topics in Geometry over a period of time, there are many gifted school children who are keen to learn formal Euclidean Geometry as their counterparts in other countries do. For this purpose, still the best book available in the Sinhala medium is '*Seegra Jyamithiya*' by J. E. Jayasuriya.

While praising Jayasuriya for his pioneering efforts, it would be unfair if I fail to acknowledge the contribution of few others towards school mathematics education in this era.

'රත්න ගණිතය' (*Rathna Ganithaya*) series was written by P. de S. Kularatne for Arithmetic having been first published in 1951. Then he wrote 'ගණිත රසය' (*Ganitha Rasaya*) book in 1956 giving various simple tips to solve arithmetic problems in question papers. A book titled 'සේකර ගණිතය' (*Sekara Ganithaya*) by H. R. Gunasekara came out in 1954 covering topics in arithmetic up to Junior Secondary level. Another writer who contributed to mathematics education at school level was C. M. Weeraratne. He authored a number of textbooks in mathematics and arithmetic and among his books were the 'පාඨශාලීය අංක ගණිතය' (*Pathashaleeya Angkaganithaya*) and 'පාඨශාලීය වීජ ගණිතය' (*Pathashaleeya Veejaganithaya*). Thomas Eapen too wrote several Sinhala medium school mathematics books during mid-1960s in the areas Arithmetic, Algebra, Trigonometry and Geometry. All above mentioned titles, at that time, were made supplementary textbooks for schools by the Education Department.

One of the most significant events in the country's education history was the Government takeover of the majority of State-assisted, privately managed, schools by the Government in 1962, with a view to streamlining the school system.

A commission was set up for a specific purpose by the Government in 1961, referred to by the name of National Education Commission, under the Chairmanship of Prof. J. E. Jayasuriya. In its Interim Report released in 1962, recommendation was made that mathematics (and some other subjects too) must be learnt in the students' mother tongue, either Sinhala or Tamil. As a result, somewhat belatedly, the Government implemented the recommendation in phases covering pre-SSC, SSC, pre-HSC & HSC during the period from 31 December 1964 to 31 December 1967.

The Commonwealth Education Conference was held in Peradeniya in 1963. In its report the Mathematics Committee recommended that Mathematics be made compulsory in all secondary schools. In keeping with this direction, Elementary Mathematics which consisted of Algebra and Geometry, was introduced in all post-primary schools in 1965. The number of students who offered Arithmetic and Elementary Mathematics at the GCE (O/L) Examination in 1966 was 120,000 and 30,000 respectively. Under 1968 education reforms, Mathematics, Arithmetic or Commercial Arithmetic was made a compulsory subject for the GCE (O/L) Examination. Applied Mathematics and Advanced Mathematics were available as optional subjects.

In 1961 a curriculum committee, with separate institutional facilities, was set up to work full-time on curriculum development. The subject areas originally selected for this purpose were GCE (O/L) Physics, Chemistry, Biology and Agriculture. Subsequently Mathematics was also added to this list. The leaders of respective curriculum committees made decisions regarding objectives, content, sequencing, methodology, evaluation, etc., of their subject areas. Development of a series of school textbooks by the curriculum committee that began in

1965 for Grade 6 concluded in 1967 for Grade 7 and in 1969 for Grade 8. Curriculum Development Centre (CDC) was institutionalized in 1968. Before that the functions came directly under Technical Education Branch of Ministry of Education and the office was located at the Technical College, Maradana. Setting up of CDC helped develop curricula to suite the future needs of the country. The main function of CDC was the revision of school curricula. Further, it was expected to maintain a continual evaluation and review of school curricula as well. Within CDC, one officer was appointed with overall responsibility to manage the Mathematics Curriculum Development and in-service Education. Under the supervision of that officer there were different teams called Elementary Mathematics Committee and Senior Secondary Mathematics Committee.

The Educational Publication Department was established on 1st October 1966 by combining the temporary set-up that existed in Education Department at the time and the Sawabasha Textbook Production Unit of the Official Language Department.

Candidates who had passes in four subjects at the University Preliminary Examination together with a pass in a Language paper in Sinhala, Tamil or English were awarded the Higher School Certificate (HSC) during the period 1945-1963. It was discontinued in 1964 with the introduction of GCE (A/L) Examination.

It has been said that during the 18-year period from 1953 – 1971 very little changes have been incorporated in the mathematics curriculum or the GCE (O/L) Mathematics Examination papers. However, during the 1965-1970 period, some new mathematics topics such as Sets, Probability, Statistics and Transformations were introduced to Grades 6, 7 & 8 curricula. By 1970 these topics were getting established in the school curricula. That prompted the introduction of the Revised Mathematics Curriculum in 1970 as a pilot project in 47 schools chosen by CDC. It is on record that initially 72 schools have shown interest to join this project. With this curriculum, for the first time in the country, learning outcomes of the subject were stated. The corresponding GCE

(O/L) examination was held in 1972 and prior to that prototype question papers were published in 1970 by CDC. Another milestone was that for the first time in history, Multiple Choice Questions (MCQ) were used at this level in Paper II of this subject.

In the meantime the rest of the schools offered the 1963 curriculum. But some changes were introduced to the traditional format of the GCE (O/L) Pure Mathematics Examination paper in 1973. The first question of the first paper had ten compulsory sub-questions carrying 40% of the total marks allotted to the paper. The first question of the second paper had eight compulsory sub-questions worth 40% of the marks for the paper. Both GCE (O/L) subjects “Mathematics (1970 Revised Curriculum)” and the “Pure Mathematics” with new format described above, were short lived.

The new government that came into power in 1970, giving priority to educational reforms, established an Education Review Committee in the latter part of the same year to report on restructuring the education system in line with the new government’s policy. Following reasons were cited, among others to justify the need for change: content of the curriculum practised in schools was designed to cater mainly to the needs of those who would qualify to enter university; the education in different schools at the same level was unequal and general education was limited to eight years; selection of students for different streams was done by the end of Grade 8, at the age of thirteen, when students were not sufficiently mature and it was felt that equality of educational opportunity was denied to some as the basis for this selection was a school examination.

Following excerpts from the Five-Year Plan (1972-76) conveys the main spirit of the new reforms:

“The main objective of the curricular change that is to be inaugurated from 1972 is to integrate the academic and vocational aspects of education in the general school system. It seeks to equip students with a good general education together with a basic familiarity with one or

more vocational opportunities available to them. This does not mean any reduction in academic content”.

“What it means is that the materials taught and the whole idiom of teaching has meaning for the student and will stand him in good stead when he leaves the system”

1972 education reforms changed the curriculum and structure of general education profoundly: the age limit for school admission was raised from 5 to 6 years to allow for greater maturity of children at entry with provision of leaving school at the age of 15+; the schooling period was reduced from 12 to 11 years, replacing the existing system with 9 years of general education and 2 years of higher secondary education ; a terminal course was designed for the pupils to sit a public examination, called the National Certificate of General Education (NCGE) examination, after nine years of general education consisting of 10 subjects including two pre-vocational subjects.

The school system was categorized into three types: Primary Education (Grades 1 – 5), Junior Secondary Education (Grades 6 – 9) and Senior Secondary Education (Grades 10 – 11).

It appears that the authorities have rushed the implementation of these reforms. Having taken the decision in September 1971 to initiate changes at two points, namely Grade 1 & Grade 6 simultaneously, ordered CDC to prepare and send the new curriculum material to schools, in less than a four-month time period, for implementation, by January 1972. CDC was required to undertake curriculum development in all subjects in all the grades within a new 5: 4: 2 school structure replacing the long standing 5:3:2:2 structure. Integrated Science and Mathematics were to be taught in all the schools having post-primary grades, thereby increasing the coverage from 800 to 4000 schools. It appears that in designing the content of the Mathematics curriculum, CDC had been heavily influenced by the curriculum, teachers’ guides and prototype question papers of the School Mathematics Project in the United Kingdom at the time.

1972 is a landmark year for the country, then known as Ceylon, as the country was declared a Democratic Socialist Republic and renamed Sri Lanka. This year is of historical importance for mathematics education also as Sri Lanka adopted the “mathematics for all” concept at secondary level education.

With the implementation of 1972 education reforms, the NCGE examination replaced the GCE (O/L) examination. Students who got through NCGE were admitted to the Senior Secondary stage, where the curriculum consisted of separate streams – biological science, physical science, social science and commerce. At Grade 10 Mathematics was a common subject for students in both the Physical Science stream and the Biological Science stream, along with Physics and Chemistry. At Grade 11 the Physical Science students were supposed to continue studying Mathematics and dropping Biology while Biological Science were supposed to do *vice versa*. At the end of Grade 11 students were expected to sit the Higher National Certificate of General Education (HNCE) examination instead of the GCE (A/L) Examination. The first group of students who passed NCGE examination in 1975 progressed to Grade 10. However this group was not able to start Grade 11 under the planned curriculum.

In fact, reforms introduced for Grade 6 in 1972 reached NCGE Examination stage for the first time in 1975 at the end of Grade 9 and it was held once more in 1976 before being abolished by the government that came in to power in 1977. The new government dissatisfied with many aspects of the then education program. Their main criticism was that NCGE is not internationally recognised. They were also of the opinion that at least ten years of education should be given before the student faces the first public examination. The use of MCQ in one of the two examination papers also have disturbed the general public and some have even interpreted this practice as students learning to gamble instead of learning mathematics. Therefore, to be consistent with this rationale the GCE (O/L) examination was re-introduced with immediate effect, at the end of grade ten, in 1978, through an interim curriculum. The study period of the cohort of students who were due to sit NCGE in 1977 was extended by another

year and they were allowed to sit GCE (O/L) examination at the end of Grade 10 under the interim curriculum adopted in 1978. CDC produced new textbooks called ගණිත ඇබසියා (*Ganitha Abasiya*) and ගණිත පුබුදුව (*Ganitha Pubuduwa*) for the benefit of students who were caught in transition. It is important to highlight that the use of MCQ continued for two more years under 1978 interim curriculum also in 1978 and 1979 at GCE (O/L) before being eliminated from examinations.

Meanwhile the policy of teaching mathematics to all was accepted by the new government and extended to Grade 10. When implementing the policy, some schools faced a considerable challenge in finding suitable teachers to deliver the topics such as formal geometry and algebra in the mathematics syllabus to their students before they sat the GCE (O/L) examination in 1978. Since it was not possible to ensure that all pupils would have the required teachers, a decision was taken by the government to give a `concession` of not offering mathematics to those sitting the GCE (O/L) examination in 1978 and 1979.

Following the abolition of the HNCE examination, two G.C.E. (A/L) examinations on different syllabuses were held in 1979. The April examination was the regular examination, and the August examination was an examination to meet the requirements of students who would otherwise have sat for the HNCE. The latter group having done the NCGE examination in December 1975 and qualified, started their HNCE classes in May 1976. They were studying the HNCE curriculum for a period of one year before the decision was made to terminate it and reintroduce a new two-year curriculum.

3. Mathematics Education – Present

The hurriedly introduced interim curriculum of 1978, as the substitute for NCGE and HNCE, was replaced by, a more stable, regular curriculum in 1980. Also in the same year, with the intention of enhancing the quality of education and improving learning outcomes,

the government took the important step of providing free textbooks to all schooling children from Grades 1 to 11.

The 1981 White Paper on Education Reforms in Sri Lanka, contained the recommendations of three committees, appointed in 1979, to report on General Education, Technical Education and National Apprentice Training respectively. The reforms recommended in this White Paper brought in some major structural transformations to facilitate greater efficiency in the education system and covered the entire range of education including General Education and Examinations, Open Schools, School Organization and Administration, Teacher Education, University Admissions , Open University, Professional and Technical Education, and a Teaching Service. As a consequence of these recommendations the Sri Lankan education system initiated School-based Assessment, the Tertiary Education Commission, the Teacher Service, the Principals' Service, and the Sri Lanka Education Service.

The Proposals for Reforms in 1981 describes the period of secondary education in Sri Lanka as having three segments: Junior Secondary – from grades 6 to 8, Senior Secondary – from grades 9 to 11 and Collegiate level – grades 12 and 13. This resulted in GCE (O/L) becoming a three-year program.

The National Institute of Education (NIE), Sri Lanka was established in 1986. The main purpose of creating NIE was to establish a unique institution for capacity building of educational managers, teacher educators and teachers, design and develop school curricula and conduct policy research on education. NIE was mandated to advise the Minister on matters related to the development of education in Sri Lanka.

Department of Examinations began assigning numbers to identify the subjects in GCE question papers in 1987 and GCE (O/L) Mathematics was allotted number 20.

In 1986, the terminology to indicate school levels was changed from “Grade” to “Year”. Also a curriculum revision was initiated for senior

secondary students in 1986 and the first GCE (O/L) examination under it was conducted in 1988. Mathematics subject was given the number 42.

According to the 13th Amendment to the Constitution in 1987 and the 16th Amendment to the Constitution in 1988, both languages of Sinhala and Tamil became the Official Languages in Sri Lanka while English assumed the status of the link language. As a result Official Language Department became the Department of Official Languages.

In 1991, Parliament passed the National Education Commission (NEC) Act on the recommendation of the National Youth Commission (1989) and NEC was established under the President as the apex body on educational policy to advise the government on overall Policy covering all aspects of Education in the country.

A Presidential Task Force headed by the Minister of Education was appointed in 1996 to implement the recommendations made by NEC in 1992. The government declared the year 1997 as The Year of Education Reforms by unveiling the New Education Reforms of 1997. They were implemented from 1998/1999.

This proposal made some minor changes to secondary education levels and they remain the same even to date. A new nomenclature was adopted to designate the different levels of secondary education: Junior Secondary – from Years 6 to 9, Senior Secondary – from Years 10 and 11 and Collegiate level – Years 12 and 13. Thus GCE (O/L) once again became a two-year program.

In 1998 through a circular the Ministry of Education introduced three-subject combinations for GCE (A/L) replacing four-subject combinations that were in place since 1964. The maiden examinations under this scheme were held in August 2000. Two new academic concepts made their debut in 2000: Common General Paper for GCE (A/L) students who seek university admission and the Z-score method to select candidates for admission to universities.

In 1999 mathematics curriculum revisions were introduced at two levels – Year 6 and Year 9. In the same year, the authorities had decided to experiment a new mechanism to address the low pass rate issue in GCE (O/L) Mathematics by examining the mathematical ability of students, at two levels of difficulty, through two examinations called Mathematics I and Mathematics II. Question papers of both subjects were based on the same syllabus. The first was assigned the number 45 and the second continued as number 42. Mathematics I targeted the future Arts and Commerce stream GCE (A/L) students and had questions from less complex mathematics topics. Students were allowed to sit for both subjects if they so wished. However, the experiment was short-lived and the model disappeared after having been available only to students sitting the GCE (O/L) examinations for the first time in 1999 and 2000. However the examinations for subjects 45 & 42 were held in 2001 and 2002 also for the benefit of repeat candidates. In the meantime, Year 9 students who were subjected to the new curriculum from 1999 had to face the GCE (O/L) examination in 2001. They were given GCE (O/L) Mathematics question papers under the number 32. This number is continued to date by the Department of Examination. It is significant to note that in both 2001 and 2002 there were three different Mathematics examinations subject numbers (45, 42 and 32) at GCE (O/L).

It was recognized in the 1997 reforms that the free textbooks given to students, on the basis of one book for one subject, had a negative effect on learning opportunities as a whole due to the fact that a single textbook in mathematics could not adequately cater to the needs of the entire ability range among students. Hence it was recommended to introduce the Multiple Book Option (MBO) with private sector participation. As a first step in this connection the Educational Publication Department initiated the Single Book Option (SBO) in 2000 by inviting bids from the private sector. Then in 2001, MBO was introduced enabling schools to have access to more than one textbook for each subject including mathematics for Years 6 to 11. This scheme

did not last long and MBO was replaced by SBO in 2005 but the involvement of the private sector continued.

DOE, for the first time in history, conducted a mock examination in June 2005 called “Mathematics Pre-Test” to give the students an idea of what would be tested in the actual examination in December. It also intended, depending on the performance of each student, to have additional corrective measures taken by schools before the December examination. This ground-breaking project was abandoned in 2006.

The Ministry of Education introduced the Competency Based Curriculum, incorporating the 5E learning cycle, to the Sri Lankan Education System in 2006, starting with Years 6 and 10 and extending the same to other Years subsequently. Each of the 5 E's describes a phase of learning: Engage, Explore, Explain, Elaborate, and Evaluate.

The aim of the mathematics curriculum under this activity-based student-centered learning model was to create individuals who are able to think mathematically, and apply mathematical knowledge effectively and responsibly in solving problems and decision making, in their daily life and the work place. GCE (O/L) Mathematics question papers also underwent changes, in line with this philosophy, by introducing problems with real-life scenarios, starting 2008.

In order to promote awareness and understanding among stakeholders of the expected standards and facilitate the learning-teaching-assessment process by enhancing student performance at GCE (O/L), DOE published a very comprehensive document in 2008 titled “Examination and Assessment Guidelines – Mathematics (for Grades 10 and 11)”.

4. Mathematics Education – Future

In Sri Lanka mathematics education is compulsory up to Year 11. This concept is commonly termed as `mathematics for all`. Even though this phrase is widely used in education policy documents its meaning has

not been precisely defined. The emphasis of mathematics education up to Year 9 is on developing basic skills required to function effectively in day to day life and on building a foundation of thinking that will enable the students to pursue more advanced mathematics later on. Also at the secondary level the student is expected to be led progressively and logically to understand the abstract concepts through appropriate methodologies to wean them away from primary level methodologies where, mathematics is taught by first introducing students to key concepts with concrete experience including examples and pictures. The assessment of achievement at this stage is, quite rightly, school based. One of the key advantages of this form of assessment is its potential to accommodate the potential range of all students and hence not being threatening to them. This approach agrees and supports the `mathematics for all` concept up to Year 9. This practice may justifiably be continued without any significant changes.

However as we move on to Year 10 and Year 11, content and methodology become more demanding and the focus changes to teaching "the basics" of higher math, including algebra, geometry, trigonometry, etc. Basically all students in this age group are compelled to learn mathematics as a subject thus distorting the `mathematics for all` concept to a concept of `same mathematics for all` which cannot be defined educationally or sociologically. This could very well be the main factor behind disastrous results at GCE (O/L) Mathematics. This becomes a grave situation since a student requires to have passes in six subjects, including Language and Mathematics, to be certified as having successfully completed the GCE (O/L).

My intention in this section is to present possible remedial solutions to this situation while benchmarking student performance against International standards so that the country would be able to produce mathematically-literate citizens who are also be able to assess critically the social uses of mathematics at the end of their compulsory school education.

Any meaningful and long-lasting improvements in student learning will require changes in mainly three areas of the education system: *firstly*, at the center of this system is the **curriculum**, *secondly*, the quality of students' **textbooks and learning resources** as the curriculum is defined largely by these material in an ideal situation and *thirdly*, ensuring that **examination and assessment** are aligned with a properly defined assessment framework.

4.1. Curriculum

In the literature, the term curriculum has many different meanings. The simple definition I use here for curriculum is the list of mathematics topics that must be understood by the student at the end of the course along with the methodology employed to achieve the identified learning outcomes as prescribed by the governing body. In Sri Lanka, authority for the national mathematics curriculum is National Institute of Education (NIE).

Three significant factors need to be considered in selecting the mathematics content for secondary education: firstly the realization that school mathematics is not the same as academic or research mathematics; secondly that the secondary school Mathematics stands for helping students develop certain “life skills” that will enable them to become informed global citizens; thirdly the recognition of Mathematics as a support subject required for use in other subjects.

While determining the curriculum in mathematics, it must be kept in mind that the majority of students would leave formal education at the end of Year 11. They would need to apply math skills and competencies in their work situation. Only a small number would go on to higher education. The curriculum needs to distinctly accommodate the requirements of both groups.

At NIE, mathematics curriculum is developed by its staff in general by taking in to account student characteristics, teacher characteristics,

resources available, individual needs, social needs, research done on current curriculum and the new trends.

In addition, through the Ministry of Education foreign consultants have also contributed to this task at various times using their individual expertise. The Ministry has secured the services of these individuals with the financial assistance from foreign funding agencies. However there is no evidence to suggest that Sri Lanka ever sought or received institutional assistance in the recent past from any recognized world body which is set up to support the mathematics education.

The United Nations Educational, Scientific and Cultural Organization (UNESCO) as a part of its mandate, promotes mathematics education globally and especially in developing countries, through international cooperation and partnerships with specialized organizations and unions. Among these are the International Mathematics Union (IMU) and International Commission on Mathematical Instruction (ICMI). IMU is an international non-governmental organisation dedicated to international cooperation in the field of mathematics across the world. It is located in Berlin, Germany and was established in 1920 in order to foster international cooperation in mathematics. IMU is the principal body representing mathematics on the world stage. ICMI, founded in 1908, is a commission of the IMU focusing on international mathematics education. Aims of ICMI include improving teaching standards around the world, through programs, workshops and initiatives and publications and working very closely with member countries of the developing world, to improve teaching standards and education. All these organizations generally believe that quality mathematics education for all students is essential for a healthy economy. The National Council of Teachers of Mathematics (NCTM) was founded in 1920 and located in Virginia, USA is a global leader and principal authority in mathematics education. NCTM Mission Statement says “The National Council of Teachers of Mathematics is the public voice of mathematics education, supporting teachers to ensure equitable mathematics learning of the highest quality for all students through vision, leadership, professional

development, and research.” There are several types of NCTM memberships available. Institutional Subscription provides the institution with leading resources in mathematics education along with up-to-date research findings on efforts to improve the teaching and learning of mathematics. Full Individual Membership is designed to meet the needs of those most concerned about and closest to students: teachers, administrators, specialists, coaches, teacher-educators, and others. NCTM has grown to be one of the world's largest organization involved with mathematics education. Even though Sri Lanka is a member state of UNESCO, it is yet to seek the membership of IMU or ICMI. Also no institute in Sri Lanka has subscribed to NCTM to date.

Establishing close association with such world organizations would benefit Sri Lanka immensely in many ways. Using their world-wide research findings we can seek assistance to align Years 6 – 9 common mathematics curricula in a cohesive and logical order. It is also important to position the expected learning outcomes at junior secondary level with international standards while implementing the total curriculum within the context of our own culture. Such a strategy would not only enable us to lay a solid foundation to cultivate logical, critical and creative thinking abilities in our students but also support benchmarking Sri Lankan mathematics education as compared with the national curricula of the best performing countries. We will also be able to share different teaching methodologies invented by member countries to effectively teach difficult topics for young minds.

As is the practice in many countries, Sri Lanka should also consider having at least two different syllabuses for GCE (O/L) classes. One syllabus (let us call it Syllabus A) would cater to the needs of those who wish to pursue GCE (A/L) subjects which require a high level of mathematical knowledge and skills and the other one (call it Syllabus B) for those who only need a practical knowledge of mathematics. Syllabus B should consist of Essential Learning Concepts (ELC) which can be defined as the indispensable content required by an ordinary individual to function effectively in a Knowledge Society. ELC need to be identified in such a way that all students would leave secondary

school well prepared mathematically for leading bright lives as productive citizens even if they will not go on to higher education and take little or no further math. Delivery of Syllabus B needs to be at an appropriate level so that no student, having progressed through Years 6 – 9, is left behind at Years 10 & 11. Syllabus A will consist of ELC delivered at a higher level than the above and additional topics that will be beneficial to those who pursue higher studies especially in the GCE (A/L) Science Stream.

There will be concerns as to how the selection of students would be done to follow the more advanced syllabus. A set of guidelines can be defined for this purpose based on the marks achieved by students in School Based Assessments (SBA) and three terms tests in Year 9.

As per current practice the grade received for GCE (O/L) Mathematics makes a difference for student's choice of GCE (A/L) subject combination. Under the suggested two syllabuses, students obtaining an 'S' grade for Syllabus B can be considered qualified to follow the A/L Arts stream (but not Commerce or Science). Students with a 'C' grade or better can be considered qualified to follow the A/L Arts or Commerce stream (but not Science). Students obtaining an 'S' grade for Syllabus A will be qualified to follow the A/L Arts or Commerce stream (but not Science). Students with a 'C' grade or better will be qualified to follow any (A/L) stream.

4.2. Learning Resources

Everybody will agree with the fact that the teachers are an indispensable pillar of strength in mathematics teaching and learning. The methods used by teachers to teach mathematics in primary and secondary schools are to a great extent influenced by the kind of resources available to them. Thus when the resources and facilities are inadequate they can be ineffective and there will be a natural tendency for their teaching approach to become teacher-centred.

Any meaningful and long-lasting improvements in student learning will require changes in many areas of the education system. At the center of this system are the learning resources. Hence the availability of quality learning material is critical in any effort in improving student achievement.

The school textbook is a book specially designed for students to learn from. It is a systematic set of selected, classified and simplified data which can be taught, presented in such a way that the learner can also use the textbook independently. In most countries mathematics education at this level relies almost entirely on the textbooks used in the classroom. Unfortunately it is not the same in Sri Lanka. Even though a textbook is available for each student it is hardly used by the student for the purpose of learning mathematics in the classroom. That is mainly because the Teacher's Guide plays the primary role in teaching while the textbook is only used as a supplementary source. This practice needs to be changed quickly if we are to improve mathematics education in the country.

The textbooks have to be carefully designed and prepared, like in other countries, indicating aims and objectives of each set of lessons, giving enough examples and problem sets similar to what they would encounter at examinations. The present Teacher's Guide should be replaced by a Teacher's Manual closely related to the textbook. Typically, the Teacher's Manual should be a reproduction of the textbook containing the same contents as the student's texts, plus teaching suggestions and solutions to selected questions. Briefly, the recommendation is to come up with a textbook that would help the students, teachers as well as parents to know this would profoundly enhance the transparency of the education process what students are expected to learn in the classroom and how students will be tested. Ideally, this manual needs to be written for Years 6 to 11 – a six volume production. It is a demanding task requiring strong curriculum design skills and recent teaching experience in the authors.

The mere presence of content in a textbook does not ensure that students will learn that content. For real learning to take place, textbooks need to focus on sound instructional strategies specifically on the concepts and skills that students are intended to learn. Further, textbooks need to be designed to thoroughly ground students in the basic mathematics concepts and their applications. The accuracy of a textbook's content is equally important, and it is important to have a mechanism to judge whether the content is presented at the proper level of sophistication for a given school Year level.

In practice, a Textbook is intended primarily for instruction and is usually commissioned by an appropriate authority and the publisher is required to adhere to the conditions laid down by the authority.

Every effort should be taken to develop a high quality textbook/s at each school Year that will help students to have better insights into the subject, to look upon mathematics as something exciting, rewarding and useful, and above all to gain confidence to face terminal examinations.

To accomplish these objectives the Educational Publications Department (EPD) can consider including the following features in future textbooks:

Table of Content: National Institute of Education (NIE) is to decide the sequence of topics and to list them term-wise within the school year.

Lesson Plan: Lessons under each topic to be divided into the class periods. With each lesson, clearly state the specific goals and desired learning outcomes, prescribed by NIE, that are to be met to ensure the students will meet the learning goals of the topic.

Exercises: Exercises of different types to be provided for students of varied abilities and the problems be graded. The more difficult questions shall be marked with asterisk (*) sign.

Class Activity: A list of activities suggested by NIE to be included under this section.

Chapter Review: At the end of every chapter, a Chapter review to be included which reiterates the key concepts and skills learnt.

Challenging Problems: This is to be placed immediately after the Chapter Review and would have to be specially designed to provide interesting and challenging problems on the particular chapter topic for more able and adventurous students.

Cumulative Exercises: These exercises to be included after several chapters (at the end of each term). In the case of Years 10 and 11, it should include typical GCE (O/L) examination type questions, as described at another place in this lecture, as per the guidelines set by the Department of Examinations (DOE). This would give students the necessary practice, reinforcement and confidence at the real examination.

Mathematics History: The history of mathematics to be included where appropriate. This is meant to supplement students with the knowledge of how mathematics has developed over the years.

Assessment Papers: At the end of the textbook, several prototype question papers of the relevant terminal examination to be included.

It is important that the curriculum developers should have an opportunity to brief the writers. Also it will be appropriate if the ministry appoints a subject specialist as a consultant to advice the textbook writers and to pass judgment on the quality of the final camera-ready copy of the textbook.

Learning resources do not refer only to textbooks. They include teacher's manuals, workbooks, prototype sample questions, e-resources, websites and other materials that the teachers can use to

assist the students to meet the expected learning outcomes prescribed by the national curriculum. It is very important that the curriculum authorities evaluate all learning resources against preset criteria and endorse them before being used in the classrooms.

Teacher's Manual needs to be a comprehensive document packet designed for teachers. The teacher's manual is typically a reproduction of the textbook, including the answer keys to the chapter Exercises, Challenging Problems, and Assessment Papers. It should have teaching suggestions/notes and explanations to the Class Activities also.

Presently, there is no central point that teachers can access immediately which can provide them with the definitive ongoing information needed to teach mathematics (or other subjects). Many teachers have difficulty, especially in remote areas, in getting official information. It is very important and timely to create a new teaching - learning culture in keeping with modern trends in mathematics education. A website set up and hosted by the Ministry of Education (MOE) could act as a direct link between MOE and the teacher. This would save time and cut through many layers of administration which all too often slow down the passage of accurate help offered by MOE. This website could inform teachers, administrators, parents, students and other stakeholders of the developments in the field of curriculum Years 6 – 11. Eventually this could be extended to all school Years and to cover all information services of MOE. The website could contain; syllabuses, syllabus commentaries, examination information, lesson plan support materials, interactive e-learning platform etc. Through this site, online facilities can be extended to provide a means for the teachers to directly interact with the curriculum developers and the Ministry approved subject specialists about ongoing and new developments in areas which are of importance and interest to them.

There are many countries providing such online support for teaching and learning of mathematics through official websites. Few examples are the following: The Australian Association of Mathematics Teachers

(<http://www.aamt.edu.au/index.php>), The National Council of Teachers of Mathematics (<http://www.nctm.org/>), The Association of Teachers of Mathematics (<http://www.atm.org.uk/>) and The NRICH (<http://nrich.maths.org/>). They are set up for the purpose of supporting mathematics education at all levels. These sites have Interactive Web-Based Tools in place for learning mathematics. These tools are appropriate for use with respective high school mathematics curricula and well-suited to the standards set by the authorities in terms of content and mathematical practices. Further, they publish a wide range of e- resources and materials especially produced for teachers and for learners.

4.3. Examination and Assessment

Examination and assessment of student learning is at the heart of mathematics education.

Assessment is typically an interactive process between students and teachers that inform the teachers how well their students are learning what they are learning. Teachers can use this information to make adjustments in the learning environment. They can also share the outcomes with students to assist them in improving their learning and study habits.

Examination generally uses methods and measures to judge student learning and understanding of the material for purposes of grading and reporting.

Teachers and parents use test results to gauge a student's academic strengths and weaknesses. General public rely on these data to judge the quality of particular schools and also in general of the mathematics education system in the country. Countries also showcase the progress they have made in mathematics education to the world by using international standardized testing.

In the last couple of decades, many countries have adopted School Based Assessment (SBA) because the traditional system of assessment

does not necessarily fulfill the modern educational and social needs. SBA includes all forms of assessment conducted by the teacher, at the classroom level, which are then collated for summative judgment purposes and fed into the exit point assessment result. Educationists all over the world recognize the immense potential SBA has in terms of validity and flexibility. At the same time there are concerns regarding issues related to reliability and quality control. At present School Based Assessment (SBA) has been implemented in all government schools in Sri Lanka from Year 6 to Year 13. Since the above stated aspects have a direct impact on the public confidence and credibility of the SBA outcome, it is important to develop mechanisms at the national level, to ensure that the expected SBA standards are maintained. There are research experiences to confirm that, when carefully implemented and continually monitored, SBA can be a successful and effective scheme.

Mathematics competitions play an important role in identifying and supporting mathematical talent in a country. They stretch students to explore mathematics beyond the traditional school curriculum.

The International Mathematical Olympiad (IMO) is the World Championship Mathematics Competition for High School students and is held annually in a different country. It encourages mathematically gifted students to develop their talents and foster international relations. Each country sends a team of up to six students for IMO. The first IMO was held in 1959 in Romania, with 7 countries participating. It has gradually expanded to over 100 countries from 5 continents. 54th IMO was held in Santa Marta, Colombia in 2013. Sri Lanka has been taking part in this prestigious competition since IMO 1995 held in Toronto, Canada.

Science and Mathematics Branches of the Ministry of Education have been assisting in conducting the National Mathematics and Science Olympiad Competition for students below 13 years of age studying in Years 6, 7 and 8. Since 2005 gifted students selected from this competition have been given the opportunity to represent the country in

the International Mathematics and Science Olympiad (IMSO) Competition organized for junior secondary students.

Certain international standardized tests, based on traditional school mathematics curricula, are also available. By participating in such tests we would be in a position compare our student performance internationally and use the feedback to gauge how young Sri Lankans are performing relative to the corresponding age cohorts of students in other countries.

The Trends in International Mathematics and Science Study (TIMSS) is an international assessment of the mathematics and science knowledge of Grade 4 and Grade 8 students around the world. TIMSS was developed by the International Association for the Evaluation of Educational Achievement (IEA) to allow participating countries to compare students' educational achievement across borders. TIMSS was first held in 1995, and it has been administered every 4 years thereafter. The two TIMSS tests are based on the mathematics topics typically covered up to and including Year 4 and Year 8. In the most recent TIMSS held in 2011, 63 extremely diverse member countries—in terms of economic development, geographical location, and population size – have taken part. The Programme for International Student Assessment (PISA) is a worldwide study, by the Organisation for Economic Co-operation and Development (OECD) in member and non-member nations, of 15-year-old school students' scholastic performance in mathematics, science, and reading. It was first conducted in 2000 and then continued every three years. The purpose of PISA is to improve education policies and outcomes. The data collected has been used both to assess the impact of education quality on incomes and to understand what causes differences in achievement across nations. More than 500,000 students from 65 countries took part in the latest test held in 2012.

The PISA mathematics test expects students to apply their mathematical knowledge to solve real-life problems. In order to solve the problems students need to have a number of mathematical

competencies as well as the knowledge of mathematical content typically meant for that age group. TIMSS, on the other hand, measures more traditional classroom content.

Out of all school level assessments, one of the most critical hurdles in the life of every Sri Lankan citizen is the GCE (O/L) Mathematics examination. According to data released by the Department of Examinations an average of only 55% of students from the total combined school and private candidates have passed GCE (O/L) Mathematics subject in the last two years 2011 and 2012. Further, the mean scores have been in the low range of 32%. This disconcerting national trend tempts one to conclude that our students are ill-prepared to compete in today's knowledge economy.

Poor result of a student in GCE (O/L) Mathematics may result from any of several factors: student was not properly taught and as a result the student has not adequately learnt to answer questions, student never had a proper mathematics teacher in the school, student's attendance in mathematics class was irregular. One can also argue that the results were so low country-wide because the examination was not appropriately designed. During my lecture, let me focus only on the lastly mentioned factor (i.e. the examination design), as an issue, and leave the other issues to another day to experts in the administrative field.

Genuine assessment needs to be aligned with the curriculum, instruction and learning tools. Many would believe that this is already in place for GCE (O/L) Mathematics. But my personal experience shows otherwise. I believe in having a mathematics assessment framework document that lays out the basic design of the assessment by describing the mathematics content that should be tested and the types of assessment questions that should be included to measure a well-defined specific level of thinking. Preparing such a framework is one of the immediate steps to be taken in our attempt to reverse the current trend of student performance at GCE (O/L) Mathematics. Such a framework will be beneficial to both students and teachers. Students will be more likely to learn because instruction is focused and they are

assessed on what they are taught in the classroom. Teachers will also be able to concentrate and manage their timetable more efficiently and effectively by integrating assessment into daily instruction and classroom activities. Finally, such instructional practices that follow alignment will help students become happy and independent learners.

Examination and Assessment Guidelines – Mathematics (for Years 10 and 11) published by the Department of Examination (DOE) in 2008 is a positive step toward the right direction and it is very close in its nature to what I propose in this lecture.

In the above document, performance standard is described as a set of operational tasks representing a level of performance associated with a subject content standard. Three levels of performance standard have been identified and are labeled as basic, medium and high. The basic level denotes the student's ability to provide partial responses which are limited in both accuracy and explanation, the medium level denotes the ability to provide responses which include supporting relevant details. The high level is intended to suggest that the student provides fully developed responses which include supporting relevant details that are accurate and appropriate.

It is commendable to note that the Examination and Assessment Guidelines, prepared for the use of students, teachers, in-service advisors, principals, educational officers and parents, contains comprehensive statements describing performance standards for each of the subject content standards under all the assessment aspects at the three levels, basic, medium and high. Further, four Test papers included in it serve well for students and teachers as guidelines in preparation for GCE (O/L) examination.

The GCE (O/L) Mathematics examination consists of two question papers called Paper I and Paper II. Paper I has two parts: Part A, having 30 questions which require short answers and Part B containing five structured questions. Students are required to answer all questions. Paper II comprises twelve structured questions equally divided into two

sections A and B. Students are given a choice and are expected to answer five out of six questions from each section. Up to year 2010 the duration for each paper was two hours but the time allocated to Paper II was extended to two and half hours in 2011 and thereafter.

As per international standards any school level mathematics assessment must be balanced according to a number of different factors, including content, level of complexity, and format. It is essential to clearly describe the guidelines for balancing each factor. In case of GCE (O/L), mathematics content has been consistently described in all documents issued by three main authorities; NIE, EPD and DOE.

However I have not come across any literature that explicitly classifies the level of mathematical complexity of test items (questions) used in GCE (O/L) question papers. Ideally, there should be test items of low, moderate and high complexity. According to the practice in other countries, low complexity items expect students to recall or recognize concepts or procedures specifying what the student is to do. In case of moderate complexity test items students are expected to decide what to do and how to do it, bringing together concepts and processes from various domains. High complexity items demand students to use reasoning, planning, analysis, judgment, and sometime creative thought. It would be very reasonable to agree that 50% of the questions in an examination are of moderate complexity while the rest is equally distributed among the low and high.

Currently GCE (O/L) Mathematics question papers contain only two types of test items: short answer questions and structured questions. This may be the appropriate time to reintroduce multiple choice questions also in addition to the above two types. Carefully designed multiple choice items can be used not only to measure routine mathematical ideas such as those based on knowledge of terms, facts, methods, and principles but also to measure complex mathematics such as those based on comprehension, application, and analysis. The composition of two question papers with respect to three types of test items should be decided after a proper study. Once we agree on the

definitions of complexity levels and the types of items, prototype test items from each of the three types under each complexity level covering all themes in the curriculum can be documented in a mathematics assessment framework. Authorities may consider these suggestions and try to further improve the previously mentioned Examination and Assessment Guidelines for the benefit of all stakeholders.

The success of such a framework depends on many things: its appearance should be both student and teacher friendly, DOE needs to make sure questions in examination papers do not considerably deviate in spirit from the prototype test items. EPD, in writing textbooks, should ensure that they are closely aligned with the prescribed content and suggested methodologies given in the syllabus and the teacher's guide as well as the assessment framework. The practice exercises in the textbook should follow the pattern set by the prototype tests. NIE should place the responsibility on teachers to familiarize the students with the textbook and the assessment framework to promote more efficient learning.

5. Concluding Remarks

In the recent years we have seen comments like “*The failure rate in the GCE (O/L) mathematics is shocking*” and “*What does the future hold for a country where so many children fail in mathematics*” in newspapers. This shows the serious situation mathematics education is currently facing in the country. In order to accomplish any sustainable improvement in student achievements in school level mathematics a fundamental change in both the approach and the underlying assumptions is required.

The poor performance in mathematics, we are witnessing today, by our students may be due to some factors that we have never attempted to query hitherto. Therefore it may be high time that the authorities embark on a deep and critical examination on how the vital areas of mathematics education have been functioning: whether the mathematics curriculum currently in place is the most appropriate for

particular age groups both in terms of international benchmarking and cultural responsiveness; whether the learning resources available are the most suitable for students growing up in a digital environment of a rapidly changing world; whether the examinations are well designed to measure the locally described performance levels while maintaining the internationally accepted norms on the test items.

The suggestions I have made on three main aspects are largely drawn from my own experience gained by participating in activities organized by various institutions coming under MOE and through the personal investigations carried out on current world trends.

In conclusion, my view is that the success of any changes to improve the standards of future secondary level mathematics education in the country will depend on how closely the three main bodies, National Institute of Education, Educational Publications Department and Department of Examinations would be ready to cooperate towards achieving a common goal. It will be the responsibility of the Ministry of Education to bring the three organizations together. I believe that the outcome of such soul-searching will be of great benefit to all stakeholders.

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