Mathematics Education in Singapore

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26 June 2013

An Institute of NANYANG TECHNOLOGICAL UNIVERSITY

- A historical perspective on developments that have shaped mathematics education in Singapore and evolution of school mathematics curricula
- Factors that may explain the achievement of Singapore students in Mathematics

MAJOR DEVELOPMENTAL PHASES Of THE EDN SYSTEM

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- 1946-1965: *Conflict-Resolution & Quantitative Expansion*
- 1965-1978: *Qualitative Consolidation*
- 1978-1984: *Refinements and New Strides*
- 1984-1996: *Towards Excellence in Schools*
- 1996-2012: *The Way Forward …*

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1946 – 1965 (Phase I)
Conflict-Resolution & Quantitative Expansion

Two major thrusts and priorities of this period stand out in bold relief.

- The first is the **use of education**, in the period after 1959 **to resolve some of the pressing conflicts and dilemmas Singapore faced in the 1950s.**
- The **second** concerns the **pressure to rapidly expand educational opportunities in Singapore** with a **view not only to democratizing education**, but also **to use education as a device for achieving national cohesion and the economic restructuring of the society.**

The White Paper (1956)

In 1959 when the People's Action Party (PAP) came to power it acted upon the White Paper of 1956 and put in place a Five-Year Plan in education. The main features of this Plan were:

- Equal treatment for the four language streams of education: Malay, Chinese, Tamil and English;
- The establishment of Malay as a national language of the new state;
- Emphasis on the study of **Mathematics, Science and Technical Subjects.**

Note: Stability of political system: The PAP has been in power from 1959 to date.

1965 – 1978 (Phase II)
Qualitative Consolidation

- **1965 witnessed the end of Singapore's merger with Malaysia** and the beginning of a new chapter in the history of Singapore. It also **marked the beginning of a transformation from statehood to nationhood.**
- Under the leadership of PAP, **education remained a key to it's survival.** Education was crucial in facilitating the nation's economic transformation and of building a socially-disciplined cohesive Singaporean society.
- There was a **shift in emphasis** from **academic to technical education to provide the manpower base for industrialization**.
- This period also witnessed the onset of systematic improvements via research undertaken by the Ministry of Education (MOE) to the education system.

1978 – 1984 (Phase III)
Refinements and New Strides

- By the late 1970s, certain ‘cracks’ and weaknesses in the system had begun to manifest themselves.
- High education wastage resulting in low literacy levels in the country.
- In line with the ‘simple objective’ of education in Singapore,

  ……***to educate a child to bring out his greatest potential so that he will grow into a good man and a useful citizen*****. (Lee, 1979)**

  as spelt out by the then Prime Minister of Singapore in 1979 and the findings of the Goh’s Report (Ministry of Education, 1979), the New Education System (NES) was introduced in February 1979.

The New Education System

- Concern – high education wastage resulting in low literacy levels in the country.
- Goh's report 1979
- New Education System introduced streaming by academic ability
- Streaming has served the system well as it is flexible
- Many pathways to cater to the diverse needs of students with varying academic abilities

1984 – 1996 (Phase IV)
Towards Excellence in Schools

1985 marked a watershed in the economic development of Singapore. Based on two key reports, one in Singapore (Economic Committee, 1986) and another in the United States (Tan, 1986), the Minister for Education in 1986 enunciated that future education policies in Singapore would be guided by three principles. These were:

- **Education policy must keep in pace with the economy and society;**
- **Basics – Languages, Science, Mathematics and Humanities will be stressed to encourage logical thinking and life-long learning;**
- **Creativity in schools must be boosted through a 'bottom up' approach i.e., initiative must come from principals and teachers instead of from the Ministry (Tan, 1986).**

1996 – 2012 (Phase V)
The Way Forward …

- In 1997, the Prime Minister, Mr Goh Chok Tong in his speech (Goh, 1997) at the opening of the Seventh International Conference on Thinking held in Singapore signaled that changes had to be made to the existing education system.
- These were necessary to prepare young Singaporeans for the new circumstances and new problems that they will face in the new millennium.
- He emphasized that we must ensure our young can think for themselves, so that the next and future generations can find their own solutions to whatever new problems they may encounter.
- He also announced at the opening of the conference that Singapore's vision for meeting this challenge is encapsulated in four words: **THINKING SCHOOLS, LEARNING NATION**.

Significant Initiatives in Education

- Three initiatives were launched in Singapore's education system in 1997:
  - National Education,
  - Information Technology (IT), and
  - Critical and Creative Thinking.

With the infusion of these initiatives in all curriculum subjects at schools, the teaching of mathematics and science have underwent significant changes compared to the time prior to 1997.

Thinking Schools, Learning Nation (TSLN) was adopted as the vision statement for MOE in 1997. It continues to be the over-arching descriptor of the transformation in the education system, comprising changes in all aspects of education.

Further Initiative in Education

- Teach Less, Learn More initiative was launched in the education system in 2003.

- TLLM **builds on the groundwork** laid in place by the systemic and structural improvements under TSLN, and the mindset changes encouraged in our schools under I&E. It continues the TSLN journey to improve the quality of interaction between teachers and learners, so that our learners can be more engaged in learning and better achieve the desired outcomes of education.
- Setting up of the Centre for Research in Pedagogy and Practice at NIE in 2004.

What is TLLM?

- TLLM aims to touch the hearts and engage the minds of our learners, to prepare them for life. It reaches into the core of education - why we teach, what we teach and how we teach.
- It is about shifting the focus from “quantity” to “quality” in education. “More quality” in terms of classroom interaction, opportunities for expression, the learning of life-long skills and the building of character through innovative and effective teaching approaches and strategies. “Less quantity” in terms of rote-learning, repetitive tests, and following prescribed answers and set formulae.
- Teachers, school leaders and MOE all have important roles to play to make Teach Less, Learn More happen.

THE EVOLUTION OF SCHOOL MATHEMATICS CURRICULUM

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The developments from 1946 to 2012 that have shaped the present School Mathematics Curricula in Singapore, are direct consequences of developments in the Education System of Singapore during the same period.

- *Diverse beginnings …*
- *Keeping in line with world trends*
- *Mathematics for every child*
- *Consolidation of content*
- *Mathematics for Knowledge Based Economies*

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Diverse Beginnings…

- Up to the 1950s, schools in Singapore were mainly vernacular in nature, i.e. there were Chinese, Malay, Tamil and English schools.
- The language of instruction in Chinese schools was Chinese and their curricula was adopted from China.
- Likewise the language of instruction in English schools was English and their curricula was adopted from Britain.
- Therefore several mathematics syllabuses were in use across Singapore, with each school adopting their own.
- The first local set of syllabuses for mathematics was drafted in 1957 and published in 1959. This set of syllabuses were for Primary and Secondary schools contained in a single booklet. The syllabuses adopted a spiral approach and were for all schools irrespective of their language streams.

Diverse Beginnings… (contd…)

- In 1959, after the PAP came into political power, the government placed emphasis on educating the masses. In schools, the study of mathematics, science and technical subjects were emphasized.

- The first local set of syllabuses was used across all schools and **little consideration was given to differences in the mathematical abilities of the pupils**.

- The secondary school mathematics syllabuses referred to as Syllabus B prepared pupils for the mathematics examinations of the Cambridge Certificate of Education conducted by the University of Cambridge Local Examination Syndicate (UCLES).

Keeping in line with world trends

- A revision of the first local set of syllabuses for secondary schools took place in late 1960's in response to the "Math Reform of the 1960's". The revised syllabus known as Syllabus C was implemented in the early 1970's. Towards the end of the 1970s the syllabus underwent yet another revision resulting in Syllabus D.
- At the secondary level, all pupils take the mathematics (elementary) course. At the upper secondary level, the more able pupils take the additional mathematics course too. Both courses are based on the "Ordinary" level syllabuses of the University of Cambridge Local Examination Syndicate (UCLES).

Keeping in line with world trends (contd…)

- Since the 1980's Singapore secondary pupils have been doing the Syllabus D. The Ministry of Education issues the syllabus for the Lower Secondary levels.

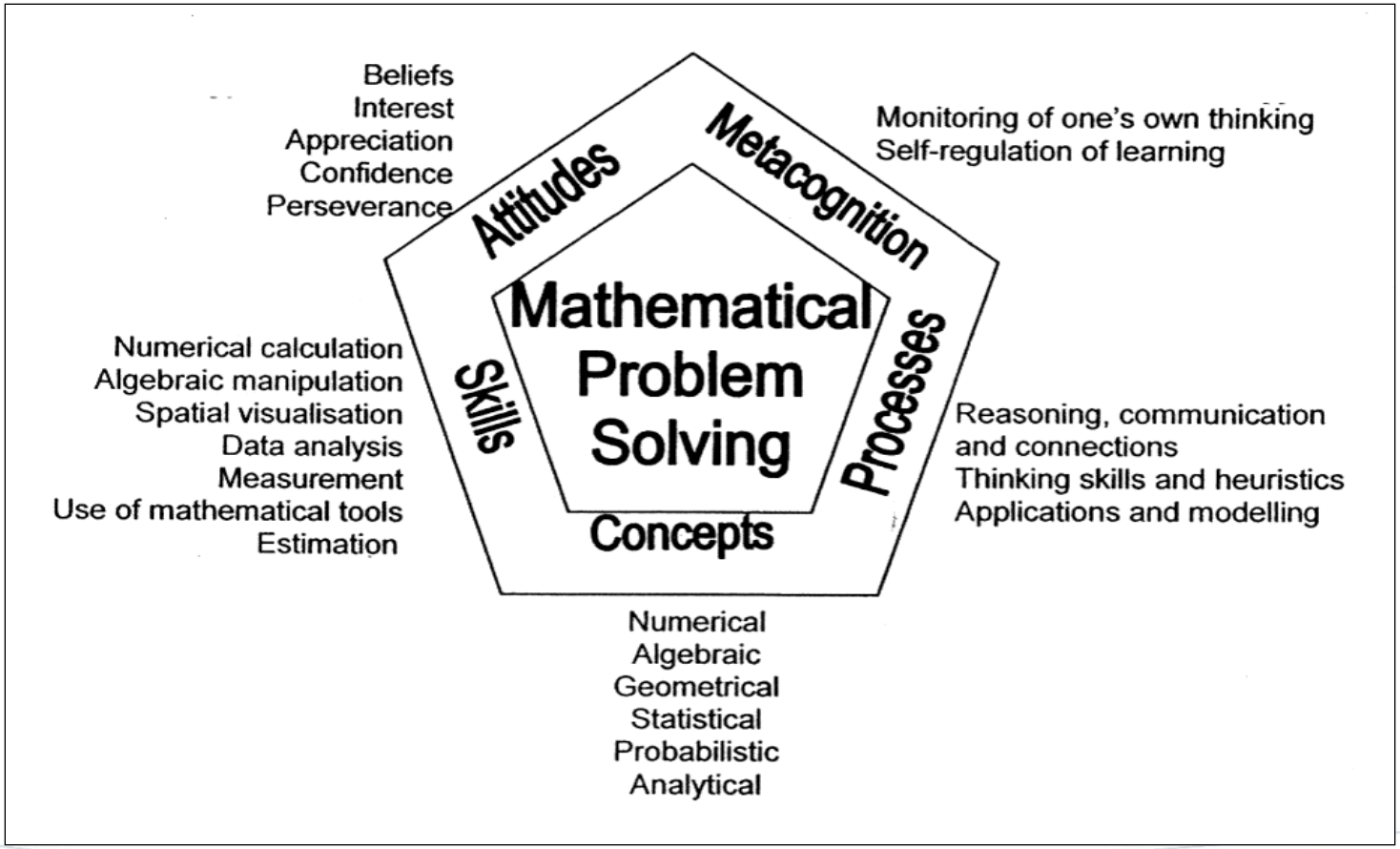
- This syllabus covers topics in Arithmetic, Mensuration, Algebra, Graphs, Geometry, Statistics and Trigonometry.

- For each topic, the syllabus describes the instructional objectives, lists the main concepts and learning outcomes. These topics are a subset of the syllabus for the "Ordinary" level UCLES mathematics examination.

Mathematics for every child

- In 1981, when the New Education System was implemented, the MOE produced a mathematics syllabus for the Express and Special Courses in the secondary school by arranging the topics in Syllabus D into a four-year programme.
- At the same time, a sub-set of the topics in Syllabus D was selected for the weaker Normal Course pupils for the “N” Level examination.
- The 1988 revision of the mathematics syllabuses (in use since 1981) led to the explicit articulation of the framework that outlines the philosophy of the revised curriculum.
- The framework shown in Figure 1 that spells out the primary focus of the mathematics curriculum as ***mathematical problem solving***.
- In 1990, the revised Mathematics Syllabus for the New Education System was implemented.

Framework of the school mathematics curriculum



Consolidation of content

In 1998, the mathematics syllabus underwent a content reduction exercise. The following rationale guided it.

- The learning of mathematics is sequential and hierarchical in nature. Therefore, alignment of all topics was scrutinized.
- Topics that were core content, i.e. essential as the foundation for further mathematics learning; developed the desired outcomes of the syllabuses; and provided continuity and completeness were retained.
- Topics that were less fundamental and not connected to other topics in the syllabus; which placed heavy emphasis on mechanical computation; which overlapped with those taught at other levels; that were too abstract for the intended level and concepts/skills that were taught in other subjects, were removed from the syllabus.

Mathematics for Knowledge Based Economies

In 1998, following the content reduction exercise, a revision of the syllabuses was undertaken to:

- Update the content to keep abreast with the latest developments and trends in Mathematics education.
- Explicate the thinking processes inherent in the subject and to encourage the use of IT tools in the teaching and learning of Mathematics.
- Ensure the content meets the needs of the country in the next millennium (21st century).

The two courses of study for primary students

- Primary school comprises 6 years of schooling.
  - The Foundation Stage (Primary 1 to 4)
  - The Orientation Stage (Primary 5 to 6)
- Foundation Stage
  - Emphasis is on building a strong foundation in English, Mathematics and Mother Tongue. All students take the same course of study for mathematics.
- Orientation Stage
  - Students are streamed. Subject-based banding is adopted. Students take either the Foundation Mathematics or Mathematics course of study.

The three courses of study for secondary students

- Pupils sit a national examination called the Primary School Leaving Examination (PSLE) at the end of Primary six. The examination assesses pupils suitability for secondary education and places them in an appropriate secondary school course that suit their learning ability.

- Three Courses are available at the secondary school level. Pupils undergo four or five years of secondary education with different emphases.
- Special Course
- Express Course
- Normal Course (Academic / Technical)

The three mathematics courses

- Special/Express mathematics course
  - 4 year / GCE'O' level maths
- Normal (Academic) mathematics course
  - 4 year / GCE 'N' level maths syllabus A
  - Additional year / GCE 'O' level maths
- Normal (Technical) mathematics course
  - 4 year / GCE 'N' level maths syllabus T
  - Additional year / GCE 'N' level maths syllabus A

The recommended curriculum time for mathematics in the secondary school is as follows:

- Special / Express Course (2.5 to 3 hours per week)
- Normal (Academic) Course (2.5 to 3 hours per week)
- Normal (Technical) Course (4 to 5 hours per week)

Secondary One – Algebra
Special / Express Course

Algebraic expressions and formulae

Use letters to represent numbers

Express basic arithmetic processes algebraically

Substitute numbers for words and letters in formulae and expressions

Simple algebraic manipulation

Manipulate simple algebraic expressions – include collecting like terms and removing brackets

Simple linear equations

Solve simple linear equations

Solve problems involving linear equations – emphasize understanding of the problem leading to formulation of mathematical expressions/equations.

Secondary One – Algebra
Normal (Academic) Course

Algebraic expressions and formulae

Use letters to represent numbers

Express basic arithmetic processes algebraically

Substitute numbers for letters in formulae and expressions

Simple algebraic manipulation

Manipulate simple algebraic expressions – include collecting like terms and removing brackets

Secondary One – Algebra
Normal (Technical) Course

Algebraic expressions and formulae

Concept and notation

Use letters to represent numbers

Express basic arithmetic processes algebraically

Substitution

Substitute numbers for letters in expressions and formulae (exclude expressions with brackets & expressions involving squares and high powers)

Simplification

Simplify simple algebraic expressions (include collecting like terms but exclude removing of brackets at this level & expressions involving squares and higher powers)

Review and Revision of Mathematics Curricula

- The mathematics syllabuses in Singapore, for schools, are issued by the Ministry of Education in collaboration with University of Cambridge Local Examinations Syndicate.

- Every six years or so, the syllabuses undergo a periodic review to ensure that they remain relevant so as to prepare pupils for the challenges and opportunities of the future and also to be in line with the national objectives.

Where we are at present

Every child in school does mathematics that is suited to his or her ability.

School mathematics curriculum, emphasizes a balance between mastery over basic skills and concepts and the application of higher order thinking skills to solve mathematical problems.

OUR REPORT CARD
Mathematics performance of our students in TIMSS and PISA

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TIMSS: Singapore students achievement in Mathematics

	Rank	Rank
TIMSS	**Grade 4**	**Grade 8**
1995	**1**	**1**
1999	**-**	**1**
2003	**1**	**1**
2007	**2**	**3**
2011	**1**	**2**

PISA: Singapore students achievement in Mathematics

	Rank
PISA 2009	**2**

Factors that may explain Singapore's performance in TIMSS and PISA

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- The Curriculum
- The Teacher
- The Learner
- The Learning Environment

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THE CURRICULUM

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Mathematics for all but more mathematics for some

- Mathematics is a compulsory school subject from grades 1 – 10.
- Mathematics courses are tailored to meet the needs of the students.
- Primary school
  - Mathematics
  - Foundation Mathematics
- Secondary School
  - Special course / Express course mathematics
  - Normal (Academic) course mathematics
  - Normal (Technical) course mathematics
  - Special / Express course Additional mathematics
  - Normal (Academic) course Additional mathematics

Note: The Normal (Technical Course) was introduced in 1994

The Intended Curriculum

- The syllabuses adopt a spiral approach.
- The syllabuses are a guide for teachers to plan their mathematics and science instructional programmes.
- Teachers are not bound by the sequence of topics but ensure that the hierarchy and linkage are maintained.
- Teachers are free to exercise flexibility and creativity when drawing up plans of work which serve as a blueprint for them to implement the instructional programme.

The Intended Curriculum

- Textbooks are an essential part of the intended curriculum.
- Produced by publishers with close guidance from Curriculum specialists of the Curriculum Planning and Development Division (CPDD) at the Ministry of Education.
- All textbooks used in schools must have the approval of the Ministry of Education.

THE TEACHER

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Teacher is Key

- To forge the vision: THINKING SCHOOLS, LEARNING NATION (1997) ahead, teachers have been identified as the key and hence their development has been accorded due importance.

Learning Journey of Teachers

- Pre-service education of teachers
  - recruitment is based on aptitude and qualifications
  - rigorous pre-service education programmes
- Professional development of teachers
  - life long learners
  - entitled to 100 hours of PD per year
  - Enhanced performance management system (EPMS)
  - Beginning Teacher
  - General Education Officer (GEO) 1 / 2
  - General Education Officer (GEO) 1A1 / 2A1
  - General Education Officer (GEO) 1A2 / 2A2
  - Senior Teacher
  - Master Teacher

EPMS helps teachers develop themselves

The EPMS clearly articulates the expectations of teachers in their chosen fields of excellence. For the field, ***excellence in teaching*** teachers must slowly but surely develop themselves in the ***core competency*** (nurturing the whole child) which comprises of 4 main areas:

- ***cultivating knowledge*** (subject mastery, analytical thinking, initiative and teaching creatively),
- ***winning hearts and minds*** (understanding the environment, developing others),
- ***working with others*** (partnering parents, working in teams) and
- ***knowing self and others*** (turning into self, personal integrity, understanding others and respecting others).

THE LEARNER

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Every child is precious

- The CHILD is the focus of the school system
- No child is deprived of opportunities or resources
- Rewards are based on merits
- Parents are key stakeholders of schools

Expectations

- Teachers have high expectations of their students
- Parents also have high expectations of their children
- Society values education as it allows people to improve their social status.

THE LEARNING ENVIRONMENT

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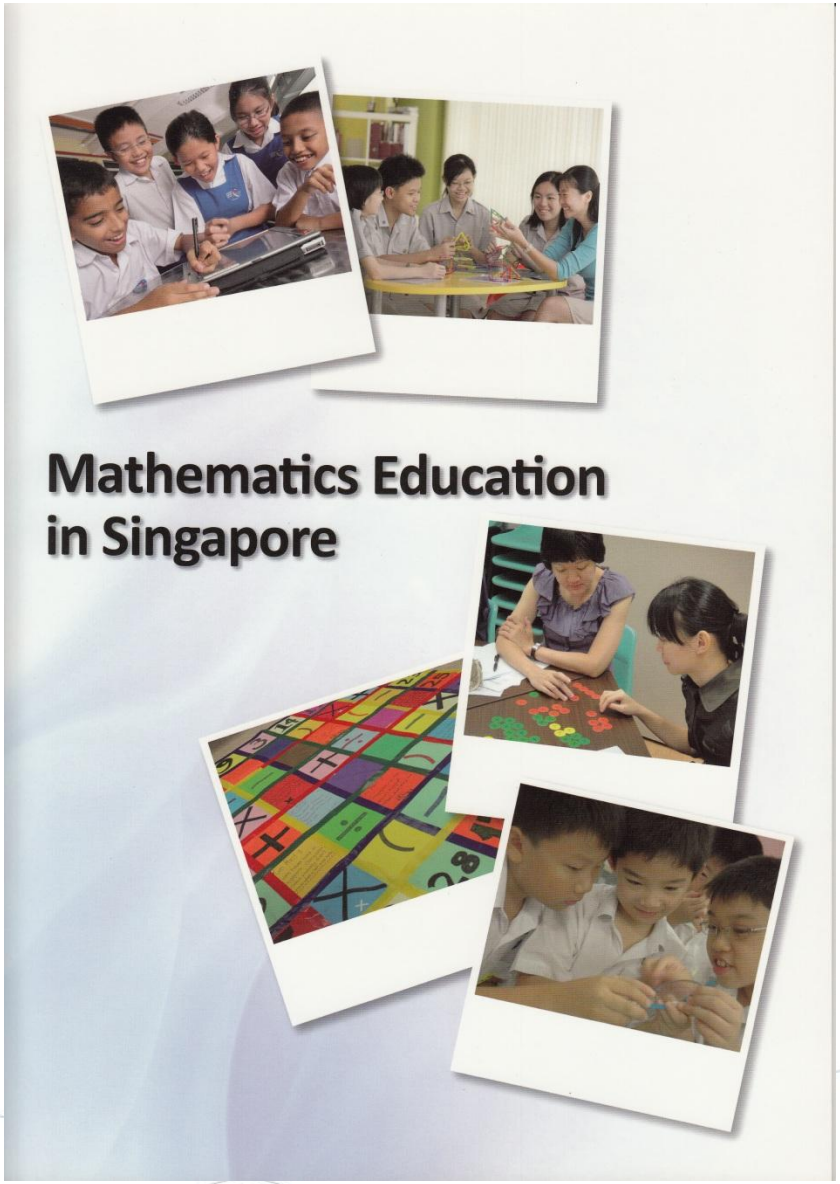
Schools

- Schools have state of the art facilities
  - learning spaces
  - ICT facilities
  - sporting facilities
- Schools are safe
- There is a fair and just system of assessment and certification
  - benchmarks exist
  - standards are maintained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