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Aligned Instructional Systems:

Singapore

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History and background

Today's Singapore is a rich, high-tech city-state. It is small (just over 716 square km), with a causeway and bridge linking it to Malaysia. It was home to a population of 5,399,200 people in 2013, of whom 3,313,200 were citizens; many of the non-citizens are foreign workers (Dept of Singapore Statistics 2013). Ethnically, its resident (Singapore citizens plus permanent residents) population is approximately 74% Chinese, 13% Malay, 9% Indian and 3% others. The standard of living is high for residents, with a life expectancy of slightly over 80 years for men and over 84 years for women and a per capita GDP of $69, 050 Singapore ($55,226 US) (MSFD 2013). The economy is based largely on electronics, manufacturing, petrochemicals, energy, environmental and financial services.

Singapore's modern history began in 1965 when it gained independence from Britain and ended its brief incorporation into Malaysia. At that time its people were very poor and very poorly educated. Education was not compulsory, even in the elementary years, and very few people went on to university – or even secondary education. Although there are various political parties, one, the People's Action Party (PAP) has been in power since independence and since that time its efforts have centered largely around making (and then keeping) the economy thriving and employment high. It was also determined to stem the tide of the ethnic animosities that were threatening to fragment the new state. From the beginning the PAP used education as a socio-political tool to achieve those ends (Sim 2014; Tucker 2012; OECD 2010).

While it made great strides in the 1960s and 70s in gaining manufacturing jobs for its low-skilled workforce, in the mid-80s the government was keen to encourage the high-skilled manufacturing sector and believed that average education levels were too far behind those of developed nations to achieve this goal. A 1986 Ministry of Trade and Industry report called for an increase in productivity through nation building, better ethnic cohesion and, fundamentally, education (Gopinathan & Mardiana 2014). Complementing its strategy to modernize the infrastructure and attract foreign investment in order to sustain economic development, the government turned the education sector into a tool for nation building.

The government believed that successful state building required success in human capital development – meritocracy, examinations as both an attainment as well as a selection measure, valuing science and mathematics, careful attention to creating high quality, credible post-secondary vocational and technical institutions were all education policies that helped Singapore develop a high skills work force. The state's ability to align teacher preparation, curriculum and assessment to meet both education and labor market needs is widely seen as responsible for the low unemployment rate of 3%.

Since the 1990s Singapore has been a major global economic player, well known as one of the Asian tiger economies, and its education system has been a fundamental element in underpinning the economy (Chua 2006).

Tucker (2012) posits that Singapore's post-war economic, education and vocational education and training policies are inextricably linked, with economic considerations the chief driver. Dividing the strategies into three – low-cost, low-skill export strategy until the mid- 1970s; capital intensive, high tech-high skill strategy from the mid-1970s to the 1990s; and creativity and entrepreneurship strategy from the 1990s to the present – Tucker describes a nation that went from a low cost attractive place for multinationals to do business, where the education emphasis was aimed at improving general education, reducing illiteracy, building up the education infrastructure and expanding vocational education, through a 'second industrial revolution' high-tech base for global manufacturing complemented by increased academic standards, an effort to retain students in the education system for as long as possible and an expansion of higher education, followed by a world-class, highly innovative producer of goods and services complemented by the education policies (noted below) alongside a world class teacher training system situated within increasingly autonomous schools and a vocational system that is largely post-secondary and state of the art.

In Singapore, there is a particularly strong alignment between education and politics. Education policy is highly centralized, although those at the center are educationalists rather than politicians per se. Schools are charged with both promoting national identity and values and developing human capital necessary for economic growth (OECD 2010). A succession of centrally driven government educational policies and initiatives have been put forward to achieve those ends including Thinking Schools, Learning Nation (TSLN) (1997), Teach Less Learn More (TLLM) (2004), Strategies for Engaged and Effective Development (SEED) (2004), Strategies for Active and Independent Learning (SAIL) (2004), Use of Pedagogies, Experiences of Learning, Tone of Environment, Assessment for Learning, and Learning Content (PETALS) (2008), TLLM Ignite! (2008) and Curriculum 2015 (C2015) (2008).

Prime Minister Goh's TSLN policy asked schools to respond to the needs of a knowledge economy by fostering innovation and creativity. Thinking Schools featured creative thinking, lifelong learning, and nation building; Learning Nation fostered national culture, creativity and innovation in school and beyond. The policy was supported by an IT Masterplan to integrate information technology in all subjects and a National Education plan to enshrine citizenship and values education (Gopinathan & Mardiana 2014). Success of these initiatives would mean a highly educated workforce with the habits of mind, values, attitudes and skills needed to develop cutting edge products and services.

Teachers saw their career paths and incentives re-developed and standards for initial teacher training and teacher qualifications raised. Curricula and assessment were to move away from the overly fact-based chalk and talk model to something much more open and creative involving project work and skills development. Subject choice increased and specialist school created. School governance shifted more toward the schools themselves with the advent of self-

appraisal underpinned by regular, though infrequent, external appraisal; there is no inspectorate in Singapore. Teach Less Learn More, begun in 2004, reinforced these new flexibilities by asking teachers to concentrate on the fundamentals of effective teaching in order to engage students, reinforce understanding and unlock potential beyond examination preparation through innovating curriculum (what to teach), pedagogy (how to teach) and assessment (how much students have learned) (MOE 2010c). One of the ways to get there was to reduce the curriculum, creating 10-20% 'white space' for inter-disciplinary and other critical and creative learning activities. Gopinathan and Deng (2006) argue, however, that school-based curriculum development was not meant to transform schools into places that created their own curriculum; schools were still responsible for implementing the externally designed curriculum.

In 2008, a rigid track-based system was loosened up somewhat so that students were sorted into three tracks in secondary school – Express, Normal (Academic) and Normal (Technical) based on where they wanted to progress. In primary schools, tracking into different streams has stopped. Instead there is subject-based banding at Primary 5 and 6 in which students take English, mathematics, science and mother tongue at either foundation or standard level, depending on their ability (see below). Curriculum 2015 (C2015) was also introduced that year, which reinforced basic education through literacy, mathematics and science, but also stressed the need for 21st century skills. This was complemented by a primary review (PERI) in 2009 that made three major recommendations: improve schools' infrastructure; invest in teachers; and provide a balance between basic knowledge and skills and values in a whole-school centered curriculum (Silver 2014). Following the PERI, Singapore also conducted a review of Secondary education (SERI) which made a range of recommendations including:

- strengthening the teacher-student relationship
- providing greater social-emotional support and career guidance
- implementing character and citizenship education
- enhancing student learning through co-curricular activities
- providing greater support to strengthen language and mathematical skills
- implementing the "Step Curriculum" for N(T) students
- strengthening articulation to post-secondary education review further
- expanding the integrated programme landscape
- establishing specialized schools for N(T) students as an alternative pathway (MOE 2010b).

Structure of educational system

Singapore has a short compulsory education phase of six years' primary school for 6 to 12/13 year olds. This is followed by four (Express) or five (Normal) years of secondary school, and one to six years' of what it labels as post-secondary education, the first two years of which are

approximately the equivalent of the last two years of US high school. Despite it being non-compulsory, almost all children enroll in post-secondary programs.

Kindergartens and childcare centers cater for children up to age six or seven. While most are privately owned and run by community foundations, religious bodies, social organizations or businesses, the MOE has in 2014 set up five kindergartens, jointly run with the Early Childhood Development Agency (ECDA), to innovate curriculum and pedagogy in early childhood education in an effort to raise the overall quality of early childhood programs.

The MOE provides a pre-school curriculum framework that emphasizes developing the whole child by engaging children's curiosity through play-based activities aimed at the appropriate developmental levels. The aim is to stimulate an interest in learning through exploration and discovery. In line with the vision and outcomes discussed above, pre-school education focuses on values, attitudes and skills rather than on specific competencies in reading, writing and arithmetic (INCA 2011).

Prior to 2003, primary education, although not compulsory, was universal, with almost 100% school enrollment of all eligible children. Following a governmental review in 2000 six years of primary education became compulsory, beginning in 2003, although some of the members of the review wanted the time period to be 10 years (Tan 2010). This is regarded as the minimum, rather than optimal, time, and 10 years of state-supported education is provided to all children. Students follow a common national curriculum (see below).

In 2009 a primary review was carried out and its recommendations accepted by the government. Although the subjects in the new curriculum look the same, there is a new emphasis on knowledge skills that focus on thinking, process and communication skills – integrated within the subjects rather than taught separately – and character development, which emphasizes instilling sound values. Two other recommendations include Programme for Active Learning, which gives greater emphasis to sports and outdoor education, and performing and visual arts and Holistic Assessment to better support learning, where there is greater emphasis on providing qualitative feedback to students and parents.

At the end of Primary 4, students take school-based tests that determine what level (band) – foundation and standard – students will study for English, mathematics, mother tongue and science during the next two years. It is initially up to parents which combination of subjects at which level their children will take, but schools decide the combination for Grade 6. Generally if students pass three or more of the tests, they go on to take all four subjects at standard level, but those who pass two or fewer may continue onto between one and three foundation subjects (MOE 2014c).

At the end of Primary 6, students take the Primary School Leaving Examination (PSLE) in English, mathematics, mother tongue and science. Whether the student took foundation or standard courses is factored into the overall score. Based on the examinations' results, students who are to continue in government and government-aided schools are admitted to an

Express (60% of students), Normal (Academic) (25% of students), or Normal (Technical) (15% of students) stream in secondary school. There is also a system of Direct Schools Admissions in which participating secondary schools can select students based on their achievements and talents even before the PSLE results are released. This is meant to promote holistic education and to recognize a more diverse range of student achievement and talent. For the brightest children there is an integrated program that goes up to university entrance and special needs students go on to four year special education programs.

Secondary schools cover the age range of 12/13 to 16/17 years. Schools are generally coeducational, but there are 24 single-sex secondary schools and three single-sex schools that educate both primary and secondary students. The same school generally will offer Express, Normal (Academic) and Normal (Technical) streams. Mobility between streams is possible. Students in the Express stream follow a four-year program culminating in the General Certificate of Education (GCE) O level exam. Students in the Normal (Academic) stream follow a four year course leading to the GCE N (Normal) Level, or sit for the O levels in the fifth year. Normal (Academic) students can bypass the N levels and go straight to O levels, or take a number of subjects at O levels alongside N levels. After N levels, Normal (Academic) students may opt to proceed to polytechnics or be admitted to the Institute of Technical Education (ITE) through a direct entry scheme. They can also be transferred laterally to the Express stream if they are deemed suitable. The Normal (Technical) program prepares students for technical higher education, jobs, or the postsecondary Institute of Technical Education (ITE), after a four year program leading to the GCE N Levels. They are able to take a few subjects at Normal (Academic) level or be laterally transferred to a Normal (Academic) course.

Since the late 80s the system has shifted from a uniform 'national' system to one of considerable diversity. Different types of schools have emerged, and within a three track secondary system, multiple pathways are now a key feature. The MOE takes a total system approach, and uses the phrase 'bridges and ladders', both to signal porosity within tracks and between schools and post-secondary institutions. Despite this clear intention it is not obvious how easy it is to shift from one pathway to another.

Since the Education Committee review of 2002, students who are of university caliber may study in Integrated Program (IP) Schools where they can bypass the O levels and go straight onto A Levels at age 17/18. The rationale behind this program is to encourage them to participate in broader learning experiences that develop their leadership abilities and critical and creative thinking. There are also a few specialist schools featuring sports, arts, mathematics and science. Once students finish secondary school, they can go on to post-secondary programs (they are still, by US standards, of high school age for at least the first year) of one to three years' duration. There are four different types:

- junior colleges offer two year pre-university programs culminating in the General Certificate of Education Advanced Level (GCE A Level) examinations Polytechnics offer three-year courses leading to a diploma

- programs run by the Institute of Technical Education (ITE) leading to industry-related and technical certificates
- Millennia Institute is a centralized Institute some of which offers three year pre-university courses leading to the GCE A Level.

Many polytechnic graduates who have done well go on to university. Students with O or N levels can take skill-based certificates in technical or vocational subjects at the Institute of Technical Education (ITE). Outstanding ITE graduates can also go on to polytechnics or universities. Currently 26% of the cohort attends university; the government plans to increase that to 30% by 2015 (MOE 2014d).

Special needs education

Special needs students outside of mainstream education usually attend government funded Special Education Schools, known as SPED schools. SPED schools include those for children with visual impairment, hearing impairment, or learning disabilities. In 2010, there were 20 SPED schools in Singapore (INCA 2011).

School year

There are 40 teaching weeks in Singapore's school year, i.e. 200 days, divided into four 10-week terms. Although the school year is longer than the US school year, examinations and other school activities can take up as much as four weeks of teaching time. National examinations take place, however, after the end of the school year.

Most primary schools used to run double sessions, with different groups of students attending school either from 7:30 am to 1:00 pm, or from 1:00 pm to 6:30 pm, from Monday to Friday. However, the MOE has made a concerted effort to switch schools to single sessions; in 2014 126 primary schools are running single sessions and 63 are partially running single sessions. Only one primary remains fully double sessioned.

Policy aims and vision

Mission

The backdrop to Singapore's educational system is the belief, enshrined in Ministry of Education (MOE) documents that national wealth resides in its people and their commitment to the nation and to their communities. They must be willing to 'strive and persevere' and believe in their ability to think, achieve and do well. Past, present and future all must come into play – education is about knowing where the nation comes from, where it is now and preparing the student for the future. The MOE's mission is to provide children with a balanced education in order to help them reach their full potential and emphases citizenship and responsibility to

family, society and country. Singapore believes that its education system is meritocratic, and that those who deserve to succeed are encouraged to rise to the top (MOE 2014a).

Vision

The national educational vision emanates from the 1997 *Thinking Schools Learning Nation* policy. TSLN foresaw a country filled with thinking, committed citizens who were able to meet future challenges, supported by a 21st century oriented education system. Schools would challenge assumptions and foster students' and teachers' participation, creativity and innovation culminating in a culture of lifelong learning (MOE 2014a).

According to this vision, national success and survival depends on education; education is a vehicle for each individual reaching his or her potential in order to make full use of talents, and, importantly use those talents to benefit the community and the nation. While encouraging all students to progress as far as they could in education, that progression depends on performance and merit as well as individual aptitude and interest. Flexibility within education is crucial since students matured 'mentally, physically, emotionally and socially at different rates' (MOE 2014a).

Students are to take pride in their work and always do their best, valuing and respecting honest work, learning the right values and attitudes, becoming self-reliant and individually competitive, while still working successfully with others. In a world in which values constantly shift, students need 'firm moral bearings'. These are achieved through a combination of approaches, and responsibility shared by all subject teachers. Character and citizenship education provides the governing framework with eight learning outcomes that are achieved through programs and subjects, including history. Shared identity is critical alongside the willingness to defend Singapore's national interests. That shared identity does, however, include respect for the different cultural backgrounds, languages and religions of Singapore's citizens (MOE 2014a).

Outcomes

A successful student who has gone through Singapore's education system must be responsible to family, community and nation, and appreciate the world's beauty, possessing a healthy mind and body, with a zest for life. The MOE describes such an individual as:

- a confident person who has a strong sense of right and wrong, is adaptable and resilient, knows themselves is discerning in judgment, thinks independently and critically, and communicates effectively
- a self-directed learner who takes responsibility for their own learning, who questions, reflects and perseveres in the pursuit of learning
- an active contributor who is able to work effectively in teams, exercises initiative, takes calculated risks, is innovative and strives for excellence

- and, a concerned citizen who is rooted to Singapore, has a strong civic consciousness, is informed, and takes an active role in bettering the lives of others around them (MOE 2010a).

A set of developmental outcomes describe key stage – primary, secondary and post-secondary – attributes, each building on the previous ones and underpinning subsequent ones. Again, it is notable that citizenship and love of Singapore feature prominently:

The Key Stage Outcomes of Education

At the end of Primary school, students should:	**At the end of Secondary school, students should:**	**At the end of post-Secondary education, students should:**
Be able to distinguish right from wrong	Have moral integrity	Have moral courage to stand up for what is right
Know their strengths and areas for growth	Believe in their abilities and be able to adapt to change	Be resilient in the face of adversity
Be able to cooperate, share and care for others	Be able to work in teams and show empathy for others	Be able to collaborate across cultures and be socially responsible
Have a lively curiosity about things	Be creative and have an inquiring mind	Be innovative and enterprising
Be able to think for and express themselves confidently	Be able to appreciate diverse views and communicate effectively	Be able to think critically and communicate persuasively
Take pride in their work	Take responsibility for own learning	Be purposeful in pursuit of excellence
Have healthy habits and an awareness of the arts	Enjoy physical activities and appreciate the arts	Pursue a healthy lifestyle and have an appreciation for aesthetics
Know and love Singapore	Believe in Singapore and understand what matters to Singapore	Be proud to be Singaporeans and understand Singapore in relation to the rest of the world

(MOE 2010a)

21st Century skills

In 2008 the MOE reasserted the need for both for the basic skills and 21st century skills and attributes. The Curriculum 2015 (C2015) policy incorporates 'strong fundamentals, future learning' (Kennedy 2013 p. 212). The curriculum fundamentals are mathematics, sciences,

languages and the humanities. Also important are a high quality work force, school leadership, collegiality and team work, school autonomy in decision making that complement the nation's direction and values. Undergirding the policy is the strong emphasis on citizenship described above, expressed through citizenship and character education.

Singapore set out a framework for developing 21st century skills and competencies at the heart of which are the social and emotional competencies of "skills necessary for children to recognize and manage their emotions, develop care and concern for others, make responsible decisions, establish positive relationships, as well as handle challenging situations effectively" (MOE 2014c) – respect, responsibility, integrity, care, resilience and harmony. A 'middle' ring of social and emotional competencies of self-awareness, self-management, social awareness, relationship management and responsible decision-making is surrounded by an outer core of 21st century competencies necessary for thriving in a globalized world – civic literacy, global awareness and cross-cultural skills; critical and inventive thinking; communication, collaboration and information skills.

Alongside regular course content, secondary curricula incorporate critical thinking, inquiry and investigating skills through project and practical work. For example, science courses contain school-based science practical assessment, which is teacher-led and marked and counts for up to 20% of the examination grade (Adamson & Darling-Hammond 2012).

More recently, concerns over an emphasis on degree qualifications, and quick upgrading efforts by polytechnic diploma holders have led to calls for skills deepening and the insertion of internships in post-secondary programmes. The recent Applied Study in Polytechnics and ITE Review (ASPIRE) report seeks to bridge the knowledge – skills divide by not just valuing both, but in also seeking integration. Beyond that report, there is now a top level committee chaired by DPM Tharman and a Future Skills Council involving employers to ensure that the ambitious recommendations are swiftly implemented.

Innovation in education

The OECD Measuring Innovation in Education (OECD 2014a) offers a way of measuring educational innovation using outcomes from TIMSS, PIRLS and PISA. It should be noted that using these data means that any innovations identified will tend to be only in the subjects or age sectors tested in these studies.

The OECD ranked Singapore as 10th most innovative system of the 29 jurisdictions covered. Its report suggests the following as Singapore's five most significant organizational innovations between 2003 and 2011:

- *more use of incentives for secondary teachers*

Singapore increased its use of incentives to promote teacher retention in secondary schools. The percentage of 8th grade[1] mathematics and science students in schools that used incentives rose from 7.2% to 47.5%, the largest gains among the 29 jurisdictions

- *more external evaluation of primary and secondary school classrooms*
  Singapore's teachers are frequently observed by people who are external to their schools – for 4th graders, 24% more were in schools that had external observers; for 8th graders the increase was 14% points for science students and 12% point increase for mathematics students
- *more parental involvement in school projects, programs and trips*
  More parents volunteered for projects, programs or trips in their child's school; once again, Singapore saw the largest increase in this metric among the 29 jurisdictions
- *more peer evaluation of teachers in secondary education*
  Secondary schools increased their use of teacher peer review – which increased by 21% points and 19% points for 8th grade mathematics and science classrooms respectively
- *more enrichment education for secondary science students*
  Enrichment activity is widely available for Singapore's 8th grade mathematics students. And as of 2007, approximately 94% of 8th Graders went to schools offering enrichment science education (OECD average 53.5%).

In terms of pedagogic innovation the OECD reports suggests that Singapore's main innovations are:

- more self-directed experiments in primary and secondary science lessons
  Singapore increased by 28% points the number of 4th grade students whose teachers asked them to plan or design experiments or investigations at least once a month; the complementary figure for 8th grade students was an increase of 10% points
- more observation and description in secondary school science lessons
  Singapore's students are increasingly asked to explain and elaborate upon their answers during school science lessons, something that the OECD claims increased students' curiosity and scientific communication skills. There was a 28% point increase in 8th grade students being asked to observe and describe natural phenomena during science lessons
- more relating of science lessons to everyday life
  Teachers reported that they increasingly asked their 4th and 8th grade science students to relate what they learned in class to their daily lives (although according to student reports the increase was very small) between 2003 and 2007
- more use of answer explanation in secondary mathematics
  8th grade mathematics teachers reported a 22% point increase in asking students to explain their answers in lessons, although the students themselves reported no difference in this metric

[1] The PISA, TIMSS and PIRLS use the terms 4th and 8th grade to denote participation by 10 and 14 year olds respectively.

- more active learning in secondary science lessons
  In secondary science teachers reported that there was an 8% point increase in their asking students to explain what they were studying in at least half of their science lessons.

Governance

The education system is very centralized in Singapore, with the MOE at the helm of almost all curriculum, assessment, teacher training, and planning matters, for all primary, secondary and post secondary schools and institutions. The Ministry sets national educational goals and coordinates the country's education program. It is led by a political appointee – the education minister – who works with senior civil servants, who typically rotate through many departments. Because there has only been one party in charge since independence, the government has been able to provide stability and continuity to education policy, and Singapore's education policies complement the government's national economic priorities (Tan 2013; Tucker 2012).

The MOE's curriculum division designs and reviews syllabuses and monitors their implementation, promotes pedagogical approaches that line up with curricular intent and designs assessments that support learning outcomes. It provides continuous professional development (CPD) so that school personnel are familiarized with syllabuses and programs; it also produces and approves instructional materials. In addition to CPD, it provides advice to schools, ministries and publishers on curriculum related issues (MOE 2014a).

Technology is critical to carrying out Singapore's curricular vision (see below) and the MOE has an Educational Technology Division that provides strategic direction for ICT in education. It aims to position Singapore as a leader of education-related ICT. It oversees the integration of ICT into teaching and learning practices, and through consultancy, builds up the capacities of teachers and school leaders and ensures a common vision of the role of technology in future learning. This is the division that oversees the planning, implementation and management of the *ICT Masterplan* (MOE 2014b).

Regionally, there are four zonal school branches that oversee the management of primary and secondary schools and junior colleges. Schools are grouped in clusters, each with its own superintendent. Superintendents are quite powerful in that they ensure schools within their clusters are networking and collaborating. They have financial and personnel responsibilities, including identifying future leaders and their necessary career development. In addition there is a school appraisal branch which is responsible for the implementation of the School Excellence Model (SEM) and the MOE Recognition System. It consults with schools on their self-assessment and conducts the external validation of schools to ensure continuous school improvement.

The Student Development Curriculum Division and the Curriculum Planning and Development Divisions oversee programs, both formal and informal, in student guidance, the arts, physical education and sport and character and citizenship education. Working together they develop and promote student-centered pedagogies, curriculum models and assessment modes to augment cognitive, affective, physical and aesthetic learning. They also conduct educational research on curriculum design and delivery. Both Divisions come under the same Curriculum Office and the Deputy Director General of Education (curriculum).

In recent years, schools have gained more autonomy. For example, the institutional structure is based on guidelines drawn up by the MOE, but determined by individual schools. School principals have control of their own budgets so have autonomy to plan and coordinate the individual school's educational programs. The cluster system consisting of around 13-14 member schools, including both primary and secondary schools, is in place to support the principals. Tan (2008) points out, however, that MOE's adoption of more school flexibility in the areas of critical and creative thinking, use of ICT, citizenship education and administrative excellence does not mean that the state has lessened its control over education, rather it remains an interventionist force in all areas of education.

Public/private

State education at the compulsory level is largely free[2] for Singapore citizens, and all schools in the education system receive public funding. The level of funding depends on what sort of school it is. Government fully funds its own schools; government-aided schools, which churches and other similar organizations originally set up, receive 90 per cent funding for their development costs. Both government schools and government-aided schools may be designated as 'independent', 'autonomous' or 'Special Assistance Plan' (SAP) schools and, as such, can receive extra funding (INCA 2011).
There are over 30 private schools, not counting 'cram' schools, which prepare students for examinations, many of which are populated by children of expatriates. Admission policies differ according to the different types of private school, and there are different caps set on pupil

[2] Although there are Standard miscellaneous fees of $6.50 per month and Second-tier miscellaneous fees of up to $6.50 per month for primary school. Fees for the first four years of secondary are $5.00 per month, plus Standard miscellaneous fees of $10.00 per month and Second-tier miscellaneous fees of up to $10.00 per month. Autonomous Schools collect Autonomous School Fees, ranging from $3 to $18 per month, on top of second-tier miscellaneous fees. Independent Schools charge a separate scale of fees. The range of school fees for local students (excluding miscellaneous fees) in 2010 was $200- $300 per month. For pre-university education, school fees after subsidy are $6.00 per month with Standard miscellaneous fees of $13.50 per month and Second-tier miscellaneous fees of $13.50 per month. Independent Junior Colleges charge a separate scale of fees. The range of fees for local students (excluding miscellaneous fees) in 2010 was $300 – $400 per month (MOE 2014 x, http://www.moe.gov.sg/education/school-fees/faqs/)

intake, some restricting locals and some restricting foreign students, depending on the type of school. The MOE registers private schools and regulates the courses they offer and their teachers. To gain registration a school must offer an acceptable curriculum and have qualified teachers; management and administration are the responsibility of the owners.

The private cram/tuition schools that cater to Singaporeans and post-secondary institutions are essentially 'topping up' post-secondary institutions that offer degree qualifications from other countries and attract a large number of foreign students. Singapore students may go to private schools such as the Australian International School on a case by case basis. There are three 'government private schools' – ACS International, Hwa Chong International and St. Josephs International, which may enrol up to 50% Singaporeans.

Under the Private Education Act of 2009, private institutions (PEIs) must meet minimum standards for governance, teacher qualifications and information disclosure and in order to register with the Council for Private Education (CPE), which is a statutory regulatory board.

Textbooks

The Ministry of Education has the power of approval for all textbooks used in Singapore. The MOE produces some of the textbooks used by Singaporean children and also works with private publishers to develop materials based on the Curriculum, Planning and Development Division's (CPDD) subject syllabuses. The development and review processes entail research and judgments by education professionals including curriculum specialists, teachers and university academics to ensure that content and skill levels align with subject syllabuses and examinations, and that the textbooks are current, accurate and appropriate. There are several iterations to the process before the materials are approved, after which schools can select their own materials from the list. Schools are able to supplement the textbooks with their own materials. Each year feedback on the textbooks is requested from teachers and their suggestions are taken into account for the next edition of the books. When errors are found, the MOE works with publishers to communicate any necessary amendments. Normally, parents buy their children textbooks, but financial aid is on offer for students whose families cannot afford to buy them textbooks. While schools are not required to use textbooks, if they do they must come from the approved list.

Guidebooks and textbooks mean that teachers can spend less time on basic lesson planning than in many other nations, but more on marking and planning details for initiatives such as 'mother tongue fortnight' (personal correspondence with Isabel Nisbet).

Accountability

School accountability

Directly after independence Singapore had to build up an education system that was replete with problems – low standards, ineffective curriculum, and low literacy levels – and so, not surprisingly, in the late 1970s standardization was introduced, with a prescribed performance model. External inspections from the MOE took place starting in 1980 and the accountability focus was on conformance with centralized standards. As things turned around for schools, accountability became more local, although school ranking was introduced in 1992, under the assumption that competition would foster improvement. School accountability was focused on performance, but a few high achieving schools were allowed more autonomy from central control with freedoms in hiring and firing, admissions policies and curriculum development. These proved successful and from the mid-1990s on were introduced in other schools. The aim was to focus on quality rather than only quantity as well as innovation, and to do so some of the quality assurance functions devolved to schools. In 2000 the School Excellence Model (SEM) was introduced, which incorporated self-appraisal, although it did include centrally developed performance indicators as well as an external inspection/validation from the appraisal branch of the MOE every five years. Ng (2013, 124) characterizes this as a 'centralized decentralization strategy' in which the government retains strategic control over schools while giving the schools tactical autonomy.

School Excellence, according to the Ministry means that:

> "Schools are responsible to parents and the community for providing the best programs and a high quality of education to their students….every parent wants his child's school to be a good school...every child is entitled to a good school. Outcomes, be they in the academic areas or non-academic areas are useful because they challenge us to pay rigorous attention to what we have achieved and what more we can achieve; where we are and where we want to be." (Ministry of Education 2000, quoted in Ng 2013, 125).

The SEM model contains nine quality criteria against which schools are judged: leadership; strategic planning; staff management; resource management; student-focused processes; administrative and operational results; staff results; partnership and community results and student results). For each criterion schools must show:

- a sound and integrated approach for systematic, continuous improvement for all criteria of quality defined by the model
- a systematic deployment of the approach and the degree of implementation
- a regular assessment and review of the approaches and their deployment, based on monitoring and analysis of the results achieved and on-going activities
- an identification, prioritization, planning and implementation of improvement activities
- a set of appropriate and challenging performance targets
- a continuous improvement of results over three to five years
- a benchmarking of performance against comparable schools
- an identification of the causes of good or bad results (Ng 2008, 242-43).

While SEM has devolved many accountability measures to the schools themselves there is still some central control. All schools do a self-appraisal using the above model, which an external MOE team validates every six years. Validation requires evidence to justify the school's judgments as well as evidence of continuous improvement through trend analyses.

Another performance measure was the School Achievement Tables, which replaced school ranking in 2004. These tables banded schools based on their academic results and also highlighted value-added achievements and success in non-academic domains. Schools with similar academic performances were banded together and exact rank was not made public although schools competed to get into and stay in top bands (Tan 2006). These league tables were abolished in 2012; the emphasis now is on recognizing best practices by schools in delivering a well-rounded education – through teaching and learning, all-around student development, staff development, character and citizenship education and partnership (MOE 2012b) .

Carrying out a set of interviews with 26 vice-principals, Ng (2013) found that they believed that schools were primarily accountable for: students' holistic development; site, funding and staff management; national survival and nation building; humanity and the future. This is a much broader concept of accountability than found in the US. When asked to whom Singapore schools were accountable the vice-principals listed students, parents, country and citizens, themselves, thus again reinforcing the notion of state-building and citizenship. Ng recounted that some of the vice-principals thought that national survival and nation-building were the main functions of schools in Singapore and therefore for what they should be most accountable. The country's future was in their (the school leaders') hands and they needed to protect the country's resources.

Ng pointed out the irony of this heartfelt notion that accountability went beyond any bureaucratic reckoning, since at the end of the day schools were government schools and all teachers, department heads, vice principals and principals are civil servants employed directly by the government. They answer directly to the MOE.

Teacher accountability

Teachers are held accountable under an *Enhanced Performance Management System* (EPMS) that was introduced in 2001. Under EPMS teachers receive three reviews each year with a supervising education officer. Teachers set targets and expected results and plan their development and training with their supervisor. After three reviews, which include a holistic view from a panel of peers as well as the supervisor, teachers are ranked from A to E and salary increments, performance bonuses and career development opportunities are directly related to the grade they receive. Promotion decisions are based on the teacher's performance, knowledge, experience and potential (Dimmock and Tan 2013).

Tan (2008) emphasized the continuance of state control over educational outcomes and less school autonomy than one might expect given a superficial reading of MOE educational aims.

She writes about the 're-regulation' of education in Singapore, in which, while schools are encouraged to innovate and improve themselves, that innovation is balanced out by standardization and central control through national syllabuses, national examinations and (the now abolished) national league tables.

Setting standards

Part of that interventionist force is a tight rein on standards, through national curriculum and assessment (see below) as well as policy initiatives, the most important of which are outlined below.

Thinking Schools, Learning Nation (TSLN)

In 1997 the government launched the Thinking Schools, Learning Nation policy, which centered on both educational and economic productivity, by developing cultural capital, providing students with critical thinking skills and enhancing educational technology (Chua 2006). To carry out its aim of creating a passion for lifelong learning and civic responsibility in students it promoted a fundamental shift from mastery of content to mastery of skills, values and competencies. The aim was for the total learning environment to be transformed, with students, teachers, parents, workers, employers, community organizations all working with the government to create a flourishing society (Ng 2008). While the TSLN policy launched many initiatives, including the recent Curriculum 2015 (C2015), Koh (2013, p. 54) argues that it 'steers the whole education system in a deterministic paradigm of educational change that aims to reproduce subject-citizens who have the "right" skills to go "global" yet with their hearts rooted to "local"/"national" identity, traditions and values that are centered around economic need." This is not, of course, to say that many teachers in Singapore see TSLN in these terms; rather many emphasize promoting education of the whole child.

Teach Less Learn More (TLLM)

Probably the TSLN initiative that has garnered the most attention is the Teach Less Learn More policy that began in 2004. In introducing the policy the Prime Minister stated that:

> "Our basic approach, as we go forward, is to go for more quality and less quantity. We will focus on the quality of learning, quality of CCA and community engagements and the quality of the whole school experience that the student goes through. We will seek to cut back on quantity, careful and calculated cuts, so as to provide more "white space" in the curriculum, space which gives schools and teachers the room to introduce their own programs, to inject more quality into teaching, to reflect more, to have more time for preparing lessons and to give students themselves the room to exercise initiative and to shape their own learning." (quoted in Ng 2008, 6).

Teachers were to review education's core, its 'why', 'what' and 'how' of teaching and students were to become engaged, interested, passionate and proactive learners. In order to accomplished this schools were to timetable in the white space for teachers so that they could plan, reflect and share, working together to customize curriculum content, hone their pedagogy and create assessments, such as project work and presentations, that suited those they taught. TLLM supported school-based curriculum development (SBCD), encouraging interdisciplinary lessons, as well as teachers acting as facilitators rather than masters, with the students themselves taking charge of their learning (Chua 2006). Lam et al (2013) note that TLLM was a challenge for many school leaders because teachers did not see it as a priority – getting good results on national tests and examinations came first. He cites examples of teachers ensuring that curricula directly aligned with subject syllabi so that students' assessment results would be enhanced, seeing this as the best way to implement possibly conflicting centrally driven curriculum policies.

Curdt-Christiansen and Silver (2013) observed English lessons that were supposed to integrate TLLM strategies and found that teachers were still very much in control, only allowing students to participate at certain junctures and in limited ways that directly included the desired content at the expense of open-ended exploratory discussion. They believe this is because teachers are still evaluated against their students' results and they are therefore under pressure to teach to the test.

Hogan et al (2013a, 2013b) are also critical of TLLM, stating that its impact has been very limited, with pockets of innovation, because the national assessment system does not support TLLM methods, pedagogy has not sufficiently changed, the central (and therefore local) implementation strategy is not strong enough and teachers have weak professional authority. Classroom talk, according to Hogan et al, remains overwhelmingly factual, especially in secondary schools.

ICT masterplan

Now in its third iteration since 1997, the *ICT Masterplan* illustrates the ambitious attempts that have been made in Singapore to ensure that all schools include technology in as many lessons as possible. Initially the plan concentrated on providing necessary infrastructure and professional support, it then turned to integrating ICT into the curriculum and set baseline ICT standards for students. The third Masterplan aims to:

- strengthen integration of ICT into curriculum, pedagogy and assessment to enhance learning and develop competencies for the 21st century
- provide differentiated professional development that is more practice-based and models how ICT can be effectively used to help students learn better
- improve the sharing of best practices and successful innovations
- enhance ICT provisions in schools to support the implementation of mp3 (MOE 2014b).

Project work

The MOE encourages project work as a way of integrating critical and creative skills – arguably 21st century skills – across the curriculum. Projects are intended to develop:

- a spirit of inquiry and thinking originally
- a willingness to do something differently, even if there is a risk of failure
- a ruggedness of character, the ability to bounce back and try again
- a willingness to stand in a team, lead a team and fight as a team
- a sense of 'giving back' to the community (Ministry of Education 2005, quoted in Chua 2006, 220).

Through collaboration, communication and independent learning. Project work features more in secondary and post-secondary education than in primary. It is compulsory for all students in their first year of Junior College (pre-university) and is an entry requirement for university in Singapore. Projects are internally assessed and must draw on knowledge and skills from more than one discipline in an open-ended and less structured manner than that found in their A level courses; the four domains upon which projects are judged are: knowledge application; communication; collaboration and independent learning. However, since projects are not particularly heavily weighted there is a danger that teachers and students might not take them as seriously as examination subjects (Bryer 2006). Ng (2008) found that students can be busily engaged in project work, yet not achieving the stated aims. Instead they 'cook up' something creative, which Ng characterizes as doing new learning with old learning methods and traditional pedagogies.

National education

Part and parcel of creating an education system to support the economy was ensuring that the education system promoted civic values and patriotism throughout primary and secondary education. National Education (NE) policy, introduced in 1997, promotes national cohesion, survival as a nation and confidence in the future by inculcating a sense of identity, pride and self-respect in Singapore's children (Ng 2008). To develop national cohesion, NE concentrates on:

- fostering a sense of identity, pride and self-respect as Singaporeans
- knowing the Singapore story
- understanding Singapore's unique challenges, constraints and vulnerabilities
- instilling core values of Singapore's way of life and the will to prevail, ensuring national success and well-being (Sim 2013).

Sim (2013) characterizes NE as exemplifying Singapore's top-down, state-driven curriculum, which, in this case, is more political than educational, a criticism that can be made of many

jurisdictions. This is not to deny that there are also educational ends to building social consciousness and identity and that the Asian heritage of community and nation first is as much cultural as political.

Teacher training

Initial teacher education

Teacher training is centrally controlled in Singapore, with the MOE responsible for initial teacher training as well as for the selection of candidates for teacher training courses. There is only one initial teacher training provider – the National Institute of Education (NIE). For those who want to work in the primary, secondary or junior college level, the NIE provides the following initial teacher training qualifications:

- a one-year Postgraduate Diploma in Education (PGDE) (all levels)
- a two-year Diploma in Education (DipEd) (primary level art, music, Tamil and Malay language only)
- a four-year Bachelor of Arts (BA) (Education) or Bachelor of Science (BSc) (Education) degree (primary and secondary schools)
- a four-year Teacher Training Diploma in either art and music, mother tongue language or home economics (for teaching mother tongue languages at primary and art and music and Food & Consumer Education at secondary)
- a two-year training program for PE leading to the PGDE (PE) or Dip(PE).

A new four year scholar teacher education program is currently being planned.

Admission onto a teacher training program requires that candidates have at least the following formal qualifications:

- PGDE: university degree
- BA/BSc (Ed): good polytechnic diploma or A level certificate or IB Diploma
- 2-year DipEd: polytechnic diploma or A level certificate or IB Diploma
- 4-year Teacher Training Scheme: O level certificate.

Candidates for teaching PE, English or mother tongue languages who do not meet the exemption criteria also have to pass an Entrance Proficiency Test (EPT). Successful candidates for the BA or BSc (Education) who do not meet the exemption criteria must pass an English language proficiency test before they can join the program. The MOE pays all of the tuition fees for teacher candidates. During their training, they receive a normal salary.

Recruitment is generally from the top third of the cohort, ensuring that the highest quality candidates are trained as teachers. Teachers are employed directly by the MOE, and beginning

teachers earn a similar amount to other graduates with similar qualifications. Beginning teachers must master at least one content area and primary teachers must also prepare, at minimum, to teach English, mathematics and one other subject. In line with the emphasis on 21st century critical skills for students (see above) trainee teachers are also geared up to teach independent learning, integrated project work, innovation, problem solving, inquiry learning and collaboration (Darling Hammond & Rothman 2011). Teachers are trained both at the NIE and in classrooms – student teachers on four year programs spend more than 20 weeks working in classrooms; for those on one year programs it is 10 weeks – and in order to graduate, students must pass both their classroom experience (Practicum) and NIE examination. The NIE is incorporating a number of innovative practices into teacher training including using video-taped sessions for teachers to analyze, integrating pedagogy to support 21st century skills, emphasizing formative and performance assessment and the generation of e-portfolios.

Placement in schools is based on central needs, although after two years teachers can request a different posting, which would then need to be approved by the MOE. Principals are also able to identify teachers they would like to have work in their schools. Unlike the US, the attrition rate among teachers is very low – fewer than 3% each year. According to Darling-Hammond and Rothman (2011) the reasons teachers stay on are: a conducive culture that has a clear mission; good salaries and rewards; and good opportunities for advancement and professional development (see Chong 2014 for a fuller discussion).

Continuous professional development

The model for professional development and learning in Singapore is very much ground-up. Every school has its own School Staff Developer and develop their own strategic plan for teacher professional development. A major part of professional learning takes place in individual schools, particularly through the Professional Learning Communities. Every teacher in Singapore has an entitlement to 100 hours of professional development each year.

In 2012 the government announced a new CPD program, the Teacher Growth Model (TGM), the aim of which is to help teachers engage in continual learning, take ownership of their professional growth and develop holistically in the 21st century. It encourages teachers to become more learner focused through multiple modes of CPD delivery – courses and training, mentoring, research-based practice, conferences, networked and experiential learning.

The model has five desired outcomes:

- the ethical educator
- the competent professional
- the collaborative learner
- the transformational leader and
- the community builder.

TGM is seen as a continuum in which teachers engage in different activities depending on the stage they have reached in their careers (MOE 2012c).

Newly qualified teachers are mentored and coached for two years by senior teachers and they also attend courses in classroom management, counseling, reflective practice and assessment. They receive a lighter workload – about 2/3 of that of a senior teacher – for the first two years. For more experienced professionals, the government funds around 100 hours of CPD each year. Outside of their approximately 20 hours of timetabled lessons per week, teachers work together on lesson preparation, observe each others' teaching, take part in professional discussions and meetings both with teachers from their own schools and those in their cluster. The government supports teachers' action research projects and provides awards/scholarships for them and there is a government sponsored teachers' network that encourages teacher instigated sharing, learning and reflection and can include learning circles, teacher-led workshops and conferences. It also hosts a website (Darling-Hammond and Rothman 2011).

Teacher assessment is based on the quality of students' learning, pastoral care, student well-being, co-curricular activities and interactions with parents, taking into account both academic and non-academic outcomes (see accountability, above). The system allows for bonuses for teachers as well as flagging up those in need of additional help. Promotion prospects are also part of the system and in order to receive top pay, teachers do not, as in the US, have to become principals and/or administrators. Instead they can become master teachers or specialists.

Formal leadership training also takes place at the NIE, working in close collaboration with the MOE. Again, centralization is key – all middle and senior leaders experience exactly the same training. Principals are appointed by the MOE and are rotated between schools and other forms of work responsibilities, usually around every five to seven years. This allows for a wider variety of leadership experiences than in most US situations (Dimmock and Tan 2013). Senior teachers and department head are expected to mentor beginning teachers (Ng 2008).

The importance of teacher training in Singapore was borne out through teachers' and principals' responses to the 2013 OECD TALIS survey (OECD 2014c). 83% of teachers reported that they had in-school classroom training in their subjects (the TALIS average was 67%) before they became fully-fledged teachers. Almost all teachers – 99% – reported having had a formal induction program, compared with the TALIS average of 44%, with high proportions of teachers either serving as mentors or being mentored. Those mentors overwhelmingly (85%) taught the same subject as those they mentored (TALIS average 68%).

Singapore teachers overwhelmingly reported that they were part of a collaborative school culture – 81% – that is characterized by mutual support and respect. They are satisfied with their jobs (88%, although the TALIS average here is 91%) and would still choose to be teachers if they could decide again (82%). Those who were active in collaborative professional learning or had opportunities to participate in school decisions reported higher levels of job satisfaction than those who were less active.

Almost seven in 10 teachers believe that Singapore society values the teaching profession highly, which was more than twice the TALIS average of 31%.

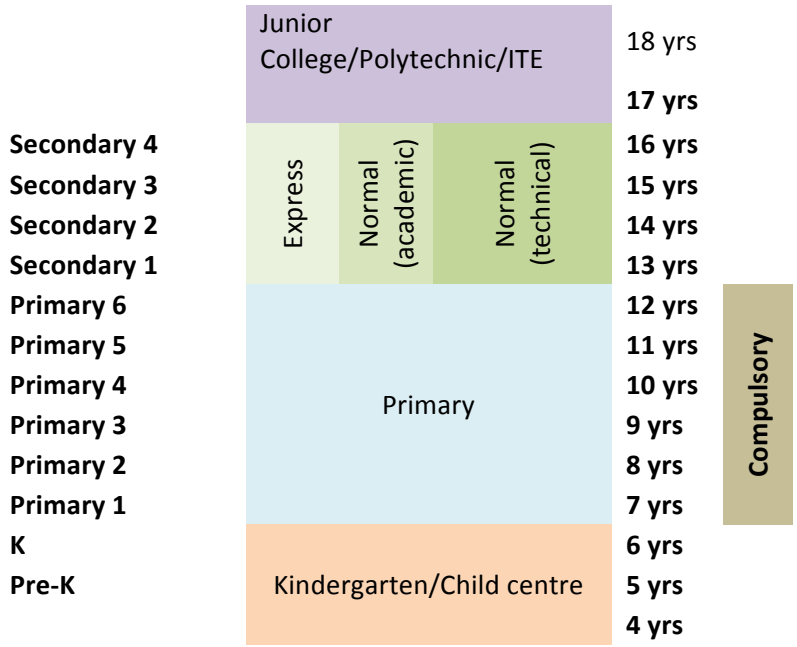
They valued the feedback that they received about their own teaching practice and used that feedback to improve their teaching practices and their use of student assessment.

Participation rates for professional development activities were high. Teachers spend more time planning their lessons (eight hours) and on marking their students' work (nine hours) than the TALIS average of seven and five hours respectively.

Types of schooling, ages of transition

The chart below shows the type of schooling available and the ages of transition from one type to the next:

Singapore school structure



Singapore's Curriculum

School operational hours are not regulated, but the MOE does provide guidelines on formal curriculum hours. For Primary 1 and 2 those are 48 periods of 30 minutes each per week and

for Primary 3 to 6, 49 periods of 30 minutes each, or about five hours a day including recess time. For secondary schools the guidelines stipulate 40 periods of 40 minutes each per week, or about six hours a day including recess time.

From Primary 1 to 4 the core curriculum includes English (33% of curriculum time), mother tongue (Chinese, Malay or Tamil) (27% of curriculum time) and mathematics (20% of curriculum time). Science is introduced in Primary 3. English usually includes general topics such health education and information literacy.

The science curriculum is informed by the Curriculum Planning and Development Division (CPDD) located in the Science Unit of the Ministry of Education (MOE). The CPDD develops syllabuses, programs and resources to support schools in science teaching and learning, from the Primary through the Secondary to the A levels. The syllabi are developed in consultation with various stakeholders including schools and the institutions of higher learning. Following the approval of new or revised syllabi, the unit conducts stringent reviews and authorizes science textbooks and related materials, such as activity books or workbooks for use in primary and secondary schools. The CPDD is a major engine driving curriculum and pedagogy in Singapore; few other OECD countries have such a centralized institution with these roles.

Primary 1 to Primary 4[3]

Subjects	**No. of 30-minute lessons per week**			
	Primary 1	Primary 2	Primary 3	Primary 4
English, including health education and information literacy	17	17	15	13
Chinese / Malay / Tamil including Character and Citizenship Education' (CCE)	15	13	12	11
Mathematics	7	9	11	11
Science	-	-	3	4
Social studies	1	1	1	2
Art and crafts	2	2	2	2
Music	2	2	2	2
Physical education	3	3	3	3
Assembly	1	1	1	1

[3] Time allocations for the Singapore curriculum are taken from the International Review of Curriculum and Assessment Frameworks (INCA) database, last updated in 2011 (INCA 2011). Reviewers from education agencies alerted us that some of the lesson periods may be out of date, but MOE documentation has not updated the number of periods for each subject.

TOTAL	48	48	49	49

Primary 5 and Primary 6

Subjects	**No of 30 minute periods per week**	
	Standard level subjects	Foundation level subjects
Examinable subjects		
English language	12-13	16
Malay / Chinese / Tamil	8-10	4
Mathematics	9-10	13
Science	5	3
Non-examinable subjects		
Character and citizenship Education' (CCE)	3	
Social Studies	3	
Art and Crafts	2	
Music	1	
Project work	Generally one project of 20-25 hours' duration	
Physical education	2	
Health education	1	
Assembly	1	
Total	49	

Secondary 1 and Secondary 2 (12 to 14 year olds)

	Special and Express	**Normal Academic**
Lessons (35-40 minutes) per week		
English	6	6
Chinese / Malay / Tamil	6	6
Mathematics	5	6
Science	6	5
Literature	2	2
History	2	2
Geography	2	2
Art and crafts	2	2
Design and technology /Home economics	3	3
Character and citizenship Education	2	2

Physical education	2	2
Music	1	1
Assembly	1	1

Secondary 1 and Secondary 2 (12- to 13-year-olds) Normal (Technical)

Examination Subjects: 31 lessons (35-40 minutes) per week	
English	8
Basic Chinese / Malay / Tamil	3
Mathematics	8
Computer applications	4
Science	4
Design and technology / Food and consumer education	4
Non-examination subjects: 6 lessons (35-40 minutes) per week	
Character and citizenship Education	2
Physical education	2
Art and crafts	1
Assembly	1

Secondary 3 and Secondary 4 (14- 16 year olds) Express

Compulsory/Core examination subjects: 24-26 lessons (35-40 minutes) per week The compulsory examination subjects are English Language, Chinese / Malay / Tamil (Special course students study Higher C/M/T), mathematics, a combined humanities subject, a science subject.	
Optional Examination Subjects: 8-10 lessons (35-40 minutes) per week Students must choose between two and four subjects from: second mathematics (for example additional mathematics); humanities (literature, geography, history); sciences (biology; physics; chemistry; science/integrated science); third language; others (including arts, religion, design and technology and food and nutrition.)	
Compulsory Non-Examination Subjects: 6 lessons (35-40 minutes) per week	
Character and citizenship education	2
Physical education	2
Music	1

Assembly	1

Secondary 3, 4 and 5 (14-17 year olds) Normal (Academic)

Compulsory/Core examination subjects: 20 lessons (35-40 minutes) per week	
English language	8
Chinese / Malay / Tamil	6
Mathematics	6
Elective examination subjects: 3 to 8 lessons (35-40 minutes) per week Students must choose between two and four subjects from humanities (literature, geography, history); sciences (biology, physics and chemistry, physics and biology, chemistry and biology); others (including arts, religion and design and technology and food and nutrition	
Compulsory Non-Examination Subjects: 6 lessons (35-40 minutes) per week	
Character and citizenship Education	2
Physical education	2
Music	1
Assembly	1

Secondary 3 and Secondary 4 (14- to 16-year-olds) Normal (Technical)

Compulsory/Core Examination Subjects: 25 lessons (35-40 minutes) per week	
English	9
Basic Chinese / Malay / Tamil	3
Mathematics	9
Computer Applications	4
Elective Examination Subjects: 3 to 9 lessons (35-40 minutes) per week Students must choose between one and three subjects from design & technology; science; food studies; elements of office administration; and arts and crafts	
Compulsory Non-Examination Subjects: 6 lessons (35-40 minutes) per week	
Character and Citizenship Education	2
Physical Education	2
Music	1
Assembly	1

Post-secondary in junior colleges (16-18+ year olds)

Compulsory Core Examination Subjects: 8 hours per week	
General paper	4
Chinese/Malay/Tamil	4
Elective Examination subjects: Students choose 3-4 GCE Advanced (A) Level Subjects at H1, H2 or H3 level.	
A levels are offered in a wide range of subjects including English Language and Literature, a number of languages, history, combined humanities, geography, mathematics, additional mathematics, biology, chemistry, physics (as well as physics and chemistry, physics and biology, and biology and chemistry), arts subjects, design & technology, accounting, a number of applied subjects, business studies, computer studies, physical education, economics and drama. A levels are available on three levels: H1 and H2 have the same level of demand, but H1 covers 50% of the content of an H2; H3 (available in fewer subjects than the other two) is for exceptional students.	4-6 hours per subject
Compulsory Non-Examination Subjects: 4 hours per week	
Character Development program	1
Physical Education	2
Assembly	1

INCA 2011

Language of instruction

The primary language of instruction is English, although exceptions are made in the case of mother tongue subjects, and character and citizenship education in primary school.

Assessment processes

Apart from national examinations (see below), all student assessment is school-based, on which the MOE provides guidelines. Continuous, formative assessment forms an integral part of the teaching-learning process, and has been encouraged through various policy initiatives (see above, especially Teach Less Learn More and the primary review). School-based mid- and end-of-year examinations provide summative evaluation. The outcomes of these assessments

are aggregated to provide a profile of the student's progress. They are the basis on which critical decisions about a student's future are made, such as placements and at what levels subjects are to be studied.

Examinations and certification

PSLE:
As mentioned above, students take school-based examinations in English, mother tongue, mathematics and science at the end of Primary 4 (age 10). On the basis of their performance in these exams, they go on to study these subjects at either Standard or Foundation level (or Higher Level for mother tongue). At the end of Primary 6, the school decides at which level to enter the child in each subject in the Primary School Leaving Examination (PSLE), which is a national test that assesses a student's achievements at primary school and determines access to secondary education. It is conducted annually by the Singapore Examinations and Assessment Board (SEAB), which was founded in 2004 to develop and implement national examinations, alongside other examination and assessment services. Students' performance in the PSLE is also one of the factors used to measure the performance of the school.

PSLE English consists of four papers: writing (27.5% weighting); language use and comprehension (47.5% weighting); listening comprehension (10% weighting); and oral communication (15% weighting). The writing paper is 1 hour 10 minutes long and consists of open-ended essay questions; the language use paper is 1 hour 50 minutes long and is a combination of open-ended and multiple choice items; listening comprehension is about 35 minutes long and contains multiple choice items; and oral communication is about 11 minutes long and is open-ended. Foundation English follows the same format, but it slightly shorter and more heavily weighted toward oral communication (20%) and less toward language use and comprehension (40%).

PSLE mathematics consists of two papers, one of 50 minutes (40% weighting) and the second 1 hour 40 minutes (60% weighting). The former contains a combination of multiple choice and short answer items; the latter consists of short answer and structured long answer questions. The foundation mathematics test, while following the same format, is shorter, at 2 hours 15 minutes, with more multiple choice items and fewer structured ones.

PSLE science is a 1 hour 45 minute test comprised of multiple choice (60% weighting) and open-ended (40% weighting) items. Foundation science is 1 hour 15 minutes long and consists of multiple choice (46% weighting), structured (20% weighting) and open-ended (34% weighting) items.

In 2013 over 43,000 students took PSLE examinations and 97.5% of them were deemed to be ready for secondary education, 66.7% in the Express track, 19.9% in the Normal (Academic) track and 10.9% in the Normal (Technical) track (see below). The other 2.5% of those assessed will either re-take the tests in hopes of entering one of the above programs or embark on vocational education.

GCE N and O levels:
The MOE and University of Cambridge International Examinations (CIE) are the joint examination authorities for the Singapore-Cambridge General Certificate of Education Normal (N) levels and General Certificate of Education Ordinary (O) levels (as well as the Singapore A levels, see below), which are taken at the end of secondary education. N levels can be either technical (NT levels) or academic (NA levels). Results determine what, if any, post-secondary track students embark on. NA levels are graded 1 to 5, with a U for ungraded; NT levels are graded A to D, with a U for ungraded.

In 2013, 212,419 students received results from NA level examinations; 5,510 students received results from NT examinations. Almost 100% of those who took it were awarded a NA level certificate, meaning they received a pass of Grade 5 or better in at least one NA subject. Of these students almost 73% were eligible to continue on to the fifth year; these are students who obtained an aggregate score not exceeding 19 points in English language, mathematics and their three best other subjects.

In 2013 98% of the NT students were awarded a NT level certificate, meaning they passed at Grade D or better at least one NT subject. They are all eligible for further study at ITE, or can transfer to Secondary 4 NA if they have obtained a Grade A in English language and a Grade B or better in one other subject.

Two thirds of Singapore secondary students undertake O level examinations. In 2005, the MOE introduced greater flexibility in the curriculum offering O level School Initiated Electives (OSIE). OSIE subjects are taken in addition to, or as replacement for, current curriculum offerings. Since 2008, Applied Subjects have been also developed by the polytechnics in partnership with secondary schools to better cater to the interests and aspirations of students who want to progress along an applied route. Grades from OSIE and Applied Subjects can be used in the computation of the O level aggregate score for admission to the junior colleges/centralized institutes, and polytechnics. O levels are graded A to F.

In 2013, 34,124 students sat for O levels and almost 100% were awarded certificates, meaning that they passed at least one examination. Almost 96% of candidates received three or more passes and almost 83% received five or more passes. Of the 4,170 Secondary 4 NA students who sat O levels a little over 90% obtained at least one pass grade. The MOE did not publish the number of students with 'good' pass grades (C and above), although only these would go on to A level courses.

GCE A-Level:
The MOE, CIE and SEAB jointly administer the Singapore A levels. Students with good O level passes are normally admitted to junior college, where they complete the A levels in two years, or to a centralized institute to complete A levels in three years. A revised A Level curriculum took effect from 2006; candidates now select subjects from three levels of study -- Higher 1 (H1), which contains about 50% of the content of a Higher 2 (H2) and is the same level of

demand, H2 which is the full two-year course and Higher 3 (H3), which is a special paper for the most able students. H1 and H2 papers are graded A to E; H3 is graded pass, merit or distinction. Students can select any combination and number of H1 and H2 subjects but they must take either the H1 General Paper or H2 Knowledge and Inquiry paper. In 2013 13,936 students sat A levels; just over 91% received at least three H2 passes, with a pass in General Paper or Knowledge and Inquiry.

International testing

Singapore is an exceptionally high performing country across all the PISA tests, as shown in the table below. However, since Singapore has only participated in PISA since 2009, any trend analysis must be made with caution. Its mathematics, reading and science scores have increased by 11, 16 and 9 points respectively[4].

The OECD measures educational equity by looking at the points differences between its highest and lowest achievers, i.e., the lower the point difference is, the closer educational opportunities are for all students. The table suggests that there is some inequity in the Singapore system, with this measure being higher than the OECD mean. Performance at the top end is impressive. 12.3% of test takers achieved a level 5 or 6 in all three main tests. 84% of top performers in problem solving were also top performers in mathematics (for the other two subjects it was over 50%). Despite the inequity measure, Singapore scores well with its Level 2 achievements, especially in mathematical literacy (OECD 2014b, OECD 2013a, OECD 2013b, OECD 2012).

PISA 2012	Score Mean = 500 SD = 100	Rank out of 65	Difference between highest (95%) and lowest (5%) achievers	Below level 2 (basic skills for life and work)	Levels 5 & 6 (top performers)
Mathematical literacy	573	2nd	344 points OECD = 302	8% OECD = 23%	40% OECD = 13%
Reading	542	3rd	329 OECD = 310	10% OECD = 18%	21% OECD = 8%
Scientific literacy	551	3rd	340 OECD = 304	10% OECD = 18%	23% OECD = 8%
Problem solving	562	1st out of 44		8%	29%

[4] The OECD considers that 40 points equals one school year on PISA performance.

PIRLS and TIMSS 2011

	Score Mean = 500 SD = 100	**Rank**	**Advanced International Benchmark (625)**	**Low International Benchmark (400)**
PIRLS 4th grade	567	5th of 45	24% International Median = 8%	97% International Median = 95%
TIMSS math 4th grade	606	1st of 57	43% International Median = 4%	99% International Median = 90%
TIMSS math 8th grade	611	2nd of 56	48% International Median = 3%	99% International Median = 75%
TIMSS science 4th grade	583	2nd of 57	33% International Median = 5%	97% International Median = 92%
TIMSS science 8th grade	590	1st of 56	40% International Median = 4%	96% International Median = 79%

Singapore has participated in PIRLS since 2001, during which time its score increased by 39 points. Participants did slightly better on informational than on literary reading. Singapore has participated in TIMSS since 1995, during which time its scores on 4th grade mathematics, 8th grade mathematics, 4th grade science and 8th grade science have increased by 16, 2, 60 and 10 points respectively (Martin et al 2012, Mullis et al 2012 PIRLS, Mullis et al 2012 TIMSS).

Detailed analysis of curriculum[5]

In this section, the following key areas of the Singapore curriculum have been analyzed: primary language, mathematics, general science and history, and secondary language, mathematics, earth science, biology, chemistry, physics, history and geography (social studies) and applied subjects. The areas of the analysis are:

- orientation – the aims, goals and rationale for the subject/content area
- coherence and clarity – the extent to which the curricula contain clear and specific goals for each grade and whether the suggested learning activities and pedagogical materials support those goals

[5] Syllabuses have all been taken from the MOE website: http://www.moe.gov.sg/education/syllabuses/.

- scope – the scope of material coverage, the number or amount of items or goals in the curriculum versus the depth of mastery proposed of each one
- levels of difficulty – to what extent the curricula items can be judged to be at the appropriate levels of difficulty. An appropriate level of difficulty should be defined as one that builds sequentially on prior and existing knowledge and presents an achievable challenge to the average student
- integration – how the different subjects within each grade of the curriculum is internally aligned
- progression – how smoothly and coherently the learning goals and proposed content of a given curriculum in a given subject progress from one grade level to the next
- key competencies – the level of development of a number of key competencies in the current curriculum and textbooks (such as problem solving, teamwork, self-learning, creativity, critical thinking competencies).

Student pathways in Singapore

Although there is no longer any steaming in primary school, students may take either a Standard syllabus or a Foundation syllabus. Students can mix between the two studying some at Standard and others at Foundation. At the end of Primary 6 (age 12), all students sit for the Primary School Leaving Examination (PSLE) in the subjects of English, mathematics, the mother tongue language, and science. Based on the results of this examination, students are admitted to one of three streams in secondary school, Express (60% of students), Normal (Academic) (25%) or Normal (Technical) (15%). These have different curricular emphases designed to match their aptitudes and interests. At the lower secondary levels, there are no national exams and schools have the flexibility to conduct their own assessment of the syllabuses based on broad guidelines.

Students in the Express stream follow a four-year program culminating in the General Certificate of Education (GCE) O Level exam. Students in the Normal (Academic) stream follow a four year course leading to the GCE N (Normal) Level, and/or sit for the O Levels in the fifth year. The Normal (Technical) program prepares students for technical higher education, jobs, or the post secondary Institute of Technical Education (ITE), after a four year program leading to the GCE N Level. This is followed by post-secondary phase which consists of Junior College, leading to GCE A Level for entry to higher education, Institute of Technical Education and other Institutes, where students may take A levels or other, technical qualifications, for entry to Polytechnics or employment.

Primary: English language

Orientation:
There are two types of syllabuses that students take in the later years of primary school, standard and foundation. For each, there is a *Language Use Syllabus*, with the emphasis on "effective communication" in "internationally acceptable English." Students may take a mix of

subject syllabuses, for instance, taking three subjects at Standard level and one at Foundation level.

The syllabus is based on the following assumptions and beliefs about language and language learning:

- language is a means of making meaning and of communication
- language is a system with its own rules and conventions which can be used to create various discourse forms or types of texts
- language learning involves cognitive and affective engagement, and interaction
- language use is guided by our awareness of the purpose, audience, context and culture in which the communication takes place
- learning English in a multilingual context is different from learning it in a monolingual or near-native context.

There is a separate *Literature in English Teaching* syllabus *"*designed to provide students with a strong foundation in the study of Literature and cultivate in them a love for the subject" that begins in the secondary school.

Coherence and Clarity:
The language syllabus sets out to combine systematic and explicit instruction in key areas of the curriculum (for example, phonics) with exposure to a rich language environment (shared reading). The curriculum is divided into: receptive skills covering listening, reading and viewing; productive skills covering speaking, writing and representing; and knowledge about language, covering grammar and vocabulary. Beneath these broad organizing concepts, the curriculum specification sets out focus areas, for example, reading comprehension, which are sub-divided into different learning outcomes, appropriate for that focus area, and beneath that are listed the skills, strategies, attitudes and behavior (SSAB) that the teacher will plan to teach, and the age range in which such SSABs should form part of the curriculum. With the exception of word recognition skills, many of the SSABs run across the entire age range, for example "note and recall main ideas and key details" is a key reading skill that is differentiated by being deployed on "age appropriate level texts" across the entire primary phase.

Scope:
The curriculum specification aims to list a comprehensive range of SSABs associated with each key area; there is relatively little differentiation by grade. This potentially means the teacher has too many itemized skills to cover, and no clear set of priorities over their relative weight or balance within a given year, and little direction on how the same skill might develop from one year to the next, for example "skim for the gist/ main idea", is defined as a relevant skill for every grade.

Levels of Demand:

Teachers are expected to differentiate their instruction depending upon their assessment of the needs of the learner but the pattern of curriculum specification keeps individual skills relatively discrete, and does not show how one builds on others that have gone before, by grade, or might be appropriately combined. The "catch up" curriculum primary (foundation) and secondary normal (technical) focuses on a selection of the skills included on the primary curriculum, for example: identify main events of the plot; make and check predictions (for example, based on details from the story) and covers comparatively few of the skills outlined for students in the secondary express normal (academic) route.

Progression:
The emphasis is on identifying the maximum range of skills to be acquired in each focus area. The precise sequence in which they might be taught individually or in combination from one grade to another is not so closely defined.

Assessment:
The assessment instruments test the acquisition of English as a second language, highlighting vocabulary and spelling.

Key competencies:
Potentially the weight of the curriculum rests with the teacher's inputs and could be fulfilled by a quite didactic approach to teaching, but it is difficult to fully assess this from documentary sources.

Primary: Mathematics

It appears the Singapore curriculum is being updated a grade at a time. What follows is based on the April 2012 document, which contains a general overview of primary mathematics followed by content for Primary 1. Where necessary this is supplemented by information about higher primary grades from the older (2006) document (MOE 2014e).

Orientation:
Learning mathematics is described as "a 21st century necessity." There are statements about providing a highly skilled workforce for a technology driven economy as well as statements about the need for mathematics as part of everyday life. There are high overall expectations, but also a sense that the mathematics curriculum will serve different goals for different children with all achieving "a high level of mastery that will serve them well in their lives" and those with 'the interest and ability", pursuing mathematics to "the highest possible level."

Coherence and clarity:
There is a statement saying that mathematics is hierarchical in nature and a spiral approach is used. For each age group content is tabulated against learning experiences. Learning experiences are described very briefly but appear to match content. For example in Primary 1 for mental addition and subtraction the learning experiences column says "achieve mastery of basic addition and subtraction facts within 20 through playing a wide range of games."

Progression between grades is clear. Content lists mainly say what should be included, but sometimes (2006 document) also specify what should not be included at this level.

Scope:
The syllabus is organized in one process strand and three content strands. The content strands are number and algebra, measurement and geometry and statistics. There is a clear statement about mathematical processes which says the teaching of process skills should "be deliberate and yet integrated with the learning of concepts and skills." Process skills are classified as "reasoning communication and connections", "applications" and "thinking skills and heuristics." These are tabulated in the 2012 version, though the implication is that the statements will be the same across age groups.

Of the three content strands, the number and algebra strand contains by far the most content at Primary 1 and although there is a gradual increase in non-number work in higher grades, number appears dominant throughout the primary grades. The number and algebra strand (though with no recognizable algebra) at Primary 1 suggests fast progress is expected across the year, as it starts with counting objects in a set, but as well as numbers to 100 and number bonds also includes addition, subtraction, multiplication and division. Money also appears as a sub strand of number and algebra. The measurement and geometry strand at this level is quite gentle, including measuring using non-standard units, telling the time to the hour or half hour and identifying and making patterns with 2-D shapes. The statistics strand at Primary 1 is about picture graphs. (This paragraph uses information from the 2012 syllabus; the rest of this section draws on the 2006 syllabus, both of which can be found on the MOE website http://www.moe.gov.sg/education/syllabuses/.)

At Primary 2 work on whole numbers is extended to1000 and there is more work on all four operations with whole numbers. Mental calculation is included and fractions are introduced, including addition and subtraction of like fractions within one whole. Work on money and time are extended (including use of decimal notation for money) and there is more on measurement, including length and mass and volume of liquids. The geometry strand includes identifying 2D and 3D shapes, making patterns with 2D shapes and identifying lines and curves. Work on picture graphs is extended to include scales.

At Primary 3, work on whole numbers includes place value, odd and even numbers and number patterns. Addition, subtraction, multiplication and division are further developed. There is work on equivalent fractions and addition and subtraction of fractions is extended to related fractions within one whole. Measurement is extended to include conversion of metric units and there is more work on time and money, including problem solving. Area and perimeter are introduced. In geometry students are introduced to perpendicular and parallel lines and to angle as an amount of turning. Data analysis is about bar graphs.

At Primary 4 whole numbers are extended to 100,000 and there is more on multiplication and division including factors and multiples. Mixed numbers and improper fractions are introduced, there is addition and subtraction of like and related fractions, fraction of a set of objects is

introduced and there is multiplication of a fraction by a whole number. Decimals are introduced up to three places, with addition and subtraction of decimals up to two places. Multiplication and division are extended to include whole number division with the answer in decimal form and division of decimals by whole numbers. There is more on area and perimeter, including solving problems related to the area of squares and rectangles and the square root symbol is introduced. There is a long geometry section at this grade, including perpendicular and parallel lines, more on angles, properties of rectangles and squares, symmetry and tessellation. Work on data includes tables and line graphs.

At Primary 5 (10/11 year olds) calculators are allowed unless otherwise stated (2006) and the 2012 version advocates the use of ICT tools to promote the development of "21st century competencies." At Primary 5 and Primary 6 there are two versions of the curriculum, standard mathematics and foundation mathematics. Most students are expected to learn standard mathematics, with likely progress to O level and beyond in secondary school. Foundation mathematics is for students who "need more time to learn."

At Primary 5 (standard mathematics, that is, most students), there is some work on calculating and solving problems with whole numbers. There is a lot on fractions, including fractions as division and four operations with fractions. Students also do four operations with decimals and are introduced to percentage and ratio. Measurement includes more on length mass and volume, area of triangles and volume of cubes and cuboids. Geometry includes more work on angles and different types of triangle and quadrilateral. In data analysis, average (mean) is introduced.

At Primary 6 (standard) there is little mention of whole number and work is on fractions, percentages, ratio and speed. Measurement includes area and circumference of circles, area and perimeter of complex figures, volume of cubes and cuboids and use of square root and cube root symbols. Geometry includes unknown angles and nets. Data analysis includes pie charts. Formal algebra is introduced here, including use of letters for unknowns and expressions in one variable.

The whole number section of foundation mathematics at Primary 5 is similar to the standard version, though there is slightly more in particular work on factors and multiples that revisits ideas introduced in Primary 4. The fraction section of the foundation section overlaps quite a bit with the standard version, though there is some consolidation of work introduced in earlier years and students are not expected to cover fractions as division or division of fractions by whole numbers. The foundation version differs from the standard in not including percentage and ratio, though decimals are included. The measurement section is similar to the standard, though there is an additional section on time including 24 hour clocks, revision of work from previous years on perimeter and less on volume. In geometry the work on angles includes consolidation of earlier work, there is nothing on triangles and work on quadrilaterals is confined to rectangles and squares. Data analysis includes consolidation of earlier work as well as introduction of averages.

Foundation mathematics at Primary 6 is about fractions, decimals and percentages and includes some ideas introduced at Primary 5 for those following the standard route. The measurement and geometry sections also include work from Primary 5 standard, such as use of formulae for volume and classification of triangles. The data analysis is about pie charts. There is no algebra section in the Primary 6 foundation strand and this is the key difference between the standard and foundation versions.

Levels of Demand:
The level of demand seems quite high. This is particularly the case in Primary 1, although this may be about the age children start primary school and also about things that children may actually be able to do when they start Primary 1, but which still appear on the syllabus at this grade. In early grades especially, the level of demand seems higher for number than for other aspects of mathematics. In the last two primary grades (although this would overlap with secondary in some countries) there are differing expectations for students following the standard and foundation versions of the curriculum. Until then, expectations seem the same for all students, though some differentiation looks possible.

Progression:
There is clear progression between grades. There is a small element of revisiting, but in the lower grades it is more about next steps. In the foundation strand for Primary 5 and Primary 6 there is more revisiting of earlier work.

Assessment:
Curriculum documents talk about formative summative and diagnostic assessment and the emphasis in this document is on integrating assessment with teaching. There is formal testing at the end of primary. The objectives of this are to test knowledge, comprehension and application, though there are quite a lot of short answers and some multiple choice.

Key competencies:
The 2012 document says quite a lot about problem solving, including mathematical modeling. Much of what is written is about applying mathematics to "real world" problems, but there is mention of other process skills and of personal qualities such as interest and perseverance.

Primary: Science

The curriculum for science has recently been updated for implementation in 2014. This brief analysis is based on the 2014 curriculum with indications of any significant changes from the 2008 version. The curriculum continues to adopt a thematic and inquiry approach to support students in exploring big ideas; developing concepts, skills and attitudes in science.). This commentary covers Primary 3 to 6.

Orientation:
The introduction to the science curriculum indicates that "the thrust of science education" is to prepare students to be "adept as effective citizens and to function in and contribute to an

increasingly technological world." There is an emphasis on the "spirit of inquiry" founded on the three key dimensions:

- knowledge, understanding and applications
- skills and processes
- ethics and attitudes.

The intention is that students should see the curriculum as "meaningful and useful" and related to the "roles played by science in daily life, society and the environment."

In the introduction to the science curriculum framework for 2014 there is new a section on 21st century competencies and their connections to scientific literacy. This indicates the aim is to prepare students to be: confident people, self-directed learners, concerned citizens and active contributors. 21st century competencies identified include: civic literacy, global awareness and cross-cultural skills, critical and inventive thinking and information and communication skills. It is suggested that science education will equip students with skills and habits of mind aligned with these 21st century competencies.

Coherence and clarity:
The syllabus framework is clear and coherent with the three dimensions of knowledge: understanding and applications; skills and processes; and ethics and values reflected throughout the curriculum documentation. The framework also sets out the requirements for freed up curriculum time known as "white space" where teachers can "use more engaging teaching and learning approaches" or other customized approaches in line with syllabus aims. The concern here is to make learning more meaningful and enjoyable.

The curriculum lists the key areas to be addressed within each of the key dimensions of learning as follows:

- knowledge understanding and application: the key themes identified are diversity, cycles, systems, energy and interactions incorporating a range of concepts in life and physical sciences. The focus of each theme is described with associated "essential takeaways" (key messages) and "key inquiry questions" for both teachers and learners.
- skills and processes: key skills are identified associated with: engaging with an event, phenomenon and problem; collecting and presenting evidence; reasoning making meaning of information and evidence; and communicating. This expands on the analysis in the 2008 curriculum.

  Processes identified are: creative problem solving, decision making and investigation.

- attitudes and ethics: this is a distinctive feature of the curriculum framework. The promotion of the following attitudes is advocated: curiosity, creativity, integrity, objectivity, open-mindedness, perseverance and responsibility.

An overview is provided of the primary science syllabus showing how key themes are revisited across Primary 3 and 4 (lower block) and Primary 5 and Primary 6 (upper block).

- approaches to learning and teaching and assessment
- guidance on teaching and learning highlights the central role of inquiry in keeping with the orientation of the curriculum. A wide range of teaching and learning approaches is advocated and mapped in detail against syllabus content. Detailed advice is provided on assessment approaches. The guidance on what dimensions to assess and how to assess is also coherent with curriculum aims.

Syllabus content:
The syllabus structure and content is clear and coherent. It is set out in blocks of two years – lower block (P3 and P4) and upper block (P5 and P6). The upper block is differentiated with more limited requirements for students on the foundation syllabus (in comparison with the standard syllabus).

For each block syllabus content is set out for each of the key themes – diversity, cycles, systems, energy and interactions. An overview of content is provided, listing key takeaways, inquiry questions and possible starting points. The starting points include links with everyday life and the work of scientists in the field. Learning outcomes are indicated for each of the key dimensions of learning: knowledge understanding and applications, skills and processes and ethics and attitudes. Outcomes are specific with expectations illustrated by examples.

Scope:
As outlined in the introduction to the framework, the syllabus content is "based on themes that students can relate to their everyday experiences and to the commonly observed phenomena in nature." The broad themes of diversity, cycles, systems, interactions and energy incorporate key areas of knowledge and understanding related to living things, materials and physical processes as follows:

- diversity – *diversity of living things*, *diversity of materials*
- cycles – cycles *in plants and animals, cycles in matter and water*
- systems – *plant and human system*, electrical systems, cell system
- interactions – *interaction of forces*, force in springs, interaction within the environment
- energy – *energy forms and uses* (light and heat and photosynthesis), energy conversion.

Areas in italics are tackled in both Primary 3/4 and Primary 5/6. Areas in normal type are tackled in Primary 5/6. Those underlined are not required for students taking foundation science).

There is no content related to space and earth sciences in the primary science curriculum.

Skills and processes and attitudes and values are included in relation to each theme, however, the range identified in the learning outcomes is fairly limited (in comparison to the range listed in the syllabus framework). For example, the most common skills listed are observe, classify and compare in Primary 3 and 4, with some greater emphasis on investigate and communicate in Primary 5 and 6.

Attitudes frequently included are curiosity, concern, objectivity and team working.

Levels of demand:
The level of demand in terms of learning outcomes for each primary block are appropriate in terms of enabling students to build on prior experiences. The greatest emphasis is on outcomes related to knowledge and understanding. Outcomes for the standard (as opposed to the foundation) curriculum for Primary 5 and 6 require use and understanding of a range of specific scientific terminology (greater than in a number of jurisdictions), such as organism, population and community (interactions within the environment) or different parts and functions of a plant /animal cell (cell systems). The level of demand and number of outcomes related to skills, processes and attitudes are both more limited and do not represent the full range outlined in the curriculum framework.

Progression:
Progression is indicated in general terms through the overview of content in the syllabus framework. Progression in skills and processes is less explicit – mainly expressed through the complexity of subject matter to be addressed than sophistication of inquiry processes. Little progression is indicated in the limited range of outcomes related to ethics and attitudes. However, accompanying teaching and learning documents and resources include more details of the different learning experiences and assessment contexts that provide students with opportunities to develop and apply the full range of concepts, skills and attitudes progressively from Primary 3 through to 6.

Assessment:
The guidance on purposes and approaches to assessment align with the curriculum aims and framework. However, in terms of what to assess, while the importance of the three dimensions of knowledge and understanding, skills and processes, and attitudes and values are emphasized, there is a greater number of learning outcomes for knowledge and understanding than each of the other dimensions. The scope of the skills, processes and attitudes outlined in the curriculum framework is not fully reflected in learning outcomes. Outcomes also make limited reference to applications, social implications or value aspects of science.

At age 10 there are tests to determine which syllabus students should be placed in for their final years in primary school.

Key competencies:
There is a strong emphasis on the development of key competencies in both 2008 and 2014 curricula related to problem solving, team-work, creativity and critical thinking. The new 2014

curriculum makes explicit links between scientific literacy and 21st century competencies. These are reflected in teaching approaches advocated and the key dimensions of the curriculum, but feature less strongly in assessment criteria.

Secondary: English language

Orientation:
Language teaching in Singapore is sensitive to the fact that English is not the mother tongue of roughly half the population. However, a command of English is seen as fundamental to Singapore's global ambitions, and it is the sole language of instruction from lower secondary onwards. Bilingualism is seen as central to the teaching of language skills, with a strong emphasis on proficiency in English.

In 2005, figures given in the *English Language Curriculum and Pedagogy Review Committee* (ELCPRC) indicate that, at home, 8% of students speak English only; 42% speak mostly English and some mother tongue or other language; 37% speak mostly mother tongue or other language and some English; and 12% hardly or do not use English.

The Singapore education system aims to provide students with a holistic and broad-based education. Given the multi-cultural and multi-racial characteristics of Singapore, the bilingual policy is a key feature of the Singapore education system. Under the bilingual policy, every student learns English, which is the common working language. Students also learn their mother tongue language (Chinese, Malay or Tamil), to help them retain their ethnic identity, culture, heritage and values (Hodge 2012).

In 2005 the ELCPRC undertook a review of the teaching and learning of English in Singapore schools. It stated: "bilingualism is and will remain a cornerstone of our education system. The ability to communicate well in both English and Mother Tongue will remain a key area of focus for us. Our students must have a good grounding in both their Mother Tongue Languages and the English Language. "

Since independence, English has played a key role in nation-building. As a lingua franca, it is the common language that binds the different ethnic groups together. It is also the language of business and diplomacy, of science and technology and will remain so in the foreseeable future.

The English language syllabus identifies three groupings of language skills:

1. listen, read and view critically and with accuracy, understanding and appreciation a wide range of literary and informational/functional texts from print and non-print sources

2. speak, write and represent in internationally acceptable English (StandardEnglish) that is grammatical, fluent, mutually intelligible and appropriate for different purposes, audiences, contexts and cultures

3. understand and use internationally acceptable English (Standard English) grammar and vocabulary accurately and appropriately as well as understand how speakers/writers put words together and use language to communicate meaning and achieve impact. Students learn grammar and vocabulary in explicit, engaging and meaningful ways. They reinforce such understanding in the course of listening to, reading, viewing, speaking, writing and representing different types of texts.

This is an unusual, and challenging, re-grouping of language skills separating, for example, the traditional speaking and listening, reading and writing, and forming a new grouping around interpretation, expression and accuracy. There is a strong, and repeated emphasis on accuracy, natural perhaps in where only 50% of the population have spoken English in the normal course of their lives, but it reflects too an emphasis on functionality, found throughout the curriculum. The reference to "standard English" is also interesting: the language of by far the majority of texts used in examinations is very much the English of the UK; there is no hint of *patois*.

To the three groupings above must be added a consistent emphasis on literature throughout the lower secondary curriculum, which augments the technical language requirement expected at this stage.

Coherence and clarity:
The specified curricula have clear and specific goals, for each grade, and to a lesser extent across each band. The curriculum is expressed very much in anticipated, assessable outcomes. The learning activities suggested are appropriate, but there is no centralized pool of learning resources. Decisions on texts and so forth are devolved to schools and providers. The levels of specificity are demanding in comparative terms.

A new syllabus was introduced in 2010. It delineates the key features of language: language use, learning outcomes, text types and grammar under 10 learning outcomes, and a further six principles of language teaching: contextualization, learning centeredness, learning focused interaction, integration, orientation and spiral progression. These are good examples of the highly codified nature of the syllabus and guidance for teachers:

> In the course of listening, reading and viewing widely a range of multimodal texts and text forms, students will gain a better understanding of our cultural values and National Education themes, and engage in Social and Emotional Learning, where applicable. Students will speak, write and represent for creative, personal, academic and functional purposes by using language in a sustained manner (e.g., in speech and writing) and by representing their ideas in a range of multimodal texts and text forms. Our most able students will do so with increasing ease and inventiveness at higher levels of proficiency.

Scope:
The scope of the curriculum is broad, and organized around the three groupings of listening/reading, speaking/writing and accuracy. Learning outcomes are identified for the full

range of language skills. In all cases expectations appear challenging. For example in the lower secondary curriculum:

> Demonstrate how the use of visual and audio resources, verbal and/or non-verbal cues can add meaning to or enhance the impact of a presentation, provide opportunities for students to plan, organize and deliver appropriately their ideas in a variety of media and forms, such as through the use of posters and planned multimedia and spontaneous presentations, expose students to a variety of spoken texts (for example, conversations, speeches).

This is very specific in its identification of a range of media, and stretching in its insistence on combinations.

The ELCPRC review of 2005 identified what it felt to be weaknesses in speaking and writing. Note the importance given to employers' comments:

> Overall, our students are competent in English, but there is significant scope for improvement in certain areas. Singapore students do fairly well in reading literacy, but standards of oral and written communication are highly uneven. Some employers have observed a decline in oral fluency, writing skills and the ability to communicate with impact.

As a result the committee recommended:

> To improve pronunciation, students will be introduced to pronunciation aids such as the International Phonetic Alphabet and on-line pronunciation software, as part of dictionary skills. Listening and speaking skills will be emphasized by encouraging oral presentations and the use of drama and debates. Building on grammatical concepts learnt in primary school, secondary students will learn more about how grammar works beyond the word and sentence and at the level of paragraphs and whole texts. Students will also be given more exposure to a wide range of text types, including literature, to encourage extensive reading and to stimulate writing.

Reform continued through into the higher levels:

> A new subject, English Language, to be offered at H1 and H2 levels, will be developed and introduced at the pre-university level from 2009. This is to encourage students with a liking and flair for EL to pursue their interest. H1 and H2 EL will encompass the critical study of language and communication to deepen students' understanding, use and appreciation of language in all its aspects. This subject will be …offered as a contrasting subject for students majoring in the Sciences, and will be an additional option for those majoring in the Arts, who may offer it in addition to Literature.

In 2013 the curriculum was further reviewed, noting strengths in mathematics, literacy and science, but expressing concern for the underdevelopment of the softer, employability skills. The curriculum remains under review, with the "teach less learn more policy" trying to move away from rote learning, and more social and functional skills being introduced into the mother tongue curriculum.

With regard to literature, the literature English Teaching Syllabus of 2013 for lower secondary outlines highly stretching and sophisticated learning outcomes and the expected attainment targets to be achieved for all students.

> Demonstrate understanding of how style contributes to the meaning of texts. Lower Secondary Students will study texts from all three literary genres: prose, poetry and drama.

For upper secondary literature becomes elective, with expectations again characteristically very high.

> By the end of Upper Secondary Literature course students will have been formally assessed in the two genres of prose and poetry and on their ability to produce sustained, critical responses to passage-based and essay questions, and questions on the unseen [prose and poetry].

At H level, which is designed only for the most highly achieving pre-university students, the syllabus contains attainment targets that would be regarded as being at undergraduate level in other systems. For example, the very brightest H3 students are also expected to attain the following:

> Learning Outcome 5. H3 students will be able to engage in independent and self-directed research. Some examples of skills they would need to achieve this include the ability to:
>
> - conduct a literature review of a topic of study
> - critically evaluate primary and secondary resources
> - synthesize the information they have evaluated into a research essay.

Levels of demand:
Teachers are given specific guidance on achieving aspirational levels of performance skill, for example:

> The development of language skills and knowledge about language involves the teaching of processes. The teacher will model and scaffold such processes for students, while guiding them to put together their final spoken, written and/or multimodal products. Spiral progression skills, grammatical items, structures and various types of texts will be taught, revised and revisited at increasing levels of difficulty and sophistication. This will allow students to progress from the foundational level to higher levels of language use.

The challenging nature of the Singapore curriculum can, perhaps, best be demonstrated through the requirements for literature. The Curriculum Planning and Development Division of the Ministry of Education requires, from lower secondary, literary selections of prose, poetry and drama, and a sophisticated level of reading from students.

> Through the literary skills of reading and responding critically and personally to literary texts, students actively construct meaning and in the process make connections between the texts, their lives and the world. The study of Literature encourages students to enter imagined worlds and explore, examine, and reflect on both current and timeless issues, as well as their individuality and humanity cultivating a questioning mind; exploring personal and social issues; and interrogating and managing ambiguities and multiple perspectives. Literature also builds in students' socio-cultural sensitivity and awareness, as well as a global outlook.

This assumes a high degree of sophistication and sensitivity of the part of the students, as well as a high degree of technical understanding, succinct but stretching:

- plot: this refers to how events are linked through cause and effect relationships within a text
- character: this refers to representations of a person, with motivations and intellectual, moral and emotional qualities
- setting refers to the time, place, physical details and circumstances in which a situation occurs
- atmosphere refers to the mood or emotional quality of the writing, usually created through the setting
- theme: this refers to the central idea(s) in a text
- style: this refers to the writer's purposeful use of language to achieve certain effects.

The approach to language teaching is both very technical (language change over the past 100 years in spelling, grammar, lexis, meaning, etymology, pronunciation, conventions and style) and very aware of the context in which language is used (terms and concepts related to language variation, regional/social/stylistic variation and change in the English language and how new varieties of English reflect the society they are situated in attitudes to different varieties of the English language).

There is a sense that the choice of English as the language of instruction is being justified in terms of social integration, social aspiration and economic success. Students consider:

- the role of standard English, in particular the place of Singapore Standard English and Singlish in Singapore
- English as a world language
- the impact of new communications technology on the use of the English language

- the influence of culture on language in general
- how language shapes our perspectives in the discourse of different institutions (for example the media, government, academia, business)
- how language is used to produce, reproduce or challenge social values and attitudes
- how texts (through lexis, grammar, semantics and discourse structure) produce representations of identity such as gender, age, social class, ethnicity, nationality, and occupation
- Why and how some groups seek to differentiate themselves through language.

Progression:
Based on the Primary School Leaving Certificate (PLSE), and to some extent planned destinations, students are grouped into three bands for their secondary education. Most English lessons are within band, but there is an element of streaming where particular subject strengths emerge. English is offered both at standard and foundation levels and is a major factor in deciding whether students will go on to Express, Normal (Academic) or Normal (Technical) streams.

Assessment:
N level English is a stretching and demanding examination, every bit as exacting as O level programs in other systems. It is prepared in partnership with the University of Cambridge Examinations Certificate. The composition paper requires firstly an essay in response to sophisticated questions, for example, "What makes a good teacher?" and deals to with economic/social issues of language use, for instance, "What are the advantages and disadvantages of so many tourists visiting Singapore each year?" This is followed by a shorter piece, a specific written task such as a letter, dealing with an emotional issue, such as embarrassment with relatives, or a bad fright in a fairground. The comprehension questions are on two challenging passages, one colorful and descriptive, and the other focused and of a technical or scientific nature. The questions are varied and taxing, including Cloze procedure, open and closed responses, and a question that asks for an extended piece of writing, a digest of an aspect of the passage. Between them the two papers cover a wide range of language use, and the responses will fully evaluate competent language use.

The assessment regime at upper secondary (pre-University) continues to be rigorous and academically demanding. In the case of literature, open book examinations are available, but within strict, prescriptive guidelines. At H2 level:

> There are 4 elective papers available and H2 candidates will choose one. Each paper will be 3 hours long. Candidates will answer 3 questions in each paper. Questions are given equal weighting in the computation of marks for the paper (i.e. 33 ⅓% each). Examinations are open book: candidates will be allowed to bring copies of their set texts into the examination room. Only underlining, highlighting or the use of vertical lines in the margins is permitted. Nothing else should be written in the texts. Any kind of folding or

flagging of pages in texts (for example use of post-its, tape flags or paper clips) is not permitted.

For Language there are equally demanding assessment requirements, with a strong emphasis on linguistic concepts, and how they relate to social and commercial realities. For example English Language and Linguistics H2:

- demonstrate understanding of linguistic concepts, methods and approaches, and apply this understanding to the construction and analysis of meanings in different modes of communication (spoken, written and multimodal)
- analyze and evaluate the influence of contextual and cultural factors in the production and reception of the English language
- demonstrate expertise in the use of English which is informed by linguistic study and using appropriate terminology.

Material will be drawn from areas such as the following: transcriptions of everyday conversations, speeches, and radio interviews; music lyrics; podcasts; tabloid and broadsheet journalism; advertisements; magazines; leaflets; non-fiction books; blogs; diaries; letters; emails; sms/text messaging; articles; biographies; writing for children; press releases and publicity materials; reviews; films; cartoons; computer games; websites.
Texts might incorporate non-standard usage (idiolect, dialect and sociolect).
Transcriptions of speech might include young and adult speech, occupational speech, and speech from different social groups. Scripted speech (i.e. dialogue from drama or similar literary-type texts) will not be used for language variation and change.

Key competencies:
Bilingualism is seen as a fundamental aspect of the wider education system with the English language the medium of instruction for all secondary education. Within the secondary curriculum there is an increasing emphasis on speaking and listening skills, and the use of language in social and economic contexts, particularly with regard to the use of an appropriate register. The linguistic element of the language is emphasized, and strong regard given to technical accuracy. The syllabus of 2010 recognizes that "the development of language skills is not linear, but recursive in nature. Similar language skills need to be revisited and reinforced at increasing levels of complexity as students progress through the levels", emphasizing recent changes in perspective, regarding language use as a skill rather than a body of knowledge.

Secondary: Mathematics

The curriculum is under review on a rolling basis. This report draws on the new syllabus for the first year of secondary school (Secondary 1), introduced in 2013, but the previous version for Secondary 2-4. Comparison of both versions of the Secondary 1 syllabus suggest that the scope and demand of the content remain much the same but the new syllabus includes an emphasis on real world problem solving and provides exemplification of the types of experiential

opportunities that students should have in order to learn the content. The orientation section has been completed with reference to the new version.

Orientation:
The rationale for the place of mathematics in the curriculum sees mathematics as a vehicle for the development of general intellectual competences as well as specifically mathematical skills. The role of mathematics in everyday, scientific, technological and economic activity is highlighted and high quality mathematics education is prioritized in order to develop an "increasingly competitive workforce." The value of mathematics to national development is accompanied by recognition of the opportunities for students to experience personal creativity and enjoyment.

Aims are defined for the mathematics curriculum in ways that reflect the differentiated provision for students at different levels of attainment. However, for all groups of students, studying the subject aims to enable students:

- to acquire skills and concepts that will support learning of mathematics and other subjects in the next phase of education (and, for those not expected to continue education, activities in everyday life and employment)
- to develop thinking, reasoning and communication skills and ability to apply mathematics
- to connect mathematics to other subject areas and applications.

For higher attaining groups of students, including those choosing to study at higher levels, it aims to enable them to appreciate the nature of mathematics as a discipline, while for lower attaining students, it aims to develop their confidence and appreciation of the usefulness of mathematics.

Problem solving is identified as a central focus of the mathematics curriculum across all age groups. This is understood to involve affective and metacognitive competences as well as mathematical skills, concepts and processes.

Mathematical Problem Solving				
Attitudes:	**Metacognition**:	**Processes**:	**Concepts**:	**Skills**:
Beliefs Interest Appreciation Confidence Perseverance	Monitoring one's own thinking Self regulation of learning	Reasoning communication & connections Applications & modelling Thinking skills & heuristics	Numerical Algebraical Geometrical Statistical Probabilistic Analytical	Numerical calculation Algebraical manipulation Sopatical visualization Data analysis Measurement

				Estimation Use of mathematical tools

Adapted from the Secondary Mathematics Syllabuses, MOE 2006

The stated intention of this description of the curriculum framework is to support teachers to provide a learning environment that is engaging, student-centered and technology enabled, promoting diversity and creativity in learning.

A vision of teaching and learning is presented that emphasizes the importance of focusing on understanding, not just recall of facts and procedures. Teaching is expected to build on students' prior knowledge and engage with their interests. A cycle of learning is described as "readiness-engagement-mastery", with a range of pedagogic strategies identified as essential for each phase of the cycle, including formative assessment and both teacher- and student-led activities. Specific mention is made of the role that ICT can play in developing understanding and problem solving through visualization, simulation, exploration and experimentation.

Coherence and clarity:
A separate curriculum is specified for each of the three levels of course in secondary school. Mathematics is a compulsory subject for all students across the four years of secondary school. Additional Mathematics is offered as an optional subject for students in Secondary 3 and Secondary 4 in the O level and Normal (Academic) courses. For post-GCE students (aged 16/17 – 19/20) there are two- or three- year courses leading to A level qualifications, offered at three levels.

The content for the four years of secondary school is clearly specified in separate syllabi for years Secondary 1 and Secondary 2 and a combined syllabus for Secondary 3 and Secondary 4 within each of the three levels of course. The structure is similar across years and levels, with minor adjustments to take into account the variation in scope of the content.

The learning experiences suggested in the new version syllabus for Secondary 1 are consistent with the content and seem coherent with the curricular orientation described above, including opportunities that seem designed to develop conceptual understanding, to make connections within mathematics and with the real world, to take advantage of the affordances of ICT and to engage in problem solving. Thus, for example, in the number and algebra content strand, proposed learning experiences include opportunities such as: collecting and discussing examples of use percentages, rates, etc. from real world sources; discussing misconceptions; working in groups to select and justify equivalent expressions; using technologies such as spreadsheets or the AlgeTools package to explore concepts and to make sense of, interpret and solve problems using algebraic representations.

Scope:

The syllabus for the higher two levels of secondary school (Ordinary and Normal Academic) is divided into three content strands: number and; geometry and measurement, statistics and probability. There is also a process strand, mathematical processes, that lists processes that cut across the three content strands. The syllabus for the lowest level (Normal Technical) has an additional context strand: real world contexts. The process strand cuts across this context strand as well as the three content strands.

Within the mathematical processes strand, three areas are identified and characterized: reasoning, communication and connections; applications and modeling; thinking skills and heuristics. The detailed descriptors of these areas are the same for the upper two levels, with a minor adaptation for the lowest level, reducing the extent to which students are expected to engage fully with the concepts and processes of mathematical modeling.

At upper (post) secondary level (ages 16/17 – 18/19/20/21), study of mathematics is non-compulsory. Here there are three syllabuses designed for students with different lower secondary experience and different post-secondary trajectories: H1 is described as building on the Ordinary level syllabus and intended for students intending to study business studies and social sciences; H2 assumes some of the additional mathematics syllabus and is intended for those continuing to study science subjects; H3 extends the H2 syllabus and is intended for those seen as specialists in mathematics.

The H1 syllabus focuses on statistics, introducing further algebra and calculus topics that are required to support the statistics content. More theoretical aspects of both pure mathematics and statistics (e.g. differentiation from first principles, definite integral as limit of a sum, derivation of statistical formulae) are explicitly excluded. This is consistent with the aim to equip students with skills for data analysis and interpretation and informed decision-making rather than to prepare them for further study of mathematical topics.

The H2 syllabus covers the same statistical content as the H1 syllabus with a few additions (including permutations and combinations, Poisson distributions, logarithmic transformation) but covers substantially more pure mathematics, including the more theoretical aspects excluded from H1. Additional topics include complex numbers, vector geometry, three-dimensional coordinate geometry, Maclaurin's series, and differential equations.

Levels of demand:
The curriculum at lower secondary level (aged 12-15/16) is organized into separate syllabuses that provide differentiated pathways for students with different levels of attainment and, in the upper years, interest in mathematics. In common with the rest of the curriculum, students are allocated to three levels and syllabuses are defined for each level (Ordinary, Normal (Academic) and Normal (Technical)), leading to GCE examinations at O level, N(A) and N(T) level. These syllabuses build on the two differentiated syllabuses (standard and foundation) in the final years of primary school. There is some flexibility to allow movement between the levels and to allow higher attaining students in the lower levels to enter for examination at higher levels, in some cases taking an extra year of study to do so for those with particular interest in mathematics, an

optional additional mathematics syllabus is available in the upper years; again this is differentiated into O and N(A) level courses.

There is strong similarity in the content for the higher two levels, the main difference being that some topics or complexities studied by the O level students are not encountered until the following year by the N(A) level students. For example, "solving simple fractional equations that can be reduced to linear equations", studied in Secondary 1 by students in the O level course is deferred to Secondary 2 for their N(A) peers. This parallel but slightly slower progress through a similar curriculum is consistent with the flexibility in the system that allows students in the N(A) course to study for one further year in order to take the GCE(O) examination. The N(T) course has substantially reduced content, developing core aspects such as solution of equations more slowly and to a less advanced level (omitting solution of quadratics by completing the square) and omitting some areas of content completely (e.g. set notation, coordinate geometry, vector geometry). The areas omitted seem to be those that are likely to have less immediate application to real world contexts for students studying at this level.

Whereas the programs of study for O and N(A) level emphasize the importance of developing conceptual understanding, communication, confidence and interest in mathematics, the program of study for the lowest attaining students, N(T) level, emphasizes that students should have opportunities to learn through "meaningful real-world contexts" and "practical hands-on experiences (including use of concrete manipulatives etc.)" as well as "leveraging ICT." This suggests a very different vision of the needs and aspirations of this group of students and less likelihood of transferring successfully from the N(T) to a higher level course. The content is reduced compared to that for higher streams. Nevertheless, it still includes considerable algebra, including manipulation of quadratic expressions and equations, and other relatively abstract and formal topics such as trigonometry. One suspects that lower attaining students at N(T) level will experience these topics with little conceptual understanding or appreciation.

The syllabi for the O and N(A) courses assume a high level of computational competence with rational numbers in the first year of secondary school (Secondary 1, aged 12/13). This underpins the extensive and demanding algebraic content. In Secondary 1, O level students learn to manipulate linear expressions and solve linear equations. In Secondary 2, they manipulate quadratic expressions, including expressions involving fractions with quadratic denominators, and solve quadratic equations by factorization. In Secondary 3 and Secondary 4, solution of quadratic equations is extended to use of the formula, completing the square and graphical methods. For students in the N(A) course, progress is somewhat slower. However, a similar end-point is expected, only graphical solution methods being reserved to the optional section of the examination. For students in the N(T) course, completing the square and graphical methods are excluded. The expected end point for higher attaining 16 year-olds is similar to that in many other jurisdictions, although it seems a very high proportion of the population is expected to aspire to this level. This end point is underpinned by an unusually demanding algebraic content in Secondary 1 and Secondary 2, the early years of secondary school.

The advanced level syllabus H1, for students intending to progress to business studies and social sciences introduces students to basic techniques of calculus and statistics, including hypothesis testing. Given the strong foundation in algebra provided in years Secondary 1 – Secondary 4 for those following the O syllabus, this seems achievable for those who have been successful at that level. The H2 syllabus assumes content of the additional O syllabus, which was optional in years Secondary 3 and Secondary 4, and is for students intending to study science subjects. This is a demanding syllabus, covering topics that, in other jurisdictions, are likely to be studied only by those intending to specialize in mathematics at university level or that are not encountered until the first year of university.

Progression:
Within each strand of the syllabus for each grade level, the content is organized into sub-topics. There is considerable continuity in the sub-topics between grade levels, with evident progression within sub-topics. The organization of the content is in accordance with the logical hierarchies of mathematics, though explicit links are not made across sub-topics. For example, in Secondary 2 (O level) the number and algebra strand includes a sub-topic ratio, rate and proportion that would provide necessary concepts and techniques for learning the sub-topic congruence and similarity (alternatively, the sub-topic congruence and similarity could provide opportunities for developing and reinforcing the concepts and skills required for learning about ratio, rate and proportion) but it is left to teachers (or the producers of learning materials) to make connections and draw students' attention to the coherence of mathematics as a discipline.

Assessment:
The program of study includes a discussion of the importance of integrating formative assessment with instruction and a few suggestions of approaches to classroom assessment. This discussion is, however, only at a general level and no exemplification is provided of formative assessment practices within specific areas of mathematical learning.

At age 16, the O, N(A) and N(T) courses are assessed by externally set national examinations, as are the optional O and N(A) additional mathematics courses and the post-16 advanced level courses. The content of these examinations is well aligned with the content listed in the syllabi for each level. The examinations use open-response questions of various lengths. More substantial questions tend to be divided into sub-tasks that guide students through the problem solving process. This means that most sub-tasks demand only that students recall and apply a single procedure and there is little expectation that students will analyze complex problems. A high proportion of questions involve no context outside mathematics itself. In those questions that do involve a non-mathematical context, the choice of what mathematics to use is either routine application to very familiar situations or is signaled very clearly. This means that, in spite of the value accorded to modeling in the programs of study, the end of course examinations do not assess important parts of the modeling process.

Key competencies:
The curriculum documents identify problem solving as being at the core of the curriculum, encompassing attitudes, metacognition and processes such as communication and thinking

skills as well as mathematical skills and concepts. The exemplification provided in the recently revised program of study for S1 indicates some possible opportunities for developing these competences but this is not extensive or explicitly referenced. The main focus of teaching is likely to be driven primarily by the list of mathematical content.

Secondary Science

At the upper secondary levels, students in the express course offer a particular science subject either as a 'pure' subject or a 'combined science' subject. Students in the N(A) course will offer either one of the N(A) syllabuses and students in the N(T) course are given the option to offer the N(T) Science syllabus. Students from the N(A) course who satisfy the requirements will go for a fifth year of study and sit for the corresponding O-level 'combined science' syllabus.

Secondary Science examinations

N Level:
The structure of the examination is that students take four of six papers:

- science (physics, chemistry) papers 1, 2, 3, 4
- science (physics, biology) papers 1, 2, 5, 6
- science (chemistry, biology) papers 3, 4, 5, 6.

- papers 1, 3, and 5 (20 marks) consists of 20 compulsory multiple choice questions.
- paper 2, 4, and 6 (30 marks) each papers consisting of two sections. Section A contains 14 marks and including a small number of compulsory structured questions; Section B contains 16 marks including three structured questions. Candidates must answer only two out of these three questions.

All papers are taken in one sitting of 1 hour 15 minutes long and weighted 50%. Knowledge and understanding questions make up approximately 50% of the marks of which approximately 20% is allocated to recall. Handling information and solving problems make up approximately 50% of the marks.

O Level:
The structure of the pure science examination is[6]:

- paper 1 (1 h, 40 marks) consisting of 40 compulsory multiple choice items and weighted 30%
- paper 2 (1 h 45 min, 80 marks) consisting of two sections. It is weighted 50%. Section A contains 50 marks and consists of a variable number of compulsory structured questions; section B carries 30 marks and consist of three free-response questions, two

[6] There is a different structure for the GCE O-level combined science 5076 and 5077

of which are compulsory with one being a data-based question the requires candidates to interpret, evaluate or solve problems
- paper 3 (96 marks) School-based Science Practical Assessment (SPA) weighted 20%. The assessment of science practical skills is grouped into three skill sets: performing and observing; analyzing; and planning.

Knowledge with understanding is weighted at approximately 45% of the marks; handling information and solving problems, approximately 55% of the marks. For paper 3 experimental skills and investigations are 100% of the marks.

Secondary Science syllabus Normal (Technical) pathway:
The syllabus states that the lower secondary school-based assessment should have the recommended weighting of 50-70% written tests and 30-50% performance based assessment.

For the upper secondary examination, the structure is:

- paper 1, 1 hour. A paper consisting of 40 compulsory multiple choice questions and weighted 40%
- paper 2, 1hour 15 min. A paper consisting of a variable number of compulsory short-answer or structured questions and weighted 60%. One of the questions is a data response question which carries 8-12 marks, requiring candidates to interpret, evaluate or solve problems using data and/or observations.

The weighting of assessment objectives is means that knowledge with understanding is weighted at approximately 60% of the marks (one third of which is recall) and handling and applying information 40%.

Secondary: Earth Science

There is no separate earth science curriculum. Earth science is contained within geography and science. Earth science is almost entirely within geography – see the geography analysis below. The science curriculum contains very little earth science, the only aspect being the study of ecosystems prescribed within the science lower and upper secondary academic curriculum.

Secondary: Biology

Orientation:
The core curriculum for all secondary school students includes science. The *Science Curriculum Framework* is derived from the *Policy Framework for the Teaching and Learning of Science*. Central to the curriculum framework is the development of the spirit of scientific inquiry. The conduct of inquiry is founded on three integral domains of (a) knowledge, understanding and application, (b) skills and processes and (c) ethics and attitudes. These domains are seen as essential to the practice of science.

Two syllabi form the core of the *Science Curriculum Framework*, one for the lower secondary Express /Normal (Academic) pathway and the other for the secondary science Normal (Technical) pathway.

The aims of the lower secondary science syllabus (as part of the Express /Normal (Academic pathway) are to:

- cultivate students' perception of science as a collective effort and a way of thinking rather than just a body of facts
- engage students in science -related issues that concern their lives, the society and the environment
- help students develop the domains that are integral to the conduct of science inquiry.

Biology is taught as an integral part of the knowledge of science. This leads on to the suite of N and O level syllabi. The aims for biology as part of the suite of O level syllabi are the same for both the N and O level syllabi, to:

1. provide, through well-designed studies of experimental and practical biology, a worthwhile educational experience for all students, whether or not they go on to study science beyond this level and, in particular, to enable them to acquire sufficient understanding and knowledge to:

    1.1. become confident citizens in a technological world, able to take or develop an informed interest in matters of scientific importance
    1.2. recognize the usefulness, and limitations, of the scientific method and to appreciate its applicability in other disciplines and in everyday life
    1.3. be suitably prepared for studies beyond Ordinary Level in biology, in applied sciences or in science related courses.

2. develop abilities and skills that:

    2.1. are relevant to the study and practice of science
    2.2. are useful in everyday life
    2.3. encourage efficient and safe practice
    2.4. encourage effective communication.

3. develop attitudes relevant to science such as:

    3.1. concern for accuracy and precision
    3.2. objectivity
    3.3. integrity
    3.4. inquiry

3.5. initiative
3.6. inventiveness.

4. stimulate interest in and care for the local and global environment

5. promote an awareness that:

5.1. the study and practice of science are co-operative and cumulative activities, and are subject to social, economic, technological, ethical and cultural influences and limitations
5.2. the applications of science may be both beneficial and detrimental to the individual, the community and the environment
5.3. science transcends national boundaries and that the language of science, correctly and rigorously applied, is universal
5.4. the use of information technology is important for communications, as an aid to experiments and as a tool for the interpretation of experimental and theoretical results.

The aims of the lower secondary science syllabus (as part of the secondary science Normal (Technical) Syllabus) are given as to:

(i) guide students in acquiring knowledge with understanding for application in their daily lives such that they:

- are motivated to learn science through contextual and hands-on learning
- are able to problem-solve and use thinking and inquiry processes
- can communicate effectively
- develop safety consciousness and safe practice
- become confident citizens who are able to cope with the changing and progressive nature of science and technology in the world.

(ii) enable students to develop 21st century competencies which would:

- enable them to acquire problem-solving skills and use thinking and inquiry processes
- enable them to become responsible individuals and productive citizens
- enable them to acquire life-long learning skills
- enable them to show care and concern for people and the environment
- allow them to use information communications technology (ICT) for communications, collaboration and as a tool for data collection and the analysis of results.

(iii) enable students to be suitably prepared for post-secondary courses, such that they:

- develop abilities and skills which would also be relevant and useful in the work place
- become aware of the impact of science and technology on society, industry, and business.

The subject matter is structured into six core modules in the syllabus. They are *Gadgets Work Wonders* (I), *Matter Around Us* and *Wonders of My Body* (I) at lower secondary, and *Gadgets Work Wonders* (II), *Food Matters*, and *Wonders of My Body* (II) at upper secondary. Three of the six modules pertain to biology, although they are not referred to as such.

There is a range of post-secondary education opportunities which can include A levels.

Coherence and clarity:
Two different pathways provide clear specific goals and guidance covering content, skills and processes, and ethics and attitudes.

Lower Secondary Science syllabus Express /Normal (Academic) pathway
The syllabus is based on the *Science Curriculum Framework* and emphasizes the need for a balance between the acquisition of science knowledge, skills and attitudes. The syllabus provides information on the following key areas:

1. knowledge with understanding and application
2. skills and processes
3. ethics and attitudes.

Knowledge with understanding and application is divided into four themes:

1. diversity
2. models
3. systems
4. interactions.

The first and last two themes are similar to those found in primary science.

The aim is to enable students to appreciate the links between different themes/topics and thus allow the integration of scientific ideas. Knowledge about science is highlighted in an introductory topic, the scientific endeavor, which builds on the students' learning of primary science as a way of exploring and understanding the physical and natural world.

For example, under the theme: *Systems*, one of the three biology-related topics, is:

Human digestive system:

- explain the importance of the digestive system
- identify the main parts of a digestive system and how they work together to perform a function
- describe how a digestive system helps in digestion of food and the part played by enzymes indigestion.

The content (including skills and attitudes) is designed for 85% of the curriculum time, leaving 15% time (called white space) to enable teachers to use more engaging teaching and learning approaches. To help teachers and students appreciate and understand the introductory topic and themes, *Essential Takeaways* and *Key Inquiry Questions* are included for each of them. The *Essential Takeaways* articulates the big ideas while the *Key Inquiry Questions* guide the teachers and engage the students in uncovering the important ideas at the heart of the introduction/theme.

A range of skills and processes are defined, including posing questions, formulating hypothesis, analyzing, and evaluating. All the skills and processes are seen as part of the total process of scientific inquiry. Examples of the exemplification of these include:

- posing questions: this is the skill involving the clarification of issues and meaning through inquiry. Good questions focus attention on important information and are designed to generate new information
- formulating hypotheses: this is the skill of making a general explanation for a related set of observations or events. It is an extension of inferring.

Processes are defined as complex operations which call upon the use of several skills. The processes are:

- creative problem-solving
- planning investigation
- decision-making.

For example, creative problem-solving is defined as: the process of thinking through a problem and generating and applying criteria to select an innovative solution that meets the requirements.

A range of ethics and attitudes are defined including:

- creativity: this is the attitude of seeking innovative and relevant ways to solve problems
- objectivity: this is the attitude of seeking data and information to validate observations and explanations objectively
- integrity: this is the attitude of handling and communicating data and information with integrity.

The syllabus makes it clear that each of the skills, processes, ethics and attitudes should be taught explicitly through the use of appropriate activities, and effort should be made to help students integrate some or all of the skills in scientific inquiry.

Upper Secondary Science syllabus (Express /Normal (Academic) pathway:
This is based upon the N and O level syllabi examined by Cambridge Assessment (UCLES) Singapore.

The N level allows students to be examined in combinations of pairs of physics, chemistry and biology. The N level can form the basis, after a further year's study, of the O Level.

The biology component covers the following sections:

1. principles of biology
2. maintenance and regulation of life processes
3. continuity of life.

The content is clearly defined as a set of learning outcomes, for example, for the topics of diffusion and osmosis:
Candidates should be able to:

a. define diffusion and describe its role in nutrient uptake and gaseous exchange in plants and humans
b. define osmosis and describe the effects of osmosis on plant and animal tissues.

The O level syllabus for combined science follows the same pattern and clarity, with an additional topic, man and his environment with a more detailed study of all four topics extending the N level.

Secondary Science syllabus Normal (Technical) pathway:
The syllabus is based on the *Science Curriculum Framework* and emphasizes the need for a balance between the acquisition of science knowledge, skills and attitudes. The syllabus provides information on the following key areas:

- knowledge with understanding and application
- skills and processes
- ethics and attitudes.

Knowledge with understanding and application is structured into six core modules. They are *Gadgets Work Wonders* (I), *Matter Around Us* and *Wonders of My Body* (I) at lower secondary, and *Gadgets Work Wonders* (II), *Food Matters*, and *Wonders of My Body* (II) at upper secondary.

The contexts within the modules provide a strong link to facilitate learning of the fundamental science concepts and to understand their applications in authentic, real life situations.
For example: *Module 3: Wonders of My Body* (I) contains detail of content:

Cells: basic units of life:

- state that all living things are made of cells, which are the basic units of life
- recognize that genes are found within the nucleus of a cell that control the traits of human and are passed from parents to children
- explain that the body can function efficiently by having different types of cells performing specific functions (bone cells, red blood cells, and muscle cells).

The content is linked to Key Inquiry Questions, for example, what are the building blocks of living things? These questions provide an overarching frame to guide instruction and learning of the important science concepts and process skills. The content (including skills and attitudes) is designed for 80% of the curriculum time, leaving 20% time (white space) to enable teachers to use more engaging teaching and learning approaches.

Skills and processes, ethics and attitudes are similar to those for the lower secondary science syllabus express / normal (Academic) pathway.

Together, these components provide clear guidance to teachers as to how the different learning outcomes should be incorporated into the learning and teaching environment at a level that is appropriate to that grade regardless of the pathway

Scope:

The Secondary science syllabi are described as essentially a continuation and further development of the primary science syllabus.

Secondary Science syllabus Express /Normal (Academic) pathway:

The lower secondary syllabus comprises four themes which are diversity, models, systems, and interactions. Biological knowledge is integral within these themes. N level has separate biological themes; principles of biology, maintenance and regulation of life processes, and continuity of life. O level adds an additional theme, that of man and his environment. In terms of biology, there is a clear progression in terms of both breadth and depth through secondary science. At the lower grades, there is sufficient breadth across biology, but much less depth. At O level there is a similar range of breadth, but a much deeper study.

For example, at lower secondary students should be able to show an understanding of the functions of the different parts of a typical cell, including the nucleus which contains genetic material that determines heredity. At O level they should be able to identify cell structures (including organelles) of typical plant and animal cells from diagrams, photomicrographs and as seen under the light microscope, including chloroplasts, cell surface membrane, cell wall, cytoplasm, cell vacuoles , nucleus, endoplasmic reticulum, mitochondria, Golgi body and ribosomes, and be able to state the functions of the membrane systems and organelles.

The pathway is quite content driven and could be viewed as somewhat traditional, for example, in emphasis on human biology.

Each learning outcome is prefaced by a command word. These appear to be based on Bloom's taxonomy. The command words give a clear indication of the depth to which each learning standard should be taught.

Secondary Science syllabus Normal (Technical) pathway:
The secondary syllabus comprises six core modules. They are *Gadgets Work Wonders (I), Matter Around Us* and *Wonders of My Body* (I) at lower secondary, and *Gadgets Work Wonders (II), Food Matters,* and *Wonders of My Body* (II) at upper secondary. The biological content is separate within these modules. Each module is very much context driven, providing an approach that places the learning of academic content (scientific knowledge and skills) in situations or issues (contexts) that are authentic and meaningful to the learners.

The modules at upper secondary follow on from, and build on, the modules from lower secondary. There is also an increase in depth from lower secondary to upper secondary.

Levels of demand:
The level of demand is appropriate for these courses in biology. This is illustrated by the way many learning outcomes build on from previous grades, and within the themes or modules.

For example, at lower secondary science (Academic), in the theme *Systems*, there are these learning outcomes:

Human digestive system:

- explain the importance of the digestive system
- identify the main parts of a digestive system and how they work together to perform a function
- describe how a digestive system helps in digestion of food and the part played by enzymes indigestion.

At O level, students are expected to describe:

- the functions of main regions of the alimentary canal and the associated organs: mouth, salivary glands, esophagus, stomach, duodenum, pancreas, gall bladder, liver, ileum, colon, rectum, anus, in relation to ingestion, digestion, absorption, assimilation and egestion of food, as appropriate
- peristalsis in terms of rhythmic wave-like contractions of the muscles to mix and propel the contents of the alimentary canal
- the functions of enzymes (for example amylase, maltase, protease, lipase) in digestion, listing the substrates and end-products the structure of a villus and its role, including the role of capillaries and lacteals in absorption.

The same examples emphasize how there is an increase in demand within the related learning outcomes at different grades.

Similar examples can be seen in the secondary (Technical) pathway.

It is interesting that even at O level there are fewer learning outcomes requiring an explanation and other higher order processes than might be expected, although there are requirements for students to “explain”, “differentiate”, “compare” and “discuss.”

Progression:
The secondary science syllabi indicate that teachers should use inquiry-based learning for the both the Academic and the Technical pathways and the guidance is identical in both. The syllabi states that inquiry-based learning may be characterized by the degree of responsibility students have in posing and responding to questions, designing investigations, and evaluating and communicating their learning (student-directed inquiry) compared to the degree of responsibility the teacher takes (teacher-guided inquiry). Guidance is provided as to how progression in the essential skills can be developed.

For example: explanation is seen as an essential feature of science as inquiry. The progression suggested is that students construct explanations when they:

- are provided with evidence
- are given possible ways to use evidence to formulate explanation
- are guided in process of formulating explanation from evidence
- formulate their own explanation after summarizing evidence.

There is no explicit progression in the learning outcomes, knowledge and understanding, although the documents do make it clear that each stage in the science framework builds upon the previous in terms of content, skills and processes.

Assessment:
The secondary science syllabi indicate that teachers should assess inquiry-based learning for the both the Academic and the Technical pathways. It is suggested that both formative and summative assessment should be used to provide a complete picture of the students’ performance and progress, and the effectiveness of the teaching and learning process. It states that assessment should provide feedback to students, allowing them to understand their strengths and weaknesses.

In addition to written tests, teachers can also conduct performance based assessment, for example, portfolios, practical work, projects, teacher observations, checklists, reflections / journals, and model-making, amongst other forms.

Key competencies:

The secondary science syllabi state that that teachers should use inquiry-based learning for the both the Academic and the Technical pathways. Inquiry-based learning is founded on three integral domains of (a) knowledge, understanding and application, (b) skills and processes and (c) ethics and attitudes. Integral with these are the higher level processes of creative problem solving, planning investigation, and decision-making. The N and O level syllabi both contain problem solving in their assessment objectives.

Secondary: Chemistry

Orientation:
The O and A level (H1 and H2) chemistry syllabi have similar rationales and aims. Notably, each of the syllabi is "designed to place less emphasis on factual materials and greater emphasis on the understanding and application of scientific concepts and principles." The rationale for this approach is to try to ensure that students develop skills that are of "long-term value in an increasingly technological world." Wide-ranging aims relating to knowledge with understanding, abilities and skills, attitudes and awareness in each of the syllabi are consistent with this rationale. The A level syllabi introduce some additional aims, reflecting the higher level of study. These aims include presenting information and ideas appropriately for different audiences and purposes, and developing self-motivation and working independently. Arguably these aims would also be valued in O level chemistry.

The rationales and aims of the N level (Express/Normal Academic or Technical) syllabi are similar to the O and A level syllabi, emphasizing outcomes relating to knowledge, understanding and application, skills and processes, ethics and attitudes that have a "direct bearing on the daily lives of the students." The N Level (Technical) syllabus was developed for 2014 and incorporates a 21st century competencies framework that is absent from the N level (Express/Normal Academic) syllabus developed for 2008 and incorporated in the syllabus developed for 2013 but absent from the other syllabus developed for 2014 – the A level H2 syllabus. Outwardly, the N Level syllabi therefore have a stronger emphasis on cross-curricular competencies than the O and A level syllabi.

Coherence and clarity:
The O and A level syllabi detail the assessment objectives, assessment methods and subject content. The subject content is organized in two parts for each topic, with content summarizing each topic and learning outcomes specifying what examination candidates should be able to do. The syllabi also summarize key quantities and units and mathematical requirements, and also provide a glossary of terms, a data booklet and, at least in the H2 syllabus, a list of textbooks. Taken together, this results in clear and coherent syllabus documents. It is notable that the documents do not suggest learning activities, and this perhaps reflects their status as syllabi rather than curricula (though not all curricula necessarily suggest activities). Rather, textbooks presumably take on the role of setting out learning activities.

In contrast to the O and A level syllabi, the N level syllabi set out not only syllabus content but also an approach to teaching and learning that emphasizes inquiry. Despite their label, therefore, they appear closer to curricula than syllabi. In addition to inquiry, the more recent N level (Technical) syllabus also emphasizes applied contexts (mentioning the PISA survey) and the use of ICT (with an emphasis on pedagogy rather than on applications in science).

The content of the N level syllabi is organized in several parts for each module/theme. An introduction/overview, key inquiry questions and sets of learning outcomes are common to both syllabi. Learning outcomes are organized in three columns, headed knowledge, understanding and application, skills and processes, ethics and attitudes. This organization of content reflects the overall rationales and aims of the courses. However, it appears fragmented and may need to be reconciled in order to plan an activity. Indeed, the upper secondary content of the N level (Technical) syllabus merges the knowledge, understanding and application and skills and processes content (but not the ethics and attitudes content). The N level (Technical) syllabus differs from the N level Express/Normal (Academic) syllabus in describing topics and suggesting lesson ideas alongside this content, meaning that this newer syllabus may be of more immediate utility for teachers. The N level Express/Normal (Academic) syllabus developed for 2013 differs from the earlier syllabus in incorporating three *essential takeaways* such as, for the models theme, "models are simplified representations of phenomena."

Scope:
The content of the N level Express/Normal (Academic) syllabus for lower secondary level comprises six themes with a cross-cutting approach to the three sciences. The chemistry content is distributed across a handful of themes in topics on the diversity of matter, models of cells and matter and interaction of forces and energy. Other themes, relating to science and technology and measurement, appear intended to establish the relevance of science to students and to provide an initial grounding in scientific enquiry that lays the basis for subsequent themes. Instead of science and technology, the syllabus developed for 2013 refers to the scientific endeavor. This content introduces students to the discipline of science but is more detailed and sophisticated in the version for 2013.

The content of the N level (Technical) syllabus comprises three modules at lower secondary level and three modules at upper secondary level. The chemistry content at lower secondary level is a module on *Matter Around Us* with topics on *Properties of Matter, Water, Solutions and Suspensions, Water Pollution*; and, *Air Pollution*. At upper secondary level, this module progresses to a particular focus on *Food Matters* with topics on *Sources of Food, Food Chemistry* and *Food Health Safety*. The scope of the content appears to reflect a particular emphasis on daily lives.

The content of the O level chemistry syllabus comprises six sections: experimental chemistry, atomic structure and stoichiometry, chemistry of reactions, periodicity, atmosphere, and organic chemistry. Chemistry of reactions comprises several topics, which include: electrolysis, energy from chemicals, chemical reactions, and acids, bases and salts. Several topics incorporate sub-

topics, such as chemical reactions, which comprises speed of reaction (with six learning outcomes) and redox (with four learning outcomes).

The A level H1 and H2 syllabi incorporate nine similar topics: physical chemistry, redox reactions in H1 or more breadth and depth through electrochemistry in H2, atomic structure, chemical bonding, chemical energetics, equilibria, reaction kinetics, inorganic chemistry and organic chemistry. The H2 syllabus incorporates a separate topic on *The Gaseous State* and other topics include many more learning outcomes in a number of additional sub-topics (for example three additional sub-topics for inorganic chemistry, each with between four and 12 additional learning outcomes), exploring chemistry in more breadth and depth than in H1.

Demand and progression:
The N, O and A level structure means that relatively little differentiation is required in any single course. Nonetheless, the level of demand appears to increase sequentially within courses and between the courses on each pathway. At N level Express/Normal (Academic), subsequent themes build on initial themes on the scientific endeavor and measurement. At N level (Technical), *Food Matters* at upper secondary level builds on *Matter Around Us* at lower secondary level. A level topics revisit O level topics to extend their breadth and depth, and introduce new topics, in H1 and particularly so in H2 (for example electrolysis at O level, redox in H1 and electrochemistry in H2).

Assessment:
At O and A level, assessment objectives for each syllabi are specified in terms of knowledge with understanding, handling information (plus applying and evaluating information at A level) and experimental skills and investigations (at O level and A level in H2 but not in H1). The approach is generally consistent with the syllabi rationales, aims, contents and assessment methods (practical assessments are limited to O level and to A level in H2). However, while the H1 rationale emphasizes the importance of experimental work, this is omitted from the scheme of assessment without explanation.

As per the O and A level syllabi, the recent N level (Technical) syllabus similarly sets out assessment objectives in terms of knowledge with understanding, handling and applying information and experimental skills and investigation. Assessment methods for summative purposes are limited to written tests but a wide range of methods are encouraged for formative purposes. Guidelines for this school-based assessment recommend 50-70% written tests and 30-50% performance-based assessments.

The lower secondary N level (Academic) syllabus states that its assessment objectives are aligned to its structure and content but no assessment objectives are actually detailed in the document. Furthermore, although the syllabus encourages a wide range of assessment methods for formative purposes, it does not provide details of any assessments for summative purposes. Perhaps surprisingly, this remains the case in the syllabus for 2013. The syllabus for 2013 states that formative assessment should be weighted as 60-70% from written tests and

30-40% from performance-based assessments, thus placing slightly more emphasis on written tests than the Technical syllabus.

Key competencies:
The 21st century competencies framework in the recent N level (Technical) and Express/Normal (Academic) syllabi comprises various core values and social and emotional competencies. These values and competencies are defined and presumably informed the development of the syllabi content but there are no explicit links with other sections of syllabus. In the Technical syllabus, the limiting of summative assessment methods to written tests with multiple choice questions (40%) and short-answer or structured questions (60%) suggests that these competencies may only be assessed to a limited extent and therefore perhaps only developed incidentally. The framework is not incorporated in the O or A level syllabi but all of the syllabi do list and define various skills and processes and ethics and attitudes. There are clear connections between the intended learning outcomes expressed in these lists and the organization of the syllabi content. Potential links to formative or summative assessments are generally not, however, made explicit in the documents.

Secondary: Physics

Orientation:
The education system has eight general outcomes for the primary, secondary and post secondary phases; these are general outcomes aimed to establish a common purpose and drive policies, but none of these are science or physics specific. The aims of the different routes are similar and wide ranging, covering knowledge and understanding, skills and processes, ethics and attitudes, but are expressed in slightly different language. For example Technical N level includes "knowledge and understanding for everyday life" while O level includes science for citizens. The highly differentiated system puts a premium on success in tests and examinations, so an important implicit aim is to cover the curriculum as assessed.

Coherence and clarity:
The different routes through secondary schools provide challenges to coherence and clarity. Each route is fully documented at each of the two or three year stages from ages 12 to 18. Assessment objectives are presented for each level and the methods and purposes of assessment are described. There is guidance on a range of issues including learning through inquiry, contextualized learning and ICT. There are glossaries of terms, particularly those used in assessments and at O level lists of mathematical requirements and quantities, as well as practical work guidelines. All of this, together with the full details of content, provides a high level of clarity within each course. The coherence of the complex system is harder to comprehend, though schools presumably develop a familiarity with the progression through the alternative routes. Some of the alternatives appear to introduce discontinuities, which will be reviewed below.

Scope:
The different routes result in a complex picture of scope, but in general this is wide and detailed.

The four-year Normal Technical N(T) science has a motivational flavor with the physics coverage in a domain entitled *Gadgets work wonders*. In the first two years, lower secondary, module 1 covers aspects of energy, heat, forces and electricity, each of which is further developed in module 2 for the upper secondary two years. The energy section has two topics: energy transfers and the use of fossil fuels. These have detailed learning outcomes for each of the three general aims of knowledge, understanding and applications (KU&A); skills and processes (S&P); ethics and attitudes (E&A). There are two lesson suggestions: a scenario where students prepare a presentation on alternative energy sources for when fossil fuels have run out, and a competition to build the best simple solar cooker. The upper secondary NT module builds on this and has a similar format. The lesson suggestion is to relate daily activities to the conservation of energy. This gives a clear indication of the "science in daily life" flavor of the course, and encourages student engagement.

The academic routes can lead to N or O examinations, with a common lower secondary course. Physics is covered in the interactions, Models and Systems themes. The energy topic has five KU&A statements and two each for S&P and E&A, reflecting a difference in emphasis from the NT route. The statements are also notably more quantitative and less contextualized. In upper secondary there is a further proliferation of routes to O levels in physics, or physics with chemistry or biology, in addition to the N route. These GCE courses are examined by SEAB and Cambridge International. Physics O level (5059) has five sections: measurement, Newtonian mechanics, thermal physics, waves, electricity and magnetism. There is no cosmology/astronomy. The energy section has seven learning outcomes that are all in the KU&A dimension, though not identified as such. Although the other dimensions of the aims are listed in the introduction to this syllabus, they are implicit here, although there is a separate section on practical skills and their assessment (see below). The physics with chemistry (5076) and physics with biology (5077) courses have an identical format, and includes around 2/3 that of the pure physics syllabus. Temperature and electromagnetic induction are omitted from that specification, and within the energy topic one learning outcome, efficiency, is omitted. There is therefore a similar content load for physics alone or in combination. No details of study time allocation are apparent. The N academic route offers Physics with Chemistry (5105) and Physics with Biology (5106). These have the same content as the physics syllabus in the O-level combined science 5076 and 5077 syllabus with the omission of "Light", "Static Electricity" and "Magnetism and Electromagnetism." There are suggested practical activities, but unlike the O level route, no practical test.

GCE A level courses in physics are offered in two years at Junior College and three years at central institutions. In physics there are three levels, H1 (8866), H2 (9646) and H3 (9811), with H1 and H2 offered as alternatives. The H1 route is half of H2 in terms of syllabus coverage (breadth) but similar to H2 in depth. H3 is for those with exceptional interest and aptitude in the subject. The assessment objectives comprise K&U and information processing, for both courses, and the addition of experimental skills and scientific processes for H2. The energy topic has eleven learning outcomes and is very similar to the Cambridge Pre-U specification in England.

In general the scope is wide and the depth appropriate for the N, O, and A designated courses. The role of practical science and the opportunities for developing attitudes according to the aims, differs according to the differing assessment regimes.

Demand and progression:
The highly differentiated routes of the school system are designed to minimize mixed ability groupings. The aims and detailed learning objectives (LOs) discussed in the previous section are differentiated in demand across the routes and through the stages of any particular route. Introductory sections of the specifications refer to progression, and in general this appears to be well handled. Examples of LOs in energy:

- NT lower secondary: recognize and give examples of different forms of energy in everyday life
- NT upper secondary: understand and apply the principle of the conservation of energy to daily situations
- academic lower secondary: show understanding that energy is transferred when work is done
- physics: state the principle of the conservation of energy and apply the principle to new situations or to solve related problems
- H2 A physics: give examples of energy in different forms, its conversion and conservation, and apply the principle of energy conservation in simple examples.

Assessment:
Assessment objectives (AOs) are presented in detail in each course specification and are appropriately aligned. For example, some of the courses do not have practical assessments, and so no AOs for experimental skills are included – although there is an expectation the studies will include practical work. No rationale has been seen for the inclusion or exclusion of practical tests. Where the course assessment includes this there are alternative arrangements for private candidates who are not in schools.

There is general advice given on formative assessment and for the lower secondary assessments which are school based a wide range of suggestions are provided, for example, using concept cartoons, mind maps and role plays. It is not clear how these school-based assessments are used in determining the study routes of students.

The schemes of assessment are detailed, usually involving a multi-choice paper (m-cp) and a structured paper (sp) and a specification is given of the proportion of the marks for the dimensions of the learning objectives.

Physics O level has two theory papers that have 45% weighting for K&U and 55% for information handling and problem solving. The practical test paper has 50% weighting for performance and observation, 25% for analysis and 25% for planning. Paper 1 (m-cp) consists of 40 questions, which give a good demand range and content coverage. There is inevitably a

preponderance of recall and calculation, but questions also test reasoning, in the contexts of, for example, the use of equipment. Paper 2 (sp) has questions that probe an area of the subject in more detail and sometimes require extended written responses. The questions include applications of understanding and interpretation of experimental results. There is one choice of question which could come from any of the physics themes, between an optics and a mechanics topic.

The H2 Physics sample paper available was limited to eight m-c questions from paper I so no evaluation of range and coverage was possible. Those reviewed are appropriate and include terminology (precision versus accuracy), application (forces on a tooth brace) and the order of magnitude estimation (of the weight of an A4 sheet of paper). The Victoria Junior College JC2 preliminary examinations Physics Higher 2 also consisted of m-cp and sp papers. The demand of the questions is high throughout with a particularly strong mathematical emphasis (– but also a concern to distinguish accuracy from precision). This is a highly selective entrance examination.

Key competencies:
The introductions to each of the specifications include a wide range of appropriate key competencies that relate to cross-curricular experiences and the development of personal qualities; for example the enjoyment of the subject and respect for evidence and precision in measurement. At the detailed level of the learning outcomes, however, there is not much exemplification of how this would work in practice, nor is there clarification in the assessment specifications. Given the clarity of the other learning outcomes, it is likely that these could be neglected.

Secondary: Social studies

The following is based on: Social Studies Syllabus Lower Secondary N(T) (2005); Social Studies N(T) Syllabus (2013).

Orientation:
Normal (Technical) students take social studies rather than history and/or geography courses. Preparing students to be citizens is at the heart of the program, which concentrates on real world issues and the values that define Singapore society. The aim is to create informed, concerned and participative citizen who can competently make decisions and contribute responsibly. Expressed aims center around creating informed, concerned and participative citizens.

Coherence and clarity and scope:
Singapore's approach to social studies is through an issues based, inquiry led program. Guiding questions are used to gain understanding of the issue at hand and the use of key understandings give insight into why a particular topic is worth studying. Students use narratives and personal accounts in order to help them relate more directly to the issues studied. The rationale behind inquiry based learning is that it develops in students critical

thinking skills, promotes co-construction of knowledge, understandings and skills, aids meta-cognition and prepares students for 21st century life. Inquiry leads to sparking curiosity, gathering data, exercising reasoning skills and reflective thinking. Students also do field based projects.

Topics for S1 and S2 include "living in a multi-cultural society", "responding to migration", "resolving conflict and building peace" and "protecting our environment." At S3 and S4 the topics are "managing our financial resources" and "caring for society." From the topics it is clear that this is not a social studies curriculum in the US sense – where history, geography, civics etc are combined, but more of a civics program. Students are, however, expected to draw on perspectives of history, geography, political science, sociology and economics.

For each topic the syllabus maps out what the issue matters, its inquiry focus, key understandings, key outcomes, skills outcomes, values outcomes and key concepts.

Assessment and levels of demand:
Social Studies N(T) is a non-examined subject. Assessment is school-based and both formative and summative and its objectives are to enable students to: 1) construct knowledge through gathering and organizing information and making observations using sources and interpreting data; 2) construct explanations through considering different point of view to make informed judgments and communicate ideas clearly and creatively; and 3) interpret and evaluate sources, checking the reliability of information gathered. Summative assessment is through group work on a performance task, for which all members of the group receive the same grade.

It is impossible to ascertain levels of demand without seeing exemplar student work, but the topics are meaty and could be studied in depth.

Key competencies:
21st century core competencies, as defined by the MOE, include civic literacy, global awareness and cross-cultural skills, critical and inventive thinking and information and communications skills. These skills are directly mapped onto the social studies program of study and suggested lesson plans are found in the social studies course book. The first of these competencies is clearly represented throughout the secondary program.

Secondary: Geography

Orientation:
The revised syllabus for 2014 has a carefully crafted orientation that balances the academic purposes of geography (and the value of geographical knowledge) with the state's desired learning outcomes (DOE). This is an exceptionally clear vision, illustrated by Figure 1 on page 2 of the document, which provides specific illustration of how geographical knowledge, understanding and skills contribute to four DOEs.

Like several jurisdictions around the world the rationale stresses "thinking geographically" (p4) as an aim – but unlike most, the document provides a clear definition, with examples of what this means for the Singaporean context with reference to four key concepts.
Far less effort is expended in this way in the secondary level syllabuses: perhaps understandably these shorter documents focus mainly on the content of the syllabus.

Coherence and clarity:
Exceptional effort has been invested in producing a document that is balanced and robust. One of the four design principles is "to ensure coherence, continuity and progression in syllabus framework, content and skills from secondary to pre-university level" (p 6). It achieves this by:

- clearly focusing on *disciplinary* knowledge, understanding and skills in the learning objectives. This is in contrast to the primary social studies program which is integrated (and although it contains geographical perspectives – Singapore in the world setting, plus topics such as farming and the physical environment – is not concerned with disciplinary distinctiveness)
- adopting an issues based framework (p7) as a strong pedagogic access point to academic studies of (mainly) *environment and resources* including water and energy, and *urban living*. This appears to be a deliberate prelude to the more systematic/thematic framework in the A level syllabus documents.

The topics providing the content of the syllabus are set out using enquiry questions, which is an effective means of communicating the issues framework.

There is a strong concise section on recommended pedagogy (p27) that specifies the enquiry process. This, linked to the introduction of the Geographical Inquiry (GI) requirement (which is also linked to mandatory fieldwork) is bold, innovative and entirely consistent with the overarching aims and DOEs.

Scope:
What is noteworthy here is a detailed scope and sequence chart. Each topic is opened up in terms of learning outcomes, knowledge and skills, conceptual development – and "MOE initiatives."

There is, however, no requirement to follow the sequence shown in this table. There is also virtually no explanation or guidance as to how the table should be used. There is little effort to distinguish intensive and more extensive geographical knowledge (breadth and depth).
Overall and in general the scope looks appropriate: the geography is substantial but not a rush through to cover everything. The recommended timings are specified in detail (48 forty minute periods over two semesters).

Levels of demand:

The syllabus has some in-built differentiation between normal and express (the latter covers more material). As already noted the design and pitch of the syllabus seems appropriate in terms of the demands it is making with regard to disciplinary knowledge acquisition and critical enquiry into substantial issues. Section 8 of the document (amplification of syllabuses) is potentially useful but may be seen to impede teacher freedom and creativity.

Progression:
As noted above, this has been thought about deeply and an appropriate response has emerged, based on an enquiry, issues-based approach, which appears to sit well between the more integrated primary social studies the lower secondary examinations and A level.

Assessment:
The documents encourage embedded assessment for learning and also a sophisticated approach to teacher led summative assessment. Regarding the latter, assessment objectives are identified for teachers and "a variety of assessment modes is encouraged" and set out on page 69 (for example, response to contemporary issues, short answer questions, structured questions and the GI). There is even a specification grid supplied as well as some specimen questions. Thus, considerable professional expectations are placed on teachers to perform assessment processes in a reasonably consistent way between schools.

Key Competencies:
Section 4 of the documents provides ten pages of definitions of '21st century competencies' and an audit which maps these to the geography program with benchmarks. The competencies are of course also tracked back to the DOEs. They are well integrated into the curriculum for geography without undermining the disciplinary integrity of the subject, which is quite an achievement.

Secondary: History

The following is based on the: History Syllabus Lower Secondary Special/Express and N(A) (2005); 2014 Lower Secondary History Teaching Syllabus Express and N(A) (2013); History GCE N(A) Syllabus 2195 (2012); History GCE Ordinary Syllabus 2173 (2012); History GCE Ordinary Syllabus 2174 (2012); History Higher 1 Syllabus (2012); and History Higher 2 Syllabus (2012), which includes materials from H1.

In lower secondary (S1 and S2) both history and social studies are non-examined subjects. Students can choose to continue their social studies or history studies in S3 and S4, but the subjects are not compulsory. Therefore schools cannot assume for higher level history (H1 and H2) study that students have taken history courses at S3 and S4 and the leaps in knowledge and understanding, skills and values reflect this situation.

Orientation:

Each historical concept is taught progressively from Secondary 1 to 4 through course books and textbooks, which are not available outside Singapore. The following commentary is instead based on published syllabuses (see above).

In common with other jurisdictions where social studies and history are not compulsory beyond the age of 13/14, there is currently no definitive scale for the teaching and learning of historical thinking progressively the same way that subjects with linear structures of knowledge building such as mathematics. Instead, what is available and practiced are broad tiers of progression, illustrated in the scope and sequence charts available in the teaching syllabuses.

Lower Secondary (S1 and S2) Social Studies
History:
The aims of lower secondary history complement broader desired outcomes of education "students should become confident… self-directed… active… and concerned citizens" and are described as being "crucial" to the achievement of these outcomes in helping students "uncover the complexities that define the human experience."

A statement of the philosophy underlying history education is provided in the document as well as a definition of the qualities of "a history learner." It details seven qualities of a history learner that the curriculum aims to develop:

- reasoned: constructs historical interpretations based on substantiated arguments
- inquiring: develops an inquisitive mind
- discerning: reads sources critically
- balanced: considers and acknowledges difference viewpoints
- knowledgeable: develops a sound awareness of key forces and personalities that have shaped international and regional landscapes
- empathetic: understands the reasons behind past developments without imposing judgment using present day norms
- methodical: employs comprehensive effort when engaged in historical inquiry by covering a range of sources, selecting and organizing knowledge effectively

The statement of philosophy indicates a focus on (1) substantive knowledge and understanding (past human experience) (2) historical epistemology (the nature of historical knowledge) and (3) a form of historical consciousness (connections between the past and the present). There are both past-referenced elements identified under the empathetic and methodical qualities and generic elements, meaning that they could support both history study as well as the study of other human sciences (anthropology, sociology and so on).

The historical focus of the syllabus becomes more apparent in the discussion of aims and learning outcomes where reference is made to history specific conceptual issues (such as establishing historical significance, cause and consequence and the key features of historical periods) in a manner that aligns with international best practice (Lévesque 2008; van Drie and

van Boxtel 2008). The detailed provision of objectives later in the document has clear focus on history specific aspects of conceptual development and demonstrates an informed understanding of relevant literature.

A key emphasis is placed on learning through inquiry in the syllabus' pedagogic recommendations. The model is generic and broadly applicable to all modes of enquiry based learning rather than history specific – it deliberately applies to all the secondary social science subjects and supports Singapore's curricular aims and vision.

Overall, the aims of the syllabus and its emphasis on inquiry align, to an extent, with what might be considered best practice in history education internationally (Lévesque 2008; van Drie and van Boxtel 2008), these features complement the 21st century skills framework (see contextual section) while simultaneously emphasizing disciplinary understanding. The latter plays a more significant role in defining the overall tenor of the document and in informing how historical thinking is modeled.

N(A) Level and O Level:
For upper secondary (S3 and S4) examination syllabuses were used, since the teaching syllabuses are not available outside Singapore. These are less full than teaching syllabuses. As with lower secondary, the N(A) and O level syllabi complement the broader desired outcomes of education. Similarly, as with lower secondary, both the N(A) and the O level syllabi are prefaced by both a statement of the philosophy underlying history education as well as a definition of the qualities of a history learner. The statement of philosophy is that:

> History education in Singapore seeks to develop in students a critical appreciation of past human experiences and connections between the past and present.

The aims and outcomes identified at N(A) and O level are substantially identical to those identified at lower secondary.[7] There is continuity between lower, upper, and post-secondary history study in the inquiry-based learning that is a key pedagogical emphasis throughout. Assessment modes at N(A) and O level include historical thinking skills (many of which are linked to historical inquiry) that are articulated through the assessment objectives.

The generic competency framework that predominates at lower secondary has a less significant role at N(A) and O level. Many of the aspects of historical thinking present at lower secondary are equally present at N(A) and O level.

[7] There are differences in the Aims and Outcomes in the three syllabus documents and these are, for the most part, minor and without significant consequence in terms of the modes of historical thinking identified. Thus, for example, 'the connections between individuals, societies, events and developments' (CPDDMOE 2014: 4) become 'interconnections' (SEAB&UCIE 2012a: 4; SEAB&UCIE 2012b: 4). One significant difference is the inclusion of the following (under Skills) in N and O level – 'drawing conclusions from the study of evidence and appreciating that historical conclusions are liable to reassessment in the light of new or reinterpreted evidence' (SEAB&UCIE 2012a: 4; SEAB&UCIE 2012b: 4).

Advanced level:
By contrast with the lower secondary and N(A) and O level examination syllabuses, there is no reference to broader desired outcomes of education in the A level specifications (H1 and H2) viewed. The aims identified in the A Level specifications are exclusively historical in focus and do not consider the wider benefits of studying history (such as impacts on students' dispositions or competencies). The A level aims align with the N(A) and O level aims, although the former do not explicitly make reference to historical significance and say less about the understandings involved in mastering historical evidence (14 rather than 93 words).

Coherence and Clarity: Lower Secondary history
Aims and learning outcomes for "knowledge and understanding", "skills" and "values and attitudes" are identified in detail and, as noted above, key aspects of historical thinking are effectively identified here. In parallel to these aims an extensive restatement of aspects of historical thinking in terms of 21st century competencies is provided. As the length of their statement shows, these generic competencies have a high profile in the document. A finer grained and clearly history-driven set of outcomes, broken down by curriculum unit, is provided and these outcomes are explicitly linked to key international research literature and make good use of it to operationalize historical thinking in a coherent manner. These learning outcomes are complemented by three assessment objectives that very effectively operationalize first and second order dimensions of historical thinking (Lee 2005). The curriculum document, then, sets clear and coherent conceptual goals; however, there is considerable duplication of goals through the co-presence of parallel curriculum architectures.

In so far as it is possible to judge from the curriculum alone (the *Guide to Teaching and Learning for Lower Secondary History* is password protected and inaccessible), the pedagogic approaches proposed are likely to align with the historical learning outcomes identified (there is a clear emphasis on collaborative historical enquiry in the document and the curriculum is organized around conceptually focused historical inquiries.

N(A) Level and O Level:
At N(A) and O level a detailed, clear and specific breakdown of the content to be covered is provided, in terms of "key knowledge", "learning outcomes" and "concepts." As has been noted, the aims, outcomes and assessment objectives identified for N(A) and O level are substantially identical with those identified at lower secondary.

Like the lower secondary document, the N(A) and O level syllabi contain tables providing amplification of their respective syllabi, however, whereas the lower secondary tables include both first (Content Concepts) and second (Historical Concepts) order components, the N(A) and O level tables are more concerned with first order issues. In addition, whereas the lower secondary document contains an additional table that includes a detailed consideration of how the curriculum will enable students to develop understandings of practicing history (broken down into "Historical Concepts" and "Historical Skills") no equivalent is present in the N(A) and O level documents. This is doubtless because of the fact that these are examination syllabuses.

Advanced level:
The A level specifications contain clear but brief assessment objectives and detailed statements of content. No pedagogic particular approaches are suggested or recommended within the examination syllabuses.

Scope:
Lower Secondary history
The lower secondary curriculum provides a history of Singapore, and its articulation into global trends and developments, from the 14th century through to the second half of the 20th century, with the greater part of the curriculum (four out of eight chapters) focusing on the 20th century.[8] The content is prefaced by an introduction on historical epistemology. The curriculum is expected to be covered in between 56-64 teaching hours over two years. The content looks achievable in the time and is broken down into content sub-units as well as in terms of the conceptual learning intended to be developed through studying content. This curriculum does not pay lip service to historical enquiry and conceptual aspects of historical learning but embeds both in detail.

In terms of breadth and depth, the curriculum should probably be described as relatively narrow in content terms (Singapore-centric) but deep (the history of Singapore is explored in detail and in a number of aspects); in temporal terms, the curriculum could be described as broad (since at least six centuries are covered) and deep in some respects (for the twentieth century, which represents half of the content) but less deep in others (five centuries are covered by the other half of the content).

N(A) Level and O Level:
The N(A) and O level curricula focus on *The Making of the Contemporary World Order (1870s–1991)*. In keeping with historical studies in most developed countries, both curricula emphasize regional rather than global in foci (for example, "European Dominance and Expansion in the late 19th century" is looked at through an East / South East Asian lens without reference to Africa or other regions of the world). Some aspects of the history of other regions are addressed (Nazism and the Cuban Missile Crisis). Both curricula are also highly political in focus and concerned with geo-politics and economics rather than with social and cultural aspects of history. Where breadth is concerned, the curricula are, narrow in scope in thematic, geographical and temporal senses. This potential narrowness is made up for by the inclusion of depth studies in the form of case studies (for example of Indonesia 1870-1900) and the O level curriculum contains more depth because it contains more content and therefore a greater number of case studies.

Advanced Level:

[8] Earlier periods are covered, particularly in chapter 2 where reference is made to developments in the 1st century CE.

H1 focuses on geo-political and economic aspects of global *International History, 1945–2000* by exploring American, European, Asian and Middle Eastern topics. H1 is narrow in temporal scope (50 years) and in themes (geopolitics and economics) but broad in geographical range. Scope for depths studies is possible (for example, taking Japan as a case study of economic growth post WWII).

H2 includes the content of H1 and, in addition, *History of Southeast Asia, c.1900–1997* focusing on political aspects of nationalism and anticolonial movements and the politics and economics of independence in the region. H2 is broader than H1 in temporal scope (97 years), similarly narrow in themes (geopolitics and economics), narrow in geographical range. Greater scope for depth studies is again possible (through the regional focus of the content that H2 adds to H1).

There is some repetition of content between N(A) and O level and H1 and H2 due to the fact that students will not always have taken N(A) or O levels prior to taking H1 or H2.

Levels of demand:
Lower Secondary history
The lower secondary curriculum is challenged in building on the foundations of the primary curriculum, since history receives limited coverage in the latter. Variable levels of demand are clearly built into the curriculum through the differentiated pathways that exist ('Normal (Academic)' and 'Express'). As elaborated in content and assessment arrangements that enable a number of modes of assessment and that incorporate levels of response marking, the curriculum provides scope for access and achievement across a wide range of abilities.

N(A) Level and O Level:
Variable levels of demand are built into the curriculum through the differentiated pathways that exist (N(A) and O Level). The differences between the two pathways are mainly:

- a difference in content (N(A) contains one fewer unit than O)
- differences in the challenges posed by assessment (thus, for example, O level students are asked to read longer sources than N(A) level students and to make reference to a larger number of sources.
- a difference in expected levels of response to questions (thus for example, N(A) level students are expected to describe and explain and O level students to explain and evaluate.

In contrast to the lower secondary curriculum, where a number of modes of assessment are available since the course is not examined, one mode of assessment is present at N(A) and O level (examination).

Advanced Level:
The level of demand generally seems appropriate to advanced level study but there is little diversity in assessment (the same two types of question are repeated twice) and limited scope

for differentiation. In H1 and H2, there appears to be no scope for independent research or investigation of historical enquiry.

Progression:
Progression from Primary to Lower Secondary
There is clear scope for coherent progression between the primary and the lower secondary curriculum in a generic sense – both emphasize generic learner competencies – and also in the sense that there is a focus in both documents on developing student-centered activity (the performance tasks highlighted in the primary curriculum from Primary 3 onwards and the emphasis on inquiry in the lower secondary). There is less scope for coherent progression in a history-specific sense, however, given the limitations of the history specific thinking in the primary document, which contrasts with the historical conceptual focus of the lower secondary history curriculum.

Progression from Lower Secondary to N(A) and O Level:
Progression between lower secondary and N(A) and O level could be clearer: in a number of respects aims and intended outcomes are identical in both cases. The formats of assessment at lower secondary and N(A) and O level change as the courses move from non-examined and school-based to externally examined at upper secondary level. The incline of difficulty between the examination models for each appear slight superficially (all closely resemble English GCSE History papers) but would be apparent upon looking at student responses.

Progression from N(A) Level and O Level to Advanced Level:
Much of the content in H1 and H2 builds on or duplicates material in the N(A) and O level specifications, but at a more sophisticated level, for reasons outlined above. There is scope for progression since topics are covered in greater depth and greater substantive complexity. Like the N(A) and O level specifications, content is relatively narrow in temporal terms so there is less scope for students to develop mastery of, for example, the analysis of change on a large scale.

Given that much of the H1 and H2 content appears to be modern and recent history there is little scope for progression in students' understandings of the diversity of the past or of the range of human experiences and societies across time. However, the syllabus endeavors to strike a balance between breadth and depth in this case by focusing the depth of understanding on specific historical issues and periods.

Learning outcomes for A level clearly build on those for O level (there is an emphasis in both on explanation and evaluation). It is difficult to be sure how far the demand placed on each mode of analysis differs between the two levels, however, without access to marked student examination papers. In the examination papers for both H1 and H2 essay questions are set (in addition to structured source questions). There is an increase in demand here in the sense that the essay questions are less scaffolded than the structured questions set at N(A) and O level.

Assessment:

Lower Secondary history:

Assessment arrangements are complex – there are two levels at which the curriculum can be assessed (Normal (Academic) and Express) and assessment models with and without an (internal) examination component in order to provide flexibility for schools. In all cases, students are to be assessed in a range of ways, drawing on coursework, collaborative work and individual tasks.

It is clear that assessment arrangements align with the curriculum in conceptual terms – assessment is driven by conceptually informed assessment objectives and, in all models, incorporates collaborative "Historical Inquiry." The former ensures that historical thinking is a key focus of assessment and the latter that both inquiry processes and outcomes feature in assessment.

N(A) Level and O Level:

Both N(A) and O level examinations have the same structure – two examination papers in two parts each (a source question and a structured essay question). N(A) is differentiated from O level in a number of ways (see above). The examinations examine students' understandings of the uses of historical evidence (in their first sections). The descriptions of the structured questions and the examples seen all align well with questions, with a cause and effect conceptual focus. It is not clear how closely they align with significance and/or change and continuity foci, however, without a full sample of examination papers over the course of a number of years. Students have a choice of structured questions and it is difficult to know how broad a range of syllabus content it is necessary to study to complete the examination successfully.

Advanced Level

Both H1 and H2 examinations have the same structure (a source section and essay questions). N(A) and O level examinations have the same structure – two exam papers in two parts each (a source question and a structured essay question). N(A) is differentiated from O level in a number of ways. The comments on N(A) and O levels are equally applicable here.

Key competencies:

Lower Secondary history:

As has been noted above the curriculum includes a detailed and extensive elaboration of competencies and the curriculum is exemplary of a competence-based approach to curriculum design. This sits alongside a subject specific and research-informed discourse in the document. It seems possible that the latter will have more impact on practice since it informs assessment arrangements and the detailed elaboration of learning objectives in the syllabus.

N(A) Level and O Level:

Key competencies continue to be included in the curricula for N(A) and O level, notably via a reference to *Desired Outcomes of Education* in the opening pages of both documents.

Advanced Level:

While both H1 and H2 focus on history specific aims consideration is given to generic competencies through the syllabuses outcomes and the mode of assessment.

Applied subjects (secondary)

With initial observations about post compulsory vocational education:
For secondary students there is no purely vocational route (see above) although students on the Normal (Technical) route follow a more applied pathway than their peers on the Express and Normal (Academic) routes. For 14-16 year olds (upper secondary) on all routes, applied subjects such as, design and technology, food and consumer studies, food and nutrition and computer applications are available.

Post compulsory vocational education:
As highlighted above, the situation changes dramatically for post-16 students. Those who follow a post-secondary vocational route get a state-of-the-art education in the Institutes of Technical Education. There has been rapid development of post-16 vocational education and training, with 65% of the cohort taking some form of vocational course. This is widely admired, "(VTE) is a world-class model today" (Seng 2008, quoted in Agrawal 2013, 23). It implies a high status for post-compulsory VET.

However post-secondary vocational education was, in the not recent past, seen in deficit terms, for example, "as a way of tackling the 'drop-out problem' and the difficulties encountered by those students who were not 'academically inclined', it was decided that the less 'academically-able' students would now have a vocational route within the education system" (Ashton et al 1999). However, realizing the need for high quality vocational education to ensure economic stability, from the 1970s onward, the government invested heavily in VET, primarily in the post-16 sector.

Marc Tucker, in *Vocational Education and Training in Singapore* (2012) speaks of a shortage of skilled workers and a rapid expansion of vocational education, based on the German model, from the 1980s onwards. This included creating the Institute of Technical Education (ITE). While there is little recent evidence of expanding vocational education within the mainstream compulsory school system, TLLM and the emphasis on 21st century skills have boosted the types of dispositions and technical prowess necessary to succeed in VET from age 16. Singapore education and training is supported by institutions having good access to information technology. In 2002, the ITE, which acts as a vocational curriculum resource for the nation, launched an eStudent and eTutor program.

In 2013 slightly over 28% of students leaving compulsory education enrolled in two-year junior colleges, slightly over 46% enrolled in one of five polytechnics and another slightly under 23% percent went to the ITE (MOE Statistics 2014).

> Technical and polytechnic education in the country is not just as a terminal, industry-ready exit qualification but it is also seen as a viable alternative to a junior college

education for progression to the university. For instance, many students and their parents opt to enroll in a polytechnic because they prefer a practice-oriented education to an academic one at a junior college. Others choose for polytechnic education because of the wide range of programs and courses offered in these institutes which lead directly to employment opportunities. These include programs in new fields such as design, interactive and digital media, biomedical and life sciences, and hospitality and tourism management. The government maintains the separation between polytechnics and universities (higher education) in order to keep their distinctive focus.

The experience of Singapore has shown how the Institute of Technical Education (ITE), which is recognized as a world-class institution focusing on VTE, has been successfully transformed into a world-class post-secondary educational institution (Agrawal 2013).

The ITE is a post-secondary institution in Singapore that provides pre-employment training to secondary school leavers and continuing education and training to working adults
The ITE works closely with industry partners, many of them global, such as Cisco, Conrad Centennial, Hewlett Packard, IBM, Microsoft, Rolls Royce, Siemens, Singapore Airlines Engineering and Yokogawa. ITE staff are required to return to industry for a minimum of three months per assignment.

There are five polytechnics. Graduates of polytechnics with good grades can continue to pursue further tertiary education at the universities, and many overseas universities, notably those in Australia, New Zealand and the United Kingdom, give exemptions for modules completed in these polytechnics.

Orientation:
The lower secondary, curriculum places an emphasis on the understanding of technology as part of its core, especially, but not exclusively in the N(T) route. Courses include design and technology, food and consumer studies, food and nutrition and computer applications, all of which are considered to be academic courses with a strongly applied orientation. In addition to this, students described as not able to access mainstream schooling, may undertake three, two and one year programs leading to careers such as baking, care, desktop publishing and facilities services. The implication is that while technology is viewed as an essential part of the standard curriculum, “vocational” for younger students is equated to craft, and provided for low achievers. True vocational education really starts, post-secondary, at age 16 or 17, and progression into this highly acclaimed Singapore VET system is from the mainstream curriculum.

Coherence and clarity:
At lower secondary the aims of the curriculum are clear. For example, the design and technology N(T) 2007 syllabus’ aims are to enable students to:

- develop an awareness of design in the made-world

- develop an appreciation of function, aesthetics and technology in design
- develop basic design thinking and communication skills
- experience the process of realizing design through making
- think and intervene creatively to become autonomous decision makers.

Students are to engage in design-and-make activities and experience a basic process of design adapted to their abilities, interest and design context.

The more challenging Special/Express / N(A) 2007 syllabus includes:

- aesthetics: appreciate the role of line, shape and form, color, texture, proportion and ergonomics in relation to design needs, understand the link between ergonomics, function and aesthetics
- design in society: show an awareness of societal and cultural influences on design
- sustainability: demonstrate awareness of environmental considerations related to materials usage, production methods and after-use disposal.

The 2014 upper secondary design and technology N(T) syllabus expands the aims of the 2007 version and emphasizes more strongly the development of 21st century skills and attitudes:

- foster positive values and attitudes for enterprise, creativity and innovation through design-and-make activities
- harness their innate curiosity and ability to create through design-and-make activities
- develop the quality of tenacity through continuous refinement of their ideas towards a viable solution within a given timeframe
- exercise judgements of an aesthetic, technical and economic nature;
- develop an awareness of design in the areas of social, culture and environment; and acquire knowledge and skills beyond that as stipulated in the syllabus through the contexts of the design-and-make activities.

The 2014 upper secondary design and technology N(A) and O level syllabuses are a bit more ambitious:

- foster positive values and develop dispositions for enterprise, creativity and innovation through research and exploration, idea conceptualisation and development, communication, working with materials and tools in response to needs identified
- harness their innate curiosity and ability to create through design-and-make activities;
- develop the quality of tenacity through continuous refinement of their ideas towards a viable solution within a given timeframe
- exercise judgements of an aesthetic, technical and economic nature
- develop an awareness of design in the areas of social, culture and environment

- acquire knowledge and skills beyond that as stipulated in the syllabus through the contexts of the design-and-make activities.

Scope:
In lower secondary, Express and N(A) students must take design and technology and food and consumer education; N(T) students must also take computer applications. Once students enter upper secondary, the applied electives differ more among the Express, N(A) and N(T) routes. Express electives include: computer studies; design and technology; design studies:

> Food and nutrition; fundamentals of electronics and principles of accounts N(A) electives include: design and technology; food and nutrition; principles of accounts; computer applications; business studies; introduction to enterprise development; elements of business skills. N(T) upper secondary students must take computer applications and can chose among myriad electives – elements of business skills; retail operations; design and technology; food studies; computer and networking; electrical technology and applications; mobile robotics.

Progression:
The Normal (Technical) route directly prepares students for technical-vocational education at the ITE. While it has more technical education than the Express or Normal (Academic) routes, the curriculum is still geared towards strengthening students' proficiency in English and mathematics. Students take English language, mathematics, basic mother tongue and computer applications as compulsory subjects. Students can then continue through to tertiary education in the universities, the five polytechnics and the Institute of Technical Education. This is overseen by the Ministry of Education. Continuing VET is the responsibility of the Singapore Workforce Development Agency, which is responsible for funding and regulation.

Assessment:
Assessment of those subjects forming part of the secondary school curriculum is against statements of competence, for example, in the N(T) design and technology 2014 upper secondary syllabus students study 18 topics/content areas in three areas (design, technological areas, and materials and practical processes), each of which includes statements such as (for the design communications topic):

- appreciate the use of design elements and principles to communicate design ideas and design aesthetics
- use quick freehand sketching techniques to explore and develop ideas
- show ideas and describe methods of construction by using pictorial drawing, exploded and sectional views where applicable
- produce orthographic drawings through the use of conventional drafting method and/or Computer Aided Design (CAD)
- use models and mock-ups as a means of testing the feasibility of a solution.

In this syllabus, there is a written examination worth 30% of marks. Students have to show their knowledge and understanding, for example, of the design and technological areas. Formal coursework is worth 70%, where students undertake a design and make project. During the course itself, students will work on structured projects, designed by teachers for students to experience the design process and to learn related knowledge and skills.

Key competencies:
Within the mainstream secondary curriculum, technology is integrated into wider social issues, a good example of which is the food and consumer education (FCE) lower secondary course (MOE 2014e). There are two core areas of study: food studies and consumer studies. Food studies equips students with knowledge about diet and health, so that they can be more discerning in choosing nutritious food for good health and be informed of the benefits of balanced meals. Students are also equipped with food management skills where they are taught culinary skills to be self-sufficient in planning and preparing healthy meals for themselves and their family. At the same time, students also learn to be appreciative of the diversity of food from different cultures in Singapore and around the world as they go through the food and culture aspect in the syllabus. In consumer studies, students learn basic principles of consumer education to manage resources and understand consumer rights, as well as responsibilities. FCE also covers the knowledge and skills of basic money management and financial literacy.

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