Singapore

Ministry of Education

Introduction

Overview of Education System

A small nation with few natural resources other than its people, Singapore has always placed a high value on education. The mission of Singapore's Ministry of Education (MOE) is to mold the future of the nation by nurturing its people. Nearly all Singaporean students attend publicly funded schools. Public education in Singapore aims to help children develop passion and capabilities for learning throughout life so that they may realize their potential, live a full and satisfying life, and use their strengths gainfully for the good of the self, family, society, and country.[1]

The Singaporean education system in the 1960s–1980s was largely efficiency-driven and more centrally controlled, with the goal of rapidly raising the basic literacy and numeracy rates within its population. Launched in 1997, MOE's vision of "Thinking Schools, Learning Nation" represented an important inflection point in the transformation of the Singaporean education system into its current form, which is characterized by flexibility, diversity, and greater school autonomy.[2] This fundamental shift was actualized through changes in education governance and the education landscape over the past two decades. Both due to its small size[a] and by design, the Singaporean education system has a flat structure of governance, with no intermediary levels of government between the MOE Headquarters (MOE HQ) and schools. The key design objective is to create a close nexus between policy and practice through achieving a purposeful balance between the centralization and decentralization of different elements of the education and school system.

The MOE HQ is responsible for selected functions within the education system to ensure that important education resources are equitably distributed across schools. More specifically, the MOE HQ is responsible for setting national policies that affect access to education and schools for all children (e.g., curriculum, school admission criteria, funding rates, and fees payable). For example, the adoption of a national curriculum ensures that children in all schools have access to the same core set of important knowledge and skills. Similarly, the MOE HQ is responsible for recruiting public school teachers, paying for their initial teacher training at the National Institute of Education (NIE), and deploying them to schools. This structure ensures that the same high standards are applied consistently in the recruitment of teachers, and that there is equitable deployment of teachers to all schools.

[a] There were 345 schools across all grade levels in the Singaporean education system in 2019.

However, the MOE HQ devolves significant autonomy and responsibility to individual schools, within broad parameters, in school administration and professional matters (e.g., pedagogical approaches for students with different needs). In fact, while schools implement the national curriculum with fidelity, teachers customize the delivery of the curriculum to meet the learning needs of their students. Similarly, schools decide the local job assignments of teachers (e.g., deployment to grade level and co-curricular activities). Such local autonomy at the school level facilitates onsite customization and is a key feature of what makes the Singapore education system nimble and responsive to students' needs.

Additionally, central oversight of individual schools occurs mainly through a holistic school management and self-evaluation framework, developed by MOE HQ in consultation with schools and other key stakeholders. Schools use this framework to guide their efforts in continual school improvement in areas such as teaching and learning, student and staff wellbeing, engagement with parents, and school leadership. The school self-evaluation is further supported by a customized validation process, carried out approximately once every six years by a team of school leaders and consultants appointed by MOE HQ, who provide an additional perspective of the school strengths and areas for growth. Having school self-evaluation complemented by validation reflects the belief that continual and sustainable school improvement is most effective when schools initiate and own such efforts themselves, guided by agreed standards of quality. This decentralized and systematic approach to school improvement allows MOE HQ to adopt a light touch in monitoring school quality, engender school ownership for continual improvement, and direct resources and support to schools where required.

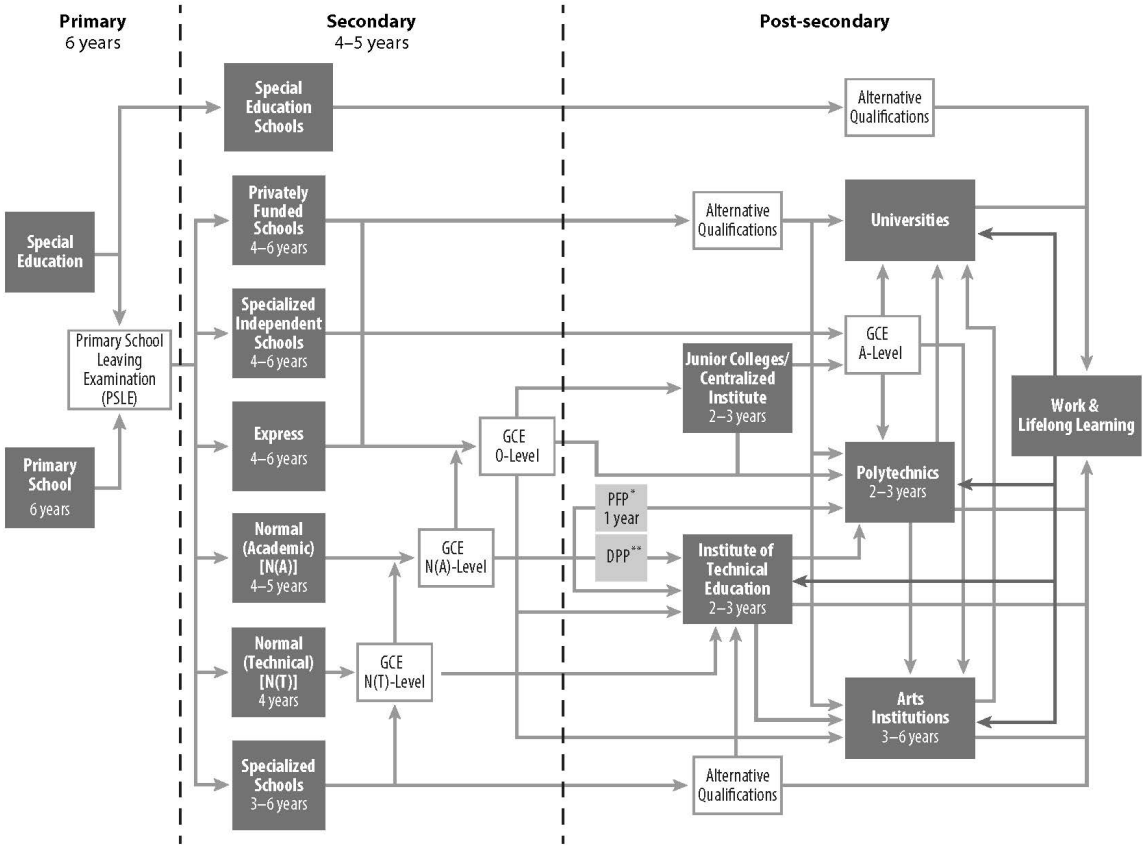
The MOE HQ also works very closely with schools, both directly through school visits and consultations with MOE HQ subject specialists, for example, and indirectly through a school cluster system. Every school is part of a cluster of 12 to 14 schools located in close geographical proximity. The cluster serves as a key platform for professional development, communication, networking, and sharing among schools.

The close working relationship between schools and the MOE HQ is further enhanced with the rotation of education officers between practitioner roles in schools (e.g., teachers, heads of departments, and principals) and policymaking roles in the MOE HQ. Officers interested in such rotations could apply for positions at MOE HQ during annual posting exercises. This process helps create a coherent system with a tight link between policy and practice. Shifting between job roles allows educators to gain insight into the policymaking and policy implementation aspects of the system such that each is continually informed by the other. Socially, the overlapping networks that follow individual officers as they move from one role to another organically facilitate a close working relationship between school personnel and HQ personnel. Overall, this practice contributes to a strong sense of common mission among school and MOE HQ personnel, and strong alignment between policy and implementation.

New education pathways and curricular options have been introduced progressively and refined over the past two decades to allow children to discover their interests and develop their

strengths in different domains. Exhibit 1 illustrates the diversity of pathways available to students today, including avenues for lateral transfers between courses of study. These pathways are designed to allow students to discover their individual talents and interests, develop and hone them so that they may acquire skills in particular domains, and inculcate a passion for learning that will drive the continual pursuit of new knowledge and skills throughout their lives.

Exhibit 1: Education System in Singapore[3]



* The Polytechnic Foundation Programme (PFP) is a diploma-specific foundation program conducted by the polytechnics over two academic semesters for students who have completed Secondary 4N(A).

** The Direct Entry Scheme to Polytechnic Programme (DPP) is a pathway to polytechnics for students who have completed Secondary 4N(A).

Although preschool education is not compulsory in Singapore, early childhood educational development programs for children under age 3 and preprimary education programs for children age 3 or older (including kindergartens) are widely accessible. Over the past several years, the government has played a more active role in raising the quality of preschool education through measures such as introducing national curriculum frameworks for early childhood education,[4,5] implementing a new quality assurance consultancy scheme for kindergartens,[6] and establishing kindergartens[7] run directly by MOE to provide quality, affordable preschool education, while catalyzing improvements in the rest of the preschool sector. With the establishment of the Early

Childhood Development Agency in 2013, there have also been further concerted efforts by the government to facilitate the enrollment of 5-year-old children who are not already enrolled in a preschool program, by reaching out to their families. With these efforts, nearly all children are enrolled in a preschool program.

Primary school education is compulsory, and formal schooling starts in Grade 1 (Primary 1) in the year in which children turn age 7. All primary school students learn a common national curriculum. To build a strong foundation in literacy and numeracy, English (the language of instruction), mother tongue (Malay, Chinese, or Tamil, depending on the student's ethnicity), and mathematics are emphasized in the primary school years. Science is introduced in Grade 3 (Primary 3). The curriculum also includes art, music, character and citizenship education, social studies, and physical education, as well as a wide range of co-curricular activities that allow students to explore their interests while imparting values, inculcating life skills, and building character.

At the end of Grade 6 (Primary 6), all students take the Primary School Leaving Examination (PSLE) which assesses students in four subjects: English language, mother tongue, mathematics, and science. For the majority of students, results from the PSLE are used as a measure of academic merit in the centralized secondary school admission system, which is both merit- and choice-based. Some students utilize their achievement in other areas (e.g., sports, music, and leadership) to gain direct admission to specific secondary schools, especially those offering special programs in these areas.

Secondary school is not compulsory, but more than 99 percent of the Grade 1 (Primary 1) cohort[b] complete secondary education each year.[8] At the secondary levels, students enroll in Express, Normal (Academic), or Normal (Technical) courses of study. These four- to five-year academic programs lead to the Singapore-Cambridge General Certificate of Education (GCE) Ordinary or Normal Level (O-Level or N-Level) qualifications. The differentiated curricula are designed to match student aptitudes and interests. Students may transfer laterally between courses of study. Recognizing that students' strengths vary across subjects, students from one course may also take certain subjects from a more demanding course. For example, about half of Normal (Technical) and Normal (Academic) students take at least one subject at a higher level—that is, Normal (Academic) and Express, respectively.

In Singapore, the study of science is compulsory through Grade 8 and the study of mathematics through Grade 10, reflecting the country's focus on mathematics and science education. At the upper secondary level, students with the inclination and interest have the opportunity to study mathematics and science on a deeper level by selecting from a wider range of electives. For example, in addition to general mathematics, students may take an additional mathematics course that delves deeper into the subject, covers a broader range of topics, and prepares them for

[b] Henceforth, "cohort" refers to the Grade 1 (Primary 1) cohort.

advanced mathematics courses at the post-secondary level. In science, upper secondary students can choose to study physics, biology, chemistry, or a combination of these subjects.

Students with special talent in the arts, sports, mathematics, or science can also choose to enroll in specialized independent schools that offer customized curricula to develop these talents. There also are specialized schools that cater to students who would benefit from a more customized and practice-oriented curriculum. In addition, some schools offer the Integrated Program, which combines secondary and preuniversity education without an intermediate national examination. Students in the Integrated Program experience an enriched curriculum that aims to broaden and deepen their thinking skills, leadership, teamwork, and communication skills.

After secondary school, the majority of students in each cohort matriculate to a course of study at a preuniversity institution (approximately 28 percent), the Institute of Technical Education (ITE) (approximately 25 percent), or a polytechnic institution (approximately 47 percent).[9] A preuniversity institution, such as a junior college, a centralized institute, or an Integrated Program school, focuses on preparing students for university education, and students graduate from these courses with a Singapore-Cambridge GCE Advanced Level (A-Level) or an International Baccalaureate qualification. ITE, on the other hand, offers a broad-based, multidisciplinary curriculum ranging from engineering to technical, business, and service skills. Working closely with industry partners, ITE provides students with enriched learning experiences, equipping them with industry-relevant technical and professional knowledge and skills. ITE graduates who perform well and have an interest in pursuing further education may progress to a polytechnic. The polytechnics offer three-year, practice-oriented diploma courses in diverse disciplines, such as business, chemical and biological sciences, communication, design, digital media, engineering, and manufacturing. Polytechnic graduates who perform well and have an interest in pursuing further education may progress to a university.

Approximately 30 to 36 percent of each cohort enrolls in government-funded, autonomous, local universities.[10] In 2019, there are six government-funded, autonomous universities in Singapore: National University of Singapore, Nanyang Technological University, Singapore Institute of Technology, Singapore Management University, Singapore University of Technology and Design, and Singapore University of Social Sciences. The rate of student enrollment at local universities is projected to increase to 40 percent for each cohort by 2020.[11]

Apart from providing pre-employment training, the ITE, polytechnics, and universities are key providers of continuing education and training (CET) for working adults. These options include full time courses, and part time skill- and knowledge-building programs that enable employees to continue developing useful and industry-relevant skills throughout their working lives. The launch of SkillsFuture in 2015 marks the latest phase in Singapore's investment in CET.[12] The SkillsFuture movement encompasses a multitude of initiatives and programs, including (a) helping students discover and develop interests during their school years, (b) providing various opportunities and support for skill development (e.g., the SkillsFuture Study Award, and the SkillsFuture Earn and

Learn Program), and (c) actively engaging industry leaders in systematically grooming and deepening industry-relevant skills for prospective and current employees.

In addition to academic studies, the development of competencies that are essential for students to thrive in the 21st century (e.g., socioemotional competencies, critical and inventive thinking, communication and collaboration, and leadership) and character and citizenship are an integral part of holistic education across all grade levels in Singapore. Students are provided with age-appropriate opportunities to engage in activities, both within and beyond the formal curriculum, which help to cultivate these competencies and values. Regular participation in co-curricular activities and community projects through MOE's Values in Action program are integral school experiences that help to achieve these goals.

Use and Impact of TIMSS

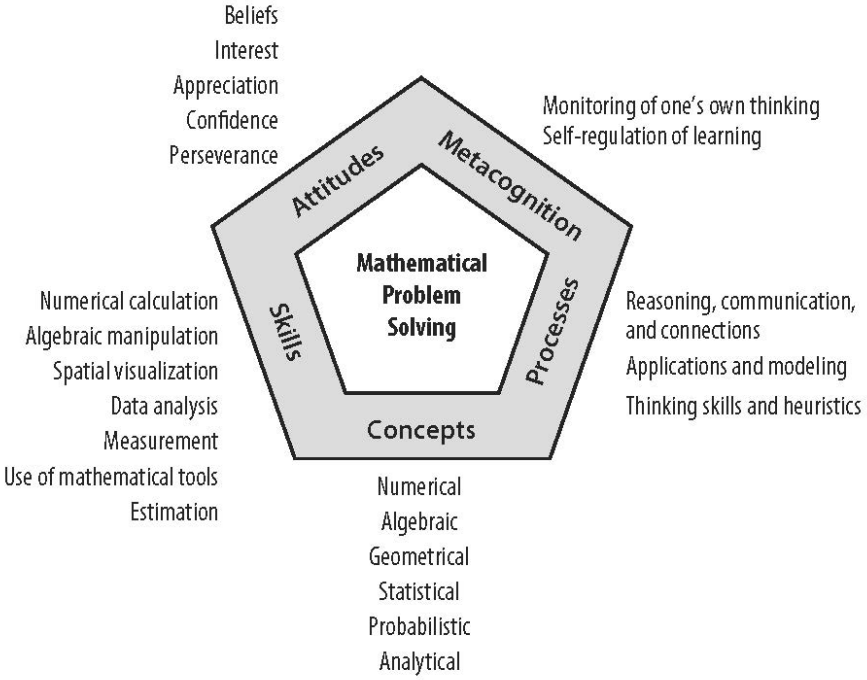
Singapore has participated in every cycle of TIMSS since 1995. Participating in TIMSS has provided insights, not just about student knowledge and skills in mathematics and science, but also about other important developmental outcomes, such as the students' attitudes toward learning the subjects and their social emotional well-being in school. For example, TIMSS data are used to identify specific strengths and weaknesses (e.g., common errors and learning difficulties) in various domains of learning for different groups of students. Insights from TIMSS are also shared with school mathematics and science department heads, who then work together with teachers to devise teaching and learning approaches that address the student learning difficulties identified by the study.

TIMSS data also serves as an additional, high-quality source of rich information, complementing other local sources, which MOE uses for secondary analyses to inform policy and program reviews, where appropriate. For example, TIMSS data on instructional time in Singapore and other education systems were used in a review of the length of school days for primary schools. TIMSS data in the Student and Teacher Questionnaires were also used to identify any early impact of syllabus changes on mathematics teaching and learning in the classrooms, as well as to determine the value of learning science and students' informal learning experiences in science.

The Mathematics Curriculum in Primary and Lower Secondary Grades

The Singapore Mathematics Curriculum Framework (Exhibit 2) guides the development of Mathematics syllabi at all the grade levels from primary to preuniversity education. It emphasizes the development of students' mathematical abilities, with a focus on problem solving. Five interrelated components support the development of problem solving abilities: concepts, skills, processes, metacognition, and attitudes. The framework provides directions for the teaching, learning, and assessment of mathematics.

Exhibit 2: Singapore Mathematics Curriculum Framework[13,14]



The Singapore mathematics curriculum comprises a set of syllabi spanning 12 years, from primary to preuniversity education. As mathematics is a hierarchical subject, higher concepts and skills are built upon foundational ones and learned in sequence. The curriculum is designed in a spiral manner where concepts and skills in each content strand (e.g., Number and Algebra, Geometry and Measurement) are revisited and built upon at each level to achieve greater depth and understanding. Exhibit 3 presents a summary of the concepts and skills to be learned by the end of Grade 8 (Secondary 2). Teachers help their students learn these concepts and skills by adopting age- and grade-appropriate pedagogical approaches. Central to these pedagogical approaches at the primary and lower secondary levels is the Concrete-Pictorial-Abstract (C-P-A) approach, whereby students build an understanding of abstract mathematical concepts from everyday experiences and meaningful contexts, using concrete and pictorial representations.

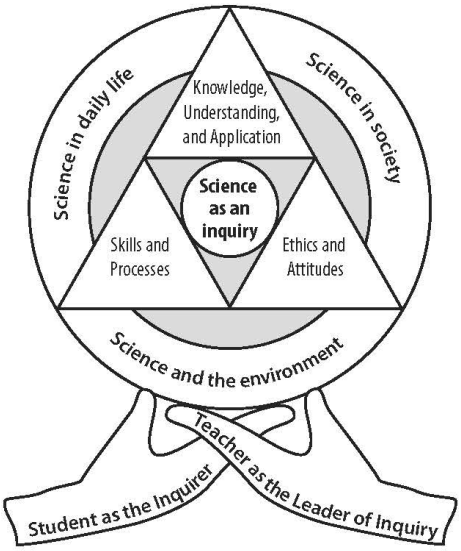
Exhibit 3: Mathematics Concepts and Skills

Primary Mathematics Grades 1–6	Lower Secondary Mathematics Grades 7–8
Number and Algebra	
▪ Whole numbers, fractions, and decimals, and the four arithmetic operations (addition, subtraction, multiplication, and division) ▪ Calculation with calculators ▪ Factors and multiples ▪ Ordering of numbers ▪ Approximation and estimation ▪ Percentage ▪ Ratio ▪ Speed ▪ Algebraic expressions in one variable	▪ Negative numbers, integers, rational numbers, and real numbers, and the four arithmetic operations (addition, subtraction, multiplication, and division) ▪ Calculation with calculators ▪ Prime numbers, highest common factor, and lowest common multiple ▪ Ordering of numbers ▪ Use of symbols including <, >, ≤, ≥ ▪ Approximation and estimation ▪ Percentage ▪ Ratio and direct and inverse proportion ▪ Map scales ▪ Rate and speed ▪ Algebraic expressions and formulas ▪ Algebraic manipulation (linear and quadratic) ▪ Functions and graphs (linear and quadratic) ▪ Linear equations with one unknown ▪ Simultaneous linear equations with two unknowns ▪ Quadratic equations ▪ Linear inequalities with one unknown
Geometry and Measurement	
▪ Measurement of length, mass, volume, time, and angle ▪ Area and perimeter of triangles, squares, and rectangles, area and circumference of circles, and volume of cubes and cuboids ▪ Properties of simple geometric figures ▪ Nets of simple solids ▪ Line symmetry	▪ Properties and construction of simple geometric figures ▪ Angles associated with parallel lines ▪ Angles of polygons ▪ Congruence and similarity ▪ Area and perimeter of plane figures, volume and surface area of three-dimensional solids ▪ The Pythagorean theorem ▪ Trigonometric ratios of acute angles in a right-angled triangle
Statistics and Probability	
▪ Picture graphs, bar graphs, tables, line graphs, and pie charts (including interpretation and use of information to solve problems) ▪ Average	▪ Data analysis (including interpretation and analysis of various statistical representations) ▪ Probability

The Science Curriculum in Primary and Lower Secondary Grades

The Singapore Science Curriculum Framework (Exhibit 4) is structured around the spirit and practices of scientific inquiry and defines three integral domains essential to the practice of science: knowledge, understanding, and application; skills and processes; and ethics and attitudes. The curriculum enables students to appreciate the pursuit of science as meaningful and useful, as it is grounded in knowledge, issues, and questions that relate to the role of science in daily life, society, and the environment.

Exhibit 4: Singapore Science Curriculum Framework[15,16]



The primary and lower secondary science syllabi are designed around themes that students can relate to in their everyday experiences and on commonly observed phenomena in nature. The five themes at the primary level are diversity, cycles, energy, interactions, and systems. The lower secondary science curriculum builds on the themes at the primary level, with an additional theme on models, and continues the way science is taught at the primary level as a way of exploring and understanding the physical and natural world. Lower secondary students are introduced to scientific endeavor to develop their understanding of how science is practiced and applied, and are provided with further hands-on learning opportunities situated in everyday contexts. This process enables students to make connections in science with their own lives and the environment. Exhibit 5 presents a summary of the topics to be learned under each theme by the end of Grade 8 (Secondary 2).

Exhibit 5: Science Themes and Topics

Primary Science Grades 3–6	Lower Secondary Science Grades 7–8
Diversity	
▪ Diversity of living and nonliving things (general characteristics and classification) ▪ Diversity of materials	▪ Exploring diversity of matter by their physical properties ▪ Exploring diversity of matter by its chemical composition ▪ Exploring diversity of matter using separation techniques ▪ Understanding diversity of living things
Cycles	
▪ Cycles in plants and animals (life cycles and reproduction) ▪ Cycles in matter and water	
Energy	
▪ Energy forms and uses (light, heat, and photosynthesis) ▪ Energy conversion	
Interactions	
▪ Interaction of forces (magnets, frictional force, gravitational force, and force in springs) ▪ Interaction within the environment	▪ Interactions through the application of forces ▪ Energy and work done ▪ Transfer of sound energy through vibrations ▪ Effects of heat and its transmission ▪ Chemical changes ▪ Interactions within ecosystems
Models	
	▪ Model of cells—the basic units of life ▪ Model of matter—the particulate nature of matter ▪ Model of matter—atoms and molecules ▪ Ray model of light
Systems	
▪ Plant system (plant parts and functions, respiratory, and circulatory systems) ▪ Human system (digestive system, respiratory, and circulatory systems) ▪ Cell system ▪ Electrical system	▪ Transport system in living things ▪ Human digestive system ▪ Human sexual reproductive system ▪ Electrical systems

Professional Development Requirements and Programs

Recognizing that teaching is a craft that needs to be continually honed through both reflective practice and purposeful professional development (PD), and that initial, fully sponsored teacher training at the NIE is only a starting point, MOE is committed to ensuring that teachers remain current, in terms of skills and knowledge, and are well positioned for the future. All teachers are entitled to 100 hours of PD per year. MOE works closely with the NIE to provide in-service training courses and advanced programs, including master's and doctoral degrees. MOE also provides specialized PD courses to update the content knowledge of teachers, and to help them keep abreast of pedagogical innovations and new assessment modes in the teaching of mathematics and science. Teachers also can benefit from experiential learning in research laboratories and in the business and community sectors through the Teacher Work Attachment program. Through these local or overseas attachments, teachers gain new experiences that, in turn, benefit their students through the fresh perspectives they bring back to their classrooms.

MOE also encourages the growth of a teacher-led culture of professional excellence and innovation among the teaching fraternity. In 2010, the establishment of the Academy of Singapore Teachers was a significant step toward achieving this aim. This teacher-led academy fosters pedagogical leadership focused on teacher collaboration in professional networks and learning communities within and across schools. It aims to strengthen the culture of teaching excellence and raise the standards of practice in the classroom and across Singapore's education system.

Monitoring Student Progress in Mathematics and Science

Schools assess students both formally and informally. From Grade 3 (Primary 3), schools typically conduct at least two summative assessments per year—one at the end of each semester. For formative assessments, teachers adopt a variety of subject-appropriate assessment methods, such as oral presentations, written tests, and portfolios. Formative assessments allow teachers to monitor student progress, identify strengths and weaknesses, and provide meaningful and immediate feedback. They also allow teachers to adapt teaching methods and materials to student needs and abilities.

Schools closely monitor student progress and work closely with parents to support student learning. Parents are updated regularly through progress reports, personal phone calls, and school-organized parent-teacher meetings.

National examinations aligned with the national curriculum are administered in the final years of primary, secondary, and preuniversity education. The Singapore Examinations and Assessment Board, in collaboration with MOE, conducts the following national examinations: the PSLE, GCE N-Level, GCE O-Level, and GCE A-Level.[17]

Special Initiatives in Mathematics and Science Education

Mathematics and science education in Singapore aims to cultivate student interest and lay a strong foundation in numeracy and scientific literacy from the early years of formal education. There are policies and programs in place designed to engage students with diverse interests and learning needs. For example, secondary school students with the aptitude and interest may opt to take more demanding mathematics and science courses. They may enroll in schools that specialize in mathematics and science. In addition, programs and resources are in place to help those who need more targeted help at both the primary and secondary levels.

A wide range of STEM enrichment programs complements the formal curriculum at both the school and the national levels. Science fairs, competitions, learning trails (where students apply mathematics and science concepts in outdoor settings), camps, workshops, and attachments to research institutes, for example, serve to engage and motivate students at all levels of learning. At the national level, MOE works in collaboration with partners such as the Agency for Science, Technology, and Research (A*STAR), Infocomm Media Development Authority (IMDA), and the Singapore Science Center to design programs for both the general student population and those with specific interests and talents. For example, the Singapore Science Centre partners with secondary schools to develop the school-based STEM Applied Learning Program, which allows students to apply their knowledge of science, mathematics, and technology to solving real-world problems. MOE provides opportunities for students with deep interest and aptitude in mathematics and science to work on research projects with mentors from institutes of higher learning and industries. MOE also works with overseas STEM education partners to provide students with a variety of exchange opportunities, with a view to broadening their horizons and inspiring them to pursue STEM careers.

Suggested Readings

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