STEM Education Landscape: The Case of Singapore

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Abstract. This conference proceeding is based upon the keynote delivered at the inaugural International Annual Meeting on STEM Education 2018 in Khon Kaen, Thailand. The title of the keynote was STEM Education and Research Landscape. During the talk, I provided an overview of STEM education in the United States, Singapore and a few other countries. STEM education in the United States has been extensively reported elsewhere (e.g., see National Academies Press). To scope this proceeding, I focus on STEM education in Singapore. Here, I offer a broad overview of the current state of STEM education in Singapore. Additionally, I provide some new information on this topic, which was not presented at the time of the talk. New STEM education-related events and efforts are emerging as I write. After all, the STEM education landscape is fast evolving in Singapore and the nearby regions.

1. The Role of the Ministry of Education

Many people have asked me: How does STEM education look like in Singapore? My summative response is that STEM education efforts in Singapore is wholistic. By wholistic, I mean that multiple stakeholders and agencies participate in the offer of diverse STEM programmes for different groups of clientele. Hence, the isn’t one, but diverse and collective efforts to promote and support STEM education. A key agent driving STEM education is the Ministry of Education (MOE), Singapore.

The Applied Learning Programme (ALP) was started by the MOE in 2013 to promote more authentic and practice-oriented learning experiences for students in Primary (Grades 1-6, aged 7-12) and Secondary schools (Grades 7-10, aged 13-16). Schools that embarked on the ALP design their own programmes emphasizing on the relevance of what is being taught to the current and future social and industry needs and trends. This is achieved through providing hands-on or experiential learning opportunities to students to enact the real-life situations so that in the process, they become equipped with the skills to apply the knowledge. Schools may design their own ALP curriculum or work with the industry, community-based entities, institutions of higher learning, and/or professional training bodies to offer the curriculum. Due to the popularity of the ALP, the former Minister of Education (Schools), Mr Ng Chee Meng, announced in Parliament that all primary schools will have an ALP in 2023 [1]. Among the ALP, which could cover STEM, languages, humanities, business, entrepreneurship, aesthetics, and so on, STEM ALP is one of the most popular programme in schools.

To support STEM education in schools, STEM Inc., the abbreviation for Science, Technology, Engineering, Mathematics innovation and creativity, or Incorporation, was established in January 2014. STEM Inc. was charged with the mandate to ignite students’ passion for STEM and they play a strong supporting role in the STEM ALP in secondary schools. They have STEM lesson packages that
can be used in the classrooms during the STEM ALP lessons. Schools can engage STEM Inc. to conduct STEM ALP lessons in their schools or at the Science Centre Singapore.

While the STEM ALP is an informal curriculum, there are formal secondary school applied subjects that are examinable at the GCE O-levels and GCE N-level national examinations (Tan, Teo, & Poon, 2017). The MOE Applied Subjects taken at O-levels include computing, electronics, exercise and sports science, and drama. There are also MOE-ITE (Institute of Technical Education) Applied Subjects taken at Normal (Technical)-Level for students in the Normal Technical tracks and these include mobile robotics, smart electrical technology and retail operations.

2. Selective STEM Schools and STEM Education in non-STEM-focused Schools

According to a U.S. report by The Committee on Highly Successful Schools or Programs for K-12 STEM Education [2], which was supported by the National Science Foundation, there are four types of STEM schools or programmes in the United States. These are STEM selective schools, inclusive STEM-focused schools, STEM-focussed Career and Technical Education, and STEM education in non-STEM-focused schools. Based on my scan of the STEM landscape in Singapore, the first and fourth types of school or programme exist locally.

In 2005, the National University of Singapore High School of Mathematics and Science (NUS High) was established to offer advanced mathematics and science programmes for academically talented students in these disciplines. NUS High is thus, similar to the elite or selective STEM-focused schools or specialized STEM school in the United States (e.g., Illinois Mathematics and Science Academy and North Carolina School of Science and Mathematics), Australia (e.g., Australian Science and Mathematics School), and the Philippines (e.g., Philippines Science High School). Other than its advanced curriculum, NUS High shares similar characteristics as other elite STEM-focused schools in terms of having highly qualified teachers with Master’s and doctorate degrees, like-minded peers interested in STEM disciplines, and students having the opportunity to do independent research projects under the supervision of their teachers, scientists, or university faculty.

Following NUS High, a second STEM-focused school, the School of Science and Technology (SST), that offers a four-year GCE O-level programme [3] was established in 2010. SST adopts an integrated approach to applied learning and a cornerstone of SST pedagogy is the use of ICT (information communication technology). SST works closely with the local polytechnics to offer applied subjects such as Biotechnology, Computing, Design Studies and Electronics to students.

While NUS High and SST are similar to the elite or selective STEM schools, some schools in Singapore also offer specialized STEM-related programmes as a niche area for a selected group of academically talented students. For example, Hwa Chong Institution has a School Scientist Programme where students embark on independent research projects with an in-house School Scientist. Raffles Institution has established the Raffles Science Institute intended to nurture students to become future leaders and pioneers of the science community. The school has an OpenLab, which is staffed by researchers with doctorate. As teacher-researchers, they supervise the brightest science students in projects such as water technology, viral biology, marine ecology, and gene-chip technologies.

3. Informal STEM Programmes

Other informal STEM programmes include STEM-based competitions and research attachments. Examples of STEM-based competitions include the Shell Singapore: The Bright Ideas Challenge held in 2017 and 2018 for secondary school students (Grades 7-10, aged 13-16) to pitch creative ideas for future cities that are vibrant, healthy, and clean to live in. The winner team could also win the chance to visit attend a STEM-related event in London. The Science Centre Singapore have also organised the Drone Odyssey Challenge which is a game-based competition to inculcate technical skillsets, critical thinking and develop appreciation of new and disruptive technologies relevant to the modern world. The competition is designed for primary and secondary school students and there are workshops and demonstrations to lead up to the competition so that students are prepared for the tasks. There are also
Maker Faire Singapore organized to bring practitioners (e.g., tech enthusiasts, crafters, educators, tinkerers, hobbyists, engineers, science clubs, commercial exhibitors, students, artists) of the maker movement to show what innovation products they have made and what they have learned.

4. STEM at Higher Education
The STEM wave has also caught on the tertiary education sector. In 2009, the fourth autonomous university, Singapore University of Technology and Design, was established. SUTD offers a design-centric and interdisciplinary curriculum through cohort-based learning approach. The Institute of Technical Education, which is a post-secondary institution for school leavers and working adults, also offers short-term STEM courses such as three-dimensional printing, creating computer games, programming mobile Applications (Apps), and mobile robotics.

5. meriSTEM@NIE
In 2018, the Multi-centric Education Research and Industry STEM Centre at the National Institute of Education (meriSTEM@NIE) was established. NIE is Singapore’s national teacher education institute and plays a key role in teacher preparation and the provision of professional and school leadership development programmes. meriSTEM@NIE is a research centre within NIE. The mission of the centre is:

- To enhance the quality of STEM literacy in Singapore through cross-disciplinary partnerships in research, teaching, and outreach so that future generations of educators, learners, and citizens are able to harness relevant STEM knowledge and skills in addressing current and emerging challenges for self and others.

meriSTEM@NIE is the first STEM centre in Singapore that engages in research, research-informed STEM education and evidence-based STEM education outreach. The Centre’s work is guided by the Integrated STEM Instructional and Evaluation Framework, which is used to inform the design of integrated lesson packages for teachers and students. The same Framework can be used to evaluate the fidelity of implementation of integrated STEM.

6. Summary
In essence, the STEM education landscape in Singapore is enriched by supportive efforts from the Ministry of Education and ground-up efforts from private and public organizations. Even as you read this piece, the STEM landscape is evolving.

References
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