Chapter 5
ICT Masterplans in Education: Singapore's Reform Efforts to Engage in a Post-COVID World

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Abstract In 1997, Singapore committed to reforming its education system with the aim of preparing young Singaporeans for changes in the coming decades. The national Information and Communication Technology (ICT) Masterplans were one of a series of reform initiatives that began with a focus towards change in teaching and learning in Singaporean classrooms with technology integration. In this article, we summarize the four ICT masterplans implemented since the "Thinking Schools Learning Nation" (TSLN) initiative. Following the introduction of the first masterplan for ICT in education, the Ministry of Education ensured that schools had infrastructure, leadership and necessary teacher training to successfully implement the initiatives. The descriptions of the implementations are valuable lessons for other national systems in the region and beyond that are seeking improvement in their education systems through technology-enhanced learning and ICT.

Keywords Singapore · ICT · Masterplans · Technology · Reform · Blended learning

5.1 Introduction

Singapore continues to rank among top ten global cities in the world for human development based on indicators of health, education and income. The country is an excellent case study of how the government and its people respond constantly to the incessant changes in globalization in the current volatile, complex and uncertain world. Education has been recognized as a critical sector, and Singapore has formulated and developed a number of national Information Communication Technology (ICT)-focused schemes to increase ICT awareness and literacy (Koh and Lee, 2008).

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Against the backdrop of a highly globalized economy that is increasingly knowledge-based, Singapore recognizes the need to foster innovation in educational delivery. In addressing these concerns, several educational policies and initiatives have been launched. An example is the TSLN vision plan. Singapore has implemented four ICT-in-Education masterplans over the last 20 years. The TSLN spiraled into a number of initiatives in subsequent years with widespread propagation of ICT in schools (Reyes & Gopinathan, 2015). This chapter provides a description of Singapore's national ICT Masterplans since 1997, summarizing their aims and achievements as well as the impact on the education, economic and social dimensions of life.

5.2 Singapore's First Three ICT Masterplans

The first ICT Masterplan (MP1) was launched in 1997 with a budget of $2 Billion SGD. The objective was to lay a strong foundation in ICT for all schools in Singapore in terms of technology infrastructure and education capacity (MOE, 1997, 2002). The target was to begin teacher capacity building for technology tools so teachers were comfortable to begin using the computers. Networked access for entire schools with Internet and an ambitious 5:1 pupil to computer ratio was planned. Towards the end of the first phase in 2002, Singapore was ranked second in the world, after Finland, in the then Global Competitiveness Report (2001–2002) for the availability of Internet access in schools (Porter et al., 2002). Between 30 and 50 hours of teacher capacity building was planned for every teacher in the system over a one-year period, which was considered remarkable by international standards. A policy was established that entitled each teacher to 100 hours of sponsored professional development per year. Teachers had to complete a few modules of just ICT training over 30–50 training hours in the initial stages of the masterplans. MP1 was implemented in three phases, starting with 22 schools in phase 1, followed by extension to all schools by 2002. At the end of MP1, all schools were equipped with necessary physical hardware and infrastructure to prepare them for ICT-based education. Teachers had been trained with basic ICT competencies and had accepted the reality of an educational paradigm that is ICT-powered. It also provided a blueprint for the integration of ICT in education as a strategy for equipping students with the requisite ICT skills to empower them to meet the challenges of globalization and technological advancements (Lee & Koh, 2008).

ICT Masterplan 2 (MP2) followed in 2003 with a budget of $600 million SGD, where a key focus was the establishment of structures, such as tiered support for schools at various levels of ICT usage for Teaching and Learning, to promote a culture of exploration and innovation in education. During this phase, a set of baseline ICT standards that every student in the system had to attain at certain milestones of education (e.g. by Primary 3 or Secondary 3 level) was also implemented. New and alternative pedagogies such as inquiry-based learning and problem-based learning emerged. ICT-related products from the students included blogs, e-portfolios, animations and videos where they demonstrated what they learned in class. It is important to note that

all of these were happening concurrently with the rise of socio-technological inno-vations such as Wikipedia, YouTube and the immersive world of Second Life. At the end of MP2, a sustainable framework for the sharing of digital educational resources and ICT-based pedagogical practices had been put in place. Teachers embarked on a range professional development programs in the form of workshops, field work, collaborations with industry partners, etc.

The third Masterplan began in 2009. Efforts to enhance ICT integration within the curriculum, pedagogy and assessment in order to keep pace with the 21st century competencies evolved (MOE, 2008). The use of ICT was encouraged not only for building technology literate citizens but also to instill higher order thinking, commu-nication and collaboration skills. A push towards varied ways of learning using ICT was encouraged—self-regulated learning, individualised instruction, anytime-anywhere learning, deeper learning, collaborative learning etc. Teachers were also encouraged to share best practices and learn from their peers. The Ministry continued to focus concurrently on leadership capacity building for implementing ICT based plans. By 2014, several initiatives like Fasttrack@school, Edvantage, and eduLab had been implemented and evaluated.

In 2019, 98% of resident households in Singapore reported they had access to Internet at home (Infocomm Media Development Authority, 2021). The evaluation study of the Third ICT Masterplan (MP3) in Education revealed that Singapore teachers had been using various tools with social media affordances such as LinoIT, Wallwisher, Glogster, MindMeister, Google Sites and Edmodo over the last five years to support self-directed learning and collaborative learning among the students (Tan et al., 2013; Seow et al., 2020)

To date, four ICT masterplans have been successfully implemented, namely, Masterplan One (1997–2002), Masterplan Two (2003–2008), Masterplan Three (2009–2014), and Masterplan Four (2015–present).

5.3 Two Decades of Education Technology

The Fourth Masterplan for ICT in Education (MP4), is meant to build on the experi-ences and successes of the preceding three Masterplans, and it therefore focuses beyond self-directed and collaborative learning (SDL and CoL) to the overall curriculum (MOE, 2015). MP4's focus is to use ICT productively to develop knowl-edge through subject mastery, skills through 21st Century Competencies, and atti-tudes through responsible digital citizenry. The alignment of this fourth master-plan follows MOE's direction towards student-centric and value-driven education, including in the areas of cyber-wellness and responsible and safe media literacy. MP4's vision is to nurture "Future-ready and Responsible Digital Learners". The two enablers associated with this objective are: (i) Teachers as Designers of Learning Experiences and Environments, and (ii) School Leaders as Culture Builders. Deeper ICT Integration in curriculum. Assessment and pedagogy, sustained professional

learning, translational research and innovation and teacher capacity development are the four approaches within MP4 to achieve the desired vision.

5.4   The Student Learning Space

The Student Learning Space (SLS) is yet another technology initiative that was rolled out in 2018 by the MOE. SLS is an online learning platform that permits all students from primary to pre-University levels to have equal access to good quality curriculum-aligned resources. The system allows teachers to conduct lessons both synchronously and asynchronously. In preparation for the development of 21st-Century Competencies (21CC), the SLS enables learners to be independent, and self-directed, and allows them to personalize their learning according to their needs and interests. Teachers have a range of tools that they can utilize to design meaningful learning experiences. They use the tools for lesson preparation, lesson enactment and evaluation.
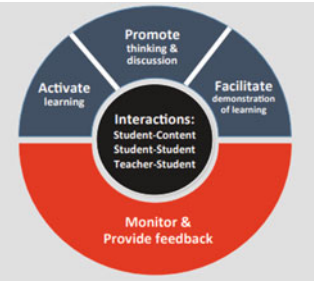
Assessment tools are built in to assist teachers to monitor students' comprehension regularly and provide targeted interventions, as well as appropriate feedback to address the gaps in understanding. The platform also facilitates sharing among teachers and educators across schools. Teachers can enrich their lessons by linking to external videos from YouTube or TED talks, in addition to an MOE library of resources. They can also use other tools and applications which can be integrated into the platform with ease. The hope is that the resources within the SLS will help in leveling the playing field for all students in Singapore by providing access to quality learning resources. Students can access these resources through school networks and the computer labs in schools. Table 5.1 shows the respective structure of Singapore's student learning space pedagogical scaffold.

The SLS was very timely in view of the COVID-19 pandemic in helping Singapore embark on home-based learning swiftly without students facing any interruption to schooling. Table 5.2 shows the roles of student, teacher and technology in active learning processes.

5.5   Impact of Covid-19 on Learning in Classrooms of the Future

The COVID-19 pandemic has disrupted education systems globally and countries around the world are grappling with the many challenge of restoring normalcy in teaching and learning for schools. There is a huge opportunity to re-imagine and transform the education systems in a post-COVID world. Technology has always been considered important as part of the 21st-century skills but most countries have also seen that technology itself presents a huge disparity between those who are

Table 5.1 Student learning space pedagogical scaffold

Lesson preparation	Lesson enactment	Assessment & feedback
Phase 1 **Establish learning outcomes**	*Phase 2* **Design & facilitate active learning with technology**	*Phase 3* **Assess quality of learning**
Q1. What are the key concepts essential to my students' understanding of this topic? Q2. What are the skills, values and attitudes, including 21CC, that are important for my students to develop? Q3. What are the success criteria that can inform me that my students are learning? Q4. What evidence would I use to know my students are learning? Q5. What is the pedagogical approach in relation to the iden8fied learning outcomes? Q6. What are technologies that can be harnessed to: • Promote learning of the key concepts; • Develop skills, values and attitudes, including 21CC; • Check for student understanding; • Monitor student learning • Provide feedback?	Q7. How would I design learning activities that promote the following active learning processes with technology? • Ac8vate learning • Promote thinking and discussion • Facilitate demonstra8on of learning • Monitor and provide feedback Q8. How would I facilitate student-content, student-student and teacher-student interactions for active learning? **Active learning with technology** 	Q9. How did the evidence of learning with technology show that learning outcomes were met? Q10. How effec8ve is the design of the learning ac8vi8es with technology?

Source: Education Technology Division, Ministry of Education, Singapore

connected and those who are not, during the pandemic. The gap between what skills children learn and what they need is getting wider in today's post-pandemic world.

5.6 Technology in Teaching and Learning Going Forward

Singapore has embarked on a journey to step up efforts to focus on students' strengths and maximise opportunities for each individual child in school. Technology can enable the creation of personalized experiences, as well as assess based on individual learner potentials. Blended learning, where a mix of face-to-face and online modes that includes a day of home-based learning (HBL), is being introduced in Singapore schools from 2021. This is the next tier of policy changes in the system involving ICT, and the SLS infrastructure is being used to implement it. The two decades of ICT Masterplans in Education have evolved from a strong focus on "Foundation building"

Table 5.2 Roles of student, teacher and technology in active learning processes

Active learning processes	Role of student	Role of teacher	Role of technology
	Interactions between teacher, student & content		
Activate learning How will students' focus and interest be oriented towards the learning objectives?	• Set own or group learning goals • Connect prior knowledge to the task	• Clarify learning objective and success criteria • Design trigger activity to elicit students' prior knowledge	1. Multimodal representation of a concept e.g. multimedia resources, websites, podcasts, webcasts, anima8ons, videos 2. Facilitate planning, participation and development of ideas e.g. wikis, email, online calendar 3. Task environments that represent and simulate real-world problems, situations and contexts e.g. microworlds and simulations, virtual/augmented reality, role-play simulations, serious games and immersive environment, manipulatives to facilitate problem-solving 4. Analysis and synthesis e.g. graphic organisers, mindmap, spreadsheets, computational tools or software 5. Iterative discussions e.g. web conferences, live or asynchronous online chat or forum 6. Collection of data e.g. data-logging devices, online survey 7. Access to information for research e.g. online libraries, databases, search engines Access to learning partners or experts e.g. email, web conferencing, social media tools, online learning network, webinars, online courses, MOOCs 8. Creation of digital products e.g. video editing, infographics, slideshows, animations, website, blog, e-books 9. Tracking and assessing e.g. clickers to gather responses to ques8ons, online quizzes, classroom management system 10. Communicate feedback e.g. email, web conferencing, social media tools, annota8on tools
Promote thinking and discussion How will students think about ideas and concepts? What skills and processes will students perform? How will students build on their current understanding?	• Engage in thinking through discussion, negotiation and meaning making Use peers' and teacher's ideas and concepts to refine own understanding	• Design tasks to connect, challenge, deepen or extend students' thinking • Provide thinking routines or scaffolds • Get students to share their ideas and concepts • Teacher articulates his/her ideas and concept	
Facilitate demonstration of learning How will students demonstrate their understanding and new learning?	• Ar8culate understanding of concepts • Demonstra8on of skills • Apply learning by creating a digital product	• Design performance tasks for students to apply their learning in various ways	
Monitor and provide feedback How can students' learning be advanced?	Provide feedback to peers • Use feedback from peers and teacher to refine own understanding • Reflect on goals and learning process	• Check for understanding using students' works • Give timely and targeted feedback • Provide opportunities for feedback from peers or experts • Ensure learning objectives and success criteria are met	

towards the "strengthening and scaling" of pedagogically sound practices. As ICT is increasingly woven into teaching and learning interactions, the implementation of ICT Masterplans would necessarily be more complex and diverse.

The culture of sharing amongst educators has been carefully nurtured through the Masterplans, and this needs to continue so that best practices can be effectively spread within the system. MP4 has envisioned the strategy of strengthened Networked Learning Communities (iNLCs) for Technology in Learning to sustain professional learning among the pre- and in-service communities. In the new culture of learning, the divide between formal and informal learning becomes blurred. Much can be learned from interaction with peers, everyday activities and the social media. Schools should recognise this and perhaps alternative assessment methods can be considered to incorporate student learning in their informal activities.

5.7 Singapore as a Smart Nation

The Smart Nation initiative is about creating new opportunities in the digital age, and transforming the way people live, work and play, so that Singapore remains an outstanding green global city (Government of Singapore, 2020). The ICT Master-plans in schools following the TSLN vision was one integral element. Today, teachers in Singapore appear much more comfortable with technology in classrooms, using it for both teaching, administration, as well as their own learning. Beginning with a vision, and a leadership to implement the vision, enabling infrastructure was followed by curricular changes. Encouraging teachers to move away from a direct-instruction to a technology-integrated inquiry-oriented pedagogy was a huge challenge, but not impossible.

Within a competitive environment, it is important that workers are able to work collaboratively in teams, think critically and innovatively, add value to existing knowledge and cultural artefacts, and be competent in the use of ICTs. Such demands have led many developed and developing countries to embark on reforming their respective education systems (Day & Sachs, 2004).

It is often assumed that high-stakes tests in Singapore inflict pressure on teachers' pedagogic styles to "teach to the test", resulting in rote learning. However, examples from various future school interventions have demonstrated that different types of assessments at classroom level have helped children to acquire the content knowledge, inquiry and creativity skills, and 21st century competencies needed for the 2030 workforce (Norris et al., 2016). Other case studies have been reported on how innovative curricular designs in science classrooms that incorporate elements that help in bridging formal and informal student learning spaces using seamless mobile technologies have been successful (Looi et al., 2016).

5.8 Conclusion

Singapore education system continues to thrive as one of the best public education systems in the world. The TSLN initiative and the accompanying ICT Masterplans were huge endeavours that attempted to transform the Singapore education system. It is important to mention that OECD's 2015 report shows that there has been no appreciable improvement in student achievement in international assessments in reading, mathematics or science, on average, in countries that have invested heavily in ICT for education. However, the argument here is that Singapore has achieved to implement ICT on a wide scale in schools so that technology can help build an inclusive and accessible society. The Masterplans have addressed digital and information divides through a sustained agenda of ICT education in schools, where there are opportunities and avenues for every student to engage and participate in the digital economy. Self-directed learning and some foundational life skills like time management, self-regulation and persistence need to be taught to students to enculturate a spirit of lifelong learning. According to a New York Times columnist (Friedman, 2020): "the most critical role for K-12 educators, therefore, will be to equip young people with the curiosity and passion to be lifelong learners who feel ownership over their education".

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