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Redefining successful teaching and learning in Singapore's education system

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Leading educational thinking and practice

Contents

This paper is a collaboration between CSE and Google for Education for the Asia Pacific Leadership Symposia. The Symposia bring together education system leaders from across Asia Pacific to share powerful leadership practices that have high impact in education transformation. The Leadership Papers combine insight into new capabilities for system leadership, analyse innovative strategy, and demonstrate the power of digital to transform learning. They provoke, share and support new thinking and innovation in education.

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Introduction

Fundamental shifts in the economy, society and the environment, at the global, regional and national levels, are redefining how people work, live and learn in Singapore. For example, rapid technological advancements globally are reshaping business models, where organisations compete on intangible assets such as intellectual property, data and user networks. Another shift relates to Singapore's ageing population and low birth rate. This demographic change will lead to a shrink in the growth of the local workforce and place strain on the social fabric of Singapore. On the environmental front, Singapore needs to balance its urbanisation need for resources and create sustainable practices to reduce its carbon footprint.

At a glance, these challenges may seem unrelated to schools. However, the Ministry of Education's mission is to

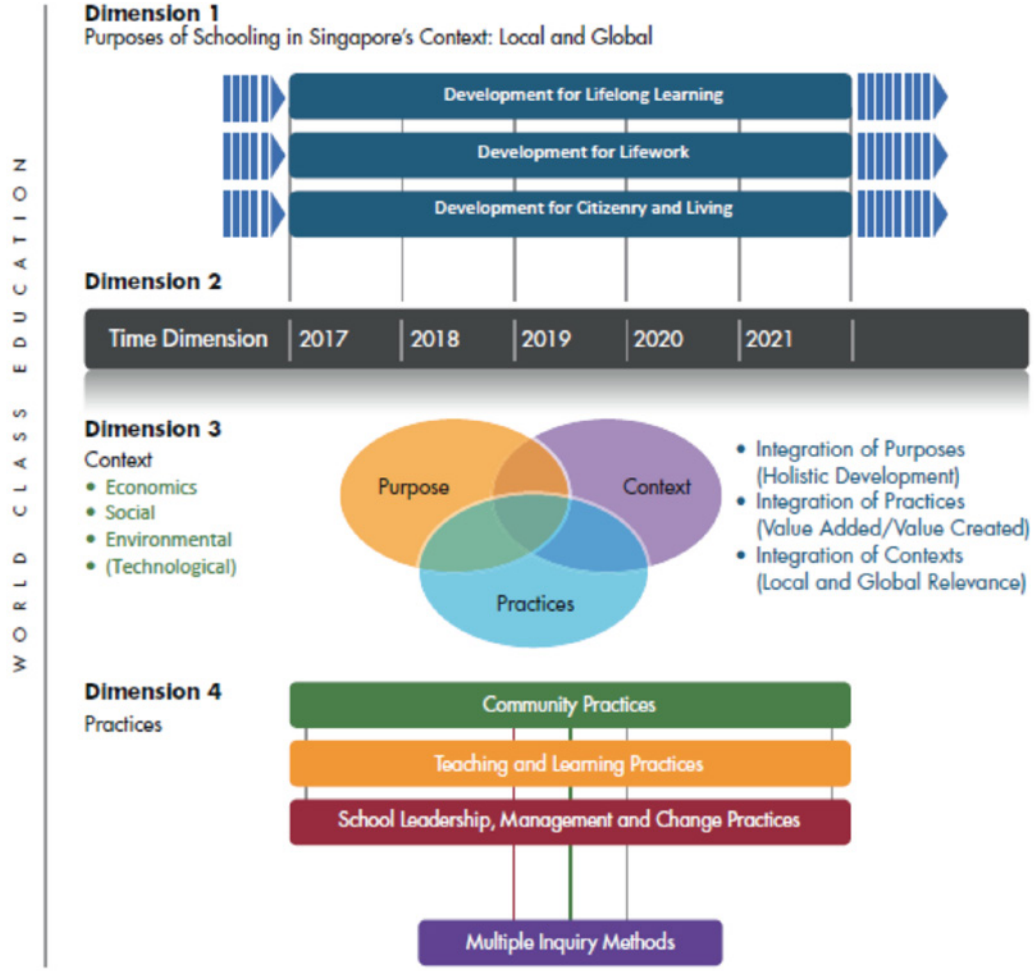
'… mould the future of the nation by moulding the people who will determine the future of the nation'.

(See moe.gov.sg/about-us/our-mission-and-vision#:~:text=The%20mission%20of%20MOE%20is,to%20think%2C%20achieve%20and%20excel.)

The challenges that Singapore faces have fundamental implications and questions for the readiness of Singapore's education system in enabling its learners actively to co-create the future of its environment, society and the economy, together with the government.

- How do we develop 'future-ready' learners who will co-create living, lifework and learning in Singapore?
- What skills, knowledge and values are needed, beyond subject mastery, to enable learners to thrive in Singapore's future contexts?

Figure 1. Multidimensional framework for educational success (copy, with permission, from Ng, 2019).



Consider my following definition of the purposes of successful education and what being future-ready means.

> *An education system can only be successful if it is able to develop future-ready individuals who will continue to learn beyond graduation, take on future lifework and thrive in a changing society and environment.*

In this definition, there is clear reference to and connection of education with lifelong learning, in order to prepare learners for the future of lifework, society and the environment. These connections stress the importance of the education system being tightly integrated and interconnected with the local contexts and larger systems. Figure 1 illustrates the connectedness of the various contexts and systems with education, which has immediate implications to inform educational practices.

In the next section I explore the importance of systems and contexts in determining the future of education in Singapore.

Contexts as defined by systems

Education and context share an intricate, mutually dependent relationship. Context shapes education; at the same time, education also shapes context. The outcome of education is to develop future-ready learners who co-shape and co-create the future contexts of economy, society and environment. In terms of economy, education develops the human capital of the work force and raises economic productivity (Ozturk, 2001; Sahlgren, 2014). Other important factors that contribute to the economy, such as politics and domestic and foreign investments, are also influenced by the education of policy makers and investment managers (Ozturk, 2001). Education shapes society by instilling social, religious and cultural values and norms to help individuals integrate into their communities. Through socialisation, education ensures that individuals are raised appropriately as members of their society (Francois, 2015). Also, education can be used for guiding individuals' attitudes and behaviours regarding environmental resources (Fu and Liu, 2017).

> Context shapes education; at the same time, education also shapes context.

Moving on from the ways in which education shapes context, let us consider the ways in which context shapes education. In particular, how do the trajectories of future contexts shape education? Context provides the frame for the specifics and details that describe the purposes of education. As mentioned earlier, successful schools are those that fulfil the three purposes of education. School leadership plays a fundamental role in leading schools to achieve success. The practices and policies implemented by school leaders are essentially shaped by the context in which the school is situated. The interpretation of the context by school leaders directs the vision, practices and criteria that school leaders set for the success of schools.

Numbers of scholars have emphasised the importance of examining school leadership in context (Braun, Ball, Maguire and Hoskins, 2011; Clarke and O'Donoghue, 2017; Hallinger, 2018; Moos, Krejsler and Kofod, 2008; O'Donoghue and Clarke, 2015). Hallinger (2018) describes six contexts in which school leadership is situated – institutional, community, national cultural, economic, political and 'school improvement' contexts.

- The institutional context refers to the education system as a whole and its various parts on the regional level, state level and local level. The structure of the education system influences the role definition and behaviour of principals, such as their allocation and use of time (Lee and Hallinger, 2012).
- The community context, such as the socio-economic composition of the school, and whether the school is located in urban or rural communities, also shapes how principals adapt their leadership.
- National culture influences the socio-cultural norms and values that are upheld and practised by school leaders. For example, whether leadership is practised in a top-down manner or a less hierarchical manner, reflects socio-cultural standards of the society in which the school is situated.
- The economic context greatly affects the resources and opportunities to which a school has access, which in turn influences the work of the school leaders.
- The political context shapes the political ideology that directs the broad policies and practices of school leaders (Bell and Stevenson, 2015).
- Last but not least, the context that Hallinger (2018) referred to as 'school improvement' context is the school improvement trajectory. At different stages of a school's improvement, school leaders will shift their focus and practices accordingly.

National policies are part of the macro-context at the national level, while 'school improvement' context relates to the specific school.

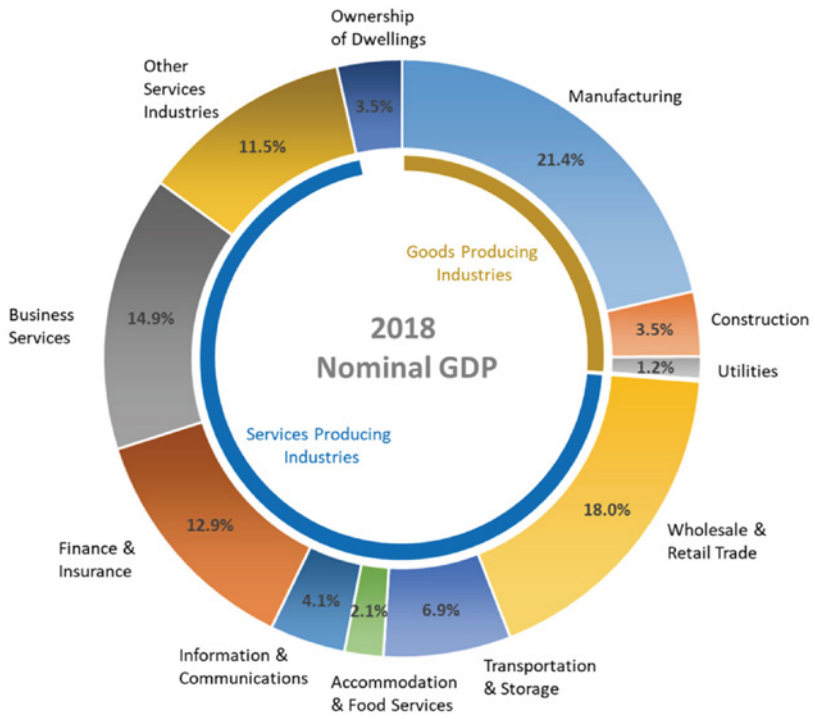
Contexts overlap and are interdependent. Overlapping and ambiguous as they might be, it is important for school leaders to take contexts seriously to achieve success for their schools. In this paper, I have selected economic, social and environmental contexts to describe the purposes of education over time. These are macrocontexts at the national level and relate to the three purposes of education identified above: learning, lifework and wellbeing. Technological aspects are interwoven into all the three primary contexts. Next, I examine the contexts in which Singapore is situated and make comparisons with other high-income countries.

Interconnectedness of the economic system with the education system

Change is constant in the economic trajectory of a country. Change includes growth in Gross Domestic Product (GDP) and new economic directions that have direct implications on change in capabilities, competencies and knowledge. When plans are announced for new economic restructuring, it becomes imperative for political leaders and educators in the country to review the current desired educational outcomes, and the related efforts being made to develop the next generation of the local workforce.

Singapore achieved a real GDP growth of 3.2 per cent in 2018 (Department of Statistics Singapore, 2019a and b), amid global uncertainties such as Brexit and

Figure 2. Contributions of different industries to Singapore's nominal GDP in 2018. Figure charted with data from Department of Statistics Singapore (2019b).



trade tensions between US and China. For 2019, Singapore's GDP growth forecast was 1.5 to 3.5 per cent (Ministry of Trade and Industry, 2020). Figure 2 shows the breakdown of the contributions of the various industries to Singapore's nominal GDP in 2018. As can be seen from the figure, the services-producing industries make up the greater portion of the nominal GDP at 70.4 per cent, while the goods-producing industries make up 26.1 per cent. For the services-producing industries, the top three contributors are wholesale and retail trade (18.0 per cent), business services (14.9 per cent) and finance and insurance (12.9 per cent). For the goods-producing industries, manufacturing is the major contributor (21.4 per cent), followed by construction (3.5 per cent) and utilities (1.2 per cent). The largest single industry is manufacturing, which consists of these clusters: electronics, chemicals, biomedical manufacturing, precision engineering, transport engineering and general manufacturing (Ministry of Trade and Industry, 2020). Together, all the industries have their roles to play in contributing to the GDP of Singapore (see Figure 2).

Trajectory of the future economy: Shift in focus of the economy (1990s, 2000s, 2010s to present)

Over the years, Singapore has shifted the focus of its economy. Table 1 (overpage) summarises this shift from the 1990s onwards. Increasingly, there is an emphasis on innovation, value creation and technology adoption and digitalisation.

Committee on the Future Economy (CFE)

Moving forward, Singapore has to remain competitive by maximising value creation, to sustain economic growth for the nation and create quality jobs for the people. To achieve this, the Singapore government set up the Committee on the Future Economy (CFE), in January 2016, to review Singapore's economic strategies for the next decade.

The CFE identified seven key strategies for developing Singapore's economy. The following briefly summarises each of these strategies (CFE, 2017).

1. ***Deepen and diversify Singapore's international connections.*** Singapore needs to continue with trade and investment cooperation with global partners, set up a global alliance for innovation, and enable its people to deepen their knowledge of Singapore's markets.
2. ***Acquire and utilise deep skills.*** Singapore needs its people to develop deep skills to stay relevant and create value in the economy.
3. ***Strengthen enterprise capabilities to innovate and scale up.*** Singapore's innovation ecosystem has to be strengthened, via commercialising intellectual property and research findings. The government will assist enterprises to scale up and encourage partnerships between enterprises. Private sector financing will be encouraged.
4. ***Build strong digital capabilities.*** The government will promote the adoption of digital technologies across all sectors of the economy.
5. ***Develop a vibrant and connected city of opportunity.*** Singapore's status as a global air and maritime hub will be strengthened. Land use will be optimised. The government will develop precincts that foster economic and lifestyle activities. The government will partner with the private sector to develop exportable capabilities, such as water technologies.
6. ***Develop and implement Industry Transformation Maps (ITMs).*** These are road maps to drive industrial transformation. ITMs will be tailored to each specific industry to help the industry achieve its potential and create jobs for Singaporeans.

Table 1. Focus of Singapore's economy for 1990s, 2000s, 2010s to present. References are Beh (2017); EDB Singapore (2014); EDB Singapore (2019).

	1990s	2000s, 2010s TO PRESENT
Global backdrop	• China emerges as manufacturing powerhouse • United States leads the internet boom • Asian financial crisis (1997-1998)	• Dot-com bubble burst (early 2000s) • Global recession (2007-2009) • Emergence of Industry 4.0 • Rise of Asia • Global trade tensions
Emphasis of Singapore's economy during this period	• The Economic Development Board (EDB) strengthens its focus on chemicals, electronics and engineering industries • Economy diversifies business units to include service sectors such as lifestyle and entertainment	• Developing higher skills in workforce, growing an innovative economy, and building a distinctive global city • Encouraging technopreneurship and fostering a vibrant startup ecosystem • Focusing on value creation and innovation: the productive use of resources and the creation of new businesses and new products • EDB continues to build on Singapore's strengths in industries such as semiconductors, energy and chemicals, biomedical sciences, aerospace, industrial machinery and infocomm technology • Building strong digital capabilities in finance, advanced manufacturing and healthcare. This will also include developing strong capabilities in data analytics and cybersecurity
Some milestones in Singapore's economy during this period	• EDB sets up the Creative Services Strategic Business Unit to promote film, music, arts, design and media • Toshiba establishes its operational headquarters in Singapore • Land reclamation for Jurong Island begins to further develop the energy and chemicals industry	• Singapore's research hub for biomedical science, Biopolis, is conceived and set up for key private and public research organisations • Renewable Energy Corporation (REC) breaks ground on its S$2.5 billion solar plant: the largest clean technology investment in Singapore • Major companies eg, Dyson, Procter & Gamble, Applied Materials and Infineon set up R&D centres in Singapore • Singapore is ranked the 6th most innovative economy in the world by the 2017 Bloomberg Innovation Index and the 2016 Global Innovation Index

7. ***Partner each other to enable innovation and growth.*** Trade Associations and Chambers (TACs), unions, enterprises and individuals will work together to generate innovation and growth, while creating a sustainable environment for the people in Singapore.

The CFE expects that the collective efforts associated with these strategies will enable Singapore to grow by 2 to 3 per cent per year on average over the next decade.

Emphasis on the adoption of new technologies and innovation

In recent years, two of the themes that have been reiterated in the government's budget statements are the adoption of new technologies and the need for innovation (Heng, 2016, 2017, 2018, 2019). These have some overlaps with the key strategies identified by the CFE, which have been mentioned in the earlier section. In the following sections I shall discuss the two themes more deeply, with some specific examples.

The need for industries, enterprises and workers to adopt new technologies is in tandem with the emergence of Industry 4.0. Across the globe, new technologies are reshaping the economies of nations, business models of enterprises and jobs of individuals. For example, the global trajectory towards high value for manufacturing requires that manufacturing companies move up the value chain (Livesey, 2006). This can be assisted through deploying suitable new technologies such as automation and robotics. High-value manufacturing is important to Singapore, as manufacturing is a significant contributor to the nation's economy. When we speak of high-value manufacturing, we consider the financial, strategic and social aspects of value (Livesey, 2006). For example, for the financial aspect, automation can reduce manpower, and thus make production more cost-effective. Recognising these trends, the government launched a new Automation Support Package in *Budget 2016* (Heng, 2016). The package was intended for firms to utilise large-scale automation, including Internet of Things (IoT) and robotics. It comprised grant, loan and tax components. Since its launch, it has helped more than 300 companies to automate their processes and raise productivity. To encourage more companies to follow their example, *Budget 2019* announced the extension of the Automation Support Package by another two years (Heng, 2019).

Another example of Singapore's support for enterprises to adopt new technologies is the National Robotics Programme, which was announced in 2015. The purposes of this Programme are to drive industry-level transformation, via deploying new technologies to solve problems that are relevant for the entire industry, as well as to create high-value jobs. *Budget 2016* and *Budget 2018* announced the expansion of this effort (Heng, 2016, 2018).

Digitalisation becomes commonplace in Industry 4.0 and has the power to transform large and small companies. The Singapore government has recognised that the first way to help its enterprises, especially small and medium enterprises (SMEs), is to help them adopt digital solutions. The SME Go Digital Programme was introduced in *Budget 2017* to make it easier for SMEs to build digital capabilities (Heng, 2017). In this Programme, SMEs receive step-by-step advice on the digital solutions to adopt at each step of their growth (Infocomm Media Development Authority, 2019).

Redefinition of Successful Education: Develop learners for future lifework

The global economic landscape is becoming more competitive, and it is imperative for Singapore to create new value in the products and services that it delivers. Singapore cannot sustain a competitive edge simply by producing what the rest of the world is producing (Lee, 2015). This calls for innovation in the jobs of the future. Also, Singapore's economic trajectory requires workers who are able to learn and apply technology quickly, to keep up with the speed of change in the age of Industry 4.0 (Schwab, 2016). Paper qualifications are no longer sufficient for employers. Increasingly, employers are looking for workers who can adapt quickly and provide creative solutions to problems. Lifelong learning becomes the norm (SkillsFuture Singapore Agency, 2019a). Those who cannot catch up will face great challenges in the future economic landscape of high-value manufacturing and high-value services jobs.

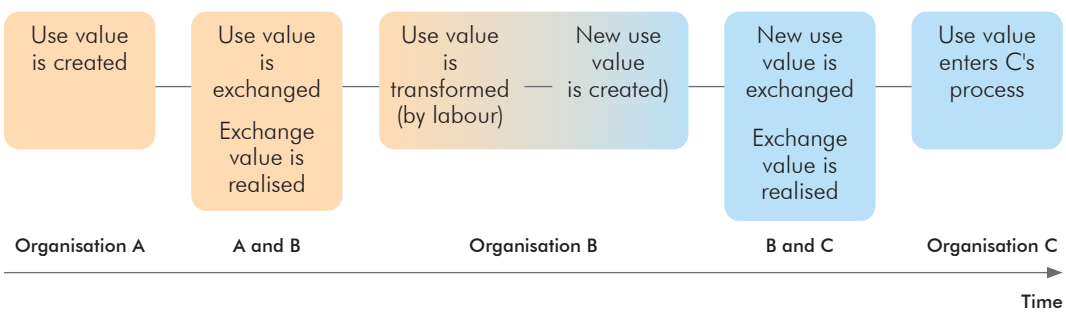
An education system can only be successful if it is able to develop future value in individuals to prepare them to take on and thrive in jobs in the future (the second purpose of education, with a future perspective). For example, education must make innovation an ingrained mindset in students to prepare them for future jobs. Developing an innovative mindset will require consistent teaching and learning environments that will foster such a mindset. Rote learning and efficient learning will no longer be enough in the new economic reality (Ng, 2021).

In the next decade, and relevant to Singapore's context, value creation will be instrumental to create new jobs, products and services, and to change the way we live, learn and work. Value creation is derived from the actions of people working on **current entity** and **utilise deep mastery, innovation and creativity** to create new use for **existing entity** (Lado and Wilson, 1994; Pfeffer, 1995; Wright, McMahan and McWilliams, 1994).

Figure 3 illustrates value creation (Bowman and Ambrosini, 2000; Lepak, Smith and Taylor, 2007).

Value creation will require educators to take a long-term view of learning. Learning for the immediate often focuses on facts and meeting standards. The long-term view of learning in value creation will require cultivating a passion for learning, having an inquisitive mind, accepting failure as part of learning and experimenting (prototyping). Fear of failure is directly associated with motivation of avoidance (Elliot and Thrash, 2004). In creating value, learners will have to overcome this fear of failure. These must be part of the repertoire of habits of practices to be ready for value creation and the future of lifework.

Figure 3. Process of value creation (Bowman and Ambrosini, 2000)



Interconnectedness of the society system with the education system

For decades, Singapore has enjoyed peace and harmony, on the whole. However, forces that threaten that peace and harmony remain, with increasing diversity within the nation brought about by factors such as religion, race and immigration. These forces are intensified by the liberal expression of views on these matters online.

Society's forces

A study conducted by the Institute of Policy Studies in late 2018 found that the level of religiosity of Singaporeans is high, with three out of four Singaporeans saying that they follow a religion (Mathews, Lim and Selvarajan, 2019). Although the study found that 97 per cent of the respondents think it is 'unacceptable or very unacceptable for religious leaders to incite violence or hatred against other religions', almost a quarter of respondents would 'allow religious extremists the freedom to post their views online'. This is a cause for concern because there is only a fine line between freedom of speech and the instigation of harm towards other religions. With the proliferation of social media, addressing radical online content will be a 'fight for the hearts and minds' (Channel NewsAsia, 2018). Online falsehoods and fake news further tear at Singapore's interfaith unity and have the potential to undermine Singapore from within (Chua, 2018). Against the global backdrop of increasing religiosity and digital connectivity, the people in Singapore will become more and more exposed to pressures that potentially undermine interfaith unity. As Prime Minister Lee Hsien Loong noted, there is powerful appeal for a global Islamic community; and, in the event of a terrorist attack, there will be great distrust among Muslims and other Singaporeans (Yuen, 2018b).

The influx of foreigners into Singapore brings about another dimension of diversity. For decades, Singapore has upheld a Chinese-Indian-Malay-Others (CMIO) framework for categorising the races of its people. Because of immigration, the category 'Others' has increased the most, by proportion, for the last decade (Cheng and Chua, 2017). Even within the Chinese race and the Indian race, intra-racial diversity grows, with immigration of people from China and India. These new immigrants have different habits, mannerisms and speech compared with locals, despite sharing the same ethnicity. Although the Singapore government has made efforts towards helping Singaporeans understand the economic rationale for foreigners, the man on the street may not understand it (Teng, 2018). Singaporeans commonly experience competition for jobs and schools, increased housing costs and crowded public transport because of foreigners. There is also the concern that having too many foreigners will dilute the national identity of Singaporeans (Nasir and Turner, 2014). Social tensions brought about by immigration are further intensified with foreigners and locals expressing hate speech of 'the other' online.

The population makeup of Singapore is becoming more and more complex. As noted by Mathews (2016) – 'A case in point would be the growing number of children of mixed parentage, who have parents not just from the different ethnic groups in Singapore but from diverse racial, nationality and socio-economic backgrounds.'

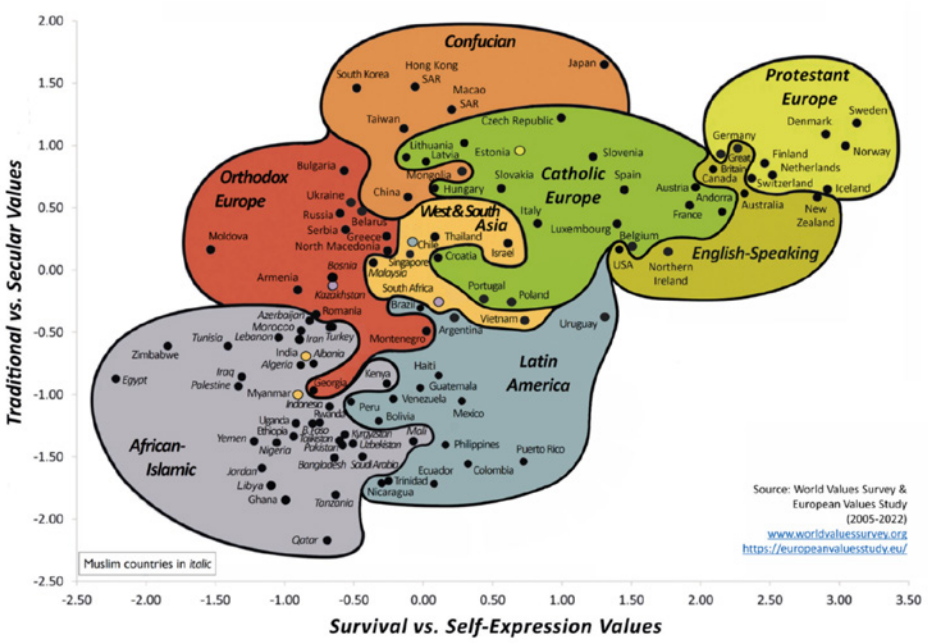
Diversity in society

Diversity in Singapore will increase. How can Singapore foster, in its people, a shared sense of belonging to the country? How can the country retain a Singaporean core with a strong and unique national identity? What policies should be made to manage diversity and foster inclusivity? These are crucial questions for the Ministry of Education in Singapore.

In terms of the Inglehart-Welzel World Cultural Map (Figure 4), Singapore adopts a mid-score between Traditional vs Secular Values. Similarly, it also achieved a mid-score between Survival vs Self-Expression Values. As a contrast, countries that are high in Secular and Self-Expression Values are liberal countries such as Sweden, Norway and Denmark, etc. It is important to note that Singapore is ranked as an affluent state in terms of GDP per capita. Yet, Singapore shows that cultural values can differ from economic ranking and wealth. Singapore has prioritised pragmatism that is based on meritocracy. Race-based policies do not play a significant role in determining the progress of Singapore in the economy and in adoption of cultural values. The ethnic composition of Singapore is predominantly Chinese 77 per cent; Malay 14 per cent; Indian 8 per cent; and Other 1 per cent, according to the 2012 CIA World Factbook. According to Hayashida (Soontiens, 2007), Chinese presence still prevails in Singapore's cultural heritage and most Chinese Singaporeans, young and old, maintain traditional Chinese values and connections (Yum, Canary and Baptist, 2015).

The government of Singapore has long recognised that social integration and cohesion are important for political stability, for GDP growth of the nation. They are also important for the social wellbeing of the people. The alternative would be distrust, chaos and bloodshed. Despite enjoying peace and harmony for decades, the 1964 racial riots serve as a grim reminder to Singaporeans of just how fragile harmony is, and how important it is for both Singaporeans and their leaders to play active roles in ensuring social integration and cohesion for the continuity of peace and harmony.

Figure 4. The Inglehart-Welzel World Cultural Map – World Values Survey 7 (2023).



To ensure social harmony in Singapore, the country has adopted three principles: multiculturalism, secularism and meritocracy (Public Service Division, 2015). For multiculturalism, ethnic diversity is acknowledged and embraced, and individuals have the right to retain their culture. For secularism, the state is secular but not against religion; and individuals have the right to practise their religion freely. For meritocracy, opportunities are given to individuals based on merit and performance, without bias to race, creed or socio-economic background (Public Service Division, 2015). A number of measures are taken to uphold these principles. For example, the Group Representative Constituency (GRC) ensures minority representation in politics. The Housing and Development Board's Ethnic Integration Policy (HDB EIP) ensures that racial communities do not form residential enclaves and that different races can live alongside one another. Also, the Maintenance of Religious Harmony Act was introduced in 1990 to empower authorities to act against anyone who potentially threatens religious harmony. In addition, there are other 'soft' approaches to help develop in Singaporeans the 'heartware' to be receptive towards diversity (Mathews and Khidzer, 2015). The Character and Citizenship syllabus in schools aims to foster in students an understanding that 'A person who values harmony seeks inner happiness and promotes social cohesion. He appreciates the unity and diversity of a multi-cultural society' (Ministry of Education, 2018). Singapore also observes the Social Harmony Day on 21 July every year, with a plethora of activities organised by schools, grassroots organisations and religious groups. It was launched in 1997 as a reminder of the racial riots of 21 July 1964. Other organisations involved in fostering inter-religion and inter-racial harmony are the Inter-Religious Organisation (IRO), the Inter-Racial and Religious Confidence Circle (IRCC), and OnePeople.sg (Mathews and Khidzer, 2015).

To help newcomers from other lands integrate into Singapore, the National Integration Council was set up. The objective for the council is to 'encourage and support ground-up integration initiatives to facilitate social interactions between Singaporeans and newcomers, and raise awareness of Singapore society, norms, and values' (National Integration Council, 2019). Further, the Singapore Citizenship Journey is a mandatory program for new citizens who have been granted in-principle approval for Singapore citizenship. The Programme is a collaboration between the National Integration Council, the People's Association and the Immigration and Checkpoints Authority of Singapore. The three components of the program help new citizens understand Singapore and integrate better.

Redefinition of education's purpose: Preparing future learners for an increasingly diverse society

Singapore's journey in social integration is not over. To preserve the peace and harmony that Singapore enjoys now, its people need to work hard to build friendships and trust to form an inclusive society. Successful education must play the role of inculcating the right values for the people of Singapore to live and work harmoniously and collegially with one another – now, and even more so in the future This is done primarily through the educational experiences and practices in schools.

As Singapore becomes more culturally and ethnically diverse through immigration, its citizens need to be even more aware of inclusivity, not just as a habit but as a way of life. Singapore needs to continue to be a fair and open country that offers avenues for cooperation amongst its people through support and empowerment.

One of the challenges Singapore faces that would affect its multiculturalism is online falsehoods. Online falsehood, colloquially known as 'fake news', first came under international spotlight during the 2016 American presidential elections. In the investigations that ensued, it was found that most of these fake news items were divisive in nature, with the intent to disunite and polarise the country (Solon and Levin, 2017). Just as it has happened in the United States, it has happened in Singapore (Infor-Communications Media Development Authority, 2019). According to national statistics, more than 75 per cent of Singaporeans have come across fake news on WhatsApp and Facebook (Ministry of Communications and Information, 2018). What is perhaps more concerning is that only 50 per cent of the citizens polled said that they were confident of their own ability for recognising fake news and more than 66 per cent felt that most Singaporeans would not be able to recognise fake news. The competence to discern fake news requires deep inter-cultural acumen, where understanding of different cultures can only be achieved through deeper interactions and engagement. Future citizens must readily seek to understand the implications of the differences and the skills required to act and decide appropriately and in a culturally sensitive way.

As Singapore becomes more culturally and ethnically diverse through immigration, its citizens need to be even more aware of inclusivity, not just as a habit but as a way of life.

Intercultural communication requires one to invest effort in making sure that one gets beyond the stereotypical image of 'the other' and gets to know the person as an individual. This requires more than just sharing the same language, as language only forms part of the communication. As mentioned in the preceding section, other factors, such as cultural contexts, influence communication greatly (Alexandru, 2012). Communication is, after all, the gateway to understanding one another. Thus good inter-cultural communication is necessary for inclusivity and multiculturalism. While the traits mentioned in the previous paragraphs are more shaped by policies and environments, which are macro factors, this is a more personal micro trait. The capacity and ability for inter-cultural communication – including the capacity for understanding cultural differences and the capacity for assuming perspectives belonging to other cultures – would be crucial in an inclusive multicultural Singapore.

Interconnectedness of the environment system with the education system

In 2015, parties to the United Nations Framework Convention on Climate Change (UNFCCC) adopted a landmark agreement on climate change in Paris. The goal of the Paris Agreement is to keep global warming well below 2°C above pre-industrial levels. Singapore signed the agreement on 22 April 2016 and ratified it on 21 September 2016 (National Environment Agency, 2019). Singapore has pledged to reduce its emissions intensity by 36 per cent from 2005 levels by 2030, and to stabilise emissions with the aim of peaking around 2030 (Ministry of Communications and Information, 2015).

Energy

Improving energy efficiency is a key strategy for reducing carbon emissions. The industry sector contributes to more than half of Singapore's greenhouse gases emissions. Mandatory practices have been implemented to address the energy efficiency of Singapore's industry sector. The Energy Conservation Act (ECA) requires energy-intensive users in the industrial sector to monitor and report energy use and emissions-related information annually. They are also required to submit an energy efficiency improvement plan and review the plan annually (National Environment Agency, 2019). The government is also studying policy options to facilitate the switch to the use of cleaner fuels in industry. By switching to cleaner fuels such as natural gas, carbon emissions from heating processes can be reduced by about 25 per cent (National Climate Change Secretariat, 2016).

Moving forward, innovation and the adoption of technology are crucial for addressing Singapore's energy needs, while ensuring that the impact on the environment is minimised.

'Green' buildings are those that reduce the negative impact on the environment by virtue of their design and operation. The Building and Construction Authority's (BCA) Super Low Energy Programme leads the green buildings movement by using energy efficiency and renewable energy solutions in buildings. The BCA has also developed a Super Low Energy Technology Roadmap that focuses on the development, pioneering and adoption of technologies for super low energy buildings. This is expected to reduce the carbon footprint of Singapore significantly, as the building sector accounts for more than one third of the country's electricity consumption (Building and Construction Authority, 2018).

Singapore is also increasingly turning to renewable energy sources. Solar energy is the most promising renewable energy option for Singapore (National Climate Change Secretariat, 2016), and could possibly meet as much as a quarter of Singapore's energy needs in 2025 (Low and Rockell, 2017). The SolarNova Programme, led by the Economic Development Board (EDB) and the Housing Development Board (HDB), aims to accelerate the deployment of solar power technology in Singapore. There are 10,000 blocks of HDB buildings on which solar panels may be installed, and HDB has pledged to instal solar panels on 5,500 blocks by 2020 (Tan, 2018). Wind energy is being utilised as well, although on a small scale. In 2017, Singapore's largest wind turbine was unveiled on Semakau Island. Wind energy is part of the offshore island's power grid system, which integrates multiple renewable energy sources, such as solar power (Lim, 2017).

Households in Singapore are encouraged to make better energy choices, with the Mandatory Energy Labelling Scheme (MELS) introduced in 2008, which allows consumers to compare the energy efficiency of different appliances. The Minimum Energy Performance Standards (MEPS) also remove energy-inefficient appliance models from the market (National Climate Change Secretariat, 2016).

Moving forward, innovation and the adoption of technology are crucial for addressing Singapore's energy needs, while ensuring that the impact on the environment is minimised. The Energy National Innovation Challenge was launched in 2011 to harness Singapore's R&D capabilities to increase energy efficiency, reduce carbon emissions and increase energy options within 20 years. The Challenge received S$300 million in funding, targeting areas such as green

buildings, green data centres, energy storage and waste-to-energy solutions (National Climate Change Secretariat, 2016). Singapore has a number of research groups and research centres working on energy research. Notable ones include the Energy Research Institute @ NTU (ERI@N), which focuses on energy solutions for megacities and the tropical environment (ERI@N, 2019).

Water

Another environmental challenge facing Singapore is that of water. Water is a precious environmental resource that is required for survival. Singapore is a water-scarce country that is not self-sufficient in water. As a small country, there is limited area for local water catchment. Singapore depends on its 'Four National Taps' for its water supply: local catchments; imported water; NEWater; and desalination (PUB, 2018a). The total water demand in Singapore currently is about 430 million gallons a day. Of this demand, imported water provides about 50 per cent, NEWater supplies up to 40 per cent, desalination meets up to 25 per cent, and local catchments make up the rest (Seow, 2018). Water demand is expected to almost double by 2060 (PUB, 2018b).

Currently, there are 17 reservoirs in Singapore, which serve as local water catchment. A noteworthy reservoir is the Marina catchment, which is created by the Marina Barrage. It is the vision of the late former Prime Minister Mr Lee Kuan Yew, who envisioned the damming of the mouth of the Marina Channel to form a reservoir. Hailed as a Singapore success story, the Marina Barrage not only creates a source of water supply, it also serves as a control for floods and as a lifestyle attraction (PUB, 2018b).

As for imported water, Singapore is able to draw up to 250 million gallons of water a day from the Johor River in Malaysia, under the 1962 Water Agreement, which will expire in 2061. Singapore's National Water Agency (Public Utilities Board, or PUB) operates the Linggiu Reservoir, which is built upstream of the river to collect and release rainwater. Singapore is also obliged to provide Johor with treated water, up to 2 per cent of what Singapore imports (PUB, 2018a).

NEWater is another Singapore success story. Making use of sophisticated membrane technologies, Singapore is able to recycle its treated used water. This helps to cushion Singapore's water supply in times of dry weather and to propel Singapore towards water sustainability and security. The high quality of the water has been verified by local and overseas experts. More than 20,000 tests have been carried out for around 190 water quality parameters. The results show that the water quality is well within international water standards (Lee, 2016).

Desalinated water from the sea is another source of water for Singapore. Desalination makes use of advanced reverse osmosis technology. Power consumption and costs are higher for desalination compared with NEWater (Lee, 2016). Nonetheless, desalinated water is an important pillar of Singapore's water inventory and is expected to provide up to 30 per cent of Singapore's water demand by 2060 (PUB, 2018a). Singapore will continue to invest in research and technology to find more efficient ways of desalination.

In 2018, PUB launched the SMART PUB Roadmap (PUB, 2018b). The aim of the roadmap is to develop PUB into the Smart Utility of the Future, by making intensive

use of artificial intelligence, automation, big data and smart work redesign. PUB operators will also undergo virtual reality training. Digitalisation of the entire water system of Singapore will be carried out to achieve better water quality management and network improvements, as well as smarter work processes. These help to increase the productivity of PUB, as well as the safety and security of Singapore's water supply.

Singapore's future development is intricately linked to environmental factors.

With economic growth and an increasing population, Singapore has to find new ways to innovate and meet its increasing water needs. We have seen how harnessing innovation and technology for NEWater and desalination play a pivotal role in addressing Singapore's water problems, increasing self-sufficiency and reducing dependency on neighbouring Malaysia. These technologies also buffer against the effects of falling water levels in our reservoirs, during prolonged dry spells brought about by global climate change. Singapore's development of water technology is far from over – Singapore has to commit to enhancing current technologies and to seeking new solutions to ensure the continuity of water security. Singapore's expertise in water treatment can even be an exportable commodity (Rahamat, 2013), allowing Singapore to capture market opportunities in other countries.

Redefinition of education's purpose: Develop learners for the future society

Singapore's future development is intricately linked to environmental factors. Greater consumption of energy and matter will inevitably follow as the country continues to develop as a modern and sophisticated city state. How Singapore will meet the increasing needs for energy and matter, while achieving its environmental pledge, is a challenge for the government and its people. There is an urgent and compelling need for Singapore to include environmental education, implement concrete actions, and apply great ingenuity to come up with novel and innovative solutions for environmental issues. Without a sustainable and liveable environment, there will be no place to support future economic development or to live harmoniously.

The environmental context of Singapore puts a spotlight on the need to derive novel and innovative solutions. Innovation and ingenuity are needed for Singapore to solve its environmental problems. With economic growth and an increasing population, Singapore has to find novel ways to address its increasing need for energy and water, while minimising impact on the environment (Ministry of National Development, 2018; National Climate Change Secretariat, 2016; PUB, 2018b). Supply of adequate energy and water hinges upon the ability of the people of Singapore to come up with creative yet feasible ways to address Singapore's challenges in these areas now and in the future. Education must foster this ability – inculcating habits for innovation in individuals while they are still in school.

Innovation is one of the key enablers for enhancing the capabilities to deal with environmental challenges. Developing competencies and habits for innovation is imperative in the new environmental landscape. Innovation is enabled by technology but is not limited to that. It is about coming up with new solutions and ways of doing things that create value in the environment. To this end, it was announced in 2016 that Singapore would commit S$19 billion as part of the five-year Research, Innovation and Enterprise 2020 (RIE 2020) plan. The plan is 'for research, innovation and enterprise activities, to support and translate research, and to leverage science and technology to address national challenges and build up the innovation and technology-adaptation capacity of our society, environment, and to drive economic growth through value creation' (National Research Foundation, 2016).

schools need to adopt visions, missions and practices that are aligned with the economic, social and environmental trajectories of the nation.

Conclusion

Successful education fulfils three purposes: development of future learners for lifework, society and environment. An education system can be successful only if it is able to develop learners for the future – individuals who will work, continue to learn beyond graduation and thrive in a changing society and environment. Macro-contexts such as the economic, social and environmental contexts of a nation, largely determine the strategic directions for education. Accordingly, schools need to adopt visions, missions and practices that are aligned with the economic, social and environmental trajectories of the nation.

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About the paper

The author developed this paper drawing on his presentation to the *GELP Tokyo 23* forum for Global Emerging Leadership Programs. Noting the interconnectedness between the education, economic and other systems in Singapore, he discusses the implications for redefining what is meant by Succesful Education, given the need to develop learners for future lifework in what is an increasingly diverse setting. He also comments on the interconnectedness of the environment system with the education system and emphasises the need to educate students to be innovative, for example to help ensure adequate supply of basic resources like energy and water, to meet Singapore's future needs.

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