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Redefining Educational Success and Learner Outcomes: Case of Singapore

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Redefining Educational Success and Learner Outcomes: Case of Singapore

1. Introduction

In this framework, we define successful education as:

"A successful education system 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."

This multi-dimensional framework (Annex 1) re-defines educational success. Being future-ready implies that learning outcomes must be dynamic and aligned to new realities that emerge over time. The framework consists of the following dimensions that provide an integrated approach to define educational success and future-ready learner outcomes:

- Dimension 1: Purposes of schooling (Development for life-long learning, lifework, and living)
- Dimension 2: Time (Past, present, and future)
- Dimension 3: Contexts (Economic, Social, Environmental – technology is integral in all the three primary contexts).
- Dimension 4: Practices (Teaching and learning practices, community practices, school leadership and management practices, inquiry practices)

2. Multi-Dimensional Framework

2.1. Purposes of Education: Dimension 1

As schools strive to be relevant and globally connected, school reform takes on both local and international contexts. International contexts have become widely associated with comparative results from international tests, such as the Trends in International Mathematics and Science Study (TIMSS) and the Programme for International Student Assessment (PISA). Countries have assumed that attaining high scores in these tests would be a strong indicator of having a world-class education system. However, education is more than just standardised testing. Thus, education success must be measured beyond these typical achievement standards. The three purposes (and outcomes) of education are in Dimension 1 (Figure 1): developing learning (knowledge); developing lifework (vocation); and developing living (citizenry, values, and sustainability) that enable individuals to live peacefully and collegially with one another in society. Successful schools must fulfil all these three purposes (Ng, 2019). These three purposes are intricately linked to the dimensions of Time, Contexts, and Practices. We will define the three purposes in detail in the latter sections.

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2.2. The Time Continuum and Being Future-ready: Dimension 2

In discussing effective schools and educational success, we need to bring in another dimension to the purposes of education – Time. Figure 1 shows how the dimension of time fits into a more comprehensive framework for successful education. Time provides perspective and focus to the purposes of education. The perspective of time is like the physics concept of vector. Vector has direction and magnitude. Direction in the time continuum consists of the past, present and future (Ng, 2019). Learning, therefore, will involve studying the past (our history), meeting present standards of knowledge, and being prepared for the future. Magnitude is the extent or 'quantity' of school activities as per point of vector (past, present, and future) in the time continuum. What extent (magnitude) of our learning and school activities do we set aside for learning the past, the present, and the future? Magnitude, therefore, will give us an indication of what schools value. Generally, we tend to focus on the present perspective of time and have a larger magnitude (extent of activities) with measures that will bring immediate value to our education system. Example, high performance in assessment brings immediate high value in the form of recognition for the individual, school, system, and country. So, we have a greater magnitude of activities related to assessment. But we need to be keenly aware of the future perspective of time. The future perspective is no less important or valuable. Future value is about the future readiness of our graduates to meet evolving and changing future landscapes. The future is about new realities that are context-situated and context-dependent. Singapore and global contexts provide the foundation to define details of future readiness.

2.3. Context (Frames): Dimension 3

Context provides the frame upon which we can have specifics/details to describe Purpose (Dimension 1) and Time (Dimension 2). In this framework, we have selected Economic, Social, and Environmental as the primary contexts to describe the purposes in Dimension 1 and 2. Technological aspects are interwoven into all the three primary contexts. For example, the economic context will require technological adoption, digitalization among others.

2.4. Practices: Dimension 4

The Practices dimension is multi-dimensional. Practices include leadership and management practices, teaching and learning practices, community practices, inquiry and research practices and more. Practices are based on sets of assumptions, beliefs, and theories. Practices cannot remain unchallenged paradigms. Our practices must evolve and be relevant to match the evolving realities of purposes, time and context.

Inquiry methods of teaching and learning must provide us relevant answers to our quest for learning, knowledge, and development. One example is the current dominant inquiry method in teaching and learning that is based on a set of behavioural objectives in learning. Behavioural objectives or specific instructional objectives are usually narrow, clearly defined, and limited to planned learning. If we only require our students to learn from what we know and have been defined by the texts, then there will be fewer opportunities to learn new knowledge or create new knowledge. We will continue to have instructional objectives, but we also need alternative inquiry methods and

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practices of learning. For researchers, our interests in scholastic pursuit of knowledge in the field must expand beyond our paradigm of research methods and adopt alternative methodologies that can answer our research questions that can contribute to theory formation, knowledge building, and translation to practice.

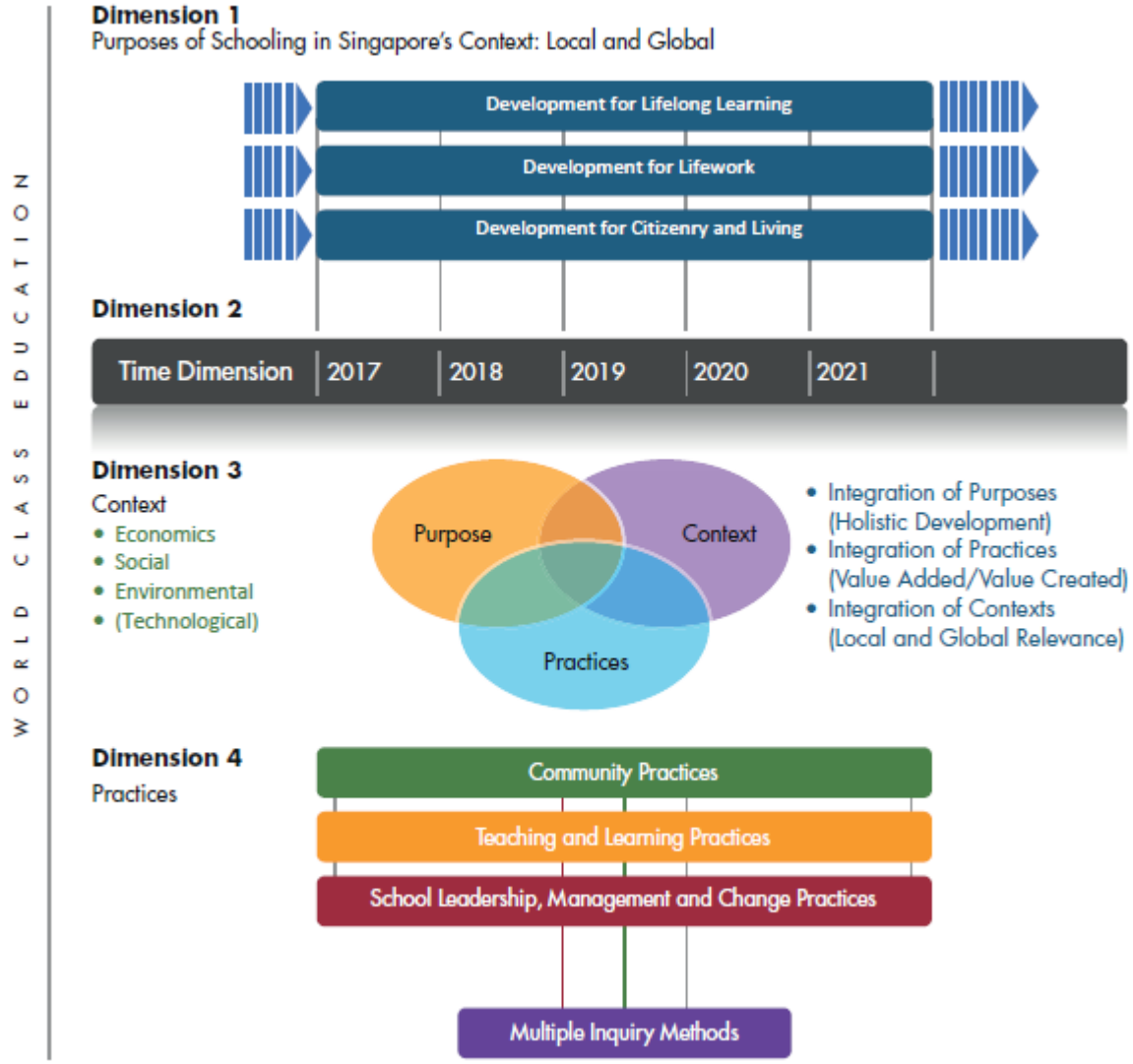

Figure 1: Multi-dimension framework for educational success (Ng, 2019)

Successful schools must fulfil all three purposes of education and be keenly aware of developing future-ready individuals. In Dimension 1 (purposes) we provided an example of benchmarks for educational success in standardized tests and exams. Singapore students consistently achieve top spots in TIMSS and PISA (Davie, 2016; Amelia Teng, 2016), bringing immediate recognition to its education system. These benchmarks are an indication of learning outcome of our students, but they only partially fulfil the three purposes. There is a need to define learning/knowledge outcomes beyond standardized tests. Learning outcomes must also be defined for the other purposes of education.

As we shall see in the following sections, there are new concepts of learning and many future challenges for Singapore in the economic, social and environmental contexts that will shape the future learning outcomes of our students. The next sections will expand and define the three future-ready purposes – learning, lifework, and living. The details and definitions are analysed from global and national contexts. Specifically, Dimension 2 (Time) and Dimension 3 (Contexts) provide the basis of how we analyse and define the purposes.

3. Future-ready for Learning

How do future-ready Singaporeans co-create learning opportunities and actively participate in sustainable life-long learning?

The recent Committee on the Future Economy report (CFE, 2017) reiterates the government's hopes of developing a nation of life-long learners, who embrace learning as part of life. This is essential to help the workforce cope with technological shifts and the impact it has on how jobs are performed. A workforce that is ready to learn allows it to be adaptive and nimble when there are new job demands or a change in industry is needed. Staying relevant through continuous learning is not only for workers in the corporate world; its importance is amplified in schools – leaders need to ensure that teachers stay abreast of educational trends, practices and pedagogies to effect student learning. As Zepeda (2013) aptly puts it, "schools that succeed are schools in which every participant is a learner" (p.xxi). Synthesis from recent literature on learning highlight the imperative that future-ready learners must embrace and practice the following concepts of learning: life-long learning, life-wide learning and life-deep learning.

3.1. Life-long Learning

A 21st century school in an advanced economy requires a vision that reflects its goals which include preparing students for the future of work and transferable skills and attributes which will build the foundation in becoming a life-long learner (Day et al., 2009; Häkkinen et al., 2017). At the 2015 Singapore Forum, then Deputy Prime Minister, Mr Tharman reiterated the importance of education to ensure a sustainable broad-based economic growth. He shared that the education system must be made less academically focused and be more conducive to life-long learning of skills. In addition, he proposes a system of life-long learning that is integrated with the real world and technological developments (Chan, 2015).

SkillsFuture was introduced in 2015 and implemented in 2016. It is Singapore's solution to life-long learning. The SkillsFuture programme involves the collaboration among multiple partners including government agencies, trade associations, unions, companies, training organisations, and the workforce. While SkillsFuture targets to develop the necessary human capital to meet economic growth objectives, it is at the same time a tool to ensure equitable provision of educational opportunities for working adults and foster life-long learning. SkillsFuture, therefore, works as a means of fostering economic growth through social stability (SkillsFuture Singapore Agency, 2017). Through SkillsFuture, the life-long learning approach aims to be inclusive throughout a citizen's entire work life and beyond. It is managed by a newly-created statutory board, SkillsFuture Singapore (SSG), parked under the Ministry of Education. This places SkillsFuture within the area of higher education policy

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(Woo, 2018). With the goal for employability, SkillsFuture is Singapore's response to the need for major transformation in the education system. Life-long learning is no longer a choice but necessity.

In order to get a different perspective of life-long learning, Figure 2 illustrates the time spent in formal school settings (life-long learning) and in informal learning environments. Stevens, Bransford, and Stevens (2005) asserted that even during the compulsory schooling period, children only spend some 18.5% of their time in formal learning situations. Indeed, learning continues throughout the lifespan of an individual. – but if life-long learning only involves attending courses, workshops, and learning in a formal setting, the total percentage is small. In contrast, The 'blue space' where informal learning takes place and cuts across multiple contexts in a person's life – in school, at work or even at home, dwarfs that of formal learning. That blue space is called life-wide learning. It is important for school leaders to recognize the importance of life-wide learning and to encourage it by providing students with opportunities to experience multiple situations and contexts.

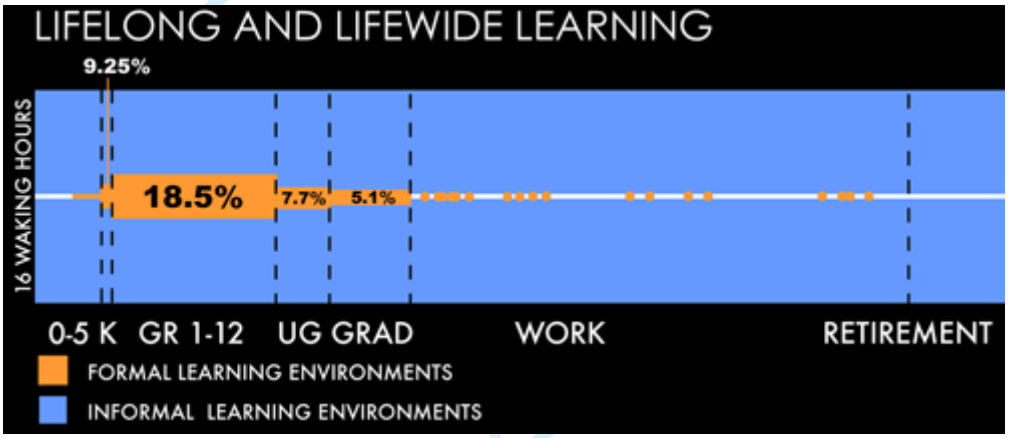

Figure 2: Estimated time spent in school and informal learning environment. (Source: Stevens et al. (2005), as cited in Bell, Lewenstein, Shouse, and Feder (2009) p. 29)

3.2. Life-wide Learning

Schools were once a main source of knowledge that was considered important. They are not today. In fact, any knowledge imparted on courses at all levels almost inevitably lags behind what can be found through electronic media and other resources (Hall, 2009). Informal learning which is depicted by the 'blue space' in Figure 2 takes place inside and outside of school where students are exposed to a whole range of what the writers (Banks et al., 2007; T.-S. Koh & Hung, 2018; Stevens et al., 2005) call life-wide and life-deep learning. The breadth and qualities of learning activities outside school are significant developmentally as they are the roles and relationships that emerge across contexts. Students routinely accessed a greater number of resources both in and out of school. Life-wide learning involves learning from physical and virtual experiences, encounters, associations and opportunities in the wider community locally and internationally.

Life-wide learning happens incidentally and not dictated by instructional objectives. At the same time, when students gain exposure from diverse experiences, the meaning-making process can be transformative for them as they reflect on their beliefs, shape their worldview and negotiate their identity (Jackson, 2012; Liang, Caton, & Hill, 2015). Other examples where life-wide learning can take

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place are: mentoring, caring for others, pursuit of learning that is not directly related to study area, and travel.

Students must embrace learning that is life-long, and life-wide. In fact, life-wide learning among students is occurring in semiotic domains that leverage on interactive, web-compatible, digital technologies such as smart devices. One implication of the prevalent and pervasive learning opportunities available for students is that formal schooling (life-long learning) will need to radically change to be effective for many students today. Future generations of learners will increasingly use newer technologies as life-style experiences and continue to embrace such learning opportunities. Teachers need to also embrace their own life-wide learning opportunities that involve the use of technology to close the divide between teachers and students in the digital era. Schools need to help students make sense of this kind of learning which will be different not only for communities but also for individuals.

3.3. Life-deep Learning

There are two facets of life-deep learning – deep mastery of knowledge and values formation. Deep mastery of knowledge is fundamental for invention and innovation. This involves a mastery of deep disciplinary and conceptual understanding, adaptive expertise, and efficiency (T.-S. Koh & Hung, 2018). An example where deep mastery is essential is the planned development of the new Science Centre and surrounding residential enclave at Jurong Lake Gardens, slated to be ready around 2025. A proposal has been made to realign the stretch of the Ayer Rajah Expressway from Yuan Ching Road to Jurong Town Hall Road in order to free up land south of Jurong Lake for residential development, and to integrate the Pandan Reservoir area with the district to form a larger and more cohesive development area. This endeavour clearly needs deep mastery of engineering, design, planning, environmental management among others. Mastery of multiple disciplines and adaptive expertise will be needed in order to make this happen.

Life-deep learning involves facilitating students' adoption of mastery goals in their learning (Midgley, 2002). If teachers want their students to focus on mastery of content and tasks, they must allow students to work on tasks repeatedly, even if they were to fail many times, until they achieve mastery. If mastery is about solving a particular problem in science, such as forming hypotheses, collecting relevant data, analysing those data, and drawing reasonable and verifiable conclusions, then students must be given opportunities to practice those skills and receive formative feedback from the teacher on their performance as a part of their instructional experience.

Values formation in life-deep learning embraces religious, moral, ethical, and social values (Knafo & Schwartz, 2004; Loewenstein, Price, & Volpp, 2016). These values guide what people believe, how they act, and how they judge others and themselves. An important process in life-deep learning is scaffolding of challenges and change that students go through. Scaffolding can be in the form of support from families, the communities that surround them, and schools. This support structure is also critical to deal with the fear of failure. Fear of failure has been strongly associated with avoidance (Elliot, & Thrash, 2004). In general, values formation in life-deep learning most often happen when students encounter critical incidents (Griffin, 2003). It is useful to identify the criteria to decide if the challenges and encounters are critical incidents that provide a rich stimulus to explore ethical, moral and social values. Typically, critical incidents include experiences of:

- conflict that troubles the emotion

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- dilemma of choice
- become a stimulus for reflection

Students are also constantly exposed to global and local cultural forces in their lives. These forces are also powerful medium of influence and play a fundamental role in determining how students learn and assimilate values (Arnett, 2002; Marsh, 1986). An example is consumerism as a way of life through marketing, media, and entertainment influence. The dilemma encountered could lean towards embracing that culture in order to feel a sense of belonging or non-consumption of consumerism which is perceived as continuing in the cycle of poverty and withdrawal. This is an example where life-deep learning occurs – whether guided or not guided, scaffolded or left to the individual's own learning. Students' learning of values are very much experienced through global influence. What educators must concern themselves with is whether the dominant values to which young people ultimately acquired are the very values that promote family togetherness, national harmony, and unity.

4. Future-ready for Lifework

How do future-ready Singaporeans shape the future of work and co-create future lifework?

As noted in the Introduction section, Singapore faces many challenges in the economic, social and environmental aspects. From 2010, global growth has been subdued and is expected to be lower than in the previous decade (CFE, 2017). Global value chains are also shifting where countries in the region (Asean) are moving up the value chain in their manufacturing and services. Moving up the value chain means that innovation and change are driving new products and services. These products and services that are currently regarded as among the most innovative and experimental ultimately end up as commodities that can be produced anywhere and by many producers. Developed economies like Singapore can grow by inventing new technology, new innovating products and services and creating new values in products and services. In addition, the confluence of rapid technology advancements with the economic, social and environmental changes bring about unprecedented challenges (as well as opportunities) for Singapore. The following sections will examine Singapore's contexts in these aspects in greater detail.

4.1. Current Economic Status

Singapore achieved a real GDP growth of 3.2% in 2018 (Department of Statistics Singapore, 2019a), amid global uncertainties such as Brexit and trade tensions between US and China. For 2019, Singapore's GDP growth forecast is 1.5 to 3.5% (Ministry of Trade and Industry, 2019b). Figure 3 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%, while the goods producing industries make up 26.1%. For the services producing industries, the top three contributors are wholesale & retail trade (18.0%), business services (14.9%) and finance & insurance (12.9%). For the goods producing industries, manufacturing is the major contributor (21.4%), followed by construction (3.5%) and utilities (1.2%). The largest single industry is manufacturing, which consists of these clusters: electronics, chemicals, biomedical manufacturing, precision engineering, transport engineering and general manufacturing (Ministry of

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Trade and Industry, 2019a). Together, all the industries have their roles to play in contributing to the GDP of Singapore.

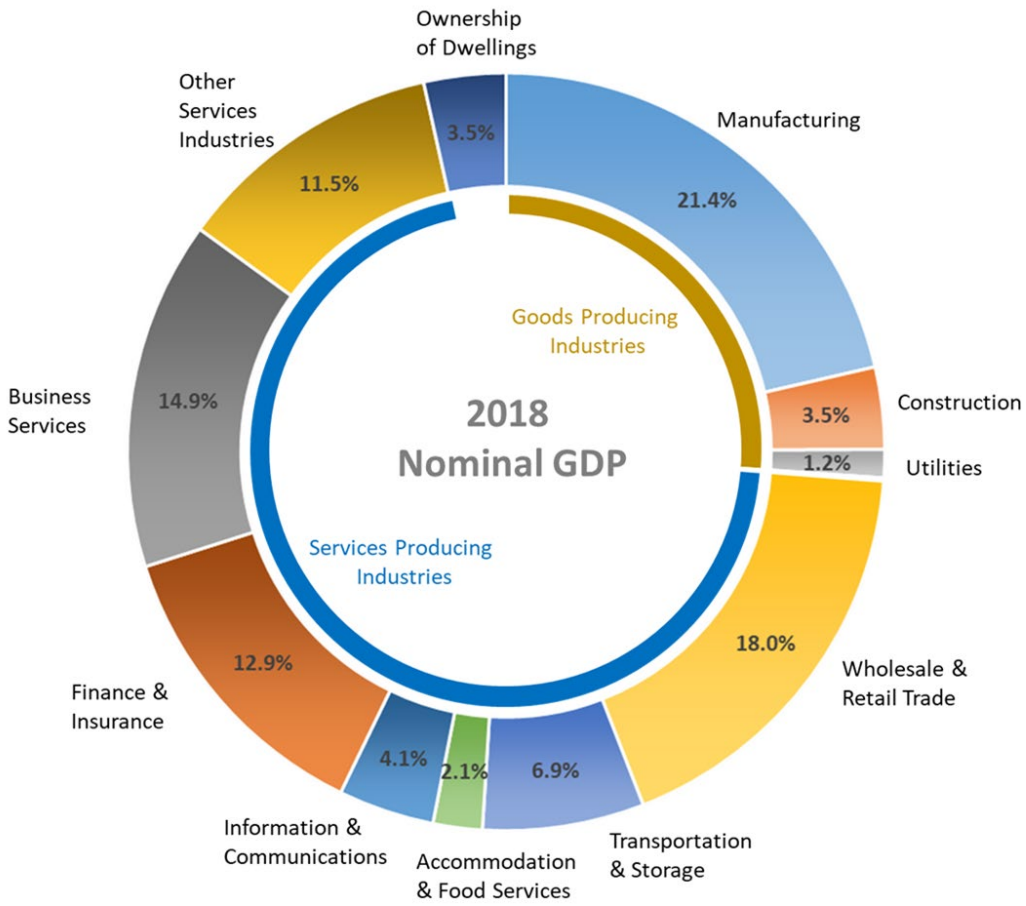

Figure 3: Contributions of different industries to Singapore's nominal GDP in 2018. (Figure charted with data from Department of Statistics Singapore (2019b).

4.2. Trajectory of the Future Economy

4.2.1. Shift in Focus of the Economy (1990s, 2000s, 2010s to present)

Over the years, Singapore has shifted the focus of its economy. The following table summarizes this shift from the 1990s onwards. Increasingly, there is an emphasis on innovation, value creation, and technology adoption, and digitalization.

	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 organizations • Renewable Energy Corporation (REC) breaks ground on its S$2.5 billion solar plant: the largest clean technology investment in Singapore • Major companies e.g. 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

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

4.2.2. Emphasis on the Adoption of New Technologies and Innovation

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Adoption of new technologies

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), which 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. Recognizing these trends, the government has launched a new Automation Support Package in Budget 2016 (Heng, 2016). The package was intended for firms to utilize large-scale automation, including Internet of Things (IoT) and robotics. It comprises 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).

Digitalization becomes commonplace in Industry 4.0 and has the power to transform large and small companies. The Singapore government has recognized 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).

Innovation

Innovation is about coming up with new solutions and ways of doing things that create value in the economy. To this end, it was announced in 2016 that Singapore would commit $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 companies to drive economic growth through value creation (National Research Foundation, 2016)." Further, Singapore would support startups in new and existing industries – a new entity called SG-Innovate would be set up to match new entrepreneurs with mentors and help them to open up new markets. The Jurong Innovation District will also be launched. It is envisioned to be a next-generation industrial district that fosters innovation for enterprise, learning and living. (Heng, 2016)

Innovation is a prevalent theme in Singapore's efforts to tap into overseas resources. The Global Innovation Alliance was announced in Budget 2017 to enable Singaporeans to network and collaborate with their overseas partners. Under this alliance, the Innovators Academy programme would help tertiary students to establish connections overseas while the Innovation Launchpads would enable business persons to connect with service providers, investors and mentors overseas. Welcome Centres are also set up to link foreign companies with Singapore partners.

4.2.3. Knowledge, Skills, Abilities (Innovative Ability) Needed in High Value Manufacturing and High Value Service Jobs

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Singapore's key competitive advantage lies in having a knowledgeable, skillful and high-ability workforce that is able to meet the challenges now and in the future.

With rapid technological advancements, many workers may feel marginalized because of the difficulties they face in keeping up with the changes in the workplace. Therefore, developing skills of the workforce in tandem with the technological transformations in companies is crucial. To achieve this, Singapore emphasizes skills mastery and lifelong learning. SkillsFuture is a major national movement aimed at helping Singaporeans of different ages develop skills for the future (SkillsFuture Singapore Agency, 2019a). Many initiatives under the SkillsFuture framework have been implemented since the launch of SkillsFuture in end-2014. Also, other schemes like the Professional Conversion Programmes (PCPs) help Professionals, Managers, Executives and Technicians (PMETs) go for skills conversion for new jobs in sectors with good potential (Workforce Singapore, 2019).

Industry 4.0 sees a greater demand for skilled professionals in growing sectors such as information and communications technology (ICT). ICT is widely used across industries, be it manufacturing or services. To enable individuals learn new ICT skills quickly, the TechSkills Accelerator (TeSA) under the SkillsFuture initiative was announced in Budget 2016 (Heng, 2016). The purpose is to enhance training and job placement for the ICT sector, by supporting reskilling or upskilling (SkillsFuture Singapore Agency, 2019b). TeSA supports STEM (science, technology, engineering and mathematics) professionals to reskill in emerging industries such as network engineering, software development and network engineering (CFE, 2017). The CFE has also recommended that the TeSA model be replicated in other sectors.

4.2.4. Implications of High Value Manufacturing, Service and Innovation on Future Human Capital

For the individual, being prepared for jobs for the future is important to stay relevant. With innovation and disruptive technologies, the nature of jobs will change radically. In addition, some jobs will disappear while others emerge. The skills and mindsets of people need to change to keep up with the new economy. Outdated skills and old attitudes will no longer serve people well.

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

5. Future-Ready for Living

How do Singaporeans contribute to a cohesive society and co-create sustainable utilization of earth's resources?

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Future-ready for living includes citizenry (social) and sustainable utilization of resources (environment). The following sections will examine the social and environmental contexts and trajectories of Singapore.

5.1. Increasing Diversity of the Society

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 (Mathew, Lim, & Selvarajan, 2019). Though the study found that 97% of the respondents think that 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 case 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 has 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.

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 categorizing the races of its people. Because of immigration, the category “Others” has increased by proportion the most for the last decade (Cheng & 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 in making Singaporeans understand the economic rationale for foreigners, the man on the street may not understand it (Angela Teng, 2018). The common Singaporean experiences 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 & Turner, 2014). Social tensions brought about by immigration are further intensified with foreigners and locals expressing hate speech.

5.2. Importance of Social Integration and Cohesion

Social integration and cohesion are important for political stability for GDP growth of the nation. They are also important for the social well-being 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 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.

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.

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For secularism, the state is secular but not against religion; and individuals have the right to practice their religion freely. For meritocracy, opportunities are given to individuals based on merit and performance, without bias to race, creed or social-economic background (Public Service Division, 2015). There are a number of measures that are taken to uphold these principles. For example, the Group Representative Constituency (GRC) ensures minority representation in politics.

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 programme for new citizens who have been granted in-principle approval for Singapore citizenship. The programme is a collaboration between National Integration Council, the People's Association and the Immigration & Checkpoints Authority of Singapore. The three components of the programme help new citizens understand Singapore and integrate better.

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.

5.3. Global Environmental Problems and Singapore's Pledge

There are more than 7 billion people in the world today. More than 50% of the world's population now live in urban areas (Steffen, Broadgate, Deutsch, Gaffney, & Ludwig, 2015). The rapid pace of urbanization places strain on the earth's environment, with ever-increasing demand for energy and matter. The post 1950 period has been termed the Great Acceleration, where global socio-economic trends such as real GDP, urban population, transportation and water exhibit a sharp rise compared to the pre-1950 period (Steffen et al., 2015; Steffen, Crutzen, & McNeill, 2007; Steffen et al., 2011). This sharp increase parallels the rise in the emission of greenhouse gases, ozone depletion and other global-scale changes in the earth system, strongly indicating the coupling of environmental deterioration with urban population increase, GDP growth and material consumption. The dire consequences of these changes in the earth system include global warming, climate change, rise in the sea level and declining biodiversity.

Global temperatures have risen by about 1 degree Celsius since the industrial age began. Thermal expansion from warmer ocean waters and melting of ice-caps lead to rising sea levels, causing widespread devastation to coastal habitats. (Nunez, 2019) Weather patterns around the world are becoming more erratic, with increasing frequency and intensity of extreme weather events. Human activities and global climate changes threaten the extinction of species – 1 million species face extinction unless massive action is taken to reduce the drivers of the decline in biodiversity (IPBES, 2019; McGrath, 2019). The loss in biodiversity has severe implications for global food security, as the resilience of agroecosystems are being undermined (IPBES, 2019). Singapore is not spared from these global threats. As part of earth's delicate ecosystem, Singapore's challenges of energy, water and food are intricately linked to the state of the global ecosystem. Despite being a small nation, Singapore has to play a role in environmental conservation.

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

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April 2016 and ratified it on 21 September 2016 (National Environment Agency, 2019). Singapore has pledged to reduce its emissions intensity by 36% from 2005 levels by 2030, and stabilize emissions with the aim of peaking around 2030 (Ministry of Communications and Information, 2015).

5.4. 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 that energy-intensive users in the industrial sector 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, 2018). 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% (National Climate Change Secretariat, 2016).

"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 buildings sector account 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 & 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 install solar panels on 5,500 blocks by 2020 (Teh, 2018). Wind energy is being utilized as well, though on a small scale. In 2017, Singapore's largest wind turbine is unveiled in Semakau Island. Wind energy is part of the offshore island's power grid system, which integrates multiple renewable energy sources such as solar power (M. Z. Lim, 2017).

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 minimized. 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 $300 million in funding, targeting areas such as green buildings, green data centers, energy storage and waste-to-energy solutions (National Climate Change Secretariat, 2016). Singapore has a number of research groups and research centers 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).

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5.5. 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, 2018c). The total water demand in Singapore currently is about 430 million gallons a day. Of this demand, imported water provides about 50%, NEWater supplies up to 40%, desalination meets up to 25%, and local catchments make up the rest (Seow, 2018). The water demand is expected to almost double by 2060 (PUB, 2018c).

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 Kwan 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 Johor River in Malaysia, under the 1962 Water Agreement, which will expire in 2061. Singapore's National Water Agency PUB operates the Linggui Reservoir that is built upstream of the river to collect and release rainwater. Singapore is also obliged to provide Johor with treated water up to 2% 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 reserve 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% 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, 2018d). The roadmap aims 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. Digitalization 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.

With economic growth and an increasing population, Singapore has to find new ways and innovate to 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 neighboring Malaysia. These technologies also buffer against the effects of falling water levels in reservoirs during prolonged dry spells brought about by

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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.

5.6. Food

In 2018, Singapore topped the Global Food Security Index (F. Koh, 2018). However, vulnerabilities exist, and Singapore's food security is susceptible to climate and natural resource risks, which can disrupt food supply to the import-dependent country. As a small country with limited land, Singapore cannot grow all the food it needs to feed its growing population. It has to turn to imports from other countries. To maximize food resilience, Singapore adopts a diversification strategy, importing from many different countries to ensure the continuity of food supply should the import from any country be affected. For example, Singapore imports rice from India, Thailand, Vietnam, Malaysia, Cambodia, Myanmar and Pakistan (J. Lim, 2015).

Nonetheless, locally produced food plays a role in buffering against supply disruptions. Currently, less than 10% of Singapore's food is locally produced. Singapore aims to produce 30% of its nutritional needs by 2030 (Singapore Food Agency, 2019). This calls for higher productivity of farmlands, given the fact that land is scarce in Singapore. Farms have to produce a greater amount of food per unit area of land, while using manpower efficiently. The way to achieve this is through harnessing innovation, science and technology (Ministry of National Development, 2018).

Moving forward, it is clear that innovation and technology must be incorporated into farming practices to raise farm productivity. As Senior Minister of State, Ministry of Trade and Industry, Dr Koh Poh Koon said (Ministry of National Development, 2018):

> "Singapore can carve a niche in urban solutions by becoming a living lab for food production technologies, just like what we've done for water recycling and desalination—turning a disadvantage into something we can be proud of."

As Singapore progresses into the future, Innovation and technology are crucial for Singapore's resource-limited environment for agriculture, while ensuring the impact on the environment remains low. By making use of innovative technologies such as indoor farming, multi-tier farming, automation and precision engineering via sensors and internet of things (Ministry of National Development, 2018), farms can intensify land use, raise output with minimal manpower and add resilience to Singapore's food supply. Low carbon-footprint practices such as those used by Sky Greens are also exemplary to the next generation of farmers.

In summary, 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 formulate sound policies, implement concrete actions, and apply great ingenuity to come up with novel and innovative solutions for environmental issues. Without a sustainable and livable environment, there will be no place to support future economic development or to live harmoniously.

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6. Summary of Singapore's Trajectories and Future Skills, Knowledge, and Values Required

The following table summarizes the trajectories of Singapore's economic, social and environmental contexts and the skills, knowledge and values required of individuals for these trajectories.

Context	Trajectory	Skills, Knowledge, Values
Economic	• High value manufacturing • New and novel services (High- tech services requiring IoT, blockchain etc.) • Commercialization of innovative solutions • Competitive advantage through purposeful and radical adoption of technology and digitalization in services and manufacturing	• Skills mastery • Lifelong, life-wide and life-deep learning • Innovation • Value creation • Technology adoption • Digitalization • Creative thinking
Social	• Increased religiosity: the threat of religious extremism • Increased immigration: the need for integration and acceptance of newcomers • Racial issues: the need for racial harmony • Aging population: the need for continuous education • Misinformation and influence of social media platforms	• Tolerance • Mutual understanding • Mutual respect • Logical reasoning (critical thinking) skills • Rootedness • Information assessment literacy
Environmental	• Increased urbanization: increased consumption of energy and matter • Global environmental problems: the need for reducing carbon footprint • Renewable energy • Energy efficiency through green and innovative solutions • High-tech water solutions for meeting the increasing water needs • High-tech and green farms for increasing local food produce	• Skills mastery • Innovation • Value creation • Technology adoption • Digitalization • Creative thinking • Sustainable lifestyle

Table 2: Summary of Singapore's contexts and future skills, knowledge, and values

7. The Need for a Shift in Educational Practices

Referring back to Section 2.4., Practices are another dimension in our discussion of educational success. This dimension includes leadership and management practices, teaching and

learning practices, community practices and more. Practices are based on sets of assumptions, beliefs, and theories. These assumptions MUST NOT and CANNOT remain unchallenged paradigms in the discussion of future-readiness. Educational practices MUST shift from the current assumptions of practices where most activities are focused on the present. The skills, knowledge, and values summarized in the table above should be the basis for re-examining the assumptions of current educational practices. Fundamental questions such as,

- What type of learning environment must institutions create to develop innovative mindsets?
- How much future value is created AS AN OUTCOME of learning? (Measures)
- How will the value of current learning for students be translated into FUTURE VALUE for human capital? (Process)
- To what extent do school activities along the time continuum affect a student's future learning outcome and perspectives?

For educational success, practices must evolve and be relevant to match the evolving realities of purpose, time, and Singapore's context. For example, students must have an innovative mindset as future value that will enable them to fit into the next decade of economic and environmental development. The capacity of generating and developing ideas is the starting point for innovation. Next, testing the ideas will allow the translation of the abstract (ideas) into reality (product). If the outcome is to turn the idea into a useful product, the final phase of entrepreneurship involves convincing users to adopt the new product. Translating these phases into the school's teaching and learning will involve a shift in educational practices, as current practices emphasizes on knowledge acquisition. For example, there is little room for students to generate ideas that are not in the planned curriculum. Current educational practices that result in this state of affairs must change (Ng, 2019).

In short, successful education needs to fulfil all its three purposes, with a keen awareness of the future perspective of time. Being context-specific, education also needs to be relevant to the social, economic and environmental contexts of Singapore. This requires a change in current educational practices. We will look at the aspects of future-ready habits of practices that have to be developed for students in Singapore in the next section.

8. Habits of Practices Required of Learners for Singapore's Future Landscape

8.1. Introduction

Rapid developments in the economic, social and environmental landscapes of Singapore have fundamental implications for education in Singapore. There is a need to draw up key attributes required of learners to develop their future value in the Singapore context. The Ministry of Education has provided a framework for competencies required of students for the 21st century to help them thrive in the changing landscape of Singapore (Ministry of Education, 2018). Competencies include skills and knowledge. At the core of this framework lies Values, as values underpin competencies and define a person's character. For example, one of the values identified by the Ministry of Education is integrity. Surrounding the Values core in this framework are the Social and Emotion Competencies. For example, self-management requires the student to have the ability to manage his or her own

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emotions. The outermost layer surrounding the Social and Emotion Competencies layer is the Emerging 21st Century Competencies layer. For instance, having information skills means that students have the skills to sieve through information and extract what is relevant from the internet.

Here, we introduce an additional dimension to the framework – Habits. There are fundamental differences between competencies and habits. While the former refers to knowledge and skills, the latter refers to carrying out behavior repeatedly in response to various situations. Both competencies and habits are crucial for learning to ensure that practices are both supported by competencies (knowledge and skills) and by the *readiness to practice or execute certain behaviors without being told.* The latter also refers to '*habits of practices*'. What habits of practices must Singaporeans have in order to co-create and shape the future of Singapore? Schools should provide the context for developing habits of practices that are important for preparing students for the future of Singapore. In other words, formation of habits of practices can be done through the everyday practices and the teaching and learning environment of the school. This is different from the need to be more explicit in developing competencies.

The implications of habits of practices on education and on Singapore's future are tremendous. For example, if a student does not develop the habit of asking questions and challenging assumptions while she is still in school, she would likely accept the status quo in the workplace of her future job. This is neither beneficial for creativity nor innovation. So, what habits are required of learners to prepare them for Singapore's future landscape? We have seen previously that Singapore's future economic, social and environmental landscapes require these values, skills and knowledge:

Dimension of future-ready learning, lifework, and living	**Brief Definition**
Mastery of learning	Mastery is "comprehensive knowledge or skill in a particular subject or activity" (Oxford dictionary). Mastery of learning in a particular domain, therefore, means having learnt the domain in a comprehensive manner. Mastery is a construct that "cannot be observed directly but can be inferred from observable performance on a set of items or tasks related to a particular concept, skill, or subject". (Guskey & Anderman, 2013)
Lifelong, life-wide and life-deep learning	Lifelong learning: Formal continuous learning to stay relevant throughout the individual's entire work life and beyond. Life-wide learning: Informal learning that takes place and cuts across multiple contexts in a person's life that allows for multiple expertise development while simultaneously support identity. Life-deep learning: Deep mastery of multiple disciplines, adaptive expertise, and values (religious, moral, ethical) formation. (See Executive Summary, Section 3 and references therein.)
Innovation	"Innovation is the multi-stage process whereby organizations transform ideas into new/improved products, service or processes, in order to

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	advance, compete and differentiate themselves successfully in their marketplace." (Baregheh, Rowley, & Sambrook, 2009)
Value creation	"Value" has two components – perceived use value, which is subjectively perceived by users; and exchange value, which is the amount paid by the user to the producer for the perceived use value. Value is created through processes that create use value and subsequently realize exchange value. (Bowman & Ambrosini, 2000)
Technology adoption	Technology refers to the "machinery and equipment developed from the application of scientific knowledge", or "the branch of knowledge dealing with engineering or applied sciences" (Oxford dictionary). Technology adoption, therefore, refers to the use of engineering or applied sciences knowledge and/or machinery and equipment to solve problems.
Digitalization	Digitalization refers to the "the adoption or increase in the use of digital or computer technology by an organization, industry, country etc." (Brennen & Kreiss, 2014) It also refers to digital transformation – the changes associated with the application of digital technology in all aspects of human society. (Parviainen, Kääriäinen, Tihinen, & Teppola, 2017)
Creative thinking	Creative thinking can be described as the process of "forming of associative elements into new combinations which either meet specified requirements or are in some way useful." (Mednick, 1962) Creativity requires both originality and effectiveness. (Runco & Jaeger, 2012)
Tolerance	Tolerance means that "others are entitled to their opinions and have the right to express them and that even though one may disagree with them, and one can live in peace with such differences". (Von Bergen, Von Bergen, Stubblefield, & Bandow, 2012)
Mutual understanding	Understanding means "sympathetic awareness or tolerance". (Oxford Dictionary) Therefore, mutual understanding means two or more people or groups share sympathetic awareness or tolerance towards each other.
Mutual respect	Respect is "the feeling you show when you accept that different customs or cultures are different from your own and behave towards them in a way that would not cause offence". (Cambridge Dictionary). Mutual respect, therefore, means two or more people or groups share the same feeling towards each other.
Logical reasoning skills	Logical reasoning skills can be thought of as the ability of people to engage in the logical reasoning and critical thinking process – asking questions to define a problem/issue/situation and designing a model, gathering evidence and testing conjectures, and argumentation and reporting. (Jones & Texas, 2017)
Critical thinking	"Critical thinking is reflective and reasonable thinking that is focused on deciding what to believe or do." (Ennis, 1985)

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Rootedness	Rootedness is a strong sense of attachment to a place and it accompanying socio-political culture. It involves physical familiarity, social connection, attachment, sense of belonging, and a sense that citizens have a say in national affairs. (G. Koh, 2008)
Information assessment literacy	Information literacy refers to the capacity of people to recognize their information needs, locate and evaluate the quality of information, store and retrieve information, make effective and ethical use of information, apply information to create and communicate knowledge. (Catts & Lau, 2008). Information assessment literacy, therefore, emphasizes the evaluation of the quality and relevance of information.
Networks	Networks may be physical or non-physical (e.g. digital). Nodes connected by links make up the basic elements of networks. Nodes may be individuals, organizations, cities or nations; and links may be of the social, cultural, business or economic type etc. (Comunian, 2011; Karlsson & Westin, 1994; Libert, Beck, & Wind, 2016) Networks are characterized by the connectivity, interaction and interdependency between the nodes.

Table 3: Dimensions of future-ready learning, lifework, and living and their brief definitions

Considering the above points, we identify six habits of practices that are required of learners to prepare them to meet the challenges of the future of Singapore. The six habits are summarized next.

8.2. Summary

The following table summarizes the six habits, their practices, and their relation to future-ready learning, lifework and living:

Habit	**Practices**	**Habits of practices associated with future-ready learning, lifework, and living**
1. Inquisitiveness	• Ask various kinds of questions to self and others (higher order questions, metacognitive questions etc.), which helps individuals make meaning, reflect and learn • Being curious	• Mastery of learning • Life-long, life-wide, life-deep learning • Innovation • Creative thinking
2. Ideation	• Respond to stimulus and context-dependent and can be through serendipity	• Innovation • Creative thinking • Critical thinking • Value creation

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	• Requires understanding of assumptions of practices and paradigms • Define, clarify, and reframe problems • Challenges the status quo • Adopt a wide repertoire of approaches to ideation that leverages on physical and virtual networks • Adopt analytics to answer big questions	• Mastery of learning • Technology adoption • Networks
3. Prototyping	• Translate ideas into action • Evaluate, verify and communicate ideas and possibilities • Allows iteration for feedback – learning from failures • Test possibilities, challenges, and potential spin offs	• Innovation • Creative thinking • Value creation • Technology adoption • Digitalization • Logical reasoning (critical thinking) skills
4. Entrepreneurship	• Seeks opportunities and pieces together information that were previously unconnected • Develops new products and services that capture new markets/users • Creates new uses • Occurs in a stimulating environment where diversity, multi-cultural, and differences exist	• Value creation • Technology adoption • Innovation • Digitalization • Critical thinking • Networks
5. Inter-cultural acumen	• Accepts diversity of values, ethnicity, and religions • Manage conflicts and seek optimal solutions • Cultivate networks of collaboration and deepen ties and friendship • Decipher false information from real in a digitalized landscape	• Tolerance • Mutual understanding • Mutual respect • Logical reasoning (critical thinking) skills • Rootedness • Information assessment literacy
6. Passion	• Full immersion in activity and persistence in the face of obstacles • The passionate activity becomes part of a person's identity • Finds meaning and purpose in the activity • Accepts failure as part of learning	• Mastery of learning • Life-long, life-wide, life-deep learning • Innovation

Table 4: Habits, their practices, and their relation to future-ready learning, lifework and living

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To summarize, developing the above habits in learners is crucial to prepare learners for the evolving realities of the future landscape of Singapore. To be successful, an education system has to take on a long-term view of educational outcomes and prepare future-ready individuals who are able to thrive in, and contribute to, the changing landscape of Singapore. Preparation of individuals for the three purposes of education – learning, lifework, and living – has to be viewed through a future lens; and learning outcomes need to be aligned with the trajectories and dynamics of the future of Singapore. The future is context-situated and context-dependent; and in this paper, we have provided a discussion on how the future economic, social and environmental contexts of Singapore require some specific future skills, knowledge and values of individuals, which can be developed and expressed through particular habits of practices.

All these imply that practices cannot remain unchanged and unchallenged in the new realities that emerge. Teaching and learning practices need to be aligned to new and evolving realities of purposes, time and context. The school environment and its teaching and learning practices must shift to foster beneficial habits of practices in learners that will prepare them to actively contribute to a sustainable future. In addition to instructional objectives, there has to be alternative inquiry methods and practices of teaching and learning. With better and more relevant teaching and learning practices, we can then nurture individuals who are truly life-long, life-deep and life-wide learners, who can actively co-create and shape the future of Singapore.

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