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Educating for twenty-first century competencies and future-ready learners: research perspectives from Singapore

Twenty-first century competencies and future readiness: a global educational imperative?

This third millennium has been variously characterized by sociologists, economists, and futurists as the Creative Age (Florida, 2002), the Digital Age (Thomas & Brown, 2011), and the Conceptual Age (Pink, 2005), just to name a few. Semantic differences aside, these labels reflect a shared acknowledgement that our twenty-first century social and economic landscape bears distinctive features that sets it apart from preceding historical periods. While standardization and mass production used to be primary generators of economic wealth in the Industrial Age, the current "digital revolution" – embodied in personal, mobile, and networked technologies – has replaced manual and routine mental labour with ideas, innovation, and personalized services. These are in turn argued to be key commodities that drive new economic growth and social mobility (Freeman, 2004; Perez, 2004).

This significant economic, sociological, and epistemological shift has in turn exerted substantial pressure on the social institution of schooling worldwide to evolve and respond to the new human capital demands of industries and workplaces, and more importantly, to the learning needs and social futures of student lives. To this end, over the past two decades, national governments and international education communities have worked concertedly to engage with two educational imperatives, among others:

(1) What are the requisite "twenty-first century competencies" (21CC) that young people need in order to be active designers of, and productive contributors to local and global futures – political, social, economic, and cultural?
(2) How can these be more effectively taught, learnt, and assessed in formal and informal educational contexts?

While definitive answers and the specifics of school curriculum may remain contested, there now appears to be some convergence among global educational scholars, policymakers, and practitioners around what constitutes 21CC and the enabling pedagogical approaches that are likely to foster them (Hanna, Istance, & Francisco, 2010; Voogt & Roblin, 2012). Some of the more notable international education frameworks for assessing and fostering 21CC are set out in Table 1.

A noteworthy point to acknowledge is that many of these commonly referenced "21CC" and "future-ready" dispositions – creativity, critical thinking, collaboration, communication, socio-emotional and lifelong learning aptitudes such as positive self-concept, adaptivity and resilience – constitute age-old attributes that have long been upheld as integral to human progress prior to this third millennium. Many of these concepts or constructs in fact bear their own distinct and established fields of scholarship that span decades if not more. Arguably, however, these were historically regarded as the expressive affordances of more elite groups in society, especially in formal education contexts (Bernstein, 2000). But in today's knowledge economies characterized by complexity and rapid change, these are no longer considered only the province of the privileged, but essential to one and all's productive participation in local, global, and virtual societies.

Table 1. Overview of international 21CC education frameworks.

National Academy of Sciences' Education for Life and Work: Developing Transferable 21st Century Knowledge and Skills	Partnership for 21st Century Skills (P21)	Assessment and Teaching of 21st Century Skills (ATC21S)	OECD Definition and Selection of Competencies (DeSeCo)	EU Key Competences for Lifelong Learning
Cognitive Competencies · Cognitive processes and strategies · Knowledge · Creativity	Learning and Innovation Skills · Creativity and innovation · Critical thinking and problem-solving	Ways of Thinking · Creativity and innovation · Critical thinking, problem-solving, decision-making · Learning to learn, meta-cognition	Using Tools Interactively · Use language, symbols and texts interactively · Use knowledge and information interactively · Use technology interactively	Learning to learn Sense of initiative, entrepreneurship
	Information, Media and Technology Skills · Information Literacy · Media Literacy · ICT Literacy	Tools for Working · Information Literacy · ICT Literacy		Mathematical competence and basic competence in science and technology Digital competence
Interpersonal Competencies · Teamwork · Leadership	Learning and Innovation Skills · Communication · Collaboration	Ways of Working · Communication · Collaboration, teamwork	Interacting in Heterogeneous Groups · Relate well with others · Cooperate, work in teams · Manage and resolve conflicts	Communication in mother tongue
Intrapersonal competencies · Intellectual openness · Work ethic, conscientiousness · Positive core self-evaluation	Life and Career Skills · Flexibility, adaptability · Initiative, self-direction · Social, cross-cultural skills · Productivity, accountability · Leadership, responsibility	Living in the World · Citizenship (local and global) · Life and career skills · Personal and social responsibility (including cultural awareness and competence)	Acting Autonomously · Act within big picture · Form and conduct life plans and personal projects · Defend and assert rights, interests, limits and needs	Social and civic competencies Cultural awareness and expression

Correspondingly, many governments worldwide have redesigned their national curriculum frameworks to at least acknowledge the importance of these key 21CC and dispositions (Shaheen, 2010), even if they are not yet able to articulate fully how best to assess and develop them across domains and over time. At the same time, many national systems have introduced a suite of education policy initiatives and reforms aimed at recalibrating what Harvard Professor Richard Elmore termed the "core of educational practice", that is, "how teachers understand the nature of knowledge and the student's role in learning, and how these ideas about knowledge and learning are manifested in teaching and classwork" (Elmore, 1996, p. 2). On this front, two major educational challenges remain.

The first major challenge lies with the question of how school systems and educators can more effectively assess and scaffold the development of these "new knowledge economy" competencies – not only at the individual level but also at the collective level – and with particular sensitivity to the highly-networked, technology-mediated social and learning contexts of contemporary life-worlds.

The second major challenge lies with the explication of the cultural and pedagogical complexities of implementing 21CC-oriented educational innovations within long-established conventions of mainstream schooling that tend to privilege the acquisition of canonical disciplinary knowledge and academic achievement, particularly from the perspectives of school leaders, teachers, and students as critical stakeholder groups.

To date, there remains a relative lack of robust and rigorous research studies that directly engage with the imperative global education challenges outlined above. Addressing this knowledge gap by foregrounding theoretically-sound, evidence-based insights drawn from research in the Singapore educational context serves as the impetus and unifying focus of this special issue.

Why focus the lens on Singapore educational research evidence and perspectives?

In Singapore, the push to educate students for the twenty-first century has been a key impetus for major policy reform initiatives over the past two decades. These major educational policy initiatives and efforts are comprehensively set out in an online report entitled "Advancing twenty-first century competencies in Singapore" by Tan, Koh, Chan, Onishi-Costes, and Hung (2017) commissioned by Asia Society as part of a larger report series on East Asian education systems (Cheng, 2017). Here, we foreground some key highlights drawn from the report, in order to provide our international readers with better contextual understanding of the current formal education landscape in Singapore.

In response to rapid technological and cultural globalization, increasing competitiveness in the global economy, and world-wide volatility arising from increasing instances of terrorism and xenophobia, the Ministry of Education undertook a major curriculum review in 1997 to rethink its goals and directions for the future (Poon et al., 2017). This led to the inception of Thinking Schools, Learning Nation (TSLN) in the same year. TSLN was a pivotal policy shift towards 21CC education that aimed to prepare Singapore's students for the future. It represented a clear articulation that the future sustainability and economic growth of Singapore depended on the ability of its people to learn (Goh & Gopinathan, 2008: cited in Tan, Koh et al., 2017), and consequently, that the transformation of pedagogy and practice in schools and classrooms was needed to broaden learning experiences and better address students' diverse learning needs (Poon et al., 2017). While there had been several curricular programmes introduced prior to 1997 that focused on enhancing students' thinking skills (Deng, Gopinathan, & Lee, 2013: cited in Tan, Koh et al., 2017), the 1997 launch of TSLN is widely recognized as a defining moment that formalized Singapore's systemic efforts in educating for 21CC that concentrated resources on teachers, infrastructure, and technology, with the aim of developing in students the necessary knowledge and competencies to respond to challenges ahead.

In this way, TSLN firmly cemented Singapore's move into educating for 21CC (Poon et al., 2017). The policy focused on enabling students to develop creative and critical thinking skills, and its strategies included the explicit teaching of creative and critical thinking skills, reduction of curriculum content, revision of assessment modes, and greater emphasis on process instead of outcomes in learning and teaching (Tan, Koh et al., 2017). Following the TSLN vision, a suite of 21CC curriculum initiatives were

systematically introduced and refined to strengthen the preparation of Singapore's young people for the future (see Table 2). This included the launch of the Framework for 21CC and Student Outcomes in 2009 (see Figure 1) that represented one of the most significant developments in Singapore's 21CC education efforts. Since its inception, the 21CC framework has been infused into the academic curriculum, co-curricular activities, character and citizenship education, as well as applied learning programmes.

In tandem with the Ministry of Education (MOE) policy initiatives and efforts towards educating for 21CC and future-ready skills and dispositions in Singapore, the past decade has seen substantial investments in teacher education and educational research into twenty-first century pedagogy and practice undertaken by academic staff and researchers at the National Institute of Education (NIE) of the Nanyang Technological University.

The NIE is the sole tertiary institution responsible for pre-service teacher education and plays a major role in the professional development of in-service teachers in Singapore's mainstream education spanning primary to junior college grade levels. The NIE is also the leading educational research institution in Singapore. Many of its faculty members are actively leading and undertaking key research on educational policy, pedagogy, and practice in Singapore schools and classrooms through competitively-funded projects. Most of these projects are administered by NIE's Office of Education Research (OER), set up in 2008 to lead efforts and spearhead programmes to advance educational research, development and innovation.

A meta-synthesis of OER-funded educational research projects conducted by NIE faculty and researchers from 2008–2016 showed that a significant number of these projects engages – either directly or indirectly – with the notion of educating for 21CC across a range of curricular domains and grade levels. The foci of these studies can be broadly categorized as (1) baseline studies of twenty-first century teaching and learning processes and outcomes across programmes, individual schools, and clusters/networks of schools, (2) the design and implementation of assessment and pedagogical innovations aimed at fostering 21CC in learners, as well as (3) change models and theories related to the scaling and sustaining of such educational innovations across the system. Altogether, these projects, both completed and ongoing, saw the development of a substantial suite of more than 100 curriculum innovation packages and new technology-mediated learning platforms that were trialled by as many as 20,000 Singapore students across a wide range of schools, year levels, and subject domains, alongside the conduct of more than 300 in-service teacher learning and professional development workshops (Tan, Monterola, Koh, & Ho, 2017).

Many of these educational research projects undertaken by NIE academics and researchers are grounded in empirical studies of schools, classrooms, and other authentic learning environments. A good half of these projects comprise MOE policymakers and school practitioners as research collaborators, which in turn reflect the dynamic tripartite relationship between research, policy, and practice that characterizes Singapore's education landscape (Poon, 2012).

To this end, we posit that a special issue foregrounding evidence-based educational research in Singapore that specifically explores the enablers and challenges of educating for 21CC and future-ready learners is both timely and relevant for educational stakeholders in Singapore, as well as the global educational community.

Papers featured in this special issue

Following an open public call for manuscripts on the Journal's website in late 2016 inviting contributions on the specified theme from within and beyond the NIE and Singapore, this special issue features 12 papers that were accepted for publication following the Journal's rigorous peer review process. We group these 12 papers into three sub-themes: (1) Fostering 21CC within the disciplines (five papers); (2) Fostering 21CC across the disciplines (four papers); and (3) 21CC and future-readiness: System-wide perspectives in formal schooling and beyond (three papers). These sub-themes and papers are further explicated below.

Table 2. Major Policy Initiatives in Singapore on Educating for 21CC and Future-Ready Learners.

Period	Policy Initiatives and Efforts
1997	**Thinking Schools, Learning Nation (TSLN):** Launched by then-Prime Minister Goh Chok Tong, following a major curriculum review to re-think its goals and directions for the future. Constitutes a pivotal policy shift towards twenty-first century education aimed at preparing Singapore's young for the future by equipping them with a deep ability to learn. Focused on enabling students to develop creative and critical thinking skills, by concentrating resources on teachers, infrastructure and technology, reduction of curriculum content, revision of assessment modes and greater emphasis on the process of learning, rather than mere attainment of high academic grades Poon et al., 2017).
2005	**Teach Less, Learn More (TLLM):** Introduced by PM Lee Hsien Loong, launched by then-Minister of Education, Tharman Shanmugaratnam. Aimed at enhancing the quality of education through emphasizing pedagogical change towards innovative pedagogies such as inquiry-based learning, and reducing syllabi so that students had more time and space to learn and explore (MOE, 2005). System-wide change involving a wide range of stakeholders and operational components (e.g., TLLM *Ignite!* package, PETALS™ framework) to support the implementation of policy to practice in schools and classrooms.
2004–2010	**Various Structural Changes:** Structural changes to reduce focus on high-stakes assessments and introduce greater flexibility into academic pathways and programmes. These include *removal of the "streaming"* practice at Grade 4; introduction of the "subject banding" scheme to support differentiated instruction and learning; introduction of *Direct Admission Scheme (DSA)* to give students the opportunity to gain admission to secondary and postsecondary level based on diverse achievements and strengths, rather than solely on academic results; introduction of the 6-year *Integrated Programme (IP)* where students enrolled in the programme (Grade 7–12) do not have to sit for the high-stakes Grade 10 GCE "O"level examinations. This provided schools with more curricular time and pedagogic freedom to stretch the learning of students, to provide greater breadth in academic and non-academic domains (MOE, 2016). IP schools can also apply to offer the *International Baccalaureate Diploma Programme (IBDP)*—an international curriculum known for its academically rigorous, broad-based, inquiry-oriented curriculum and flexible assessment modes—as an alternative matriculation qualification instead of the GCE A levels. Four *specialized independent schools* were also founded in 2004, 2006, 2008, and 2010 respectively to nurture talent in sports, mathematical science, arts, and technology.
2010	**Primary Education Review and Implementation (PERI) and Secondary Education Review and Implementation (SERI):** Committees formed to evaluate and improve the quality of primary and secondary education in Singapore. PERI aimed to foster in young students a suite of 21CC and dispositions, including curiosity, confidence, and collaboration, by focusing on social-emotional development, non-academic curriculum and lifelong learning (MOE, 2009). Key PERI initiatives included Holistic Assessment (HA); Programme for Active Learning (PAL); PE, Art & Music (PAM) education; Engaging Pedagogies (EP); Strategies to ensure more attention for individual pupil development (SEAIP); as well as enhancing infrastructure and investing in a quality primary teaching force.
2009–2010	**Framework for 21CC and Desired Student Outcomes:** A pivotal 21CC policy thrust that formally articulated (i) a revised set of four desired student outcomes (Confident Person, Self-Directed Learner, Active Contributor, Concerned Citizen) in 2009,and (ii) a "Total Curriculum" Framework for 21CC and Student Outcomes in 2010 (Figure 1). Broadening the earlier focus on thinking skills, this framework expanded the scope of 21CC to include values, emotions, interpersonal skills and emerging forms of 21CC (Poon et al., 2017). Intended for infusion into each school's total curriculum, i,e., the entire learning experiences of a child in the school spanning the academic and non-academic areas.
2011–2012	**Character and Citizenship Education Framework (CCE) and Values in Action (VIA):** CCE launched in 2011 by then Ministry of Education, Heng Swee Keat, intended to instill a sense of responsibility in students towards country and fellow citizens, and develop their social-emotional competencies. VIA introduced in 2012 to emphasize the provision of authentic learning experiences that encourage students' involvement in community and nurture them to become socially responsible citizens.
2013	**Applied Learning Programme (ALP) and Learning-for-Life Programme (LLP):** To be undertaken in all schools by 2017, the ALP focuses on interdisciplinary knowledge and the application of skills to professional real-world settings; the LLP aims to nurture students' character and values, and develop their interpersonal skills.
1997–Current	**ICT Masterplans 1, 2, 3, and 4:** This aimed to equip each school with the necessary socio-technical infrastructure that will not only provide access to modern technologies, but also become an enabling mechanism for enacting the pedagogical shifts articulated in the TSLN and TLLM vision, as well as the more recent 2010 Framework for 21CC, and with a view to achieving the desired outcomes of education (see Figure 1).

Adapted from "Advancing Twenty-First Century Competencies in Singapore" by Tan, Koh et al. (2017). Online Report. Asia Society. Adapted with Permission.

Figure 1. Framework for 21CC and desired student outcomes. Source: https://www.moe.gov.sg/education/education-system/21st-century-competencies. MOE, Singapore.

Sub-theme one: fostering 21CC within the disciplines

While there have been clear, vocal calls to educate students for the twenty-first century among governments, scholars, and policymakers, policy initiatives do not necessarily reflect what is occurring in the daily practices of formal and informal learning in schools. The articles in this section provide empirical evidence of how twenty-first century education is enacted in various ways through disciplinary specific ways of teaching and learning. Common across the articles is a resistance towards traditional factory or "Fordist" model of schooling through encouraging learner-centred constructivist pedagogies geared towards developing students' sense of agency. These shifts have occurred largely in response to two shifts in teaching as a result of two globalizing forces in the twenty-first century landscape.

The first major globalizing force concerns technological globalization and the subsequent digitization of the workplace. According to the Organization for Economic Cooperation and Development (OECD) (2016), 95% of workers in large businesses and 85% in medium-sized businesses now have access to and use the internet as part of their jobs. Yet, 56% do not have sufficient skills to complete tasks in a technology-rich environment. Consequently, the burden falls on schools to equip students to not only utilize technological tools but to "mediatize" teaching through expanding text forms to include richer, multimodal texts and through tapping on multiliteracies in instructional practice (Jewitt, 2008; New London Group, 1996).

In "Use of comics to enhance students' learning for the development of the twenty-first century competencies in the Mathematics classroom", Tin Lam Toh, Lu Pien Cheng, Siew Yin Ho, Heng Jiang, and Kam Ming Lim discuss how comics can facilitate twenty-first century skills in Mathematics. The use of such a multimodal text injects fun in learning thereby increasing students' interest in the subject. They discuss pedagogical approaches that encourage students to discuss their interpretations of comics in teams, pose problems, and make connections to real-world scenarios. Such approaches ultimately pushed students to become more active and engaged learners.

The wealth of information readily available online necessitates an emphasis on equipping students to be critical, discerning readers of texts. This competency should be infused in all subjects in the curriculum. In "Educating Science teachers in the twenty-first century: implications for pre-service teacher education", Aik Ling Tan, Peter Peng Foo Lee, and Yin Hong Cheah argue for the need to shift the focus of science teaching and learning away from content to equipping students with competencies to critique and evaluate scientific knowledge. The current culture of science classrooms is dominated by didactic

teacher-centred instruction. Conversely, students need to be trained to evaluate given evidence and be equipped with argumentation skills to persuade and defend their positions. In their analysis of pre-service teachers who engaged with competing scientific theories, they discuss the potential of such strategies for facilitating critical social interactions in science classrooms.

The intensification of global interconnectedness has led to a greater recognition of the importance of cultivating "soft skills" such as resilience, collaboration, and communication within the disciplines. In "Developing twenty-first century competencies through the Arts: a case study of a high performing secondary school band in Singapore", Leonard Tan examines how 21CC can be cultivated through the arts. His ethnographic research on a school band showed how opportunities can be provided for students to perform and so cultivate collaboration and dispositions such as resilience, patience, and a desire for excellence. More importantly, learning in such out-of-classroom settings can strengthen social bonds among students leading them to care and feel a sense of responsibility for one another.

Beyond these opportunities, classroom pedagogies also play a crucial role in helping students acquire desired twenty-first century dispositions. In "Nonlinear pedagogy and its role in encouraging twenty-first century competencies through Physical Education: a Singapore experience", Miriam Yi Lee Chang, Jia Yi Chow, Chris Button, and Clara Wee Keat Tan focus on the use of nonlinear pedagogy in Physical Education. Nonlinear pedagogy is learner-centred emphasizing autonomy and guided discovery. Findings from a study involving primary school students showed that such pedagogies facilitated social skills and teamwork. The application of nonlinear pedagogies essentially gave students more freedom to explore, resulting in greater perceived competence in their learning, as well as more opportunities to demonstrate problem-solving and creativity.

The infusion of 21CC discourse in the curriculum has served to push the boundaries of conventional approaches to teaching. At the same time such innovations are often mediated by the attendant local socio-cultural conditions and nuances as these continue to evolve. In "The 'vernacularization' of global education policy: media and digital literacy as twenty-first century skills in Singapore", Csilla Weninger focuses on media and digital literacy. As has been the case in many countries including Singapore, the English language has been the vehicle for media literacy education. One drawback to this is that media literacy becomes tied to the teaching of specific skills with insufficient attention paid to socio-cultural engagement. Drawing on an analysis of media literacy related policies and curricula in Singapore as well as survey results of English teachers' media literacy instruction, she highlights the prioritization given to critical-analytic skills and the lack of emphasis on creative, expressive uses of media. She argues that such a protectionist approach to media literacy should be challenged in order to develop more critically engaged citizens in the future.

Sub-theme two: fostering 21CC across the disciplines

Complementary to the preceding sub-theme focusing on fostering 21CC within the specific subject domains of Mathematics, Science, Arts, Physical Education, and Literacy, the next four papers underscore the transdisciplinary nature of 21CC that can be cultivated across domains. The juxtaposition of these four papers with the first five papers engage to some extent with a current discernible debate in the field: that of whether 21CC and its constitutive elements, such as creative and critical thinking, are domain-specific or domain-general, and/or whether this distinction in fact matters (e.g., Mishra, Koehler, & Henriksen, 2010; Plucker & Beghetto, 2004).

In "The complexities in fostering critical thinking through school-based curriculum innovation: research evidence from Singapore", Liang See Tan, Elizabeth Koh, Shu Shing Lee, Letchmi Ponnusmay, and Keith Tan examine the impact of different curriculum innovations on students' critical thinking competencies. The paper discusses two innovations with distinctive features: one that strongly infuses the arts into the curriculum throughout the whole course of study; and another, known as the "Integrated Programme" aimed at providing schools with more curricular and pedagogic freedom to stretch students' learning needs, by removing one high-stakes national standardized secondary school leaving

exam. This paper appropriates a socio-cultural approach to illuminate how critical thinking outcomes is promoted through the confluence of curricular contexts and processes.

We then turn the lens from fostering critical thinking in students to teachers in "Developing student teachers' critical thinking and professional values: a case study of a teacher educator in Singapore" by Li Cai, Ee Ling Low, and Chenri Hui. Through a rich and in-depth qualitative case study of one teacher educator, this paper explores how thinking and values in student teachers are cultivated in the Singapore context. The paper uses the theoretical lens of modelling to foreground how the delicate interweaving between values and competencies, identity and pedagogy, as embodied in teacher educators can potentially bring about desirable outcomes in the preparation of student teachers for the twenty-first century education landscape.

Next, in the paper "Global education and its tensions: case studies of two schools in Singapore and the United States", Suzanne S. Choo argues that global education aimed at preparing students with the skills and dispositions to live in an interconnected world should be a key priority in 21CC policies and practices. She examines two schools that have adopted a whole-school approach to global education by integrating global issues and emphasizing critical, ethical, and affective dispositions to respond to global problems in all subject areas. On one hand, a whole-school approach to global education is beneficial in pushing both teachers and students to connect disciplinary knowledge with real-world global issues thus enabling students to become more globally aware. On the other hand, she highlights the tensions that emerge when disciplinary boundaries limit complex engagement with global problems that tend to be multidimensional in nature. Consequently, there is then a need to connect discipline-specific learnings with broader sociohistorical knowledge and diverse transnational "globalscapes" as well as negotiate intellectual and affective engagement with the lived experiences implicit in global realities.

Last but not least within this sub-theme, the paper "Nurturing grateful and connected twenty-first century learners: development and evaluation of a socially-oriented gratitude intervention" by Imelda S. Caleon, Ronnel B. King, Jennifer Pei-Ling Tan, Michelle Low, Chee Soon Tan, and Gregory Arief Liem reports a quasi-experimental study that examined the effectiveness of a socially-oriented gratitude intervention in promoting secondary school students' sense of gratitude and perceived interpersonal relationships. Findings showed the potential of the intervention to improve students' gratitude levels, albeit only to a small extent, and prevent the decline in the quality of students' relationships with their parents and peers. This study and its findings are noteworthy in that gratitude is an important personal attribute associated with academic performance and well-being (Waters, 2011), and that social aware-ness and relationship management are two of the key social-emotional competencies underpinning students' twenty-first century competencies in the Ministry of Education's Framework for 21CC and Student Outcomes (Ministry of Education, 2015). Whilst future research needs to refine the study design and its intervention mechanisms, this preliminary study constitutes a promising step towards promoting Singapore students' intrapersonal twenty-first century competencies.

Sub-theme three: system-wide perspectives on 21CC and future-readiness in formal education and beyond

As Singapore strives towards becoming a smart and future-ready nation (Economic Development Board, 2017; Smart Nation & Digital Government Office, 2017), it is fundamentally important for its young people to develop the competencies to navigate challenges and changes of the twenty-first century. These competencies require them to continuously engage in the cycle of learning-unlearning-relearning processes. The three papers in this section underscore issues revolved around the sustainability, scal-ability, and relevance of 21CC beyond the world of school, into the world of life and work. Seventeen years into the twenty-first century, it is clear that this time will see deep shifts and shocks in the global landscape, with advancements resulting in the "paradox of progress" (National Intelligence Council, 2017, p. iv) that will shape individual and collective responses.

Specifically, individuals will need to not only understand shifts in the system and associated organ-izational forms, but also acquire and update skills to adapt to these shifts. A central idea in the three

papers suggests that, whether changes are driven by pedagogical or policy innovations, a key to future readiness is how individuals exercise ownership over their own learning and are prepared to evolve and adjust as contexts change.

In "Innovation becoming trajectories: leveraging lateral and vertical moves for collaborative diffusion of twenty-first century learning practices", David Hung, Yancy Toh, Azilawati Jamaludin, and Hyo-Jeong So demonstrate how educational actors from three schools champion their pedagogical innovations. The three school-based innovations are part of an encompassing study on the meta-study of projects awarded under an MOE-supported funding programme to surface and spread ground-up ICT-based pedagogical innovations that are aligned with the thrusts of 21CC. They find that successful innovation diffusion capitalize on the affordances of existing structures in the educational system but require a fine balance between lateral (decentralized) and vertical (centralized) moves. In such a journey, roles and configurations evolve and unfold as actors respond to economic, social, and policy triggers in the wider ecological environment. It is the dialectical interplay of lateral and vertical moves in the system that the authors argue can contribute towards the sustainability of innovations, including the ones that are promoting 21CC.

In "The importance of career clarity and proactive career behaviours in predicting positive student outcomes: evidence across two cohorts of secondary students in Singapore", Melvin Chan highlights the importance of career clarity. Specifically, he focuses on the predictive validity of proactive engagement, which he operationalizes as a potential "third" variable and an important source of intentional self-regulatory behaviour that promotes positive development, especially among late adolescents. The notion of proactivity broadly refers to initiative-taking, self-starting and future-ready behaviours in which individuals take it upon themselves to identify opportunities and act on them, rather than to wait for things to happen. Analysis from two studies of secondary school students suggests that the clarity of career goal is an important starting point for engaging in meaningful career exploration. Clearly, the clarity of career goals is crucial for young people to be future-ready.

The idea that education needs to prepare individuals for the world of work and life is clear in the last paper, "Lifelong learning in Singapore: where are we?" by Johnny Sung and Simon Freebody at the Institute for Adult Learning, Singapore's national centre for continuing education and training (CET) research, learning, and practice. The paper discusses a recent national policy initiative, SkillsFuture, which demonstrates Singapore's focus on lifelong learning. Using Delors Four Pillars of education, and data from the OECD Survey of Adult Skills (PIAAC), the authors make a comparison between Singapore and its international counterparts using Singapore's Lifelong Learning Index. Their analysis suggests that although this initiative is in its early days, its future success will hinge not only upon a sound understanding of the genesis of lifelong learning but also on how well it is informed by Singapore's historical development and future aspirations. Their paper invites us to critically examine how the promotion of young people's future-readiness should consider the social, cultural, and economic contexts of Singapore as a society.

Concluding remarks: significance of this special issue

The papers in this issue serve to provide wide-ranging on-the-ground perspectives of how 21CC has been translated in practice across specific subjects, schools, programmes, and systems. As the future remains volatile and unpredictable, attempts to articulate the kinds of skills, competencies, and dispositions students will need in the future are inevitability speculative. 21CC discourse remains at a nascent stage in Singapore despite attempts to concretize a framework and describe various innovative practices and policies. As our understanding continues to develop, there is also a need to problematize the dominant discourses of 21CC. Frameworks, particularly those propagated worldwide by organizations such as the OECD and P21 (see Table 1) may perpetuate the language of competition and economic rationality pushing for the alignment of curriculum around skills considered necessary for employment in the global marketplace.

Consequently, policymakers and educators may inadvertently be pressured to privilege the question of how to implement 21CC most effectively over more philosophical questions about why 21CC is valuable for a flourishing life and citizenry. In this sense, the next stage of development of 21CC may need to lend greater attention to exploring the ethics and values informing twenty-first century schooling as well as articulate a clearer philosophy of education grounded on a vision of the kinds of character, dispositions, and virtues that twenty-first century school leaders, teachers, and students need to have. More specifically, the challenge is how Singapore can develop its own brand of 21CC values and philosophy not merely adapting frameworks and discourses propagated by scholars and organizations from the West but one that is derived from the voices of its own scholars and educators and that takes into account its situatedness in multicultural and Asian contexts.

The transition from an industrial-oriented education model towards a 21CC educational agenda is by no means a straightforward or linear one for any education system, whether at the district, state, national, or international levels. As empirically demonstrated by social economist Carlotta Perez in her seminal work on techno-economic paradigms and socio-institutional innovations, it often takes two to three decades for policy reforms to result in observable shifts in socio-institutional "common sense" and cultural spheres of practice. In the same way, curricular and structural reforms in the education sector, including teacher preparation and professional learning, as well as strong articulations between rigorous research and practice, often take on complex and nonlinear trajectories and therefore require ample time, patience, and commitment to the cause, before systemic shifts may be witnessed in the pedagogical and learning landscapes in schools, classrooms, communities, and society at large. In a similar vein, the possibilities and accomplishments throughout Singapore's journey of engaging with the global 21CC educational agenda would expectedly be fraught with social, cultural, technological, and pedagogical complexities, tensions, and dilemmas.

By turning the focal lens on Singapore as a microcosm of contemporary education and foregrounding multidisciplinary empirical research, challenges and knowledge gaps associated with educating for 21CC and preparing future-ready learners, it is our hope that this special issue will serve to push beyond simple binary formulations and broad generalizations of Singapore's education system, to generate more nuanced evidence-based insights and stimulate deeper questions for the education sector at large, in the Asia Pacific region and beyond.

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