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Gifted Learners and How to Develop Them

Teo Chew Lee, Sima Aghazadeh, Jeanne Ho
With appreciation to Tan Liang See for her invaluable contribution and advice

NIE Working Paper Series No. 21

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Suggested citation: Teo, C. L., Aghazadeh, S., & Ho, J. (2021). *Gifted learners and how to develop them.* (NIE Working Paper Series No. 21). Singapore: National Institute of Education.

ISBN: 978-981-18-0212-6

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Abstract

Singapore aims to build a flexible and diverse education system to help students discover their talents, realise their full potential and develop a lifelong passion for learning. This national aspiration is grounded in the Singapore education system's recognition of individual differences in learning and implementing a strategy in which we seek to lift the bottom while not capping the top. Just as all learners need a supportive learning environment with adequate challenge, so do gifted learners. This paper synthesises and critiques research evidence on understanding and educating gifted learners to inform policy and practice in Singapore. The paper includes elaboration on the differentiation of learning environments to develop gifted learners.

Introduction

Singapore aims to build a flexible and diverse education system to help students discover their talents, realise their full potential and develop a lifelong passion for learning. This national aspiration is grounded in the Singapore education system's recognition of individual differences in learning and implementing a strategy in which we seek to lift the bottom while not *capping the top* (Chia, 2018). Although streaming (i.e., academic grouping) has served our education system well since its inception in the 1980s, shifts towards a knowledge-based

global economy require the system to re-examine existing practices in grouping students for efficient teaching and learning. While all learners need a supportive learning environment and opportunities to experience a sense of achievement, research shows that these enablers should be adjusted appropriately to facilitate advanced learners (Kyriakides, Christoforou & Charalambous, 2013). A one-size-fits-all pedagogical practice could limit the potential of advanced learners (Gallagher, 2004; Plucker, Burroughs & Song, 2010), defined as both higher-ability learners and gifted learners. This paper aims to highlight the cognitive and affective needs of the gifted and talented and elaborate how learning environments can be differentiated to provide effective support for the brightest in Singapore classrooms. This paper synthesises research evidence on educating gifted learners to inform policy and practice.

For this purpose, the paper consists of three sections: Section 1 synthesises the changing conceptions of giftedness and talent development in the international literature. Following that, Section 2 presents different gifted programmes and provisions for gifted learners. Finally, Section 3 discusses the challenges and limitations surfaced in the literature of gifted education, and offers some implications for educators, policymakers, and future research.

Section 1: Changing Conceptions of Giftedness and Talent Development

1.1 Understanding the cognitive characteristics of giftedness and talent

Gifted students are those who have the potential for outstanding performance that is above the grade level of their age peers. These students learn at a faster rate (Colangelo, Assouline, & Gross, 2004) and more readily find, solve and act on problems (Sternberg, 1985). They are also better able to grasp and manipulate abstract ideas, making connections between these ideas (Gallagher & Gallagher, 1994; Ruthsatz, Ruthsatz, & Stephens, 2014; Leikin, Leikin & Waisman, 2017).

Progress in neuroscience research has sought to provide a better understanding of how the brain functions in the process of learning in general and in gifted children in particular, which might help explain giftedness. Through non-invasive neuroimaging methods (e.g., EEG, MRI, fMRI), which enable observations of brain structures and processes during cognitive tasks, neuroscientists have investigated the brain functioning of gifted children. These are done in comparison with their non-gifted peers, across several domains: in music (Geake, 1996; Stewart & Williamon, 2008); in mathematics (O'Boyle, 2008; Prescott, Gavrilescu, Cunnington, O'Boyle & Egan 2010); and in the languages (Saintpierre et al., 2002). A consistent finding from these studies is that gifted participants demonstrate more activities in certain lateral regions of their frontal cortices than their non-gifted peers. The bulk of research in this area consistently reported that gifted subjects display enhanced frontal cortical activation and inter-hemispheric functional connectivity, as well as enhanced neural processing and cerebral bilateralism (e.g., Neubauer & Fink, 2009; Geake, 2009).

Prescott et al. (2010) also examined the brain functioning of mathematically-inclined gifted children by using a mental rotation task. They observed greater activation of the left hemisphere in a process that essentially requires the activity of the right hemisphere. They indicated that these children show a more generalised cortical activation, better inter-hemispheric communication, and thus a more integrated brain function, compared to their non-identified peers. In another example, Shaw et al. (2006) conducted a large longitudinal study, spanning from early childhood to young adulthood (307 individuals, ages 3.8–29), to explore the relationship between structural brain development and Intelligence Quotient (IQ), as assessed by the Wechsler scales of intelligence. The authors reported that children with superior levels of intelligence experience a significantly different pattern of brain development from children with average and high intelligence. In extensive research on giftedness in mathematics, findings have shown both hemispheric differences as well as regional differences (Zhang, Gan, & Wang, 2017). Studies like these provide evidence that there are anatomical differences in the brain functioning of children with higher intelligence and abilities that we can use to triangulate with the current understanding of giftedness.

Similar neurological findings can be found in areas of analogical reasoning and creative thinking. Geake and Gross (2008) suggested that analogical reasoning may be one of the most critical foundations for giftedness where the prefrontal cortex and executive functions, including memory, inhibition and task switching, are core components of giftedness. This finding corroborates with findings related to gifted mathematics students. Ongoing studies of giftedness in creativity continue to suggest a predominant role of the dorsolateral prefrontal cortex, but also parietal association cortices and the precuneus (regions associated with identity and perspective taking) (Andreasen & Ramchandran, 2014). If we focus primarily on conscious acts of creativity, the prefrontal cortex has been found by a series of studies to play a predominant role, consistent with the work presented above (Dietrich, 2004). However, we need to be aware that all these studies depend on accurate measures of creativity, which are not yet developed (Sawyer, 2011). Definitions of creativity are socially constructed and are further complicated by socio-cultural value systems (Banaji, Burn, & Buckingham, 2010).

At this point, neurological support for the development of giftedness is still in its infancy, and it is therefore dangerous to speculate specific advice. However, we could pull together the neurological findings above to derive some general principles that are supported by neuroscience:

- First, giftedness can be seen as a type of expertise. It has been well documented that cortical thickness is practice and expertise dependent. Well-practised meditation has been shown to be associated with increased cortical thickness, particularly in the prefrontal cortex and insula (Lazar et al., 2005). Even video gaming has been shown to affect cortical thickness in adolescents, with increase in cortical thickness in areas of the prefrontal cortex and precuneus (Yuan, et al, 2013), with specific gains in the dorsolateral prefrontal cortex (Kühn et al, 2014). Relating these studies to the cortical thickness studies of gifted individuals, interventions can be developed to better cultivate giftedness. However, these research findings lack ecological validity and so have to be further studied and tested to establish their appropriateness in practice in the real world.

- Second, giftedness is associated with holding information in the mind and manipulating that information. In essence, giftedness is associated with internal modelling and imagination. In general, teaching practice focuses extensively on cultivating students' outwardly focused attention but may not have sufficient focus on cultivating students' internal imagination. Groups of neuroscience researchers have postulated that facilitating the mindful switching between task-focused and reflexive imagining could go a long way toward developing intellectually, creatively, and culturally-diverse gifted students in the sciences (Gotlieb, Hyde, Immordino-Yang, & Kaufman, 2016; Immordino-Yang, Christodoulou, & Singh, 2012).

We also need to note another development in neuroscience, which is neuroplasticity, i.e., the concept that the brain, far from being immutable after childhood, is constantly reacting to experiences throughout life. Therefore, the brain's ability to change, as a result of educational and environmental experiences, has cast doubts on the concept of intelligence as being innate and genetically programmed (Lucas & Claxton, 2010). The neuroplasticity of the brain asserts that creativity and intelligence are fluid and dynamic processes and that "IQ, the most common measure of intelligence, fluctuates within a person's lifetime as well as from generation to generation" (Martinez, 2013, p.xiii). This supports the point later in Section 1.3 that gifted identification, instead of being a one-off phenomenon, should occur at multiple points across time, using multiple selection criteria for giftedness (Lohman, Korb & Lakin, 2008; Merrick & Targett, 2004). The brain's ability to change because of educational experiences also reinforces the importance of providing enriching educational experiences to children on the ability continuum, beyond those officially identified as gifted.

1.2 Research evidence on the affective aspect of giftedness

Besides the cognitive aspects of giftedness, neuroscience research also studies the motivation and seeking behaviours of gifted learners. One of the components of giftedness is the intrinsic motivation to continually engage in practice and seek new information (Mönks & Mason, 2000). A neural network of interest here is the seeking system, which is a brain loop responsible for foraging in animals

and sustained exploration (Wright & Panksepp, 2012). This area of research should examine regions associated with growth mindset and intrinsic motivation (Ng, 2018). It is also of interest how extrinsic rewards may undermine this type of motivation at the neurological level (Murayama et al., 2015). The examination of these networks and giftedness has been relatively unexplored even though a commitment to a domain is core to the definition of giftedness. A related motivational experience, that is associated with giftedness but understudied, is flow (Csikszentmihalyi, 1992). This construct is the experience of timelessness and total absorption in an activity. Understanding the neuroscience of giftedness will undoubtedly require further exploration into this area.

Neuroscientists and psychologists have also raised the point that measures of giftedness are ignoring some key abilities such as social-emotional imagination, of which no reliable measure has been developed yet (Gotlieb et al., 2016). Immordino-Yang's work has examined the differences in the default mode network, a network associated with internal reflection. This network includes the region of the precuneus mentioned earlier, which is associated with constructing an internal narrative, developing a sense of compassion and admiration (Immordino-Yang, McColl, Damasio, & Damasio, 2009). Clearly as a society, we also prize these skills, but they have yet to enter the discussion of giftedness.

While the literature documented the cognitive characteristics of the gifted, there is also extensive literature emphasising the important role of affective needs in developing giftedness and talents. A key concern about engaging gifted learners in learning advanced materials is their capacity to handle stress and anxiety. Nevertheless, Neihart (2007) found mixed conclusions when examining the socio-affective outcomes of ability grouping. Some research described positive effects on self-esteem or self-concept for all learners in gifted ability-grouped contexts (Ireson, Hallam & Plewis, 2001; Gentry & MacDougall, 2008). In contrast, some researchers argued that not all gifted learners take heed of peer-comparison (Makel, Lee, Olszewki-Kubilius & Putallaz, 2012; Trautwein, Ludtke, Marsh & Nagy, 2009).

In view of this, it is important to differentiate between research findings for advanced learners and for students who are in the mainstream. For instance, unlike the average-ability secondary students, Tan's (2011) research using multiple group path analysis revealed that entity belief (i.e. students having a fixed mindset about their abilities) has a positive relationship with mastery goal among high-ability students. Furthermore, entity belief was not detrimental to gifted students who scored well in Mathematics. This is an example to illustrate possible psychological differences between average and high-ability students. However, such findings could be due to its specific context as there is also research which shows that fixed mindset is counter-productive to creative work, and areas in which a continual process of problem formulation and solution is required.

Researchers (Simonton, 2000; Subotnik & Jarvin, 2005) observed that to develop talents, gifted and talented individuals, they would require psychological and mental strength to deal with pressure and stress, to rebound from perceived setbacks and critique. This would help these individuals manage tensions arising from working on substantial, complex, and ambiguous problems or from generating creative products. More recently, researchers explored the affective needs that help gifted and talented students to succeed and validated the talent development megamodel in New Zealand, Singapore, and South Korea (Olszewski-Kubilius et al, 2019). The megamodel not only emphasises that different talent domains have varying and unique trajectories in development, but are also associated with psychosocial skills such as motivation, resilience and strategic risk taking. The megamodel also highlighted that the variations and unique trajectories differ in the starting, peak and end points and have implications for the identification and nurturing of talents. Olszewski-Kubilius, Subotnik, & Worrell (2015) identified psychosocial skills and psychological strengths as the critical levers that enable individuals to move to higher stages of talent development and accomplishment. Moreover, the type and relative importance of psychosocial skills required at each stage of talent development differs. Hence, Jarvin & Subotnik (2010) underscore the important role of the teacher to deliberately cultivate psychological skills and provide psychological strength training so that individuals can advance to the higher stages in developing their talents. In other words,

the affective and cognitive aspects of giftedness are inseparable.

1.3 The social-cultural nature of giftedness

Conceptions of giftedness and talent are social-cultural. Sternberg and Zhang (1995) listed five criteria which one needs to meet to be judged as gifted. These criteria include excellence, rarity, demonstrability, productivity and value. Such criteria signal how society perceives giftedness and prioritises resources to nurture gifted individuals in an education system (Dai & Chen, 2013; Freeman, 2005). As such, the development of gifted education is a multifaceted process as the definitions of giftedness vary from culture to culture and nation to nation, derived from various philosophies and systems of beliefs. Since the conceptions of giftedness and talent are what a society values, their conceptualisations can change over time and place (Sternberg, 1985). It is therefore understood as a social construct and not just a fact of nature (Borland, 2005). As such, there is no consensus among researchers as to what constitutes giftedness (Ambrose, VanTassel-Baska, Coleman, & Cross, 2010; Balchin, Hymer, & Matthews, 2009; Moon & Rosselli, 2000; Pfeiffer, 2002; Ziegler & Raul, 2000). Therefore, instead of seeking a consensus on definitions, it is more useful to understand different conceptions of giftedness and the ways gifted education serves its designed purposes contextually (Matthews & Dai, 2014).

The term “giftedness” has many synonyms, like “high achievement”, “aptitude”, “able”, and “talent” but each term can assume different meanings, among which gifted and talented are most commonly used. Although some researchers use gifted and talented synonymously (e.g., Csikszentmihalyi & Robinson, 1986), others seek clear distinctions. For instance, Gagné (1985) defines giftedness as the possession and potential application of outstanding abilities (competence), which places the individual among the top 10 per cent of his/her peers. Talent designates the outstanding mastery of systematically-developed abilities (or skills) in at least one field of human activity (Gagné, 1985) if there are both intrapersonal and environmental factors to facilitate the developmental process of giftedness. Thus, gifts can develop into talents with consistent outstanding performance in a specific area. In this way, one can be gifted without necessarily realising his/her

talent, but not vice versa. Historically, the concept of giftedness has evolved from more restrictive and conservative conceptions, such as the use of IQ (Terman, 1925), to the more liberal and inclusive ones, which view giftedness as dynamic and socially constructed. Therefore, newer conceptions of giftedness are broader, more complex, and more inclusive (Renzulli, 2002; Callahan, Hertberg-Davis, & Missett, 2013; Ziegler & Stoeger, 2017; Mönks & Katzko, 2005; Sternberg, 2000).

Researchers (Mönks & Katzko, 2005; Moon, 2006) have summarised the various conceptions of giftedness in the extant literature as follows:

1. *Psychometric definitions*: These are based on a stable personality trait or potential, which is considered independent of other variables, such as environmental or historical context. Examples under this tradition are Terman's (1925) definition of giftedness as a score over 140 on the Stanford-Binet IQ test, or Julian Stanley's (Stanley, 1996) definition as a high score on an off-grade-level test of mathematical or verbal reasoning ability.

2. *Multi-component definitions*: As a reaction to the restricted perspective of psychometric single-component theories, different relevant components (cognitive and non-cognitive) are considered in assessing and identifying giftedness. Examples of such additional components are creativity or task commitment in Renzulli's three-ring conception of giftedness (Renzulli, 1986). Gardner's multiple intelligences and Sternberg's analytical, creative, and practical intelligences are other examples (Gardner, 1983; Sternberg, 2000).

3. *Psychosocial definitions*: Also known as the moderator approach (Mönks & Katzko, 2005) and a further development of multi-component conceptions, psychosocial definitions emphasise the role of both the individual and his/her environment in the development of giftedness. Tannenbaum (1986), Gagné (1985, 2003) and Subotnik, Olszweski-Kubilius and Worrell (2011) provide examples of psychosocial

conceptions of giftedness. Differentiating between potential and performance, this approach aims to transform domain-specific gifts into increasingly excellent performances or achievements in that domain. Comparatively, these definitions provide a broader possible framework for giftedness (Harder, Vialle, & Ziegler, 2014).

4. *Systemic definitions*: These perceive giftedness or potential not as a person's characteristic or sum of characteristics, but as a property of the system that the person is part of (Ziegler, 2005). With a holistic perspective, this approach views performance as the result of complex interactions between individuals and their material, social and informational environment, which should evolve towards a complex transformational process, enabling the person to demonstrate performance on a higher level in a particular domain. Currently, only Ziegler's *Actiotope model* of giftedness (2005) provides the precision and comprehensiveness to qualify as a systemic approach. Based on this model, an actiotope has an individual component (i.e., endogenous learning resources) and an environmental component (i.e., exogenous learning resources). Ziegler and Baker (2013) termed the former as *learning capitals*, and the latter as *educational capitals* (See more details in Ziegler, Chandler, Vialle, & Stoeger, 2017).

Among these models, while the conception of giftedness examines the shades of differences in intellectual potential among individuals (Tannenbaum,1986; Renzulli,1986,1999, 2012; Gagné, 2003; Subotnik et al., 2011), the development of conception of giftedness increasingly emphasises the importance of a deliberate and systematic design of nurturing and supportive environments (Ziegler, 2012). Notably, the model and conception of giftedness focuses on the interaction and dynamics between the individual and his/her learning environment. There were even suggestions to build an ecosystem to develop giftedness that is synergistic in nature, that requires constant refining of designs to improve the system (Ziegler & Stoeger, 2017). However, such a systemic ecological approach has yet to be empirically tested in

practice (Ziegler & Stoeger, 2017). At the other extreme, Borland (2005) was frustrated with the exclusiveness of gifted education programmes and the biases of identification instruments and processes. He proposed conceiving gifted education without gifted children, in which, the concept of giftedness and identification procedures should be abandoned. Instead, he advocated differentiating curricula and instruction such that they are responsive and connected to all students with diverse backgrounds, abilities, and talents. Such an approach is a challenging ideal for any society as it requires a teaching force that is competent in differentiating curricula and instruction to recognise and cater to the diverse needs of all learners.

1.4 International perspectives of gifted education

Gifted education is valued and conceptualised differently from country to country. There are countries with a long tradition of gifted education such as the United States, China, Germany, and Russia, and others, like Mexico and the Czech Republic, which recently adopted gifted education (Reid & Boettger, 2015). Mandelman, Tan, Aljughaiman, & Grigorenko (2010) distinguished three categories of factors that influence the conception and approach towards gifted education in any given country: social-cultural, political and economic. Although there are three categories in theory, they tend to overlap in practice.

One key factor influencing gifted education is the country's social-cultural inclination towards meritocracy or egalitarianism, with some leaning overtly more towards one direction. For example, Israel's and Singapore's education systems declare themselves to be meritocratic, while the systems in France, Spain and Nordic countries such as Finland, Denmark and Sweden declare themselves as egalitarian. The egalitarian culture tries to embody an educational philosophy that recognises individual differences and provides differentiated instruction to meet the needs of high-ability learners without labelling them as gifted. For example, gifted education in Denmark is still a sensitive topic and there is a lack of political recognition or legislation regarding gifted children. In Finland, although there is no formal legislation on gifted students, the country's policy advocating differentiated education has greatly benefitted its gifted students (Reid & Boettger, 2015). Sweden has changed its direction towards this group by developing support materials for all schools to increase awareness on who gifted students

are and how to provide educational supports for them, thus explicitly acknowledging gifted students as a distinct group with particular needs (Mellroth, 2015). Under their egalitarian tendency, some countries like New Zealand and Australia sought to be more inclusive towards their ethnic minority students. For example, the New Zealand Ministry of Education outlined a vision in 2012 for gifted and talented learners, that stressed the need for services to nurture gifted and talented ethnic minority students (Riley & Bicknell, 2013). In Australia, gifted and talented indigenous students were formally acknowledged by the Aboriginal Education Unit in 1996. While countries such as the United States and the United Kingdom differentiate the terms “gifted” and “talented”, countries that hold an egalitarian view on gifted education do not use such terms.

Related to social-cultural factors, the role of parenting and home environment and interactions is another variable influencing a society’s conception of giftedness. Parents and families have been described as “the most critical component in the translation of talent, ability, and promise into achievement for gifted individuals” (Olszewski, Kulieke, & Buescher, 1987, p. 6). Parents’ perceptions of, and attitude toward, giftedness and gifted education are rooted in their social and cultural backgrounds in some way. For example, research showed that Asian American parents tend to influence their children’s achievement through high levels of monitoring, pressure, and support (Campbell & Mandel, 1990, Wu, 2008). In addition, the motivational climate created in the home environment can provide a solid structure for not only explaining giftedness but also in predicting gifted students’ academic engagement and behaviour (Ames, 1992).

From a political and/or economic perspective, some countries see their education systems in more pragmatic ways; they see gifted education as a means to a better future for their nations (e.g., India, Turkey, Singapore) (Frantz & McClarty, 2016). This “better future” could indicate both better economic gain as well as pursuit of life-satisfaction beyond monetary rewards. According to the Singapore Ministry of Education, nurturing the gifted individuals to their full potential will help to ensure the nation’s progress and prosperity (Ministry of Education, 2019). China also realised the importance of this pragmatic factor

whereby "supernormal" students are given special provisions (Vialle & Ziegler, 2015). Kirby (2014) argued that from the Chinese central government's perspective, gifted education reform is synonymous with building the national strength, developing talent for the collective good, and not primarily for individual merit. As such, the Chinese government structures their gifted education based on domains instead of gifted students. For example, the objective of *The Mount Everest Plan*, leaning heavily toward mathematics, science, engineering and technology (STEM), is to promote technological modernisation and economic progress (Dai & Steenbergen-Hu, 2015). Similarly, in Russia, even with its attempts to minimise individual differences and establish equity, the education system has always been interested in identifying and utilising the outstanding abilities of gifted and talented individuals for the societal "common good", especially in mathematics and the sciences (Jeltova & Grigorenko, 2005). Thus, specialised programmes involve societal investment with the expectation that such investment will be paid off through the high-level educational accomplishments of individuals. The Russian conception is also highly domain-specific, seeking to identify gifted and talented students in the domains of academic, performing arts, and sports (Grigorenko, 2017), mainly through various performance-based competitions, such as Olympiads.

Given the above political, social-cultural and economic factors, it comes as no surprise that there is a plethora of conceptions, and approaches toward gifted education among different countries. What is obvious is that there is no singular universally agreed conception of giftedness and one definition does not and cannot fit all students and contexts comfortably and efficiently. All in all, giftedness has taken up multiple forms and developed over time. The theoretical evolution in the conception of giftedness has brought us to the current conception, which views giftedness as "dynamic, fluid, domain-specific and context-sensitive processes" (Matthews & Dai, 2014, p. 335), evolved from narrow and essentialist perspectives to more exclusive and liberal ones. Thus, it moves away from neat divisions between "gifted" and "not-gifted" toward an emphasis on developmental diversity (Dai, 2010; Horowitz, Subotnik, & Matthews, 2009; Peters et al, 2014). Therefore, giftedness is fluid and responsive to different factors such as environment and time, rendering the conclusion that giftedness is not

a fixed trait (Dai, 2010). The multidimensional conception of giftedness in the West has generally formed the basis of the conceptions of giftedness in Asia (Chan, 2000). In recent years, many places in Asia (e.g., Taiwan, Singapore, Hong Kong) have begun to broaden their conceptions of giftedness to include more than test scores. There is also a growing awareness of twice-exceptional children and the need to cater to the unique needs of these children (Niehart & Tan, 2009).

While conceptual definitions provide a theoretical description of giftedness as to what constitutes giftedness, operational definitions provide concrete guidance on how gifted students can be assessed and identified in a particular context, and are thus closely linked to identification procedures (Moon, 2006). Both forms of definitions are necessary for designing effective gifted programmes and services.

1.5 Identification of giftedness

The diversity of conceptions, as well as the dynamic and fluid state of intelligence, ability and giftedness across time, raises the question of how gifted children should be identified. Practitioners and policymakers have increasingly realised the need to align the conception of giftedness with the mode of identification. The process of identifying children as gifted must consider factors such as the variety and degrees of giftedness, variation in personality traits, and variation in socio-economic backgrounds (Wellisch & Brown, 2012). As a result, the mode of identification is also diverse.

Identification procedures have evolved from being solely based on IQ or achievement tests to the use of a variety of instruments and selection criteria. Researchers argued that the use of IQ cut-off alone does not consider recent changes in the definition of giftedness to include gifted potential and talent development (Pfeiffer, 2002) and fails to identify different kinds of gifted students (e.g., those with non-academic abilities as well as other abilities, such as the range of verbal talents that include debate, story-telling, toastmaster, diplomacy speeches) (Borland, 2009). To make a comprehensive and reliable judgement of individual development potential, the identification process should consider a variety of cognitive, non-cognitive characteristics, learning

environments, objective measures such as achievement tests, and subjective measures such as rating scales and portfolios (Merrick & Targett, 2004). For example, in the identification of musically-talented children, besides pen-and-paper musicality tests, other aspects should be considered, such as the relationship between motivation and musical creativity, intellectual abilities, and character traits (Arsić, 2016; Subotnik et al., 2011).

While an identification-based practice is still prevalent in gifted education, a system-based paradigm, with the ideology of cultivating gifts rather than identifying gifted individuals, has emerged in recent years (Borland 2005; Renzulli, 2012). Researchers advocate the matching of interests and abilities to gifted-cultivation for all students, and argue that programmes, rather than individuals, should be labelled as gifted (Borland, 2005, 2009; Matthews & Dai, 2014). The focus is to create an educational environment that can afford to conceptualise and operationalise the multitude of giftedness and talents. Borland (2005) referred to this as "gifted education without gifted children as the only way to ensure the field's viability" (p. 17) while Lo & Porath (2017) call for a shift from "education for the gifted" to "education that is gifted" (p. 351) to ensure every student in the classroom is properly challenged.

Another conundrum in identifying the gifted is when or at what age children should be identified. Different age periods can be found in different countries: 2–4 years old; 4–6 years old; and 6–18 years old. However, the 6–18 years old category is the most common one (Nevo & Rachmel, 2009). According to a report from the National Association for Gifted Children, & The Council of State Directors of Programs for the Gifted (2015), 26 states in the United States identified children as gifted in kindergarten and the elementary grades, compared to 11 states that provided additional identification services during middle school and only 9 states during high school.

Different gifts and talents have different developmental trajectories. For example, gifts and talents in chess players, pianists and gymnasts, as well as math whizzes, can emerge as early or even earlier than kindergarten (Bloom, 1985). Depending on the type of gift and talent, if

the level of sophistication is high, researchers agree that these extreme gifts and talents should be identified as early as possible in order to optimally direct and develop the potentials (e.g., Heller & Hany, 2004; Perleth, Schatz, & Mönks, 2000).

However, early identification is not without its drawbacks. Rotigel (2003) highlighted the concerns of asynchronous developments amongst physical, intellectual, and emotional dimensions among very young gifted students. In addition, when examining the performance of elementary school students in a longitudinal study, Lohman et al, (2008) found that students' scores in reading and mathematics are not the same at different grade levels. Students who were identified as gifted at Grade 4 did not perform similarly well in Grades 6 and 9. Thus, it is possible that some students who are late-bloomers are not identified as gifted at an early age but may later develop their gifts and talents. Also, some young students identified as gifted at an early age may not be considered gifted at a later age. Moreover, giftedness in different domains appears to be age-based. Children gifted in mathematics may show promise at a younger age, compared to gifted students in social sciences who appear to demonstrate their abilities in adolescence (Feldman & Goldsmith, 1986).

As elaborated earlier, giftedness is a plural and complex construct and so is its identification (refer to Appendix A for details of each identification method, its corresponding concept of giftedness, examples, pros and cons). To isolate just one factor (e.g., age) and analyse how it influences the outcome may not provide a comprehensive and valid view of the individual's development. Gifted identification, instead of being a one-off phenomenon, should occur at multiple points across time, using multiple selection criteria for giftedness (Lohman et al., 2008; Merrick & Targett, 2004). This is what is happening in Singapore. Although gifted students are first identified at the end of Grade 3 in primary school, gifted students who might not have been identified earlier have the opportunity at secondary level to join specialised independent schools like the NUS Math and Science High School or the Integrated Programme (IP) Schools. The concept and thus criteria for giftedness in Singapore has also been expanded to include the arts and sports, as seen in the establishment of School of

the Arts (SOTA) and the Singapore Sports School.

In summary, since there are diverse gifts and talents valued in each culture and society, the key consideration for identifying the gifted and talented is to delineate a clear target group of the gifted population that a programme seeks to serve (refer to Appendix B). In addition to the target group, the purpose of identification is imperative to map an appropriate curriculum with success criteria to foster gifts and talents. Broadly speaking, the literature informs us of three approaches in identifying gifted and talented learners: (a) use of multiple criteria (Merrick & Targett, 2004); (b) identification at multiple points in time (Feldman & Goldsmith, 1986; Lohman et al., 2008); and (c) going beyond identification to focus on gifted programmes rather than gifted individuals (Borland, 2005; Lo & Porath, 2017). Adapting a combination of the three approaches in managing talents in an education system could ensure potential candidates do not fall through the cracks.

Section 2: Educational Provisions for the Gifted across the Globe

In this section, we review and synthesise movements in international gifted education, deriving from various gifted education initiatives around the world, including the Russian model of development of gifted children, Gifted Education in China, Taiwan, Hong Kong, Germany, France and Israel. This section acknowledges differences in the macro-environments and reviews how the programmes are organised and how well they have served gifted students. Overall, very few studies affirm the efficacy of specific design and delivery mode of gifted education programmes to enable us to draw causal inferences of specificities of the programmes on student outcomes. Thus, it is not wise to take on an approach that uses these research results to compare and rank the characteristics of gifted programmes for research implications on policy. Instead, the research will help in the understanding of the different rationale and strategies that differentiate various programmes.

2.1 Forms and functions in differentiating curriculum and

instruction for gifted learners

The purpose of identifying gifted students is to provide appropriate educational programmes as a form of intervention to nurture gifts and talents. While a core curriculum serves as a benchmark for all students, this falls short in accommodating the diverse learning needs of gifted students. A core curriculum often results in examination-oriented pedagogical practice and prescriptive content, which in turn might hinder the curricula differentiation necessary for gifted students (Tan et al., 2020). Differentiating curriculum and instruction will support gifted students' sophistication of thinking, and provide opportunities for problem solving and creativity (Tan, Ponnusamy & Quek, 2017). Such differentiation provides sufficient intellectual challenge necessary for this group of learners to grow and excel; thereby addressing the diverse needs of these students (VanTassel-Baska & Brown, 2007). However, such differentiated curriculum and instruction come with inherent operational challenges in a formal school setting. The following section illustrates a plethora of differentiated curricula and programmes within school settings and through partnerships with university and research institutes.

In a formal school setting, the provision of curriculum differentiation can be designed and implemented either within curriculum time, or outside curriculum time. Moreover, within curriculum time, differentiation is achieved through a combination of two basic models:

- self-contained classes, in which gifted students are grouped in the same classes, sharing similar academic requirements. Most self-contained gifted programmes are designed for students who are working at significantly more advanced levels academically than their grade-level peers.

- pull-out programmes in which students are selected to attend a challenging, differentiated, and enriched curriculum with special classes in a subject or interest area.

In reviewing the myriad of gifted programmes and permutations in

their structure and organisation, it is essential to understand that research on the effects of gifted programmes is generally inconclusive (Delcourt, 1994; Delcourt, Cornell, & Goldberg, 2007). There are recent studies (mostly in America and Europe) that have found little or no programme effect on these gifted students except that they are already more exceptional than students who do not attend the programmes (Bui, Craig, & Imberman, 2014; Welsch & Zimmer, 2018). However, there are equally robust studies that have suggested that gifted programmes in various forms (e.g., enrichment pull-out programme) have a considerable positive impact on gifted students' performances (Booij, Haan, & Plug, 2016; Beuermann, Deither, & Jackson, 2018). It is interesting to note that earlier research in the 90s generally showed positive effects of various gifted programmes on the students (Coleman 1983; Parke, 1983; Reis et al., 2005), but recent work seemed to suggest otherwise (Bui et al., 2014; Welsch & Zimmer, 2018).

With such contrasting findings on the impact and efficacy of gifted programmes, we begin to see a need to understand the strengths and weaknesses of each model, and not so much to seek a golden formula for gifted education. Each model has its strengths and weaknesses. On the one hand, self-contained classes work well in customising the pace of learning and differentiating curriculum and instruction; however, the self-contained class setting may not be optimal in integrating these students socially into the school environment. Each model can take either an acceleration or enrichment approach in teaching and learning. The acceleration mode of instruction features fast-paced, advanced content and certification whereas an enrichment mode of instruction emphasises the breadth, depth and complexities of the curriculum.

In the self-contained class setting, some countries, including the United States and Taiwan, use grade skipping and other subject-based or grade-based acceleration strategies to accommodate gifted students' unique learning trajectories (Rogers, 2007). For example, in Taiwan, grade 1–12 gifted students can receive advanced curriculum and course materials, summer or Saturday camp activities, and mentorship programmes. The acceleration practices are generally grouped into four categories based on students' learning pace and academic performance: (a) credit by examination (e.g., early admission, early

graduation), (b) acceleration in one/some/all subjects, (c) curriculum compacting, (d) grade skipping in one or some subject, or whole-grade skipping (Ministry of Education, Republic of China, 2019). Such an accelerated approach generally places a greater emphasis on examination performance in the gifted programme. With a performative culture, there are issues such as exam-oriented instructional practice, lack of quality affective education, heavy workload for teachers, enormous pressure for students, and the failure to utilise resources in the community (Kao, 2012). This approach focuses on early graduation and certification, rather than the joy of learning.

Benny and Blonder (2016) examined the impact of Israel's core curriculum on gifted students and found the regular Israeli classroom focuses on the low level or "weak" students, which might dampen the learning needs of gifted students. This gave rise to a myriad of enrichment and out-of-school programmes, especially those that specialise in mathematics education. For example, a collaborative out-of-school programme with Tel-Aviv University, known as Ben Arbel Programme for Outstanding Mathematics students, exposes gifted students to university-grade mathematics. Another example is the Davidson Institute, which is a part of Weizmann Institute of Science, which offers mathematics and science by mail courses and science summer camps. Although Israeli students are not top performers for Mathematics and Science in the Programme for International Student Assessment (PISA), with these enriched curricula that complement the core curriculum, Israel has the highest number of start-ups per capita in the world and is ranked second place in innovation (Arieli, 2017). This relationship between giftedness and innovation and its possible basis from the designed curriculum is an important area to explore.

One of the primary concerns of gifted programmes seems to be on the effort to eliminate adverse socialising effects on gifted students. The hybridisation of the pull-out and self-contained model is intended to eliminate the "big fish little pond effect" (Seaton, Marsh, & Graven, 2009), which occurs when the self-esteem of a gifted child who is used to excelling in his/her regular group may be affected as the child moves to a class of gifted students. For example, the enrichment school-day-

model of Israel's gifted programme model is designed to help students manage the negative social impact so that they do not lose motivation. In this model, students who have been identified as gifted attend the centre once a week and remain in the neighbourhood heterogeneous school on other regular school days.

Pull-out programmes attempt to build the student's unique strengths and talents in specific areas and consider more general characteristics related to creativity, motivation, learning preferences, and particular interest areas. The effectiveness of the pull-out programme might be compromised when it comes to details, such as how the students are placed in each programme and how they are allowed to move between programmes. These details and decisions are not easily worked out, yet they are instrumental to the success of such pull-out programmes. For example, Hong Kong adopted a three-tiered approach, from integration in a school-based whole class approach to a pull-out programme within a class, to out-of-school support for exceptionally gifted students (Tommis, 2016). Tier 1 refers to the development of higher-order thinking, enrichment and extension, creativity and personal competence in all subject areas. Tier 2 refers to general enrichment and specialised training in specific subjects. In Tier 3, the Gifted Education Bureau encourages schools to design activities catering to individual needs. These activities include counselling, mentorships, and early entry to advanced studies, study camps, and research projects. Students in Tier 3 can also study credit-bearing university courses. The tiers are not meant to be rigid. Students who show the capacity and readiness for other tiers will be assessed via various modes, e.g. their portfolios. They can then move between the tiers to engage in activities that are optimal for their growth. Although such a three-tiered system seemingly affords a high level of customisation and flexibility, researchers have surfaced implementation gaps, such as a lack of clarity in the identification criteria for the three tiers, and the lack of connections amongst the tiers to better cater to students' progression and development. Comparing the Hong Kong and Israeli curriculum and programme models, Phillipson, Phillipson and Eyre (2011) favour the Israeli integrated approach to Hong Kong's tiered approach.

There is a myriad of out-of-school programmes. It would be useful to understand their strengths, and see how the same strength of flexibility, breadth and width can be created within a school-based curriculum. Overall, the delivery of gifted education has become more diversified than ever, from confining itself to traditional "gifted programmes" to a continuum of services in and outside of school such that timely opportunities to develop specific talents and interests can be provided (Renzulli & Dai, 2003). Out-of-school programmes can be conducted in collaboration with industry partners, independent organisations, or universities.

2.2 Building flexibility in curricula and programmes to facilitate learning

In view of the abovementioned pros and cons of different forms and functions of differentiated curricula and programmes, educators, policymakers and scholars have learned that it is imperative to build flexibility in the design of curricula and programmes. However, flexibility requires the education system to foster school leader and teacher competencies in differentiating curricula and programmes (Neihart & Tan, 2015; Tan et al., 2020). Countries that have taken such a teacher-driven or school-driven curriculum design and implementation approach include the Republic of Slovenia, the United States, South Korea, Taiwan and Singapore. Recognising that teachers have intimate knowledge about the needs of their students, teachers in these countries are given the autonomy, albeit to different extent, to redesign the curriculum.

The Republic of Slovenia's gifted programme is a school-based initiative with a growing number of private initiatives in the education of the talented (e.g., sports, theatre schools, music schools, art schools, dance schools) (Mönks & Pflüger, 2005). For this reason, a higher level of flexibility is seen in programmes within the school. Students in Slovenia learn the same subjects at different depths and detail in the way the objectives and standards are set and the methods are applied (Bedeniković Lež, 2017). Teachers design differentiated approaches in grades 4–7. Gifted students get to follow their field of interest and level of knowledge as they are placed in separate teams to work on different tasks within their regular classes. The strength of this arrangement is that gifted students get to stay in their initial community, hence reducing

the possibility of being isolated from their peers. Also, the flexible and school-based system allows gifted students to be given individual tasks, receive individualised teaching, be granted accelerated progress or parallel teaching, and participate in a particular team after school. Creative workshops, research camps and preparation for contests are given emphasis. A similar model can be seen across Europe with varying degrees of school autonomy.

In South Korea, the curriculum of regular Science high schools is regulated by the central government. However, some schools in Korea that are providing for the gifted, e.g. Hangsung Science High School, have been given autonomy over the curriculum for the gifted students. They are able to do the following: (a) more advanced level courses in science with more than 35% of the units dedicated to science; (b) more activities for developing skills needed to be creative experts in science; and (c) more than twice the units allocated for elective courses in science. Schools can choose to either develop their own programmes or utilise enrichment programmes developed and distributed by the National Research Institute for Gifted Education.

The New Zealand Ministry of Education (2000) advocates a continuum of provisions for gifted students. This includes the in-class and out-of-school options. Gifted Kids (formerly known as the Gifted Kids Programme) is one such programme with a differentiated gifted curriculum that allows for acceleration, with increasing complexity, depth, challenge and creativity (VanTassel-Baska & Reis, 2003). The Gifted Kids Curriculum (Gifted Children's Advancement Charitable Trust) is a research-based curriculum specifically designed for gifted students in a one-day-a-week pull-out programme (Bate, Clark, & Riley, 2012). Aspects of the curriculum can be adapted for use in a mainstream school for some students, but the curriculum is neither designed, nor suitable for a mixed-ability class.

In Singapore, as we move to broaden conceptions of giftedness and to diversify provisions for gifted and high ability students, there has been a move towards a school-driven curriculum design and implementation approach, particularly at grades 7–12. This is evident in the establishment of 18 Integrated Programme (IP) schools and of specialised independent schools like the NUS High School of Math and

Science, the Sports School and the School of Science and Technology in Singapore (Neihart & Tan, 2015). In primary schools, the Gifted Education Branch (GEB) supports schools (beyond the nine schools offering the Gifted Education Programme[GEP]) to provide GEP-like programming for high-ability students in English, Mathematics and Science (MOE, 2019; Neihart & Tan, 2015). The move towards a curriculum that endorses creativity and innovation would serve well in developing a child in a holistic manner. These factors can be enhanced and promoted in students with proper coaching and mentorship, something that can be modelled by the sports and arts schools.

Although there are benefits in a school/teacher-led flexible curriculum approach, such an approach is highly dependent on school leader and teacher knowledge in the field of gifted education, their ability to craft an appropriate curriculum vision in educating gifted students and their competencies in differentiating curriculum and instruction (Tan et al., 2020). Research evidence shows that Korean teachers, who are trained to teach science in the gifted programme, place an overwhelming importance on the cognitive component, showing less awareness of the personal and environmental components of creativity (Seo, Lee, & Kim, 2005; Starko, 2017). There are similar findings from Project Synergy (William & Mary, School of Education, n.d.), a cross-cultural research study on secondary gifted classroom teaching practices in Singapore and the United States. Findings based on classroom observation revealed an under-utilisation of problem-solving and research strategies in both cultures. These findings suggest that teachers need a unique set of skills and knowledge to optimise the learning of gifted students, and also raises a need to support teachers in adjusting their existing pedagogical practice in their day-to-day interaction with gifted students.

Professional development programmes for teachers working with gifted students is a complex matter. Research on professional development for teachers in gifted education has tended to focus more on teachers' beliefs about these exceptional students, the way they identify with these students, and their affective connections with the students (Lassig, 2009; Geake & Gross, 2008). Research also supports challenging teacher attitudes toward, and beliefs about gifted education in order to correct the teachers' misconceptions about the how and what of gifted education (Fraser-Seeto, 2013; Plunkett & Kronborg,

2011). There is general agreement on the positive effects of a flexible curriculum in gifted education, but the implementation is far more complicated than a centralised curriculum.

2.3 Capitalising expert communities to extend learning opportunities

In providing advanced content and skills for the gifted learners, the curricula and programme differentiation takes the form of *co-creation of the curriculum by school and partners in the expert community*. The Päivölä School, in Helsinki, collaborates with universities (e.g., Tampere University, the Tampere Technical University, the East Finland University and the Nokia company) to design a national mathematical talent development programme called The Päivölä School Mathematics Programme that deviates from the mainstream Finnish practice. The upper secondary school students are given the option to complete a 3-year course in 2 years. This option of fast progress and gaining university credits in upper secondary school gives high-ability students long-term advantages[1].

As an example of industry partners, in Finland, a cooperating partner of the schools, such as Nokia, provides opportunities for students to gain work experience during their school years at the Toijala centre of Nokia. This is a curricular activity, implemented 12 hours each week across two years which goes beyond simple workplace practice. Based on their time spent at the company, students can establish important contacts, which they can capitalise on later, preserving their motivation and acquiring up-to-date knowledge on the IT world (Tirri & Kuusisto, 2013).

In the United States, the National Centre for Technological Literacy (NCTL) was established within the Boston Museum of Science in 2004. The NCTL is an independent organisation that brings engineering and technology into PreK-12 curricula. Students can join the activities independently, within the context of the educational system of both Massachusetts and the whole of the United States. In most countries, centres similar to the NCTL, related to the natural

[1] https://talentcentrebudapest.eu/talentmap/finland/tarttila-valkeakoski/paivolan-kansanopiston-matematiikkalinja-paivola-school

sciences, and offering out-of-school educational programmes, are referred to as the flagships of talent development. There are similar centres for the natural sciences all over Europe. In many cases, these are independent institutions, such as the Palace of Miracles in Hungary. Similar institutions can be found, for instance, in Switzerland, Germany or Poland, where the Warsaw Copernicus Centre involved in the development of scientific talents opened its gates in 2010 (http://www.kopernik.org). NCTL programmes also provide support to gifted programmes in other countries. For example, NCTL developed a series of engineering programmes for students in Hungary.

In Germany, early talent development opportunities in areas, such as mathematics and science programme, for kindergarten children have been integrated into the system. With the help of various associations that are committed to advising and promoting gifted and talented children in Germany, able students can join the talent development system outside school. Examples of such programmes are Mensa in Germany or the International Academy of Music for Supporting the Gifted in Germany (Fischer & Muller, 2014).

Another example of a gifted programme designed in collaboration with partners, including university professors, is the Summer Enrichment Programmes (SEP) in Saudi Arabia for gifted students (Aljughaiman, Nofal, & Hein, 2015). In these collaborative programmes, teachers may also collaborate with specialists in gifted education to co-create the curriculum and to discuss issues related to practice, pedagogy and content knowledge (Ward & Landrum, 1994). However, relatively little is reported (in English publication) about these enrichment programmes in the Saudi Arabia to understand its development and successes (Aljughaiman & Grigorenko, 2013).

In the United States, university-based centres (e.g. Johns Hopkins's Centre for Talented Youth and several other talent support centres) provide gifted education services, such as Talent Search, in a variety of out-of-school programmes. When students are ready for high school, these specialised independent high schools are an option. In Vienna, one of the most interesting and best-known scholarships is the Junior-Alpbach, which gives the winners of the national contests and students from Alpbach an opportunity to work with Nobel-Prize winners or other

well-known scientists on various projects for a few days.

Provisions for gifted students in Hong Kong are diverse with service providers from the university, non-governmental organizations (NGOs), and commercial sectors offering a range of courses (Nagy & Zsilavecz, 2011). In Hong Kong, a few universities, such as the Chinese University (CUHK) in their Programmes for Gifted and Talented (set up in 1995), as well as the Science Academy for Young Talent, and the University of Science and Technology (HKUST), have pioneered and provided courses for high-ability students for more than 10 years. More recently the Centre for the Development of the Gifted and Talented (CDGT) in HKUST, introduced a "Dual Programs" in which secondary students can enrol in University-level courses whilst still at Secondary school (The Hong Kong University of Science and Technology, 2017).

In China, the Mount Everest Plan is implemented through the pilot school-based programmes for academically gifted students as pull-out programmes operated by designated top universities, such as Peking University and Tsing Hua University. The pilot gifted programme was developed to look into innovative teaching practices (such as English instruction, mentorship, and a research-oriented programmes of study) and to create a system conducive to the development of gifted students, specifically in the development of creative talents (Yan & Berliner, 2016).

In Spain, a gifted education programme (The ESTALMAT programme[2]) was created with the support of the Faculty of Mathematics of Complutense University, Madrid, the Spanish Royal Academy of Sciences, and the Vodafone Spain Foundation. The selected children were invited to a two-day kick-off camp with a focused engagement with parents to win the parents' support and cooperation. After the programme, the students stay connected with the system and their teachers via the Internet, taking part in weekly sessions, regular mathematical seminars and conferences. The ESTALMAT Student

[2] https://www.uv.es/uvweb/college/en/news-release/presentation-estalmat-a-programme-which-stimulates-maths-skills-children-burjassot-campus-1285846070123/Noticia.html?id=1285865258196

League was created in response to student demand and has maintained a high retention rate. The long-term goal is to create a professional network, which provides lifelong assistance to students in the area of mathematics.

These international efforts to connect gifted students to different organisations, communities and universities provide mentorship and enrichment opportunities to the gifted students in domains beyond the expertise available in schools. In Singapore, schools have traditionally worked with universities, academic institutes, local communities, and various organisations to support student learning in general. To support the development of gifted students in Singapore, we can continue to source for and work with expert communities outside of school to extend the learning of gifted students.

2.4 Effects of differentiating curricular and instruction

In general, programme structures of gifted education vary; its grouping can occur within a class or across classes, and can be a one-off special event or an ongoing arrangement to facilitate differentiated curriculum and pedagogical approaches to maximise gifted students' potential. Given such varied and expansive acceleration and enrichment programmes, it is imperative to examine the effects of each programme type. In response to critique related to the socio-emotional disadvantages of acceleration and ability grouping, a few noteworthy research syntheses highlight the cognitive and affective gains of the abovementioned learning settings. As early as the 1980s, Kulik & Kulik (1984, 1991) investigated the effects of ability grouping and showed there is a marked academic achievement gain across all subject areas, as well as a moderate increase in attitude toward the subjects where students are grouped full-time in special programmes. Rogers (1991, 2002) found substantial academic gains for five of the six more specific forms of acceleration, namely, non-graded classrooms, curriculum compacting, grade telescoping, subject acceleration, and early admission to college. The sixth form of acceleration—Advanced Placement was found marginally gainful. Moreover, in a longitudinal study with mathematically precocious youth, Lubinski, Benbow, Webb & Bleske-Rechek (2006) found that the subject-based talent development

programme markedly enhanced the development of high levels of spatial ability, investigative interests, a promising aptitude for developing scientific expertise and sustained commitment to scientific pursuits. Steenbergen-Hu, Makel and Olszewski-Kubilius (2016) synthesised approximately 100 years of research on the effects of ability grouping and acceleration on K-12 students' academic achievement and concluded that acceleration appeared to have a positive, moderate and statistically significant impact on students' academic achievement.

Although the academic gains associated with acceleration and peer ability grouping are well documented, resistance to their use for gifted students continues due to concerns that such practices will cause social or emotional harm to students. However, Neihart (2007, p. 333) reported that "there is no evidence that accelerated gifted students as a group will have problems making friends or getting along with others or that they will become overly stressed, depressed, or suicidal." Evidence which shows that grouping students of high ability together benefits their achievement is far more established than that on the socio-affective effects of such grouping. In short, peer ability grouping seems to have positive socio-affective effects for some gifted students, neutral effects for others, and detrimental effects for a few.

In a longitudinal study of gifted primary school pupils with a comparison group, Vogl and Preckel (2014) investigated whether social self-concepts and school-related attitudes and beliefs are affected by full-time ability grouping of the gifted. They found that full-time ability grouping hardly had any effects on the variables under study. Attending a gifted class initially had positive effects on students' social self-concept of acceptance, but no effect on the social self-concept of assertiveness. Children in gifted classes exhibited more interest in school and reported better student–teacher relationships than their counterparts in regular classes.

In another study, Kim (2016) examined research on 26 studies on enrichment programmes (studies from outside the United States published in English were included in the search) serving gifted K12 students and synthesised the studies, between 1985 and 2014, on the effects of enrichment programmes. This study included enrichment

programmes or courses, specifically designed for gifted students, with content adjusted for depth and expanded learning experiences within the topic beyond a compacted curriculum. Kim found that enrichment programmes had a positive impact on both gifted students' academic achievement and socioemotional development. They observed the largest effect size for academic achievement and socioemotional development among students who went through summer residential programmes. The study found the diverse interactions and diverse programmes in these summer residential programmes to be likely contributing factors to the academic achievement and socioemotional development effect sizes.

In terms of classroom instruction, research generally suggests that less structured teaching methods and more student agency in the process of learning can raise the performance of gifted children. We would like to highlight a recent study that has been well cited in supporting differentiated content and instruction for gifted students (Callahan et al, 2015). In this study, the authors devised a randomised experiment among gifted primary-school (year 3) pupils in more than 200 American classrooms. Pupils were given access to instructional units in poetry and research skills for one year. The intervention in the study was based on the principles of content and instructional differentiation for children deemed to be gifted, emphasising deep understanding of principles and skills in a discipline. Teachers guided students to work on topics of their own choice, with students adopting methods and tools that are similar to professional communities in the respective fields. For example, the unit in research skills was concluded with pupils designing and carrying out a complete research project, which they then presented in front of other children, parents, and teachers (Callahan, Moon, Oh, Azano, & Hailey, 2015). Results showed that children who experienced these specially designed instructional modules outperformed those receiving the instruction given in the control groups.

Broadly speaking, the research evidence offers explanations for the complexity of structuring programmes and grouping gifted students. Rogers (2007) opined that one size does not fit all; whether that solution involves mixed-ability classroom or ability grouping in one or many of its forms. In designing an appropriate enrichment programme

for gifted students, whether within or out-of-class curricular, it is critical to ensure clarity (of curriculum vision and goals), coherence (of programmes), alignment (between programmes and to vision), and continuity (Renzulli, 1986).

Section 3: Implications

In the previous sections, we reviewed and synthesised advances in the literature surrounding curriculum, identification, and measurement of giftedness. In general, there is a shift towards an understanding that giftedness is dynamic, fluid, domain-specific and context-sensitive (Martinez, 2013; Matthews & Dai, 2014), and an acknowledgement that a differentiated curriculum is necessary to develop varied gifts and talents. We will discuss the implications in three intersection areas of policy, practice, and research.

3.1 Implications for policy

Research that focuses on education provision and economic growth has shown that a 10% increase in the number of students with basic skills and the same 10% increase in the number of students who reached a superior level of performance can mean a 1% increase in per-capita growth (Hanushek & Woessmann, 2009). Investing in helping gifted students to to optimise their potential has positive and concrete economic impact. In addition, as Sahlgren (2018, p. 2) puts it, “the societal reward for finding out how to stimulate gifted children to reach their true potential could be significant indeed.” The economic significance of nurturing gifted students raises two issues: broadening the range of gifts/talents valued by society and the need to establish some monitoring and mentoring system to support schools who are the main providers of an enriched and differentiated curriculum for our gifted students.

a. Over time, Singapore has expanded its concept of giftedness to include the arts and sports, via its establishment of specialised independent schools, such as SOTA and the Singapore Sports School. To support the government’s message that developing artistic and sporting talents is important, there is a need to support the arts and sports industries beyond schooling years, so that students who graduate from such schools can

utilise and excel in their talents. There is a need to continue to recognise Singapore artists and sports talents, and to help them build good branding and sponsorships to support their work. This in turn will help promote SOTA and the Singapore Sports Schools as exemplars of the multiple pathways for students with different talents. In doing so, parents can be encouraged to support their children, who possess diverse talents in different areas.

b. In alignment to the move towards full subject-based banding, the Ministry of Education(MOE), might want to consider how they can develop teachers' capacities to stretch the higher ability students who study a subject discipline at the G3 level in secondary schools. Recognising that there are students who excel in specific subjects ensures that these students are supported in their development and broadens societal perception of giftedness. Currently, the Gifted Education Branch (GEB) supports primary schools in providing GEP-like programming for high ability students. A similar approach could be adapted for secondary schools, perhaps in collaboration with the professional body proposed in Section 3.2 c.

c. In moving towards a more decentralised system with greater autonomy given to schools, it means that schools, like the IP schools, have to conceptualise and design their own curriculum to meet the needs of their gifted and high ability students. However, as noted by Tan et al. (2020), designing and implementing enrichment programmes for high ability students can be challenging, especially when school leaders and teachers may not have an in-depth understanding of the learning needs of gifted students or the expertise to reframe curriculum and instruction to broaden students' learning experiences. Beyond developing an appropriate school-based curriculum, teachers need to shift their pedagogical practice. However, evidence from a 6-year study of 4 IP schools

suggests that teachers have difficulties doing so, partly due to a lack of expertise, and partly due to an ingrained culture of the need to prepare students for high stakes examinations (Tan et al., 2020). We suggest that there is a need for the Ministry to put in place mechanisms and processes for the development, review and refinement of the IP curriculum, given that this is now the main platform at the secondary level to develop our gifted and high-ability students.

3.2 Implications for practice and research

In the section, we discuss the various aspects of teaching the gifted, the professional development of teachers and the research agenda.

a. Teaching the gifted

Some reviews and research have pointed out that our system is more effective at developing schoolhouse giftedness, valuing academic ability above creative output (Heng, 2000; Heng & Tam, 2006). There is consensus that less structured teaching methods, e.g. a discovery-based pedagogy that promotes individualised content and instruction, can raise performance and creativity among gifted children (Bielaczyc, Pirolli, & Brown, 1995; Kapur & Bielaczyc, 2012; Tan et al., 2016; Wittwer & Renkl, 2008). Although Singapore teachers generally have knowledge of a wide repertoire of pedagogical approaches, they tend to exercise a high level of control even in discovery or inquiry-based learning (Bautista, Tan, Ponnusamy, & Yau, 2016; Tan et al., 2020). There is a need for subject curriculum specialists to monitor the way in which these students are engaged by their teachers in class to ensure that they are sufficiently challenged cognitively and for their unique potential to be optimised (VanTassel-Baska et al., 2008). This is especially important for teachers in the specialised independent schools and in IP schools who do not have the same level of access to GEB's expertise and professional development as compared to the primary schools GEP teachers, who participate in two years of mentoring and instructional coaching by GEB (Neihart & Tan, 2015).

Beyond acquiring the expertise to teach gifted students, teachers need to believe they can exercise pedagogical flexibility, rather than having to focus on ensuring positive academic results.

b. Building enhanced teacher capacity to differentiate curricular and instruction for all

We propose that it might be worth exploring Borland's (2005) call to focus on cultivating gifts in all our students, beyond just cultivating gifts in individuals who are identified as gifted. In a sense, the Singapore education system subscribes to a similar belief in its emphasis on differentiating instruction to optimise the learning and potential of every child. This is similar to Borland's argument that we should differentiate curricula and instruction that is responsive to students with diverse abilities and talents. The challenge in such an endeavour is the need to develop teachers who are competent in differentiating curricula and instruction, and who are equipped with skills to stretch their students' cognitive abilities.

In the National Institute of Education (NIE) Initial Teacher Preparation (ITP) programmes, there is a segment on higher ability in the Educational Psychology course, a core course for all pre-service teachers. It discusses the characteristics of high ability children and the strategies employed for advanced learners. The e-learning session in this course prepares student teachers to cater to the needs of diverse learners. Besides the abovementioned course segment, NIE has offered electives for pre-service teachers and various forms of professional development in the past. This includes advanced diplomas and Masters courses for in-service teachers (refer to Appendix C). However, most of these courses were discontinued due to a lack of demand or because special funding for these courses ended. The most recent in-service course offered was the Certificate in differentiating curriculum and instruction for high ability learners (CDCHAL), which began in 2018, and had only one run for a group of 6 IP teachers in the first year. There is a need for coordination between NIE and MOE to diagnose the learning needs of teachers with respect to catering to high ability children (beyond those in the Gifted Education Programme),

develop relevant courses and encourage teachers to sign up for these courses.

Besides NIE, it might be useful for GEB and Master Teachers who specialise in the teaching of high ability students to share teaching strategies for such students with teachers who teach students in mainstream schools. These strategies need adaptation instead of direct transfer, but they will undoubtedly be a useful resource for all teachers. The GEB, together with two Master Teachers, has been working with teacher-leaders from the HAL Networked Learning Community since 2018 to share differentiation principles and strategies with mainstream schools.

c. Establishing a professional body to advocate and advance efforts in practice and research in Gifted Education

Despite the vested interests in fostering giftedness and talents, it appears that our system has a predicament in being able to cater to only a small percentage of gifted learners, i.e. the top one percent. This may have created a sense of entitlement, rather than privilege, among students and their parents who were selected into the GEP. In addition, this exclusivity is perceived by some as a socially divisive mechanism. One way to modify such mentalities is to diffuse the idea that entering the GEP is equivalent to a higher academic status. Instead, the system should increase access to quality educational experience to high ability students beyond those who are selected into the GEP. A way forward is to establish a professional body that could play a critical complementary role to change the abovementioned mental models, as well as facilitate access by non GEP students to quality learning experiences. An example is the Hong Kong Academy for Gifted Education (HKAGE)[3]. The HKAGE, a non-

[3] HKAGE website: https://www.hkage.org.hk

government organisation[4], funded by The Hong Kong Jockey Club Charities Trust, complements the role of Hong Kong Gifted Education Bureau (EDB) by implementing programmes for high-ability learners, as well as providing education for parents through workshops and courses. In the United States, the Belin-Blank Centre for Gifted Education[5] is a non-profit, self-sustaining professional body that caters to the learning needs of the gifted and talented. In addition, the Belin-Blank Centre for Gifted Education emphasises research to advance understanding of giftedness and talents. The establishment of such a professional body in Singapore, whether a statutory arm or a non-profit, self-sustaining organisation, not only relieves the burden of organising programmes and professional development by the current administrative body but also devotes resources to conduct research. This professional body, working in collaboration with GEB and NIE, could deploy educators and researchers who have credentials in gifted education to lead the design and implementation of quality enrichment programmes for high-ability students and provide parent education programmes. The institute could lead in defining key problems to be studied, formulate a research agenda to achieve deeper understanding of these problems, and actively engage policy makers in discussing their work and their findings. It also has the potential to develop into a regional centre for talent development in ASEAN and the Asia Pacific.

d. Proposing new research areas

To date, there has been limited research in Singapore on the efficacy of the GEP in Singapore although it was first implemented in 1984.

[4] The Hong Kong Academy for Gifted Education (HKAGE) was set up in 2007. It is a non-profit making organisation with a Board of Directors. ts mission is to be a world-class institution offering the highest standards of information, support and appropriate learning opportunities to gifted students aged 10-18 years who consistently perform in the top 2% of the age-related ability range, and it also supports parents, teachers and researchers in Hong Kong. There are 10 directors from different sectors, including the Education Bureau, psychologist, academics, and professionals from various sectors such as legal and finance, representing a wide spectrum of stakeholder groups. Under the Board, four Committees have been formed to oversee the strategic direction and development of the Academy.

[5] https://belinblank.education.uiowa.edu/

Besides, since Singapore has expanded the pathways available for students with different gifts, through the establishment of SOTA and the Singapore Sports School, it might be timely to study the impact of these specialised independent schools in developing their targeted talents. The last research study on SOTA was from 2008 to 2014 (Tan & Ponnusamy, 2013; 2014) during the first six years of SOTA's establishment. In addition, as indicated in section 1.2, other possible areas for research on gifted students can include studies on motivation, self-regulation, the concept of flow, and the development of social emotional imagination or skills.

3.3 Concluding thoughts

Singapore prides itself in its ability to develop a successful and consistently high performing educational system, which includes its gifted education programme and provisions for high-ability learners. It is important to balance high rankings in international education metrics with a curriculum which nurtures creativity, innovation and passion. As Roeper notes, "True success in teaching gifted children can only be achieved when the passions of the child-her soul and mind-are accepted as the foundations upon which we bridge society's expectations as well as our own" (Roeper, 1997, p.166). The holistic education experience we create for the gifted children aims to develop both their cognitive abilities and character. We have been successful thus far. We need to continually adopt a critical lens to review our system, its institutional and social structures, the mechanisms and conditions, to surface possible gaps and hindrances so as to continue to facilitate the development of young Singaporeans latent talents and potential.

Appendix A: Identification method, its corresponding concept of giftedness, pros and cons

Table 1: Identification methods

Methods	Concept of giftedness	Examples of tests & countries	Advantages/Pros	Disadvantages/Cons
Intelligence/ Ability tests	Psychometri IQ-based	• Stanford–Binet • Intelligence Scale The Wechsler family of tests • Nonverbal tests of intelligence (e.g. the Naglieri Nonverbal Ability Test (NNAT) & Raven Standard Progressive Matrices) Used in many countries, including Australia, NZ, Russia, Austria, Germany, France, Israel, South Korea etc.	Standardised tests with established validity in multiple countries (Cao, Jun, & Lee, 2017).	Intelligence as a unitary & static inherited trait, found only in a very small fraction of the student body (Terman, 1925). Language bias Suggestion: to use nonverbal tests of intelligence (Ford, Grantham & Whiting, 2008) but validity of such tests are still being debated (Lohman, Korb & Lakin, 2008).
Achievement tests Measuring what students know/ understand about a content/ subject area	Psychometric	• The Stanford Achievement Test • The Iowa Tests of Basic Skills (ITBS) • Above-level tests (Warne, 2014) • Norm-referenced tests (Oakland & Rossen, 2005) Exemplified in China's first step identification through the top 3% in the National College Entrance Exam (Dai, & Steenbergen-Hu, 2015; Zhang, 2017, followed by written tests in Math & Physics	Standardized tests and academically specific Above-level tests are popular in Talent Search programmes	Measures students' existing knowledge rather than their general ability or potential

Appendix

Creative tests Assess both cognitive abilities (e.g. divergent thinking, making associations) & non-cognitive aspects of creativity (e.g. motivation, flexibility, independence)	Multi-component Conception based on Gagné's DMGT & Renzulli's Three-Ring & Sternberg's WICS include the creativity domain. Concept of gifted behaviours	The Torrance Test of Creative Thinking (TTCT) Hong Kong uses their own version of the TTCT to identify the creatively gifted (Chan, 2000; Tommis, 2013) In Korea, the National Research Centre on Gifted Education develops logical thinking tests and creative problem-solving tests in math and science (Korean Educational Development Institute, 2011)	TTCT is a widely used validated assessment to measure fluency, originality, and elaboration for creativity Less ethnicity and gender biases than standard IQ and achievement tests (Kaufman, Plucker, & Russell, 2012) Creativity can be nurtured through education	The psychometric validity of such assessments is questionable as it depends on how well the assessors know the students, how well they understand the questions and theory of creativity underlying them, and how objective the assessors are (Kaufman et al., 2012). Suggestions: to be part of a broader evaluation process that can add to the overall picture rather than a single method
Performance assessment Assessing students' performance based on a demon-stration of skills/ knowledge in a specific domain	Psychosocial	Diagnostic testing followed by prescriptive instruction (DT =>PI) (Stanley, 1996) Portfolios showing students' best work over time In Russia, the identification of gifted students is primarily through performance-based competitions such as Olympiads	Evidence of learning gains in specific areas, such as scientific research skills, problem-solving skills, and persuasive writing (VanTassel-Baska, Johnson, & Avery, 2002) Stanley's model prevents students' loss of interest as it concentrates on what students do not know about a subject, ensuring appropriate educational challenge for gifted learners. Portfolios allow a variety of student choice in terms of content and learning styles and encourage higher levels of thinking and reflective practice (Johnsen, 2004).	Differences in interpretation of rubrics and of the performance assessment scores (Stecher, 2010) Reliability and validity of portfolio assessment are debatable due to the lack of uniformity in portfolio assessment as different assessors can evaluate portfolios differently.

Appendix

Non-performance assessment Using nomination/ rating scales by self, peers, parents or teachers, e.g., teachers rate student characteristics in intellectual ability, academic skills, creativity, leadership, and artistic talent	Psychosocial	The Scales for Rating Behavioural Characteristics of Superior Students; The Gifted and Talented Evaluation Scales; The HOPE Teacher Rating Scale; The Gifted Evaluation Scale 3rd edition (Cao et al., 2017; Gilliam & Jerman, 2015) Teacher nominations are used in schools in many European countries like Austria, Switzerland, France, Ireland, the Netherlands, Poland, Portugal, Romania, Sweden, Slovenia, Latvia, Hungary, and the UK. Also used in NZ and HK. Parents are also involved in the nomination process in the school systems of Switzerland, Germany, France, Greece, Ireland, Italy, the Netherlands, and Slovenia.	A more comprehensive assessment of gifted students including different types of giftedness (Jarosewich, Pfeiffer, & Morris, 2002) Provide valuable information that cannot be obtained through performance measures but only if appropriate instruments (i.e., rating scales) and formal guidelines are provided (McBee, Peters, & Miller, 2016) Utilise the unique position of parents to contribute as they have a longer period of engagement with their children out of school, and have a better perception of their cognitive abilities and behaviours (Acar et al., 2016). Nominations and ratings are best to be used as supplements to other methods and not as the single point of evidence for a final decision (Pfeiffer, 2002)	Teachers' lack of training about gifted characteristics and effective identification and their common reliance on personal conceptions or preconceptions of giftedness which may not reflect the operational definitions of giftedness (Acar, Sen, & Cayirdag, 2016) Teachers' bias towards students who conform to their values, expectations, and instructions, or exhibit socially desirable behaviours that are not necessarily giftedness (Siegle, Moore, Mann, & Wilson, 2010). Parents' bias and also their lack of knowledge of giftedness can cause wrong judgments (Li, Pfeiffer, Petscher, Kumtepe, & Mo, 2008). Personal qualities of the rater and personal desire to participate in gifted programmes pose limitations to self-ratings (Cao et al., 2017).

Appendix

Multiple-criteria methods Combining results from different assessment instruments and methods (Acar et al., 2016; Cao et al., 2017)	Multi-components (e.g. Mönks' Multifactor model; Heller's Munich Model (Heller, 2010)	Different instruments to concurrently assess both quantitative (e.g., ability tests and achievements tests) and qualitative measures of giftedness (e.g., ratings and performance assessments) In Germany & Hungary, criteria for choosing gifted children include grades, competitions, IQ tests, parent checklist, & nominations (Reid & Boettger, 2015)	Advocated by many researchers A more comprehensive assessment of giftedness, including students of diverse backgrounds and a better understanding of the provision of multiple opportunities. Potential to select those who currently excel as well as those who are most likely to continue to excel (Acar et al., 2016).	Need clarity as to which identification methods to use and how information obtained from different methods should be combined.
Systemic method	Systemic/ Actiotope	ENTER model: explore, narrow, test, evaluate, and review (Ziegler & Stoeger, 2004)	Assessing not only the actual state (e.g. IQ score) but also the dynamic of the development of the entire Actiotope (including all kinds of data about the acting individual and the environment- family life, early development of the child, school experiences, hobbies, and friends).	Too theoretical and needs empirical evidence to support

Appendix B: Identification methods/tools adopted by different countries

Country	Examples of Identification methods/tools	References
Australia	Use of IQ tests (e.g., Wechsler Intelligence Scale for Children–III and Stanford -Binet Intelligence Scales); group-administered IQ tests (e.g., Cognitive Abilities Test [CogAT] and the Australian Council for Educational Research [ACER] General Abilities Tests [AGAT]); teacher nominations; and measures of school achievement (or curriculum-based assessments). Current trials called "tailored testing" for the NAPLAN testing which will allow gifted students, many of whom currently hit the ceiling on this test, to demonstrate advanced abilities. This will increase the usefulness of NAPLAN as a tool for identification. Coolabah Dynamic Assessment (CDA) for Australian Indigenous children: as a classic test-intervention-retest dynamic assessment approach, it has been specifically designed as an identification instrument that seeks to reveal learning potential rather than facilitate long-term cognitive change. Like other dynamic assessments, CDA uses the Raven's Standard Progressive Matrices (RSPM) instrument at pre-test and post-test to examine children's potential to learn.	Jung & Hay, 2018 Walsh & Jolly, 2018
New Zealand	Use of teacher observation and nomination; rating scales; teacher Observation Scales designed for identifying children with special abilities and needs; assessment tools, including standardised tests (e.g. tests of intelligence, achievement tests, and tests of creativity); parent/ Wha'nau/ peer/self-nomination; educational psychologist nomination (the Stanford–Binet Intelligence Scale and the Wechsler Intelligence Scale for Children (WISC), are administered by qualified psychologists who recommend appropriate interventions); authentic assessment such as portfolios, performances, and auditions. Of the 768 schools formally identifying gifted and talented students, 97% reported use of teacher identification; the least frequently reported forms of identification were IQ testing (14%) and Wha'nau nomination (19%). Wha'nau nomination was reported as more readily used in the identification of culture-specific abilities and qualities; achievement tests in academic and intellectual areas; auditions and performance in visual and performing arts; and teacher rating scales in creativity.	Anderson, 2000; https://gifted.tki.org.nz/define-and-identify/identification/identification-tools/ https://www.nzcer.org.nz/pts/ teacher-observation-scales Riley & Bicknell (2013)

Appendix

Russia	The process of identification and selection of GAT students is primarily through various knowledge or performance-based competitions, i.e. Olympiads and distance education whereby students correspond directly with the school by receiving and submitting assignments. The identification process in three domains are: academic subjects, sports, and fine arts. Standard academic tests are used for inclusion purposes whereby those with outstanding performance on written and oral examinations are selected. Also, the Russian versions of the Stanford–Binet, along with nonverbal measures of intelligence, such as the Cattell and the Raven Progressive Matrices are used. To enter Lavrentiev Physics–Mathematics Boarding School, applicants must first participate in mathematics and physics competitions. The most successful students (winners and near-winners) get invited to the summer programme as a trial run to determine whether they are qualified to be admitted to the school's full-time programme.	Grigorenko, 2017; Ushakov, 2010 Jeltova, Lukin & Grigorenko, 2009
Ireland	Irish Centre for Talented Youth (CTYI) administers a Talent Search to identify high-ability students. Letters are written to all schools in the country to ask them to identify students who have scored at or above the 95% on a standardised test.	O'Reilly, 2018
Austria	Ability tests for enrolment into special secondary schools (focusing on sports, arts, or music) Teacher nomination or self-nomination with evidence of above-average school performance and high scores in psychometric tests for pull-out programmes and summer academies.	Weyringer, 2013
Germany	Possible criteria for choosing gifted children to the special programmes are grades, school external achievement (competitions), performance tests (IQ), questionnaires (filled by the child, or the third party), parent checklist, nominations, as well as institutional criteria. Teacher nomination is often consideration of broad range of characteristics involving high (cognitive) abilities, creativity, interests, and motivation, standardised tests and other classroom assessments.	Reid & Boettger, 2015
Hungary	identification process is based on several criteria, such as the within school achievement, external achievement (competitions), teacher nomination, third party nomination and the psychologists' nomination based on psychological tests. Overall, schools and teachers are responsible for identification and recognition of gifted and talents students. For Mentorship programmes for gifted high school students, the selection is based on students' achievements in various competitions. Exceptionally talented 12-13 year-olds, are recommended by the Hungarian Talent Support association.	Reid & Boettger, 2015

France	Teacher-nomination; parent-request (has to be approved by a board of teachers); recommendation by educational psychologists (normally through Wechsler Intelligence scales)	Balchin et al., 2009
Israel	The Identification process is on a country-wide scale. The same preliminary test administered to all pupils, based on performance on group intelligence tests. Most pupils are given the Ortar Test, which is a combined set of subtests, correlating with the Wechsler Scale. Students between the top 1% - *3%,* (with a score of approximately 140+ IQ) are accepted to the gifted programmes. Two new criteria are planned to be used in the selection: level of motivation and level of creativity. Based on the variety of special programmes, age Range is from 8-18: The Henrietta Szold Institute administers the Szold tests for the Ministry of Education. These tests are given usually in either grade 2 or grade 3 and they have two stages: in stage 1 all students take an initial 'filtering' examination in literacy and arithmetic: this is revised every year. The top 15% achieving students of each class are invited to take the stage 2 examinations, which aim to assess the general cognitive ability of the students. After stage 2, the top 1.5-5% of students are invited to participate in a variety of programmes for the gifted and excelling, taking place in about 50 Israeli centres. The Szold Institute examinations do not correlate with the Wechsler Scale of Intelligence. APM (Acceleration Programmes in Mathematics): students aged 13-15 are selected by their teachers; MES (Mathematics for Excellent Students): for 12-17 year olds; NOYC (Noam Outstanding Youth Centre) Maths Summer Camp: 20 outstanding students grades 9-12 selected on the basis of school recommendations and interviews; Ariela Foundation: the top 20% of lower and upper secondary school students who demonstrate high ability in one or more fields through the Maof Assistance Programme, a nationwide initiative to promote excellence amongst outstanding youngsters through ongoing personal mentoring and long term tailor made assistance; College for All: targets high achieving primary school students from low SES background (~12.5%) Talpiot (Israeli armed forces talent development programme): Israeli students completing high school are required to serve in the Israel Defense Forces, typically for two years (women) or three years (men). All students in Grades 11-12 are tested. Those who score in the top 5% are invited to undertake a programme that combines basic military training, officer training and completion of a degree. Applicants are sifted and up to 200 attend a final selection process overseen by former graduates. Annual intake ranges from 40-50 participants.	Burg, 1988 Nevo & Rachmel, 2009 David, 2016

Appendix

	Skirball Excellence 2000 for grades 5-6 & Mitchell Excellence 2000 for lower secondary, grades 10-11: students are selected by their teachers using five criteria of high achievement, high learning potential and willingness to face new challenges, curiosity and creativity, determination and motivation and commitment to complete the programme followed by a screening test and interview. Around 10% of learners are admitted, taught in classes of 15-20. TYHSA (Thelma Yellin High School of the Arts): up to 15% annually are from immigrant populations, while others are from disadvantaged backgrounds or disabled. Students are selected on the basis of audition and interview. Havruta High School for Leadership and Culture, Israel Centre for Youth Leadership (ICYL): potential students complete and submit an application form. If their applications are successful, they will be called in for the first of a series of interviews with school staff. If those go well, recommendations will follow. To round out this assessment – more qualitative than quantitative – grades and test scores will also be considered, but not as the main factor.	
China	A 3-step process: Step 1: Applicants who score at the top 3% in the National College Entrance Exam (main test) are eligible to enter the second round of the screening process. Step 2: Eligible applicants take an internal written test in math and physics with an emphasis on proficiency and flexibility in problem solving. Step 3: Finalists are required to spend one week with the SCGY (Special Class for the Gifted Young) staff, when they take lessons in math, physics, and English, taught by university professors, and then are tested on their comprehension skill and the rate and ease of learning. In addition, interactions and observations during the finalists' 1-week campus visit are documented and used as a dynamic assessment. Therefore, first academic performance and then multiple methods for selecting well-rounded students are important. For example, all the secondary schools use a combination of intelligence tests, academic achievement, interviews, and behaviour observations for admitting students to the special programme.	Dai, & Steenbergen-Hu, 2015 Zhang, 2017
Hong Kong	Schools and educators are responsible to nominate a quota of their students who then undergo domain-based tests or interviews for being identified for special programmes. There is a rigorous evaluation process via triangulation of results. Use of a combination of tests of ability, such as the Hong Kong Wechsler Intelligence Scale for Children and the Ravens Standard Progressive Matrices test for the 'intellectually gifted', tests of achievement for the 'academically gifted', and the Hong Kong version of the Torrance Tests of Creative Thinking or the Wallach-Kogan Tests for the 'creatively gifted'. Use of teacher, parent, and peer nomination checklists are being considered for their ability to complement the identification process. For the Exceptionally Gifted Students Scheme, teachers nominate students who they believe would benefit from advanced studies in leadership, mathematics, and sciences.	Chan, 2000 Tommis, 2013

Appendix

South Korea	Use of Korean-Kaufman Assessment Battery for Children (K-ABC); Korean-Wechsler Intelligence Scale for Children (K-WISC-III); Torrance Tests of Creative Thinking (TTCT); Aptitude test; General intelligence test; achievement test. Performance assessment tool developed by KIPO and KEDI is also recommended. The National Research Centre on Gifted Education (NRCGE) develops logical thinking tests and creative problem-solving tests in math and science which are implemented each year at the same time all over the country. The key difference in the Korean selection process is the importance of assessing potential and competencies rather than test scores. The final selection is conducted in selection review committee organized by gifted education institutions. Various identification criteria such as school recommendations, various documents, personal interview, science camp, and test results on giftedness and academic aptitude of the students, are utilised.	Korean Educational Development Institute, 2011 https://giftedphoenix.wordpress.com/2012/03/20/gifted-education-in-south-korea-part-2/
Japan	There is no standard protocol or specific identification method. Based on national exam ranking and admission criteria of schools hosting the pro-STEM programmes.	Isoda, 2007 Basister & Kawai, 2018

Appendix C: NIE Courses Related to High Ability Learners

<table>
<tr><th>NIE Programme</th><th>Course Type</th><th>Year start – Year end</th><th>Course Code & Title</th><th>Remarks</th></tr>
<tr><td>Pre-service PGDE (Sec)</td><td>Elective</td><td>2005-2005</td><td>PED563 Understanding and helping pupils of high intellectual ability</td><td></td></tr>
<tr><td>Pre-service PGDE (Sec)</td><td>Elective</td><td>2006-2008</td><td>QED581 Differentiating Instruction for Able Learners</td><td></td></tr>
<tr><td>B. Ed. (Primary) – Part-time</td><td>Elective</td><td>2009- 2012</td><td>
<table>
<tr><th>Course Code</th><th>Course Title</th><th>Hours</th></tr>
<tr><td>AKT101</td><td>Understanding Gifts, Talents & Exceptionalities</td><td>9</td></tr>
<tr><td>AKT201</td><td>Curriculum Differentiation for Highly-able Learners</td><td>9</td></tr>
<tr><td>AKT301</td><td>Talent Development & Programming</td><td>9</td></tr>
<tr><td>AKT302</td><td>Nurturing Creative and Talented Learners</td><td>9</td></tr>
<tr><td>AKT401</td><td>Building Research, Inquiry & Creative Capacities</td><td>9</td></tr>
</table>
</td><td>• This programme is no longer offered.
• Only AKT 401 was offered in 2011 as there were no takers for the other courses</td></tr>
<tr><td>Degree</td><td>Elective for NIE/ NTU undergrads</td><td>2013-2015</td><td>AKT 101: Understanding Gifts, Talents & Exceptionalities</td><td>• All completely subscribed by NTU students only
• Nos – 20-25 students</td></tr>
</table>

Appendix

<table>
<tr><th>NIE Programme</th><th>Course Type</th><th>Year start – Year end</th><th>Course Code & Title</th><th>Remarks</th></tr>
<tr>
<td>Advanced Diploma in Teaching High ability learners</td>
<td>In service</td>
<td>2008 - 2014</td>
<td>
<table>
<tr><th>Core Course Code</th><th>Course Title</th><th>Hours</th></tr>
<tr><td>IEC4009</td><td>Understanding and Providing for Learners with High Ability</td><td>24</td></tr>
<tr><td>ISE4102</td><td>Curriculum for Highly Able Learners</td><td>24</td></tr>
<tr><td>IEC4010</td><td>Programming for Talent Development</td><td>12</td></tr>
<tr><td>IEC4011</td><td>Practicum in Teaching Learners with High Ability</td><td>39</td></tr>
<tr><td>IEC4017</td><td>School-based Action Research</td><td>12</td></tr>
<tr><td colspan="3">Elective courses</td></tr>
<tr><td>ISE4201</td><td>Language Arts and Social Studies for the Highly Able</td><td>39</td></tr>
<tr><td>ISE4202</td><td>Science and Mathematics for the Highly Able</td><td>39</td></tr>
<tr><td>ISE4203</td><td>Teaching Thinking Skills</td><td>39</td></tr>
<tr><td>ISE4204</td><td>Creativity and Problem-Solving</td><td>39</td></tr>
</table>
</td>
<td>The course is run both as an ADBSLN elective & PD.

The numbers for last year (2019) - 6 pax only (none fr PD).

2018 - was 6 ADBSLN students and 4 doing it as PD.</td>
</tr>
<tr>
<td>Advanced Diploma in Special Learning and Behavioural Needs</td>
<td>In-service/ Elective</td>
<td>2012- ongoing</td>
<td>IEC4008/ 5008 Understanding and Providing for Pupils with High Ability in Mainstream Classrooms</td>
<td></td>
</tr>
</table>

Appendix

<table>
<tr><th>NIE Programme</th><th>Course Type</th><th>Year start – Year end</th><th>Course Code & Title</th><th>Remarks</th></tr>
<tr>
<td>Certificate for Teaching High Ability learners (CeTHA)</td>
<td>In service</td>
<td>2007-2012</td>
<td>
<table>
<tr><th>Module Number/ Course Code /Title</th><th>Hours</th></tr>
<tr><td>Module 1: IEC4009 Understanding and Providing for Pupils with High Ability</td><td>24</td></tr>
<tr><td>Module 2: ISE 4102 Curriculum for Highly Able Learners</td><td>24</td></tr>
<tr><td>Module 3: IEC4010 Programming for Talent Development</td><td>12</td></tr>
<tr><td>Module 4: IEC4011 Practicum in Teaching Learners with High Ability</td><td>10</td></tr>
</table>
</td>
<td>• Course was stopped after 5-year funding cycle ended.</td>
</tr>
<tr>
<td>Certificate in differentiating curriculum and instruction for high ability learners (CDCHAL)</td>
<td>In service
Cross-listed with the MEd (High Ability Studies)</td>
<td>2018 - ongoing</td>
<td>
<table>
<tr><th>Module Number/ Course Code /Title</th><th>Hours</th></tr>
<tr><td>Module 1: IEC 6011 (cross coded with MHA901): Understanding Learners with High Ability and their Affective and Moral Needs</td><td>52</td></tr>
<tr><td>Module 2: IEC 6013 (cross coded with MHA 903) Curriculum for Highly Able Learners</td><td>52</td></tr>
<tr><td>Module 3 : IEC 4043 Practicum in Teaching Learners with High Ability</td><td>10</td></tr>
</table>
</td>
<td>• See https://www.nie.edu.sg/professional-and-leadership-development/professional-development-programmes-courses/certificate-programmes/certificate-in-differentiating-curriculum-and-instruction-for-high-ability-learners
• Only 1 run done for a group of 6 IP schoolteachers in 2018-2019. Since then we have not been able to offer the course as there are too few takers from IP schools (3- 4).
• For other schools. there is not much focus on “differentiating for high ability learners”– 2 major reasons come up when asked– 1) HAL needs are currently being serviced by Gifted Ed programme and by school-based specific-subject after-class enrichment (e.g. E2K) 2) in- class differentiation is challenging and done sporadically.</td>
</tr>
</table>

Appendix

<table>
<tr><th>NIE Programme</th><th>Course Type</th><th>Year start – Year end</th><th>Course Code & Title</th><th>Remarks</th></tr>
<tr>
<td>Master's in Education (Gifted Education)</td>
<td>Higher Degree</td>
<td>2006-2016</td>
<td>
<table>
<tr><th>Course Title</th><th>Hours</th></tr>
<tr><td>Core Subjects
MEd 871 Educational Inquiry I
MEd 872 Educational Inquiry II</td><td>39</td></tr>
<tr><td>Required Specialisation Subjects
MSE 821 Understanding Learners with High Ability
MSE 820 Differentiated Pedagogies for High Ability learners</td><td>39</td></tr>
<tr><td>Elective Specialisation Subjects
MSE 830 Affective Needs & Moral Development of the Gifted
MSE 831 Identification of Potential & Interventions for Talent Development
MSE 832 Critical and Creative Thinking for High Ability Learners
MSE 833 Issues, Policies and Trends in Gifted Education
MSE 834 Administration and Evaluation of Programmes for High Ability Learners and Talent Development</td><td>39</td></tr>
</table>
</td>
<td>• This was a 3 AU version and has been tweaked to current 4 AU courses.</td>
</tr>
<tr>
<td>Masters in Education (High Ability Studies)</td>
<td>Higher Degree</td>
<td>2017- ongoing</td>
<td>
<table>
<tr><th>Course Title</th><th>Hours</th></tr>
<tr><td>Core Subjects
MED900 Educational Inquiry
MED902 Integrative Project</td><td>
52
26</td></tr>
</table>
</td>
<td>• Last intake Jan 2019 (no intake this year as numbers are very small)</td>
</tr>
</table>

Appendix

NIE Programme	Course Type	Year start – Year end	Course Code & Title	Remarks
			Required Specialisation Subjects (52) MHA901 Understanding Learners with High Ability and their Affective and Moral Needs MHA903 Differentiating Curriculum and Pedagogies for Learners with High Ability ***Elective Specialisation Subjects*** (52) MHA 902 Affective Needs & Moral Development of the Gifted MHA 904 Critical and Creative Thinking for High Ability Learners MHA 905 Issues, Policies and Trends in Gifted Education MHA906 Using Multicultural Children's Literature to Facilitate Social and Emotional Learning among Exceptional Learners	
One-off PD for Science teachers in NUSHSMS	In service	2017	IEC 0022 Understanding Teacher Questioning and Increasing Student Talk (4hrs)	• Once off PD
One-off PD for SOTA	In service	2015	IEC 2023 Instructional differentiation for Arts-Inclined Learners (6.5 hrs)	• Once off PD
FCTHAL Sc NIE	In service	2012 & 2013	Foundation Course in Teaching High-Ability Learners Science (NIE) Module 1 & Module 2.	• There was only 1 run each year

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