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《香港教研學報》（《教研學報》）乃一年一度出版的學術性刊物，內容以教育研究、教育行動研究及教學經驗分享為主。《教研學報》的投稿者多來自本港及海外的教師、師訓機構的導師、教育研究人員及學者。有興趣人士可到教師及校長專業發展委員會網頁（https://www.cotap.hk/index.php/tc/t-share/educational-research-award-scheme）閱覽《教研學報》。

以下為《教研學報》之評審及編輯委員名單。

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Complementing STEAM education and SHAPE initiative in Hong Kong: A transformation of arts education to humanities education

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Abstract

The STEM to Science, technology, engineering, arts, and mathematics (STEAM) movement has been taking root over the past few years because of moving forward for achieving the sustainable development of educational goals and meeting the needs of a 21st-century economy. STEM alone will neglect some key components that will be significant for future generations to thrive in the present and fast-approaching future. STEAM is thus deemed a way to take the benefits of STEM and complete the package by integrating these principles in and through the arts. Hong Kong STEM education was first proposed in 2015, the coherent linkage has been come across recently in the updated primary school curriculum guide to rename STEM education as STEAM education as a concert with the newest policy initiative, but it does not specify how the integration between arts and STEM should be carried out. Because of this local context, the intrinsic case study method will be adopted in this paper to argue that Hong Kong STEAM education can be developed systematically through existing arts education curriculum framework, yet more efforts should be done by shifting further to humanities education with SHAPE (Social Sciences Humanities & the Arts for People and the Economy) initiative to overcome the long-lasting problem of lower attention on arts education.

Keywords

STEAM education, Hong Kong, SHAPE (Social Sciences Humanities & the Arts for People and the Economy), Arts education, Humanities education

1. Introduction

STEM (Science, technology, engineering, and mathematics) came along from American Competitiveness Initiative in 2006 with the introduction of education standards and a new curriculum, representing the center of the United States' focal education policy to produce experts and workers with excellent science and technology knowledge, creative problem-solving skills, and eventually increase the economic competitiveness of nations (Hardiman & JohnBull, 2019). It aims to enhance students' performance in mathematics and science, increase the number of highly-qualified STEM teachers, encourage the number of educators participating in innovation, and motivate schools to apply research-based STEM curricula and interventions. This initiative did not only increase various STEM fields and employments, improve the quality of STEM teachers and provide more capital for STEM, but also invited business companies to have more involvement in STEM education (Mohr-Schroeder et al., 2015). Hence, STEM education has evolved rapidly and globally in the last two decades.

However, the STEM to Science, technology, engineering, arts, and mathematics (STEAM) movement has been taking root over the past few years because of moving forward for achieving the sustainable development of educational goals and meeting the needs of a 21st-century economy. STEM alone will neglect some key components that will be significant for future generations to thrive in the present and fast-approaching future. Thus, STEAM is not only deemed a way to take the benefits of STEM, but complete the package by integrating these principles in and through the arts. It facilitates STEM to a higher level because it allows students to connect their learning in these critical areas with arts practices, elements, design principles, and standards to provide the whole pallet of learning at their disposal (Kobayashi, 2019). Remarkably, the emerging remote learning during the COVID-19 pandemic has turned into dehumanizing education, considering that human interaction has been shifted to technology inevitably (Dervojeda, 2021a). Therefore, technological mindfulness and the value of technology are especially highlighted in Education 5.0 (Dervojeda, 2021b).

Hong Kong STEM education was first proposed in 2015 as one of the key education agendas and remained emphasized in the ongoing curriculum renewal. In the meantime, the coherent linkage has been come across in the updated primary school curriculum guide to rename STEM education as STEAM education in concert with the newest policy initiative (Education Bureau, 2022), but it does not specify how the integration between arts and STEM should be carried out tentatively (Curriculum Development Council, 2017; Education Bureau, 2020). This proposed alignment may restrict the development of STEAM education in Hong Kong. Because of this local context, the intrinsic case study method will be adopted in this paper to argue that Hong Kong STEAM education can be developed systematically through the existing arts education curriculum framework. Nevertheless, more efforts should be made by shifting further to humanities education with the SHAPE (Social Sciences Humanities & the Arts for People and the Economy) initiative to overcome the long-lasting problem of lower attention on arts education.

2. Literature Review

2.1 Why Choose Art to STEM Education?

STEAM has resulted from integrating the arts into STEM, derived from STEM + Arts. It is a follow-up trend by STEM, identifying an educational discipline for children to spark their love and interest in sciences and arts. Children will have to cultivate creativity sense for enquiry and investigation in every matter in STEM-related subject knowledge. If they need to adapt to an ever-evolving world, in-demand skills will be the prerequisite for innovation to prepare them for the STEM workplace. In STEAM education, project-based learning across all five disciplines can empower teachers to provide an inclusive climate for student engagement and contribution (Dolgopolovas & Dagienė, 2021). Compared to the traditional teaching mode, STEAM will leverage the synergy between the modeling process and math and science content, and boundaries between modeling techniques and scientific/mathematical thinking will be blurred. Students taught under a STEAM framework could not learn solely on the subject matter; they also need to be taught how to learn, ask questions, experiment, and create (Rolling, 2016).

STEM and the arts were often conflictingly observed by the public (Sousa & Pilecki, 2013). However, combining these seemingly opposite sides brings the variety and diversity necessary for innovative product design. Sousa & Pilecki (2013) further figured out that the characteristics of STEM are analytical, reproducible, and logical, whereas the characteristics of the arts are subjective, sensual, and likely frivolous. Science and the arts complement each other because "science provides a methodological tool in the art, and art provides a creative model in the development of science" (Kim et al., 2012, p.2). The transition from STEM to STEAM does not simply attach art to STEM or use the arts as a tool to educate STEM, the nature of arts is integrative. The birth of STEAM can be explained by the concept of arts integration that the arts can be utilized as an adhesive to link non-arts subjects. In Miller & Bogatova's (2018) 's investigation of integrated arts education implementation, the subject boundaries of non-art subjects can be debilitated by integrating arts under the interdisciplinary approach, which enables students to search for connections between subject knowledge and skills. Moreover, in the perspective of artistic creation, the artistic creation process starting from creative ideas, imagination, and thinking to production, must involve various knowledge and abilities, which the creator comprehensively uses to demonstrate the characteristics of interdisciplinary integration (Smith, 2011). In other words, the arts can easily connect various concepts, information, and STEM knowledge and inspire creative ideas (Herro & Quigley, 2019).

Additionally, STEAM can enhance students’ learning performance, reduce behaviour problems and improve their learning attitude. Land (2013) discovered that students could gain a better understanding and combine knowledge under the application of integrated arts. Likewise, Hardiman and JohnBull (2019) indicated that students in STEAM groups remember content better than in traditional STEM teaching. Moreover, Herro and Quigley (2019) reported that students' behaviour problems sharply reduced since they were involved more. In addition, Kong and Huo (2014) spotted that exerting STEAM programmes in schools could charge students' attitudes positively about science education, have greater levels of self-efficacy for STEAM education, and gain more interest in scientific learning. Students might have higher motivation and interest to learn and aspire to STEAM careers after participating in art-integration programmes (Lim et al., 2015).

2.2 Essentials of creativity in Education

The art aspect of STEAM mainly refers to creativity in education, (e.g., Kang et al., 2013; Madden et al., 2013), it includes divergent thinking and results in a product in “producing something novel” (Sousa & Pilecki, 2013, p.50). Therefore, students might have to improve their creative thinking skills in the educational environment because this is important for their career development. Creativity has to be nurtured in the learning environment because creative thinking will be needed in different activities to result in positive outcomes. Students' competencies in self-reflection, advanced thinking skills, and collaboration with others can be enhanced (Crow, 2008). In order to improve students' creativity in formal and informal learning opportunities, essential skills, innovation, and creative thinking will be required.

STEAM education allows students to develop and improve creative thinking and problem-solving skills, and the arts integration encourages innovation through the mix and match of STEM knowledge and creative thinking. In STEAM lessons, when students encounter problems in diverse settings, they must first define issues and suggest different ways to address them with their creativity (Beghetto, 2017). In addition, Hardiman and JohnBull (2019) found that the effect of art-integrated teaching might be prolonged since students receive art-integrated instruction, they can apply strategies and perform better in daily life. Sousa & Pilecki (2013) stated STEAM education has several advantages, including a) development of cognitive growth, b) improvement of long-term memory, c) enhancement of social growth, d) reduction of stress, e) increasing the appeal of subject areas, and f) promotion of creativity. Once all advantages can be integrated into STEM education, students might get ready for today's challenges in STEM problems and be more interested in STEM fields (Kang et al., 2013), STEM fields could also be more attractive to students (Land, 2013).

Creativity is gradually becoming more important in STEM projects and disciplines in the past decades. When creativity becomes highly valued in modern education, the purpose of arts in STEM education is to impart creativity and critical thinking to improve children's cognitive and affective skills while internally motivating them to learn (Yakman, 2008). It could also widen their horizons into thinking about the world, empathy, communication, and the social sciences because arts are where things like education, sociology, and linguistics fall, also connected to STEM fields. In this respect, teaching the arts could include hands-on and emotional learning experiences that would interest and internally motivate children in their education, engage students in the content, and improve their success in STEM subjects. When the arts are used as a pedagogical tool for teaching non-arts subjects, known as arts integration, it shows promise for learning and retaining academic content, transferring knowledge to other learning domains, and developing creative thinking and problem-solving skills. The arts serve as a springboard for traditionally teaching STEM subjects with the types of creative thinking that encourage innovation. Furthermore, Yee-King et al. (2017) found that computational education could be well linked with the STEAM approach. The learning outcomes in the arts-integrated approach can help students develop sophisticated programme skills, compared to those who learn computing coding in regular classes. Another study shared a similar view that middle and high school students who engaged in STEAM project-based lessons can be more proficient in using their creativity within the instructional activities and enhance their self-efficacy in STEAM (Oner et al., 2016). In sum, such studies suggest that arts-integrated learning within STEM not only improves academic achievement, it also affects interests, attitudes, self-efficacy, and performances toward STEM subjects, as well as awareness of STEM-related career trajectories.

2.3 Implementation and Benefits of STEAM Education

STEAM education emphasizes that students learn and be knowledgeable across a wide range of disciplines, which aligns with the current educational trend to support transdisciplinary practices. In this perspective, STEAM education will link up with other subjects enabling students to integrate the knowledge in investigating the problems (Quigley & Hero, 2016). As Nicolescu (2002) emphasized, STEAM is transdisciplinary and can help solve complicated problems and offer innovative solutions. It could be further considered a kind of transdisciplinary learning, allowing students to experience self-directed and creative learning methods. Through problem-based learning or project-based learning, students receive a sense of accomplishment and self-efficacy and positive emotional reinforcement such as success and satisfaction (Park et al., 2016). Through STEAM learning, students can improve their life skills, such as communication, problem-solving, and collaboration (Ng & Ng, 2021). Students would gain concrete working abilities to write reports, collect information, and time management. At the same time, they can develop the skills to evaluate their performance as self-assessment skills (Chung & Li, 2021). Students understood the assessment criteria from past projects and started to determine the level of their work; public presentation and peer-evaluation also fostered their self-assessment ability (Jeong et al., 2019).

Successful STEAM education is when students acquire targeted knowledge through projects and connect with the natural world (Land, 2019). The STEAM curriculum development requires lots of planning which is the biggest challenge of educating STEAM. The center of STEAM is cross-curricular collaboration since teachers have professional subject knowledge but not all STEAM domains with concrete knowledge. In this connection, teachers must cooperate with other teachers, experts, or professionals to co-plan and even co-teach. In a STEAM lesson, teachers should highlight at least three related disciplines, namely transdisciplinary teaching, the arts and humanities, and technology integration (Herro & Quigley, 2019). Cooperation with experts or other teachers is necessary for teaching across disciplines, and the choices of subjects are important for natural discipline integration. Different forms of arts can be added in STEAM for the arts and humanities, such as design process, digital media creation, and presentations with images. Moreover, technology integration means that students use technology in the process of STEAM lessons. For example, students applied technology pieces like 3-D printing, design software, and video presentation to build birdhouses (Herro & Quigley, 2019).

Land (2019) pointed out that Project-Based Learning (PBL) is significant in STEAM education, which proposes challenging questions to students as the starting point. Normally, students are required to complete the project with components including a certain level of subject knowledge, artistic design, and the application of a research-based approach. Also, students would form a group of four to six, exchanging their ideas and thoughts. Professionals and teachers may provide extra support as inspiration and guidance to assist students in completing the objective-driven project. Teachers can evaluate students' performance by commenting on their drafted designs, progress reviews, and assessment of the end product and presentation of the item (Land, 2013). In the same way, Herro and Quigley (2019) proposed scenario creation as the platform for STEAM education, allowing students to bring out different solutions for addressing a problem related to a topic. Combining the arts and STEM disciplines is beneficial in crafting a problem scenario. The student's interest, the connection with real-world and local issues, and the topic's meaning are important components in creating a scenario regarding students' developmental status and educational level. Besides, PBL or Challenge Based Learning (CBL) emphasizes the active role of the students presenting with a project-based or a problem-based study (Ubben, 2019). Students will be motivated by PBL because of their self-efficacy in handling authentic problems and the chance to cooperate with other students, which shows PBL is suitable for students from primary school to university.

Jeong et al. (2019) proposed a framework of STEAM education with three parts: the openmindedness nature of creative design, emotional touch, and connections to real life. It illustrated that students would learn how to enhance their communication and collaboration skills under the collaborative project design. Students could experience the self-directed process of seeking suitable solutions and absorbing enough new knowledge to come up with their final work. Besides, emotional touch was an important part of a victorious problem-solving skill. Park et al. (2016) defined emotional touch as "experiences that enable a positive cycle of self-directed learning where students feel interested, confidence, intellectual satisfaction and a sense of achievement, as they find motivation, passion, flow and personal meaning in learning." Those positive emotional rewards foster students' learning interest, motivation, and wishes, eventually upgrading to self-direction learning.

According to Yakman and Lee (2012), STEAM education can facilitate students' ability to transfer knowledge with higher-order thinking among disciplines. Wells (2013) also proved a similar view, who mentioned that with the element of arts in STEAM education, students would be encouraged to apply knowledge from different domains with personal creative pursuits on focusing the designed-based problems. The design progress engages students to access multiple disciplines and perspectives on a needed basis, which is the core principle of transdisciplinary practices. As a matter of fact, students are expected to learn STEAM expert knowledge in a specific discipline, so boundaries can be removed to implement arts-infused education better. Students also should have a better sense of connecting with a more profound and unique understanding across the integration with STEAM disciplines so that STEAM competencies can be developed through the transdisciplinary approach. This is a crucial step to fostering students equipping problem-solving, creativity, and innovation in students' learning.

To sum up, STEAM education is not mutually exclusive with STEM education. It expands and enriches the scope of STEM education. It is a curriculum philosophy that empowers STEM teachers to engage in school-based curriculum development and develops a humanistic vision of 21st-century education and their role as professionals. STEAM education should be able to provide a creative design space for teachers in different learning areas to collaborate in developing integrated curricula and learn how to be individual innovative teachers (Taylor, 2015). Every STEAM educator can draw inspiration from PBL programmes and engage students in transformative learning based on five interconnected ways of knowing: visionary and ethical knowing, relational knowing, cultural self-knowing, critical knowing, and knowing in action (Taylor, 2016).

3. Promotion of STEAM Education and Development of Arts Education in Hong Kong

3.1 Formal Launching of STEM Education and STEAM Education in Hong Kong

Under the STEM movement worldwide, policymakers realized the importance of arts which can facilitate STEM education and educate students with innovation and creativity (West, 2013). Hence, this session will review the history and positioning of STEM education and arts education in Hong Kong.

STEM has gained increasing attention from countries over the past decade (Sanders, 2009). In Hong Kong, in response to the ever-changing economic, scientific and technological development, STEM education was proposed in the 2015 Policy Address and further supported in the 2016 Policy Address. It acts as a key emphasis in the ongoing renewal of the school curriculum that is essential for students' life-long learning and whole-person development. Apart from cultivating students' interest and developing a solid knowledge base in Science, Technology, and Mathematics, it aims "to strengthen students' ability to integrate and apply knowledge and skills across different STEM disciplines and to nurture their creativity, collaboration and problem-solving skills, as well as to foster their innovation and entrepreneurial spirit as required in the 21st century" (EDB, 2016, p.1). A holistic and integrated approach is adopted, including "1) Renewing the curricula of the Science, Technology and Mathematics Education Key Learning Areas (KLAs); 2) Enriching learning activities for students; 3) providing learning and teaching resources; 4) Enhancing the professional development of schools and teachers; 5) Strengthening partnerships with community key stakeholders; 6) Conducting review and disseminating good practices" (p.2). Ultimately, it hopes to equip students' critical thinking ability across different disciplines to apply and integrate their specific STEM knowledge in tackling actual problems in their daily life. This learning process enables life-long learning and facilitates the development of well-rounded individuals. In 2022, the government officially announced to step up the promotion of STEAM education "for all", "for fun" and "for diversity" in primary and secondary schools, in order to supporting the STEAM literacy for our future generations and sustainable innovation and technology development (Lee, 2022).

3.2 Arts Education Development in Hong Kong

Art education is set within the profound changes in education since the handover of Hong Kong to China in 1997 (Ball, 1999; Hughes, 1999; Mok, 2003). A reform of the academic structure, including curriculum, assessment method, and medium of instruction, was carried out by the Education Commission in 1999. The main direction of the education reform was elaborated by the two major policy documents (Education Commission, 2000; CDC, 2001). The notion of whole-person development and life-long learning is advocated through a quality education within the formal curriculum and nurturing students with generic skills, such as creativity. Art education is delivered through integrated learning that "leads students to acquire a holistic understanding and deeper insights into what is being studied" (CDC, 2002a. p.61).

The education reform in Hong Kong aims to enable students to attain overall development and life-long learning (CDC, 2000). Traditional subjects are grouped into KLAs and taught in schools using new Key Learning Area curricula. Visual arts and Music are grouped under the Arts Education KLA. The purpose is to "enable students to broaden and diversify their arts learning experiences through different channels" (CDC, 2002, p.52). The curriculum design of the Arts Education KLA emphasizes "Learning across the arts" and "Learning across KLAs ."The "Learning across the arts" enables students to "make associations with learning experiences in a variety of art forms," and "the Learning across KLAs" also enables them to "develop a broader understanding of historical, technological, cultural and social context ."With interdisciplinary learning across KLAs, students can "investigate and critique culture through the arts, integrate their learning experiences and gain deeper insights into the subjects they are studying" (CDC, 2002, p.54). Arts integration should be able to provide students with unique learning experiences that are “parallel and equal” to those gained in non-arts learning (Wong, 2012). The aim of teaching interdisciplinary arts is reflected in the Visual Arts Curriculum Guide (Primary 1 to Secondary 3) (CDC, 2003a) and Music Curriculum Guide (Primary 1 to Secondary 3) (CDC, 2003b). Given the principle of an integrative approach, "art appreciation, criticism and art making should be integrated and combined rather than compartmentalized in learning and teaching" (CDC, 2003a, p.4). A thematic approach is encouraged to be adopted to link visual arts with other art subjects (CDC, 2003a). On the other hand, the Music Curriculum Guide states that Music maintains its subject integrity by linking it with other subjects using related concepts. Connecting the Music contents with the other KLAs can later extend students' learning experiences, deepen their understanding of knowledge, and enhance their motivation to learn Music (CDC, 2003b, p.62). Both curriculum guides suggest possibilities for implementing an interdisciplinary arts curriculum. The curriculum implementation falls on individual schools to work on their school-based integrated arts curricula. However, the idea of curriculum integration is not well-received by teachers in Hong Kong as it is perceived to generate inferior academic content (Morris, 1998). Teachers in Hong Kong also possess a limited conceptual understanding of curriculum integration, reflecting that subjects are structured in a distinct academic division. These teachers may not have enough opportunities to practice curriculum integration (Yeung & Lam, 2007). It would pose challenges to teachers to practice integrated arts education.

The implementation of the new senior secondary academic structure in 2009 has further enhanced the interface between primary, junior secondary, and senior secondary education by offering diverse pathways for students to continue their pursuit of the arts at the senior secondary level (CDC, 2017). The position of arts education is set as:

"To enable every person to attain all-round development in the domains of ethics, intellect, physique, social skills, and aesthetics according to his/her attributes so that he/she is capable of life-long learning, critical and exploratory thinking, innovating and adapting to change" (EDB, 2021)

As the entitlement of every student and to broaden and diversify their arts learning experiences, Arts Education has the following aims to help students:

- develop creativity, critical thinking, and communication skills, and nurture aesthetic sensitivity and cultural awareness;
- develop art skills, construct knowledge, and cultivate positive values and attitudes;
- gain delight, enjoyment, and satisfaction through participating in arts activities; and
- pursue a lifelong interest in the arts (EDB, 2021).

In the Hong Kong curriculum context, STEM education is promoted through the KLAs of Science Education, Technology Education, and Mathematics Education. The Arts Education KLA can contribute to the promotion of STEM education through incorporating elements of STEM into arts learning activities that teachers can:

- guide students to discuss and appraise works of the arts from the scientific, technological, and mathematical perspectives for widening students' scope of understanding of the arts;
- assign project work (e.g., designing a video game) and engage students in learning across the Arts Education, Science Education, Technology Education, and Mathematics Education KLAs; and

- invite students to apply technology to explore alternative means for creating and performing the arts (CDC, 2017, p.17).

Apart from classroom learning, Arts Education can be implemented outside the classroom and school in Life-Wide Learning (LWL), which refers to student learning in real contexts and authentic settings. Such experiential learning enables students to achieve specific learning goals that are more difficult to attain through classroom learning alone. The experiential learning acquired through LWL helps students to achieve the aims of whole-person development. It enables them to develop the life-long learning capabilities needed in our ever-changing society. All students in Key stages 1-3 should be provided with LWL opportunities to help them gain the five essential learning experiences, including Intellectual Development, Moral and Civic Education, Community Service, Physical and Aesthetic Development, and Career-related Experiences (CDC, 2001). For physical and aesthetic development experiences, opportunities for authentic experiences outside the school/classroom to complement studies in Physical Education and Arts Education should be explored and valued. Arts Education can also be promoted at the senior secondary level through Other Learning Experiences (OLE). Aesthetic development is part of the essential component of Key Stage 4 within the Art Education KLA curriculum; it plays a vital role in helping students lead healthy lives and achieve whole-person development (CDC, 2017). Without summative assessment, students can learn the arts in an A-C-P-R circle, a relaxing learning circle through appreciating, creating, performing, and reflecting. Specifically, aesthetic development experience differs from the elective subjects of Music and Visual Arts. It aims to provide all senior secondary students with rich and meaningful arts learning experiences, foster students' life-long interest in the arts, and cultivate positive values and attitudes. In contrast, Music and Visual Arts aim to help individual students to develop their specialization in these two art areas (CDC, 2017, p.24). Schools are encouraged to arrange structured arts learning sessions as an important mode of implementation, and various co-curricular activities should also be arranged to engage students in learning the arts in authentic contexts (CDC, 2017, p.24).

The development review of Arts education and STEM education shows that the infusion of arts in STEM is insufficient. The alignment is also not attached effectively to boost the development of STEAM education in Hong Kong. Therefore, the following section will suggest an evolution of integrating humanities with other KLAs as an initiative to achieve a comprehensive interdisciplinary curriculum to promote STEAM education.

4. Discussion

4.1 From STEAM Education to SHAPE initiative: The Next Paradigm Shift?

Humanities are understood as uniquely capable of promoting the capacity to understand logically and analytically, the acceptance of different perspectives or circumstances, and the effective usage of imaginative problem-solving. However, it is questionable how science and humanities can be linked to each other (Slingerland, 2008). Given that humanistic knowledge is valuable because it must be practical, valued, and understood contextually for dialectic meaning-making, Menand (2010) argued that re-articulating the value of a liberal arts education is required when equipping humanities sense and knowledge enables complex inquiry and innovation on problem-solving, even though current rhetoric highlights the vulnerable or impractical nature of liberal arts in the technological age. Therefore, Duncan (2010) believed that integrating arts and humanities into STEM education is a "well-rounded curriculum." It is a big step forward in connecting various academic subjects and knowledge, considering that a rich core curriculum empowers students to develop convictions and unleash their full potential in many aspects (Lewis, 2015). On the one hand, humanities can complement STEM through encouraging students' self-expression to think critically about abstract ideas and approach challenges from fresh perspectives, boosting their ability to solve complex issues creatively and innovatively and letting them feel connected to the broader world (Goldfine, 2024). On the other hand, STEM can also strengthen humanities while students are allowed to blend technical skills with critical and creative thinking. For instances, data analysis and visualization can help students dive deeper into historical trends, linguistic patterns, or cultural shifts. Students can further understand ethical dilemmas in technology, such as artificial intelligence and climate change, equipping them for interdisciplinary or multidisciplinary knowledge where technical and ethical insights go hand in hand (Goldfine, 2024). When humanities possess an enormous capacity for deluding ourselves, humanities education should be considered as the development of humans instead of "human capital" (Cassidy, 2015). Under this context, humanities and arts graduates must be attached with an understanding of scientific and technical knowledge to inform the development of the human condition for humanistic STEM.

The liberal arts education approach emphasizes multidisciplinary nature to foster creative thinking by combining studies in STEAM fields. The STEAM curriculum is critical to provide innovations in modern science and technology. STEAM curriculum can address the complicated issues that sophisticated problem-solving skills and innovative solutions can be provided to tackle the problems of the more significant population, global interconnection, and technological advancement (Madden et al., 2013). It can also be seen that supplementing liberal arts education with STEAM elements in the liberal arts curriculum can better prepare liberal arts graduates with the skills required for the 21st-century innovative economy and teach them to participate as full partners in making the world around them (Marmon, 2015). The common public discourse regarding STEM and liberal arts education is to frame the value of the humanities and arts as a way of "topping up" or "rounding out" the perspectives of STEM graduates. It is argued that STEM students can complement their technical and science skills in arts and humanities education. They can understand and explore scientific discovery and technological development from different aspects, demonstrating that creativity can be cultivated in arts and humanities for STEM problem solving (Oner et al., 2016). It is also expected that STEM can "top up" the skills that students can gain in the traditional liberal arts through sharpening their creativity, diagnostic skills, and design.

Against this backdrop, infusing STEM education into the SHAPE initiative can be necessary for every student to develop their capacities to become future global citizens in the 21st century. It is an idea not only to celebrate the value of social sciences, humanities, and the arts and to demonstrate their relevance and value to ourselves and society but also to encourage people to study them, build meaningful lives and contribute to society using the knowledge and skills they gain in doing so (Black & Goldsworthy, 2021b). While STEAM does not capture "S" and "H, it signifies STEAM focuses more on the value of integrating art and design with STEM rather than the value of integrating STEM with social sciences and humanities. SHAPE subjects have value, which is on par with STEM, but SHAPE highlights more on the human world to accomplish rehumanization (Black, 2021). SHAPE initiative is expected to use the knowledge and insights to inform others to leverage art and design more hugely valuable to the design of products developed by technology. It is believed that many more benefits can be gained from integrating STEM disciplines across the social sciences, humanities, and the arts with the human world's time and space (Uysal, 2021). In light of critically understanding the interaction of people and the natural and physical world, working in STEM and SHAPE subjects need to engage closely with one another so different social issues can be appropriately addressed, such as inequalities, war, injustice, etc. (Black, 2020).

4.2 Revitalizing Humanities Education in Hong Kong: Incorporating the SHAPE initiative to facilitate STEAM Education Through Other KLAs

4.2.1 Personal, Social, and Humanities Education as a new KLA to promote STEAM Education and the SHAPE initiative

Hong Kong humanities education is presently promoted under the Personal, Social, and Humanities Education (PSHE) KLAs curriculum. PSHE will provide learning experiences through which students acquire social literacy and the necessary social enquiry skills. It also calls for understanding human beings as individuals and groups concerning time, space, the environment, and their place in the cultural and material world. The current approach connecting STEAM education and the PSHE KLA curriculum is to share the same objective for promotion. PSHE KLA can not only focus on strengthening students' ability to integrate and apply knowledge and skills, developing students' creativity, collaboration, and problem-solving skills but also contribute through cross-KLA learning activities (CDC, 2017c). Teachers can collaborate and provide social and meaningful contexts for students to apply knowledge and problem-solving skills. Although the multidisciplinary approach requires every teacher to expose students to relevant subject knowledge at different times and contexts to make a connection eventually, it is always difficult to judge if the students have correctly comprehended the concept and reflected in their assignments. Nevertheless, Ng and Ng (2021) demonstrate a showcase as a trial about integrating humanism into the traditional STEAM curriculum to stimulate the students' innovation in a people-oriented approach. To situate in Hong Kong context, this paper recommends that integrating humanities education in other KLAs could let the SHAPE initiative be promoted and implemented more effectively.

According to Chan et al. (2020, p.36), humanities education in Hong Kong can be understood as a holistic personal education that enables students to realize their potential and develop their value systems so that every student can equip both practical and intangible knowledge emerged. Frankly, a school-based curriculum has been encouraged for a long. However, it is generally not easy for arts and humanities teachers to convince the school management to place higher importance on the integrative arts curriculum in developing children's holistic understanding. The major challenge is the lack of holistic arts and humanities knowledge, skills, and confidence. Time and resources are other barriers for arts and humanities teachers in exploring the integrative SHAPE curriculum, and even the arts education curriculum guide asserts that arts education contributes significantly to children's aesthetic and whole-person development, creative and critical thinking, cultural awareness, and effective communication (CDC, 2002, p.3; CDC, 2014). Given that the integrated arts curriculum is not a mandatory policy, the teaching profession and school administrators are not widely interested in such initiatives, causing the existing shortcomings of integrated arts curricula in Hong Kong.

In the updated ongoing curriculum renewal, humanistic qualities are identified as one of the key focuses out of seven elements. [1]PSHE KLA is classified into five dimensions: Self, Others, History, aesthetic appreciation, and environment and nature. Humanistic qualities are one of the critical cornerstones of PSHE and are significant for promoting students' whole-person development. With humanistic qualities developed, the value of every human individual will be respected to pursue self-actualization. Students will be more open to individual acceptance in valuing themselves as unique, possess self-esteem and an open-minded mentality, seek meaning in life, and strive for excellence. They should equip a caring attitude to create an inclusive society by treating others as equals and each other with mutual respect. Students should appreciate and inherit history and culture as everyday human experiences to cultivate an enhanced capacity for aesthetic appreciation. To make a better world, they will care much more about the environment and nature to achieve sustainable development. In the local curriculum context, the SHAPE initiative can be integrated across all KLAs to promote STEAM education (Table 1), while the SHAPE curriculum should include a wide range of arts experiences and culturally contextual specific humanistic forms so sustained and systematic learning in the skills can be represented as a way of thinking and presentation of each of the humanistic quality (Bamford, 2006). SHAPE initiative could also stimulate students' critical awareness and sensitiveness, the role of a teacher is to ensure students' humanistic abilities have been aligned with curricular goals (Lindström, 2012). UNESCO's initiative echoes this integration that arts education has to teach the arts and humanities or bring related subjects into curricula through the catering development of humanities nurturing (UNESCO, 2006, pp. 1-2).

1 Seven key focuses included humanistic qualities, entrepreneurial spirit, values of education, e-Learning, generic skills and their integrative use, and promotion of national and global understanding and language across the curriculum.

Table 1 The revised KLAs with STEAM education and SHAPE initiative

Level	Key Learning Area							
	Chinese Language Education	English Language Education	Mathematics Education	Science Education	Technology Education	Personal, Social and Humanities Education	Arts Education	Physical Education
P1 – 6 [1]	✧ Chinese Language ✧ Putonghua	✧ English Language	✧ Mathematics	✧ General Studies [2]			✧ Music ✧ Visual Arts	✧ Physical Education
S1 – 3	✧ Chinese Language ✧ Putonghua	✧ English Language	✧ Mathematics	✧ Science	✧ Technology Education Key Learning Area Curriculum [3]	✧ Chinese History [4] ✧ Citizenship, Economics and Society [5] ✧ Geography ✧ History ✧ Religious Education	✧ Music ✧ Visual Arts	✧ Physical Education
S4 – 6 [6]	✧ Chinese Language ✧ Chinese Literature	✧ English Language ✧ Literature in English	✧ Mathematics	✧ Biology ✧ Chemistry ✧ Physics	✧ Business, Accounting and Financial Studies ✧ Design and Applied Technology ✧ Health Management and Social Care ✧ Information and Communication Technology ✧ Technology and Living	✧ Chinese History ✧ Economics ✧ Ethics and Religious Studies ✧ Geography ✧ History ✧ Tourism and Hospitality Studies	✧ Music ✧ Visual Arts	✧ Physical Education (General PE) ✧ Physical Education (PE Elective)
	✧ Citizenship and Social Development/STEAM/SHAPE							

Additionally, in terms of the fundamental nature of Hong Kong's education context, the possibility of implementing an interdisciplinary arts curriculum is doubtful because usually, school administrators and teachers will be resistant, causing one of the challenges in designing more integrated arts curricula. Traditionally, teachers' perception of curriculum integration means a loss of professional status. Thus teachers' professional identity rooted as a specific subject teacher in their subject would come across as a challenge for the adoption from a subject knowledge-based approach to a whole-person curriculum approach and directly cause conflicts with the profession's status quo (Cheung-Yung, 2006 & 2010). Yet, Hong Kong teachers have not gained many experiences in conceptualizing cross-discipline teaching and learning. The lack of exposure to integrated learning and conventional training on a single subject may undermine the possibility and effectiveness of grasping the concepts of interdisciplinary pedagogical teaching and learning, particularly in STEAM education (Chen & Lo, 2014). It is hoped that the integration between arts education and humanities education can allow students to gain insights into the richness of society, experience cultural diversity, and care for the reality of human beings through purposeful engagement with art, empowerment through inquiry, and aesthetic meaning-making in LWL and OLE activities. It can be seen as the transition from STEM education to STEAM education in Hong Kong (Lam, 2020).

4.4.2 Embedding design education and design thinking into STEAM education

According to design education history in Hong Kong, design-related subjects are often associated with design, craft, and technical content and are named "technical subjects" (Siu, 2008). Design education was provided to learn manual work for the industry, in parallel with the industrial development to produce craft work in solving a real-life problem (Siu, 2011). Nowadays, design education is provided in Visual Arts (VA) subject and Design & Technology (D&T) subject in primary and junior secondary level, while Design & Applied Technology (DAT) subject is provided in the senior secondary level. However, it should be noted that D&T focuses more on technology elements, and the subject's contents tend to emphasize solving problems through technology instead of design concept (Wong & Siu, 2018). Although DAT aims "to provide students with fundamental knowledge and skills in technology and design and to cultivate them the attributes of innovation and entrepreneurship necessary to face the rapid social, economic and technological changes in a knowledge-based economy," the values and attitudes to be developed in both subjects are less related to design (Curriculum Development Council & the Hong Kong Examinations and Assessment Authority, 2007, p. 3). Meanwhile, the newest update on VA subject in primary and junior secondary levels remained in 2003 (Curriculum Development Council & the Hong Kong Examinations and Assessment Authority, 2003), showing that the development of design education is lagging STEAM education and the disarticulation between design education and STEAM education advocacy recently (EDB, 2022).

Under such circumstance, it is necessary to embed design education to make future connections between STEAM and real life. The supplement of the design education to transit STEM to STEAM is important because practices such as engaging in critique, modeling, evaluation, and argumentation have usually been underemphasized in the context of STEM education in Hong Kong. It should be asserted that the arts are about discovering and creating ingenious ways of problem-solving, integrating principles, or presenting information. Picturing an architect might require engineering, math, technology, science, and arts to create stunning buildings and structures (Makaklı, 2019). The arts and engineering can apply different techniques, strategies, and tools in the STEAM paradigm. The inclusion of the arts in teaching STEM may become an extra exposure for students to explore the world in different ways, especially when they are encouraged to adopt an open mind and find new ways to solve problems through experimentation and exploration from interdisciplinary mode of teaching and learning. Interdisciplinary integration is hence essential because it provides a rich ground for the development of creativity to let students synthesize knowledge and skills from different disciplines to create unique solutions (Li, 2024). By applying to STEM disciplines, design thinking can also be fostered because it is a cognitive process of design work and a thinking skill to create new artifacts or ideas or solve real problems (Cross, 2011). The interdisciplinary nature of design and creative problem-based approach enables better facilitation of STEAM for students and teachers because it engages the analytical and intuitive both jointly in artistic and scientific ways (Henriksen, Mehta & Mehta, 2019). When students combine their STEAM knowledge with real-world experience, integrating relevant disciplines can be more apparent when designing new products and nurturing aesthetic literacy (Culén & Gasparini, 2019). Eventually, realizing design thinking in STEAM education can help students succeed in the interconnected and digital world that hopes to enhance their problem-solving skills (Razzouk & Shute, 2012).

5. Concluding Remarks

Some debates emerged amongst STEM enthusiasts worldwide who believed that studying "Arts" would remove the emphasis on what they were trying to achieve with STEM. However, STEAM supporters explain that STEAM education explores the same subjects but incorporates creative and design thinking into the STEM teachings (Costantino, 2018). Traditionally, the arts and sciences were viewed as two very different fields of study, but STEAM education marries the two fields together to create a multidisciplinary approach to technology development, robotics, industrial design, engineering, and more (Gogus, 2015). Besides, STEAM and SHAPE initiatives can be inter-complemented, given that one discipline may be more in the lead than the other to ensure synergies. STEAM, in this sense, is about more than converging the fine arts and design thinking into STEM fields because arts are supposed to tie with expressiveness, evoke emotion, generate empathic understanding, and stimulate the imagination. It disrupts habits of mind, creates open-mindedness, and elicits emotional awareness (Eisner, 2008). Arts also enable us to discover our humanity to sit well with education for sustainability, meaning that humanities are woven into STEAM just like everything else (Yakman, 2008). As a result, STEM and SHAPE initiative can embrace greater in our existing knowledge and create new knowledge (Oliver, 2022). Provided that arts are instrumental for economic benefits rather than life-enriching qualities in Hong Kong (Whitbread & Leung, 2019), this paper concluded that arts education should be embedded with the SHAPE initiative and PSHE KLA to facilitate humanities education development. The extension of humanities education to PSHE KLA and other KLAs may provide a more extensive ground to promote and implement local STEAM education effectively because the student can achieve personal meaning-making and real-world connections. They can also construct their learning to become more resilient, goal-directed, critical, and creative thinkers echoing design thinking (Cooper, 2017).

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香港 STEAM 教育到 SHAPE 倡議：從藝術教育轉型至人文教育

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摘要

STEM 過渡至 STEAM(科學、技術、工程、藝術和數學)運動在過去十年中已經成為趨勢，因為它有助實現教育範疇中的可持續發展目標，以滿足廿一世紀的經濟需求。若單靠 STEM 作為基礎，我們的教育會忽略幫助未來世代在急速發展步伐下所必須習得的重要知識和技能部份，以回應未來發展的需要。因此，STEAM 提倡之目的是應用 STEM 好處並與藝術結合。香港於 2015 年首次提出 STEM 教育，並於最近更新的課程指引中改名為 STEAM 教育，但並沒有明確指出藝術與 STEM 的融合應如何實踐。故此，本文目的是探討香港 STEAM 教育可以如何透過現有的藝術教育框架進行系統性發展。然而，香港 STEAM 教育亦應該更努力透過 SHAPE（益及於人民與經濟的社會科學和人文藝術）倡議進一步轉向人文教育導向，以扭轉長期對藝術教育不太受重視的情況。

關鍵詞

STEAM 教育、香港、SHAPE(益及於人民與經濟的社會科學和人文藝術）倡議、藝術教育、人文教育

主流與輕中度學生的三項共通能力提升效果研究：高福耀紀念學校的實踐探索

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摘要

本文通過香港耀能協會三所肢體傷殘學校早年共同研發的共通能力「能力圖表」，再發展成「能力系統」，就高福耀紀念學校的學生作出全面剖析。研究團隊與學校同工勾劃出針對該年學校發展計劃而要檢視的其中三項能力 (溝通與協作能力、運用資訊科技能力、批判／明辨性思考能力) 作出評估研究。研究分兩個階段進行，第一階段為前測，於學期中進行 (3 月中旬)，第二階段為後測，於學期終進行 (8 月中旬)。研究團隊於「能力系統」中抽取相關的題目，利用谷歌問卷，要求任教不同程度班別的科任教師填寫。不同程度班別的問題數目略有出入，問卷題目共 12 至 16 題。研究團隊利用兩個階段的數據作出前後對比，從而計算出三種能力於每位同學、每班、以致全校整體的表現。就學生層面，班別層面之間的兩組數據變化，研究團隊進一步利用 SPSS 系統「成對樣本 T 檢驗」，計算出是否存在顯著的差異，以及相關的信度。研究團隊為回應三年學校發展計劃中的「共通能力」表現，綜合了全校 11 班的三項共通能力的結果，得出「溝通與協作能力」、「運用資訊科技能力」和「批判／明辨性思考能力」的表現均錄得提升，而升幅比較下，「溝通與協作能力」最為優秀。

關鍵詞

共通能力、溝通與協作能力、批判性思考能力、運用資訊科技能力

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引言

根據教育局 (2014, p.17)《基礎教育課程指引 - 各展所能、發揮所長》所述「共通能力」是「學習的基礎，能幫助學生學得更好。通過不同學習領域／科目的學與教，可以培養學生的共通能力」。香港耀能協會高福耀紀念學校 (下稱「高福耀紀念學校」) 向來重視學生學習與成長，而「共通能力」的培養更是該校三年學校發展計劃中的重點發展項目之一。鑑於「共通能力」是人學習能力的基本因素，是學童本身的能力表現，教師於每天的教學過程裡，不難觀察，但是卻不容易測量。這對「三年學校發展計劃」當中需要評核來說，可謂是一大難題。

是次研究團隊為該校校長及兩位資深教務主任，他們透過香港耀能協會協力製訂的能力表現項目，再從九種「共通能力」中，經研究團隊商討後配合學校發展計劃篩選出當中的三項 (溝通與協作能力、運用資訊科技能力、批判／明辨性思考能力) 作研究方向，製作一籃子的測驗項目，為全校不同智能程度的學生進行評估，研究出當中共通能力表現的成效。

文獻探究

學界推動「共通能力」已逾二十年，惟本地各大院校的相關論述研究卻相當匱乏。本地研究方面，有學者曾針對特定課外活動對學生共通能力的影響進行探討，例如 Chow, Chin, Mok, Edginton, Li, Wong & Tang (2009) 曾就青年營探險服務的活動，針對 112 名來自香港浸信會（沙田圍）呂明才小學的 8-12 歲兒童完成為期四天半的住宿營計劃，就協作、溝通、創造力和解難能力作出成對樣本 T 檢驗的研究，結果顯示學員在參與計劃後，其協作、溝通、創造力和解難能力都有顯著的提高。該項研究集中在一個特定的課外活動，與日校學生平日上課的發展能力完全不同。此外，也有學者就智障學生通過歷奇為本學習及虛擬實景學習兩種介入方式，研究體驗式學習對智能發展的六種共通能力的影響 (Sin & Wong, 2021, Dec 8)。海外研究方面，共通能力並不限於教育局提倡的九種能力，而涉及更廣泛的概念。有海外學者利用對學術人員的深入、半結構化訪談，研究了共通能力與不同學科之間的關係，並指出批判性思維、分析、解難和溝通能力在每個學科中都以完全不同的方式進行 (Jones, n.d.)。此外，也有學者統計了 340 份問卷，針對來自羅馬尼亞兩所知名大學的 500 多名管理及商業本科和研究生課程的學生，進行學習知識轉變為共通能力的研究，結果表明大多數本科課程的學生對學習持開放態度，共通能力有所提升 (Bratianu & Vatamanescu, 2017)。有關的研究並非在本地教育局「共通能力」的框架內進行，而且和本地教育有很大程度上的文化迥異。

研究問題及目的

主流與輕中度智能障礙學生在「溝通與協作能力」、「運用資訊科技能力」和「批判／明辨性思考能力」這三項共通能力上，經過教學介入後會否有顯著的提升？

本研究旨在透過量化評估，探討高福耀紀念學校的學生在接受日常的教學後，其共通能力（「溝通與協作能力」、「運用資訊科技能力」和「批判／明辨性思考能力」）的發展成效。

研究過程

能力系統的建立

根據教育局 (2014) 的定義，九種「共通能力」包括：協作能力、溝通能力、創造力、批判／明辨性思考能力、運用資訊科技能力、運算能力、解決問題能力、自我管理能力和研習能力。鑑於特殊學校的學生能力所限，局方推出的「共通能力」並未能完全適用於有特殊教育需要的學生。有見及此，2021 年，香港耀能協會三所肢體殘疾學校共同協作，重新審視九種「共通能力」的項目，並就主流、調適、輕度和中度課程的能力分別作出進一步的調適，結果形成了九種「共通能力」配以四種不同程度的能力圖表。換句話說，不同智能的學童都會有一套適切自身需要的共通能力指標。

為了使學童更能掌握自己的目標，協會於每一項的能力下，再就四個不同的學習階段，拆分成不同的能力目標，形成一幅 (9x4)36 項能力陣圖。而 36 項的不同能力目標下，會先按四個不同的學習階段，再細分為 3 至 7 個小目標，以及相關的能力顯證。九種共通能力、四個課程、四個不同的學習階段，總共有 (9x4x4)144 項能力。如果把 3 至 7 項的小目標和每項小目標下的數十項能力顯證都計算在內，則有上千項的細目，構成一套龐大的「能力系統」。

1. 溝通能力		
能運用適當的方式以表達個人的意願、需要、情感及意見，並能領會別人所表達的意思，做出回應或相應的行動；樂意與人交流，跟人溝通時保持專注和恰當的社交禮儀。		
階段	目標	表現例證
第一學習階段	1. 依循簡單及常用的口頭指示	1. 在日程/課堂中，能適當回應簡單及常用的口頭指示 (例如: 「唔好」、「洗手」、「坐低」)
	2. 建立回應的意識	2a. 能對自己的姓名有反應
		2b. 能回應與個人姓名有關的問題(例如:「邊個係XXX」)
		2c. 能回應與個人有關的「誰」問題 (例如: 「邊個玩呀？」)
	3. 增加詞彙 (形容詞、常見物件及身體部份)	3a. 能理解常用形容人物的形容詞 (例如: 「凍」、「乖」、「叻」)
		3b. 能理解常用形容物件的形容詞 (例如: 「大小」
		3c. 能在聆聽常見物件的名稱後，指出/尋找該物件
		3d. 能在聆聽身體部位的名稱後，指出自己/別人的身體部位
	4. 建立表達個人需要及意願的意識。	4a. 能以口語/非口語表達個人所需要之物品/食物/玩具/協助
		4b. 能以口語/非口語表達個人的簡單意願包括拒絕及接納
	5. 加強模仿意欲	5a. 能專注聆聽/觀察別人的說話/聲音/動作
		5b. 在口頭提示下，專注聆聽/觀察別人後，能模仿別人的說話/聲音/動作
	6. 建立圖片/相片的概念	6a. 能在協助下使用相片/圖片表示需要的物品
		6b. 能在協助下使用熟悉人物的相片表示求助
	7. 掌握基本的溝通禮貌	7a. 能運用合適的聲線/身體語言溝通
		7b. 能與溝通者保持適當的目光接觸
		7c. 在提示下能運用表示禮貌的詞語(例如: 早晨、唔該、拜拜)
第二學習階段	1. 依循常用的口頭指示	1a. 能在不同的環境中(例如: 外出活動、在大堂活動) 回應日常生活指示(例如: 「攞書包」「拉起衫袖」「坐好d」)
		1b. 能跟從兩個步驟提示(例如: 「擺完書包返埋位」)
	2. 增加詞彙(如常用的位置詞、疑問詞等)	2a. 能理解「什麼」、「做什麼」「誰」、「哪裡」及二選一的問題，並以口語/動作作出適當的回應
		2b. 能理解位置詞彙(例如: 「跌左喺櫈下面」、「掛係枱側邊」)，並作出適當的回應
	3. 加強表達個人需要及意願的技巧。	3a. 能以口語/非口語表達個人需要
		3b. 能以口語/非口語表達個人期望做的活動/去的地方/邀請的人物/選擇的物品種類(包括形狀、顏色、大小等)
	4. 提升辨認照片及圖片的能力	4a. 能在提示下辨認常見之物品相片/圖片(按學生能力而定)表示需要的物品
		4b. 能在提示下使用常去地方相片/圖片表示需要前往的地方(如學校各室或與家人常去的地方)
	5. 掌握溝通的禮貌	5a. 能主動運用表示禮貌的詞語(例如: 早晨、唔該、拜拜)
		5b. 能以身體語言表示禮貌的詞語 (例如: 微笑、握手)
	6. 加強與人溝通的意欲	6a. 能主動與班中熟悉的教職員溝通
		6b. 能在提示下，與班中同學及校內的教職員溝通

圖為中度智能第一學階的溝通能力的小目標及表現顯證。

研究團隊與學校同工就龐大的「能力系統」作出商議，勾劃出針對該年學校發展計劃而要檢視的其中三項能力(溝通能力、運用資訊科技能力、批判／明辨性思考能力)，作出評估研究。研究分兩個階段進行，第一階段為前測，於學期中進行(3 月中旬)，第二階段為後測，於學期終進行(8 月中旬)。研究團隊於「能力系統」中抽取相關的題目，利用谷歌問卷，要求不同程度班別的科任教師填寫。不同程度班別的問題數目略有出入，問卷題目共 12 至 16 題。高福耀紀念學校有別於傳統做法，以學階來分班，全校共 11 班，學生 67 人，包括小學和中學課程。普遍教師都會任教多於一班，並就不同班別的不同學生逐一回答問卷。

鑑於學階分班的模式，加上每班學生人數不多，研究團隊難以傳統的級別模式來做統計。基於這個因素下，研究團隊改以每位學生獨立單位計算作出研究。研究團隊利用兩個階段的數據作出前後對比，從而計算出三種能力於每位同學、每班、以致全校整體的表現。就學生層面，班別層面之間的兩組數據變化，研究團隊進一步利用 SPSS 系統「成對樣本 T 檢驗」，計算出是否存在顯著的差異，以及相關的信度。

研究結果

------ 學生層面

綜合任教教師就不同學生於不同共通能力題目的評分，最終作出了綜合計算。5 分為最高，代表最認同，1 分為最低，代表最不認同。以 C1 班為例，該班學生屬主流級別的第二學階，而共通能力就三大範疇

(溝通與協作能力、運用資訊科技能力、批判／明辨性思考能力)的問卷，各自有 5 題，一共有 15 題題目。該班的題目如下：

1. 能理解及回應不同類型的文章及話語
2. 能運用不同的表達方法，來介紹資料和表達意見，並解釋意念
3. 能按能力、目標和情境的要求，選用恰當的溝通方法
4. 樂意與不同人士溝通
5. 對於別人的意見，能採取開放及樂於回應的態度，欣賞及鼓勵他人
6. 能操作常用的資訊科技
7. 能用不同方法輸入英文和中文
8. 能在教師的協助下，用多媒體資源學習
9. 能在學習活動中，用資訊科技工具與人溝通及處理資訊
10. 能建立正確的使用資訊科技的態度
11. 能從資料中選取有用的部分，並加以分類和組織
12. 能識別和表達主要概念、問題或主要議題
13. 能理解簡單而直接的因果關係
14. 能分辨明顯的事實與意見
15. 能訂定問題、作出推測／估計和假設

以上 5 條題目來自「能力系統」中，關於主流班別第二學階的三大範疇下的小目標。前 5 題針對「溝通與協作能力」、接著 5 題針對「運用資訊科技能力」而最後 5 題則針對「批判／明辨性思考能力」而設。

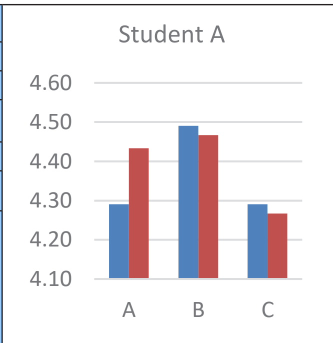
班中 5 位學生的前後測驗平均分數如下：

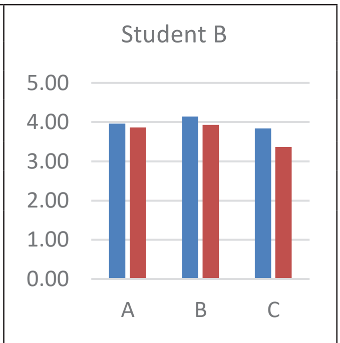
Class C1 (5 is highest, 1 is lowest)															
Student A	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15
202122 T1 avg	4.27	4.09	4.27	4.55	4.27	4.55	4.36	4.73	4.27	4.55	4.09	4.18	4.73	4.36	4.09
202122 T2 avg	4.33	4.17	4.33	4.83	4.50	4.50	4.33	4.67	4.50	4.33	4.17	4.17	4.50	4.33	4.17
Student B															
202122 T1 avg	3.7	3.8	4	4.1	4.2	4.2	3.9	4.3	4.2	4.1	3.6	3.9	4.2	4	3.5
202122 T2 avg	3.67	3.50	3.83	4.17	4.17	4.00	3.50	4.17	4.00	4.00	2.83	2.83	4.00	3.83	3.33
Student C															
202122 T1 avg	3.25	3.42	3.00	3.92	3.33	4.00	3.42	4.08	3.42	2.92	3.17	3.33	3.75	3.50	3.18
202122 T2 avg	3.50	3.50	4.00	3.83	3.67	4.00	3.80	4.17	4.00	3.67	3.00	3.33	3.83	3.67	3.33

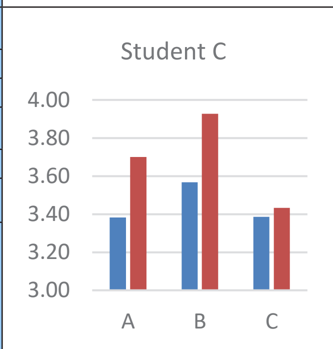
Student D															
202122 T1 avg	4.09	3.73	3.64	4.18	3.73	4.36	3.91	4.36	4.27	4.00	3.82	3.82	4.36	4.00	3.73
202122 T2 avg	4.33	4.00	3.83	4.50	3.83	4.33	4.00	4.33	4.00	4.17	4.00	4.17	4.00	4.00	4.00
Student E															
202122 T1 avg	4.20	3.90	4.10	3.60	3.50	4.20	4.10	4.50	4.30	3.60	4.00	4.10	4.50	4.30	3.70
202122 T2 avg	4.00	4.00	4.00	3.83	4.00	4.00	4.00	4.17	4.00	4.00	4.00	4.00	4.17	4.17	4.17

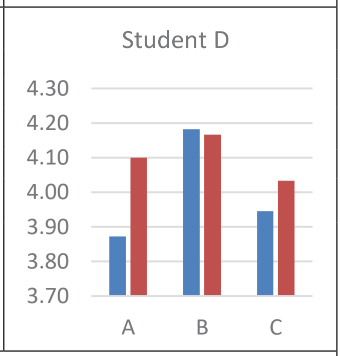
圖一中，1-5 題為「溝通與協作能力」相關的題目，6-10 題為「運用資訊科技能力」相關的題目，11-15 題為「批判／明辨性思考能力」相關的題目。綜合各題的分數，研究團隊得出三項共通能力的平均分數，從而製訂不同學生的相關能力表現。從下表可見，同學 A 於「溝通與協作能力」(A) 的表現為上學期 4.29，下學期 4.43，有明顯的上升。而同學 A 於「運用資訊科技能力」(B)、「批判／明辨性思考能力」(C)，分別由 4.49 下降到 4.47 及 4.29 下降到 4.27，有輕微退步的表現。科任教師填寫問卷是基於其專業的觀察，不受其他因素影響，而這是綜合任教該班的所有科任教師填寫出來的結果，具有一定的可信性。

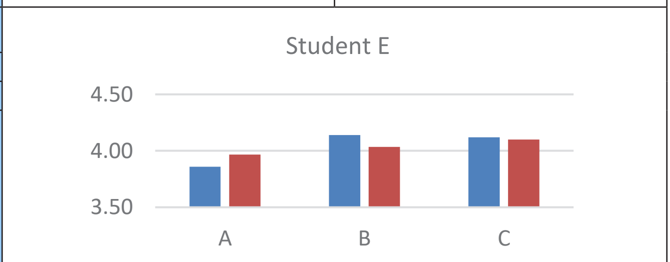
Student A	A	B	C
202122 T1 average	4.29	4.49	4.29
202122 T2 average	4.43	4.47	4.27
Student B			
202122 T1 average	3.96	4.14	3.84
202122 T2 average	3.87	3.93	3.37
Student C			
202122 T1 average	3.38	3.57	3.39
202122 T2 average	3.70	3.93	3.43
Student D			
202122 T1 average	3.87	4.18	3.95
202122 T2 average	4.10	4.17	4.03
Student E			
202122 T1 average	3.86	4.14	4.12
202122 T2 average	3.97	4.03	4.10











成對樣本 T 檢驗

撇除 3 位學生數據不完整，研究團隊把每位學生的前測與後測數據，輸入到 SPSS 分析系統，進行成對樣本 T 檢驗，對比出三種共通能力分別是否存在顯著的差異。

成對樣本統計資料

		平均數	N	標準偏差	標準錯誤平均值
對組 1	T2A	3.9214	64	.64350	.08044
	T1A	3.6937	64	.68411	.08551
對組 2	T2B	3.7331	64	.67707	.08463
	T1B	3.5683	64	.71879	.08985
對組 3	T2C	3.4240	64	.62425	.07803
	T1C	3.3770	64	.72410	.09051

成對樣本檢定

		程對差異數 標準錯誤平均 95% 差異數的信賴區間							
		平均數	標準偏差	值	下限	上限	T	df	顯著性（雙尾）
對組 1	T2A - T1A	.22764	.35256	.04407	.13957	.31570	5.165	63	.000
對組 2	T2B - T1B	.16483	.59472	.07434	.01627	.31339	2.217	63	.030
對組 3	T2C - T1C	.04695	.54690	.06836	-.08967	.18356	.687	63	.495

三項共通能力的結果顯示，只有「溝通與協作能力」和「運用資訊科技能力」的 *p* 值 (.000)、(.030) 皆少於 .05，達到研究的顯著性，而「批判／明辨性思考能力」(.0495) 則未有顯著性差異。

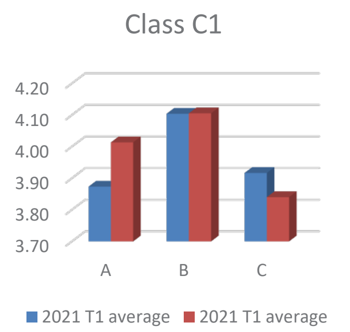
信度分析

研究團隊就前後兩個學期的數據，進行信度分析。上學期量表 alpha 系數為 .965，而下學期量表 alpha 系數 .941，皆表示存在高度的一致性。

------ 班級層面

研究團隊利用班中同學所得的數據，從班的層面計算出三項共通能力的指標，得到各班的整體表現。以 C1 及 G 班來說，該兩班的三項「共通能力」分別表現如下：

Class C1	A	B	C
2021 T1 average	3.87	4.10	3.92
2021 T2 average	4.01	4.11	3.84



Class G	A	B	C
2021 T1 average	3.51	3.45	3.40
2021 T2 average	3.87	3.65	3.60

C1 班為主流班別，而 G 班為輕度班別。從兩班的數據來看，主流班別的「批判／明辨性思考能力」有退步的情況 (由 3.92 跌至 3.84)，而其餘各項皆錄得不俗的升幅。

成對樣本 T 檢定

研究團隊就班級層面的前測與後測數據，輸入到 SPSS 分析系統，進行成對樣本 T 檢驗，對比出三種共通能力分別是否存在顯著的差異。

成對樣本統計資料

		平均數	N	標準偏差	標準錯誤平均值
對組 1	T2A	3.9429	12	.25614	.07394
	T1A	3.7107	12	.40442	.11675
對組 2	T2B	3.7132	12	.36743	.10607
	T1B	3.5674	12	.42118	.12158
對組 3	T2C	3.4112	12	.31736	.09161
	T1C	3.3923	12	.50637	.14618

成對樣本檢定

		程對差異數							
					95% 差異數的信賴區間				
		平均數	標準偏差	標準錯誤平均值	下限	上限	T	df	顯著性（雙尾）
對組 1	T2A - T1A	.23220	.21542	.06219	.09533	.36907	3.734	11	.003
對組 2	T2B - T1B	.14579	.50058	.14450	-.17226	.46384	1.009	11	.335
對組 3	T2C - T1C	.01882	.44925	.12969	-.26662	.30426	.145	11	.887

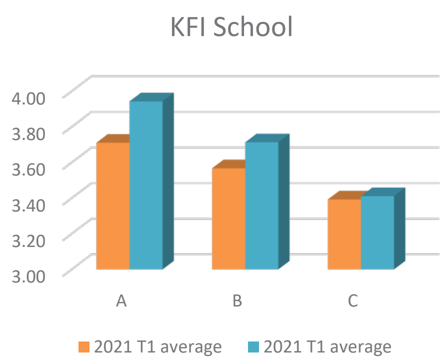
三項共通能力的結果顯示，只有「溝通與協作能力」*p* 值 (.003) 少於 .05，達到研究的顯著性，而「運用資訊科技能力」(.335) 和「批判／明辨性思考能力」(.887) 則未有顯著性差異。

信度分析

班級層面，研究團隊再就前後兩個學期的數據，進行信度分析。上學期量表 alpha 系數為 .949，而下學期量表 alpha 系數 .814，皆表示存在不俗的一致性。

------ 全校層面

KFI School	A	B	C
2021 T1 average	3.71	3.57	3.39
2021 T2 average	3.94	3.71	3.41



研究團隊為回應三年學校發展計劃中的「共通能力」表現，綜合了全校 11 班的三項共通能力的結果，得出「溝通與協作能力」(A) 的表現為上學期 3.71，下學期 3.94，「運用資訊科技能力」(B) 的表現為上學期 3.57，下學期 3.71，和「批判／明辨性思考能力」(C) 的表現為上學期 3.39，下學期 3.41。三項指標都錄得提升，而升幅比較下，「溝通與協作能力」最為優秀。

研究限制及建議

針對以上結果，研究團隊考量到有以下幾項因素：

第一，共通能力變化可能受到非教學因素影響，需謹慎解讀數據背後的成因。以同學 D 為例，在「溝通與協作能力」上的表現由上學期到下學期有明顯提升。若僅從數值來看，這似乎顯示教學介入具有成效。然而，深入探討其學習背景後發現，該同學在疫情期間接受居家學習，增加了與家人互動的機會，也可能因此提升了基本溝通技巧。此外，部分課堂轉向線上進行，亦促使學生更主動地透過視訊方式與教師或同儕互動。這提醒我們，單純依靠量化數據容易忽略現實情境對學生能力發展的潛在影響。教師在解讀評估結果時，必須結合學生的個人經歷、家庭支持程度以及教學安排等多方面因素，才能更準確地判斷真正的能力進步與其背後的原因。因此，學校鼓勵教師在個案會議中分享學生的學習歷程，協助彼此更全面地理解數據背後的真實情況。

第二，質性與量性的互補是深化共通能力評估的關鍵。本研究採用量性方法，透過前測與後測的數據比較，提供了一種客觀、可追蹤的評估框架，有助於教師了解整體學生在特定能力上的趨勢變化。然而，這種方法在樣本數較小的情況下，難以完全反映每位學生的獨特成長軌跡。因此，研究團隊認為，未來的研究應結合質性方法，例如教師訪談、學生學習日誌或個案觀察記錄，作為量化結果的補充。這種「質與量並重」的方式，不僅能幫助教師更深入了解學生在日常學習中的實際表現，也有助於學校發展更具針對性的教學策略。

第三，數據較少。高福耀紀念學校為一所以學階及智能分班的學校，每一班的人數不多，有的只有數人，有的約 10 人。加上整體學生人數不多，原始數據相對有限，有礙進行數據的分析。共通能力的分析全仗著香港耀能協會與校方的研究團隊共同協作，以自身的教學專業，研發共通能力分析圖表「能力系統」，再應用到自身的學校上，作為校本的發展檢視。學生人數所限，未能如主流學校般可以有龐大的數據收集。

第四，學生隨著學階的提升，會採用不同的學階的共通能力陣圖。當橫跨兩個學階的時候，如小三升小四，小六升中一、或中三升中四，當中比對的意義，便值得成疑。這個情況，研究團隊有責任讓同儕知悉。

本研究只集中在三種共通能力，但教育局對「共通能力」的分類有九種，仍有六種需要研究團隊再作進一步的分析。研究團隊正審視分階

段完成九種共通能力的研究。如果發展理想，有關發展或會整合在學生個人發展的系統內，成為學校學生每年必須檢視的能力發展項目之一。

綜合而言，本研究確實存在一些限制，特別是在樣本規模和學校背景的特殊性上。由於高福耀紀念學校是一所服務肢體傷殘學生的特殊學校，其學生人數有限，每班人數上限為 10 人。學校根據不同的學階與智能分班，導致整體數據量相對較少，難以進行大規模的統計分析或廣泛推論。然而，這也正是本研究的重要價值所在：在特定的教育環境中，探索共通能力的培養與評估方式，並發展出一套適合這所學生的能力系統。這種以校情為本的研究模式，雖然不具普遍代表性，但卻能為其他特殊學校提供可借鏡的框架與實踐路徑，進一步推動共通能力在特殊教育領域中的發展與應用。

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Improvement Effect of Three Generic Skills among Mainstream and Mild-Moderate Students: A Practice-Oriented Exploration at Ko Fook Iu Memorial School

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Abstract

This paper employs the generic skills "Competency Chart" developed in the early years by the SAHK for the schools serving students with physical disabilities, which was later developed into a "Competency System" to provide a comprehensive analysis of students of Ko Fook Iu Memorial School. The research team and school colleagues identified three generic skills to be studied in the school development plan (Communication and collaboration skills, Information technology skills, and Critical thinking skills) for assessment research. The research was undertaken in two stages. The first phase consisted of a pre-test administered during mid-March, followed by a post-test administered at the end of the school term (mid-August). The research team took relevant questions from the "Competency System" and utilized a google form questionnaire to have subject teachers from various levels of classes fill out the questionnaire. The amount of questions varies slightly between level groups, with the questionnaire containing 12 to 16 questions. The research team used the data from the two phases to make a before-and-after comparison, and thus calculated the performance of the three abilities for each student, each class, and even the entire school as a whole. Regarding the changes in the two sets of data at the student and class levels, the research team employed the SPSS system's

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"Paired Sample T-Test" to determine whether there are significant differences and the related reliability. In response to the "generic skills" performance in the three-year school development plan, the research team combined the results of the three generic skills of the schools 11 classes and discovered that the performances of "Communication and collaboration skills," "Information technology skills," and "Critical thinking skills" are all improved.

Keywords

Generic skills, Communication and collaboration skills, Critical thinking skills, Information technology skills

教育強國視野下的香港校長領導力培育機制與發展

Cultivating Principal Leadership in Hong Kong under the Vision of Building an Education Powerhouse

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油麻地天主教小學 Yaumati Catholic Primary School

摘要

本文探討香港在「教育強國」的願景下，校長領導培育的歷史發展、現行制度及其存在的挑戰。香港自 1981 年起逐步建立完善的校長培訓體系，包括擬任校長資格認證、新入職校長專業發展課程，以及在職校長的持續專業發展要求。這些措施有效提升了校長的專業能力和領導水平。然而，現有培訓仍缺乏宏觀的「教育強國」視野，課程內容偏重理論知識而缺乏實踐導向，培訓模式亦過於單一。未來可透過完善培訓內容，加強「教育強國」導向，並優化培訓模式，以進一步提升香港校長的領導素質，推動教育事業高質量發展，為建設教育強國作出貢獻。

關鍵詞

教育強國、校長領導力、領導力培養、專業發展

Keywords

Education Powerhouse, Principal Leadership, Leadership Cultivation, Professional Development

一、引言

2022 年 10 月，中國共產黨召開第二十次全國代表大會，提出到 2035 年要建成“教育強國”，強調教育在國家發展中的優先地位，並指出要為黨育人、為國育才，全面提高人才培養的品質（習近平，2022）。校長是推動優質教育的關鍵人物。隨著校本管理的實施，校長在資源分配、課程發展和員工培訓等方面擁有更大的自主權，這同時也帶來了更大的責任。當前的教育改革旨在改變學生的學習態度和習慣，引進新的學習模式和教學策略，而學校領導層的素質對於這些變革至關重要。持續的專業發展是提升校長領導才能和專業水平的關鍵（教育署，2002）。

在推行“教育強國”的過程中，中國內地在校長領導培育方面採取了一些值得香港參考的做法。例如，教育部《關於進一步加強中小學校長培訓工作的意見》文件中強調校長的專業發展和培訓，開展多樣的領導力培訓項目，以提升校長的管理能力和教育素養。在校長選拔制度上亦逐漸向專業化和系統化發展，確保選出的校長具備相應的專業背景和實踐經驗。

新加坡的教育強國實踐同樣值得關注。新加坡在校長培訓方面注重實踐與理論的結合，新加坡主要兩大校長培訓項目，即教育管理文憑 (DEA) 和教育領導者計劃（LEP）採用多元化的培訓模式，強調校長在教育改革中的引領作用 (李冠嫺，2007)。

二、香港校長的培訓歷史發展

自 1981 年《香港教育制度全面檢討》報告提出為校長開辦在職訓練課程以來，香港的校長培訓便逐步發展。這一建議為校長培訓奠定了基礎。隨著 1991 年《學校管理新措施》的推出，教育署委託大學舉辦小學校長培訓課程，讓校長學習校本管理和有效領導等知識，這是校長培訓的重要一步。

在 1984 年至 1997 年間，教育統籌委員會發表了七份報告，提出提高小學校長學歷的建議，以加強其行政和專業領導能力（劉煦元，2022）。這些報告彰顯了對校長專業化的重視，並促進了香港校長培訓的制度化發展。

2000 年，香港的教育改革提出九大重點，其中包括提升校長及教師的專業水平。2002 年，教育署發出《校長持續專業發展指引》，強調校長的專業發展與持續進修的重要性。隨著 2004/05 學年起，擬任校長

必須獲得資格認證，這標誌著香港校長培訓制度進入了更為嚴謹的階段。

三、香港校長培訓制度

根據教育局「校長持續專業發展的理念架構」，香港校長的培訓制度分為三個階段：

3.1 擬任校長階段

自 2004/05 學年起，擬任校長必須獲得校長資格認證並符合聘任條件，方可考慮聘任為公營或直接資助計劃學校的校長。具備最少五年教學經驗的擬任校長，需持有認可的師資培訓資歷，並參加為期兩年的校長資格認證程序。此程序包括專業發展需求分析、擬任校長課程及專業發展資料冊（教育局通告第 1/2024 號）。

3.2 新入職校長階段

自 2002/03 學年起，新入職校長在入職後的首兩年內必須修畢特定的專業發展課程，根據個人及學校的需要參加持續專業發展活動，並每年向法團校董會提交個人持續專業發展資料冊。

3.3 在職校長階段

在職校長每年需參加約 50 小時的持續專業發展活動。在三年內，應至少參加 150 小時的活動。在職校長必須參與三大模式的持續專業發展，包括系統學習、實踐學習及為教育界和社會服務，並在三年周期內設有時數限制，上限為 90 小時，下限為 30 小時。

四、校本經驗與專業發展網絡的影響

在回顧香港校長培訓的歷史和制度時，不能忽視校本經驗的傳承和專業發展網絡的影響。香港的校長培訓雖然在制度上逐漸完善，但在實踐中，校長的領導力培養仍然受到多種因素的影響。

4.1 校本經驗的傳承

校本經驗是校長領導力培育的重要組成部分。新入職校長往往需要在實際工作中學習如何應對各種挑戰，這些經驗的積累對於其專業發展至關重要。許多校長在任職過程中，通過與資深校長的交流、觀摩和學習，獲得了寶貴的實踐經驗，這是正規培訓課程所無法完全替代的。

4.2 專業團體的支持

專業團體對校長的支持也不可或缺。這些團體提供了專業交流平台，促進校長之間的交流與合作，幫助他們在新政策和教育理念下進行有效的實踐。例如，各學校議會、校長會和其他教育界專業組織提供的研討會和工作坊，能夠幫助校長獲取最新的教育資訊和領導技能。

總的來說，香港的校長培訓制度涵蓋了擬任校長、新入職校長及在職校長三個階段，並透過不同的認證及持續專業發展要求，確保校長的專業能力及領導水平。然而，對於校長領導力的培養，除了制度化的培訓外，校本經驗的傳承和專業發展網絡的支持也至關重要。

五、現況反思

香港的校長培訓制度逐步完善，旨在提高校長的專業素質和學校管理水平。然而，當前的培訓仍面臨一些挑戰，特別是在「教育強國」理念的實踐上。這一理念強調教育在國家發展中的核心地位，期望培養具創新能力和國際視野的人才。對校長而言，這不僅是提升專業素養的要求，也是推動學校發展的指導思想。香港校長的培訓在以下幾方面仍有提升空間：

5.1 缺乏宏觀視野：目前的培訓內容主要集中在學校管理和領導技能的培養，對於宏觀的教育政策和國家教育發展理念的理解不足，未能充分反映「教育強國」的目標。

5.2 理論與實踐脫節：部分培訓內容過於理論化，缺乏與學校實際管理和教學需求的結合，導致校長在實踐能力上提升有限。

5.3 互動性不足：現有培訓模式偏重知識的灌輸，互動性較低。課程多以講授式教學為主，缺乏案例分析和實踐環節，這不利於校長的決策能力和解決問題能力的培養。

總的來看，香港的校長培訓制度雖然已經有了一定的基礎，但仍需在宏觀視野、理論與實踐的結合以及互動性方面進行改善，以更好地支持校長的專業發展和學校的整體進步。

六、培訓方向的建議

為了更好地支持校長發揮學校的領導作用，香港的校長培訓需要在內容和模式上進行創新與完善。

6.1 加強「教育強國」導向

教育局應加強校長培訓的「教育強國」導向。在保留現有學校管理和教育領導內容的基礎上，進一步加強對國家教育發展、教育改革重點以及前線教育理念的培訓。這將使校長能夠在宏觀視野下謀劃學校發展，從而更好地對接國家教育的需求。

6.2 創新培訓模式

培訓課程應創新模式，以增強互動性和參與度。教育局可建立靈活多樣的持續專業發展機制，保留必修培訓的基礎上，賦予校長更大的自主選擇權，鼓勵他們積極參與討論和交流，從而培養獨立思考能力和決問題的能力。

6.3 理論與實踐結合

將理論與實踐相結合，以提高培訓的實效性。應充分吸納一線學校管理和教學的實際案例，組織校長進行問題檢視和模擬決策等實踐訓練，增強培訓的針對性和實用性。這些措施將幫助校長在日常管理中靈活應用所學知識，提升實踐能力。

七、教育局近年培訓上的創新

近年來，教育局在培訓上作出了不少改革，這些改革方向與上述建議相呼應，例如「領航教師及校長培訓計劃」及「STEAM 領導人員研習班暨交流團」，這兩個培訓項目都加入了教育強國的視野。

7.1 領航教師及校長培訓計劃

為了推動香港教育的持續發展，教育局計劃自 2024 年起啟動「領航教師及校長培訓計劃」。此計劃在國家教育部的支持下，以先導方式進行，為期三年，重點培訓具潛力的香港校長。該計劃結合華南師範大學的教師研修與交流指導，並與內地專家進行深入交流和跟崗學習。這不僅加強了兩地的合作與交流，也旨在培養符合教育強國理念的優秀校長隊伍，提升教育質量，推動香港教育的卓越發展。

7.2 STEAM 領導人員研習班暨交流團

自 2025 年起，教育局將舉辦「STEAM 領導人員研習班暨交流團」。這為期五天的研習班將在上海聯合國教育科學文化組織教師教育中心舉行。課程包括國家級專家的講座和高科技產業的參觀，深入解釋國家 STEAM 發展的最新政策方向及技術應用。在此期間，校長們將有機會與當地教師進行觀課和交流，分享教學經驗和心得。這不僅增強了他們

對香港 STEAM 教育未來發展的認識，還能配合科教興國的理念，期望為學生提供更豐富和創新的學習經驗，以培養具備未來競爭力的人才。

總結

總的來說，建設教育強國需要高素質的學校領導團隊作為支撐。香港雖已建立較為完善的校長培訓制度，但仍需進一步提升，以更好地培養在「教育強國」視野下的卓越校長。透過優化培訓內容和創新培訓模式，並結合近期的培訓創新項目，不斷提升校長的專業能力和領導水平，為實現教育強國的目標貢獻力量。

未來，校長培訓應著重於提升宏觀視野，加強對國家教育政策的理解，並結合實踐經驗，從而有效應對不斷變化的教育環境。同時，增強互動性和實踐導向的培訓模式將有助於校長在實際工作中更靈活地應用所學知識。這不僅關乎校長的個人成長，更關乎整個教育生態系統的持續發展，最終為香港的學生提供更高質量的教育。

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正向領導提升校園正向氛圍

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保良局田家炳兆康幼稚園

摘要

隨着社會環境的急遽變遷，領導者的挑戰日趨沉重，而校長是學校的最高領導者，其領導風格將會影響校園氛圍、辦學績效，致使其建構之教育目標及學校文化也深深影響教師的教學及工作效能（謝傳崇，2011）。校園的氛圍，更是直接影響團隊工作滿意度的關鍵因素，因此正向領導被視為增強校園正向氛圍的最有效策略。本文將探討正向領導的理論及其在校園環境中的應用，強調在學校營造正向氣氛、建立正向關係、保持正向溝通的重要性。本文並提出實施正向領導的具體建議，供教育工作者參考，以建立更具支持性和包容性的正向校園環境。

關鍵詞

幼稚園、正向領導、積極心理學、變革型領導、正向教育

一、引言

幼稚園校長作為領導者，不僅需要關注學生的學習及發展需要，還應注重教師的專業成長和情感需求。研究顯示，領導者的行為和態度直接影響教師的士氣、工作滿意度及其對學生的影響（Leithwood & Jantzi, 2000）。因此，正向領導在幼稚園的應用具有重要的意義。隨着正向教育理念的發展，學校日益重視正向領導。根據 Seligman 的積極心理學理論，正向領導強調以積極的方式影響他人，發掘和利用個體的優勢，進而提升整體的工作氛圍與績效（Seligman, 2011）。

二、正向領導的理論

正向領導的概念主要由馬丁·塞利格曼（Martin E. P. Seligman）提出。他強調領導者應以積極的方式帶領團隊，提升成員的內在動機和滿意度，並培養正向情緒來提升個體和群體的幸福感（Seligman, 2011）。具體而言，領導者可聚焦強化員工的優點，建立積極的工作環境，並通過正向回饋，增強員工的自我效能感，例如領導者可以定期表揚員工的成就及貢獻，從而提升員工的自信心與工作投入度。當領導者注重員工的優點而非指正其不足時，能顯著提升員工的被認同感，從而促進組織的績效。

此外，變革型領導理論進一步補充了正向領導的實踐基礎，強調領導者通過魅力、激勵和共同願景來提升團隊凝聚力與創造力（Bass, 1985）。領導者可以透過會議，讓員工參與制定團隊目標，確保員工理解並認同組織的長期目標，從而激發員工的內在動力，增強凝聚力。同時，通過公開分享成功案例，強化團隊的共同價值觀。

(一) 積極心理學

積極心理學由馬丁 · 塞利格曼（Martin E. P. Seligman）創立，根據 Seligman（2002）的理論，情緒狀態對個體的表現有重要影響。當教師感到被重視和支持時，他們更容易展現創造力和工作熱情。這種正向情緒不僅提升教師的教學質量，還能感染學生，從而營造積極的學習氛圍。學校領導者可實施「正向回饋計畫」，定期於會議公開表揚教師的創新教學案例，例如欣賞教師創新設計的互動式科學實驗活動。這種肯定讓教師感到被重視，激發他們進一步嘗試創新的教學方法，如加入遊戲化元素來提升學生參與度。教師的教學熱情越提高，學生在課堂上會表現出更高的興趣與主動性，學習氛圍更加積極。

(二) 變革型領導

Bass 將變革型領導定義為一種通過激勵、啟發和個人化關懷來提升

追隨者動機和績效的領導方式（Bass, 1985）。在學校情境中，領導者可以通過清晰的願景和目標，引導教師共同合作，提升整體的教育質素。校長應以身作則，展現對教育改革的承諾。例如，校長可親自參與教師培訓工作坊，展示終身學習的態度，激勵教師仿效；也可制定一個明確的願景，例如「打造以學生為中心、注重創新的學習環境」。在教師會議上，校長分享這一願景，並鼓勵教師提出創新的教學方法，共同實現目標；更可鼓勵教師嘗試新的教學策略，並提供資源支持教師進行課程設計，激發教師的創造力；校長宜定期與教師進行一對一會談，了解他們在教學中的挑戰，並提供針對性的專業發展機會。例如，為一位對戲劇教學感興趣的教師安排參加相關的培訓。

三、正向領導在校園中的應用

正向領導結合積極心理學與變革型領導，能有效促進幼稚園的正向文化與教育質素。根據上述理論基礎，校園領導者可以參照以下應用實例，以變革型及正向領導的策略，提升學校的正向氛圍。

(一) 結合變革型領導的激勵性動機，建立正向願景與文化

校長應制定以幼兒幸福與全人發展為核心的願景，例如「打造一個充滿快樂、探索與關愛的學習園地」。通過定期分享願景，校長激勵教師和家長共同參與，營造正向校園文化。校長在教師會議中分享幼兒的正向成長故事，並鼓勵教師設計以遊戲為基礎的學習活動，增強幼兒的學習興趣。

(二) 結合積極心理學的理論，發揮教師與幼兒的優點

正向領導鼓勵要發現每個人的亮點或長處。校長可通過觀察與對話，識別教師的教學優點與幼兒的個人特質，如好奇心、社交能力，並提供機會讓他們展現。校長可公開表揚他們的性格強項，讓教師分享自己的教學專長，並設計符合幼兒興趣的活動。例如，一位擅長講故事的教師帶領「故事劇場」，讓幼兒參與角色扮演，培養語言能力和自信心，以提升他們的自我效能感。

(三) 結合正向領導的正向關係與變革型領導的個人化關懷，促進正向關係

校長應建立教師、家長與幼兒之間的信任與合作關係，通過積極溝通與支持，增強互信及正向關係。例如可舉辦「家長與教師共學日」，安排老師及家長參與親子手工藝學習活動，並與家長進行溝通，了解幼兒的成長需要；校長也可定期與教師面談，提供個人化支持，以增強校園成員的幸福感與歸屬感。

(四) 結合變革型領導，鼓勵創新與成長

校長應鼓勵教師嘗試創新的教學方法，例如融入正向心理學的「感恩練習」或「正向回饋」活動，激發教師的創造力與幼兒的學習熱情；更可支持教師嘗試「正向日記」活動，讓幼兒每天記錄一件快樂的事，培養感恩與正向思維；通過正向鼓勵，從而提升幼兒與教師的內在動機。

(五) 結合正向領導，營造正向環境

校長通過環境設計與正向活動，創造一個充滿快樂與支持的校園。例如，設置色彩繽紛的學習角落、展示幼兒作品，或舉辦「正向遊戲日」活動，鼓勵分享正向經驗。校長更可在校園內設置「感恩牆」，讓幼兒、教師和家長貼上感謝便條，增強社群的正向互動。

四、正向領導應用實例

謝傳崇（2014）整理國內外正向領導的相關研究，歸納出校長正向領導的四個概念，包括：（一）正向思考表現穩定良好的情緒；（二）正向態度關懷團隊成員表現；（三）正向營造溫馨學校氛圍；（四）正向塑造卓越共同願景（謝傳崇，2014）。謝傳崇（2012）認為校長的教育理念、價值觀與領導風格是學校成功的關鍵，校長必須展現正向的執行力與影響力，以正向思考的方式處理校內外事務，並以身作則，用關懷態度和同理心看待及協助員工解決問題，使學校瀰漫正向氛圍，與學校成員共同建立正向願景，達成教育的積極目標。校長在學校應用正向的領導可以顯著提升教師的士氣、學生的學習動機，以及整體校園氛圍。

以下為筆者於幼稚園推動變革型及正向領導策略的實例：

(一) 激勵正向情緒，營造正向氣氛

正向領導是以積極、正面的方式激勵教職員，促進學校的正向文化。從行政政策層面，校長須制定管理層明確的正向領導政策，例如要真誠地聆聽員工的心聲，鼓勵教師互相關心與支持，公開表揚團隊或個人的成就、分享成功教學成果等，並將正向領導原則納入學校的願景。學校會定期舉辦教職員正向工作坊，培訓正向思維與情緒管理技巧；學校已建立表揚機制，校長會透過校內通訊平台、校務會議、畢業禮等場合，適時表揚教師的成就，感謝教師他們的辛勞與付出，這有助於將正向情緒融入學校文化，增強教職員的歸屬感與工作動力。另外，正向的人事管理能降低教職員的壓力，培養積極的工作心態，學校已

設立康樂組，會定期舉辦團建活動、提供心理健康支持，亦規定行政人員於非辦工時間及假期期間，避免於群組發佈工作訊息，以平衡同事的工作與生活；學校也採用正向評鑑方式，聚焦教職員的優點與成長，而非僅指出工作的不足。在資源分配層面方面，合理的分配資源，能支持正向氛圍的建立，如公平地資助同事參與正向或領導力培訓課程，也要妥善分配各小組預算，讓同事感受學校給予的支持，增強教職員的滿足感，促進正向情緒的傳播。

（二） 關懷員工，建立正向關係

學校為教師提供足夠的情緒、專業發展或資源上的支援，並尊重教師的專業，與他們建立良好的夥伴關係，要充分信任教師與賦權，藉此能建立教師的教學信心與能力。另外，員工之間建立友善的人際關係，非常重要，這能為教師帶來正向情緒及團隊精神，促進心理健康，提升教學效能。校長及管理層會定期與教職員進行一對一對話，了解其需求與挑戰，提供適切的支持。學校的各級級主任會與駐校社工肩負關懷同事的工作，有需要時會提供適切的支援；校長及管理層一直推行「開門政策」，鼓勵教職員隨時與領導層交流，增進信任；領導層也會以身作則，樹立榜樣，如常存感恩、關懷與同理心，並展現積極、包容的態度，例如公開感謝教職員的努力。學校已建立「正向夥伴制度」，讓資深教師與新進教師結對，分享經驗，建立關係，並適時提供支援；也定期舉辦家長參與活動，如親子遊戲日、家長面談會等，更設立電子溝通平台，讓教職員與家長建立信任與合作關係；學校會透過會議，鼓勵教職員採用正向教育法，如表揚學生的努力與進步，而非僅關注成績，且製作了正向貼紙、正向襟章及生日襟章，適時送予學生，強化他們正向行為；這些策略能讓教職員、家長及學生感受到被關懷與支持，從而更願意以正向態度與各方互動，建立和諧關係。

（三） 善用支持肯定，保持正向溝通

正向溝通是正向領導的核心，需透過肯定與支持來實現。校長會定期舉行全體教師會議，鼓勵每位教師分享想法和建議，讓他們自由討論教學中的挑戰和成功經驗，這不僅增強教師之間的信任，也促進教學策略的交流。要讓校園內充滿正向的溝通，校長向員工傳達指導的訊息時，必須聚焦在事件本身，而非針對人；也要善用支持性的語言，並因應員工的優點，肯定他們的貢獻，表達具體的回饋與欣賞；即使傳達負面訊息，亦要採用支持性及有效協助教師成長的表達方式，或提出可行建議，避免出現攻擊性及批判式的言詞。校長會因應活動性質，發送群組或個人感謝訊息，具體指出教職員的正面影響；也善用家

長電子群組，發送學校正面資訊，分享教學成果與正面故事，增進家長信任；也鼓勵教職員回饋學生時，使用正向語言，如以「你這次進步很多！」替代「你還需要努力」，並教導學生以正面方式表達對教師的感謝或建議。總括而言，透過正向溝通，教職員感受到被支持與肯定，從而更願意主動與各方建立積極的互動。

(四) 建立共同願景，賦予正向意義

學校與教職員建立共同願景能團結教職員，激發其對正向教育意義的認同，推動學校成為健康、正向的學習場所。校長在推動學校發展時，必須與員工建立共同願景，把握不同時機闡述及分享辦學理念。學校會舉辦「正向教育研討會」，分享如何透過教學實踐學校願景；也安排老師、職工、家長及學生出席正向教育及培訓，也將正向心理學原則融入課程設計，鼓勵教職員設計促進學生幸福感與成長的教學活動。同時，校長要帶領教師超越個人利益，示範利他行為，並讓教師清楚知道他們對學生的影響力，了解教育目的和初心，以助學校成員釐清教育的意義與價值。

(五) 中層領導是關鍵人物

中層領導是學校變革與正向領導的關鍵人物，透過培訓、賦權與支持，中層領導能成為正向與變革型領導的典範，帶動學校整體變革。於推動正向教育前，校長必須與他們建立共同願景，並為他們提供「中層領導正向領導培訓」，內容涵蓋變革型領導、正向心理學與團隊管理技巧；也要安排資深領導者指導中層領導，分享實務經驗；並設立「中層領導交流圈」，定期舉辦會議，讓中層領導分享經驗與挑戰。校長更要建立支持系統，鼓勵中層領導提出創新建議，並在試行後給予正向反饋；且給予中層領導決策空間，如允許其設計正向教育活動或變革計畫，從而更能推動正向領導。

五、實例分享

根據謝傳崇（2014）提出的校長正向領導四個概念，筆者有以下行動實例，推展正向領導提升校園正向氛圍：

(一) 正向思考表現穩定良好的情緒

校長以重作則，積極推行正向教育，帶領教職員共同定下願景，展現穩定的領導情緒和積極態度。校長遠赴澳洲 Geelong Grammar School 進行學習及交流，顯示對正向教育的熱忱與投

入，保持正向思考並激勵團隊。校長通過學習與交流，展現積極進取的態度，帶動學校整體正向氛圍的提升。

(二) 正向態度關懷團隊成員表現

學校成立康樂組，定期籌辦聯誼活動，為員工送上生日或其他喜慶的祝福，關顧及提升員工的幸福感。校長安排教師參與正向教育課程，提升專業能力，並設置舒適的教員休息室，關注教職員的身心福祉。這些舉措體現校長對教職員的關懷，通過具體行動支持團隊成員的幸福感和專業發展，促進正向的工作表現。

(三) 正向營造溫馨學校氛圍

學校重新裝修，借鑑澳洲學校的環境佈置，設置與正向教育有關的圖畫、心靈樽、正向金句及「感恩牆」，讓家長、教職員及兒童表達心聲。各課室以不同顏色布置，營造色彩鮮明的學習環境，增強愉悅氛圍。這些環境設計和設施創造了溫馨、正向的校園氛圍，讓所有持份者感受到被重視和尊重，營造正向的溫馨氛圍。

(四) 正向塑造卓越共同願景

校長自 2017 年起與教職員共同定下正向教育願景，讓家長、教職員、兒童通過「學習」、「活出」、「教學」及「滲透」等方面，將正向的種子播在他們心中，營造良好的正向校園氛圍。我們把正向理念融入學校課程及活動，舉辦教師及家長正向工作坊、增設「我是正向小寶寶」課程、製作親子心靈樽及正向遊戲日活動等，並通過與屬校和同業的交流分享，將正向價值觀延伸至家庭和社區。於持份者問卷中，有 4.38 平均值的教師認同正向教育的成效顯著，另外，有 4.47 平均值的家長認同學校能幫助其的子女養成良好品德，學校更協助辦學團體撰文分享成功經驗，顯見學校推展正向教育深得各持份者認同。校長通過制定共同願景並融入課程與活動，以全校參與模式共同實踐正向教育，塑造卓越的學校文化，並將影響力擴展至更廣的層面。

五、結論

學校領導對提升正向校園氛圍極具意義。校長的正向領導理念，賦予學校成員正向的教育意義。校長以身作則，建立積極的溝通環境，強調感恩與認同，促進合作，提供支持及鼓勵成長，從而塑造正向文化，最終能帶動學校提升整體效能。

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Positive Leadership Enhances the Atmosphere on Campus

CHEUNG Fung-mei

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Abstract

With the rapid changes in the social environment, the challenges faced by leaders are becoming increasingly complex. As the highest leader in a school, a principal's leadership style significantly influences the campus atmosphere and educational outcomes, which deeply affect the educational goals and school culture, as well as teachers' teaching and work efficiency (Xie Chuanchong, 2011). The campus atmosphere is a critical factor which directly impacts job satisfaction among the team members, makes positive leadership an effective strategy for enhancing a positive school environment. This article explores the theory of positive leadership and its application in the school context, emphasizing the importance of fostering a positive atmosphere, building positive relationships, and maintaining positive communication among different stakeholders. It also provides specific recommendations for educators to implement positive leadership and offer educators insights to create a more supportive and inclusive positive school environment.

Keywords

Kindergarten, Positive Leadership, Positive Psychology, Transformational Leadership, Positive Education

教育強國下的領導視野：從傳統體育到數字體育

Leadership Perspectives in Building an Education Powerhouse: From Traditional to Digital Physical Education

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摘要

「數字體育」是指透過科技手段（如 AI、物聯網、可穿戴設備及虛擬實境等）進行體育活動、訓練和評估的教育模式，旨在提升學生參與度與學習成效，並促進個別化學習。

在邁向教育強國的過程中，香港學校面臨著推廣體育的挑戰。過去的新冠疫情對學生的健康造成負面影響，防疫措施如停課和運動場所關閉，減少了學生參與體育活動的機會，加劇了青少年肥胖和體能下降等問題。一直以來，香港的教育以學術為主，體育為副；同時，傳統體育的推廣方式亦偏重技術，容易令學生感到挫敗。數字體育引入校園正能帶領學校走出以上困局。學校運用數字工具記錄體能數據，有助於制定適合的體育課程，促進學生的全面發展。南屯門官立中學已開始實施數字體育課程，利用虛擬現實和 AI 技術增強學生的運動能力。這種創新體育的方法能鼓勵學生自主學習，提升運動興趣和能力，為實現教育強國的目標奠定基礎。數字體育將在學校中扮演重要角色，校長的領導力在推動這一變革中至關重要。

關鍵詞

數字體育、數字教育、創新科技、智慧體育

Keywords

Digital Physical Education, Digital Education, Innovative Technology, Smart Physical Education

前言

政府推行的MVPA60政策，強調學生每日應最少進行60分鐘中等至劇烈體能活動，這與數字體育即時追蹤學生運動量的能力形成互補。透過裝置記錄與分析數據，學校能實時監察學生活動量是否達標，進而作出課程調整。

同時，PE SSPA政策令體育納入學業評估的一部分，提供契機將數據導向評核模式全面落實，強化數字平台在評估中的應用價值。

在邁向教育強國的過程中，香港的學校在推廣體育方面面臨著諸多挑戰。2019年新冠疫情對青少年健康造成了深遠的影響，除了因疫症爆發直接影響了學生的健康外，社區防疫措施如停課和關閉運動場所，亦減少了學生參與體育活動、比賽及訓練的機會，這進一步加劇了青少年肥胖和體能水平下降等問題，長遠而言也影響到學生的身心發展。根據衞生署「學生健康服務2023/24學年周年健康報告」的數據，在2021/22學年的疫情高峰期，全港中學生超重率攀升至22.1%，顯著高於2018/19年疫情前。進入2022/23及2023/24學年後，該比率回落至約20%，但仍比疫情前高出約0.1到0.6個百分點。這是一個令人擔憂的趨勢。世界衛生組織也指出，缺乏體能活動和不活躍的生活方式已成為全球公共衛生問題，直接影響青少年的體適能、認知能力及身心健康。因此，推廣體育的迫切性實在不容忽視，而一向已存在的體育教學似乎未能回應這方面的需要，在這樣的背景下，校長的領導力起了一個非常重要的作用。我們希望透過引入「數字體育」進入校園，以科技提升體育的成效，促進學生的全面發展，為實現教育強國的目標貢獻力量。

推動體育發展刻不容緩，惟近年考驗和挑戰重重

推動體育發展刻不容緩，但近年來面臨著諸多考驗和挑戰。在邁向教育強國的背景下，香港的教育傾向重文輕武，而傳統的體育推廣方式往往過於注重技術，對體能有較高要求。儘管學校努力讓學生接觸不同的體育項目以提升學習興趣，但現行的評核方式單一，未受過課堂以外的運動訓練的學生可能因表現不佳而感到挫敗，這直接降低了他們對運動的興趣。正如黃志德先生在其論文《從歷史看香港學校體育的發展》所指出：「以教師為中心、以技術學習為導向的教學方式，不僅偏頗了能力較強的少數學生，也壓制了學生的創造性，使能力較弱的學生感受到極大的挫敗感。對學生而言，體育的功能應該是多元化的，可以是快樂的玩耍，也可以是高深技術的掌握，還可以是知識與技術的同步進步。」因此，學校在設計課程時應考慮更多元評估與參與途徑，減少只著重技術與體能的限制。

若體育課程過分集中在技術與體能操練，會忽視學生對「運動樂趣」與「自我效能」的體驗。學校應透過設計具情境化與合作元素的活動，例如團隊比賽與遊戲式訓練，建立以學生成就感為本的「全人運動觀」。

雖然大多數學校採用具備清晰評核指標的體適能測試來評估學生的體能，但在實際的體育課堂中，教師往往難以清楚記錄每位學生的表現及學習進程，以滿足個別學生的需求。雖然體適能測試具清晰指標，但在大班教學情境中，教師難以即時為每位學生提供個別化回饋。若缺乏科技支援，評估往往流於形式。透過 AI 或感應裝置即時記錄學生表現與生成分析報告，教師可依據結果提供針對性指導，縮短回饋時差，提升教學效能。因此，校長的領導力在這裡尤為重要，他們需推動體育數字化，突破傳統體育的限制，進而促進學生的全面發展與主動學習，以應對當前的挑戰。

構建數字體育新格局，突破傳統體育瓶頸

健康校園，體育先行。教育局銳意加強運動訓練以提升學生的健康水平，使學生在實現身心健康和獲得良好校園適應能力的同時，能養成良好的生活方式。按照香港小童群益會於 2018 年的調查，如學童每星期進行中等至劇烈強度的活動的時間較長，其快樂程度會較高；而步行時間較多的學童亦較快樂，可見恆常運動對身心健康至關重要。疫情後社會復常，青少年也逐步重返運動場所，學生亦開始就不同的運動項目作常規操練，學界比賽也重新舉辦，學校必須抓緊機遇，突破傳統體育的瓶頸，以提升學生的體能表現及參與體育活動的興趣。

現時「數字體育」於體育界迅速發展，學校可利用現代科技和數字工具，把體育與科技融合，同時把體育鍛鍊、競技健身及互動娛樂互相結合，為學生提供更豐富、多元的學習體驗，藉此推動校園體育教育的創新和進步。以「智慧管理系統」為例，學生於立定跳遠、引體上升及短跑等運動的訓練成績與表現均可於電子屏幕上顯示，方便查看及紀錄成績。相較傳統的體育課堂，這方式有利準確地量化學生的體能表現，其所收集的數據能協助老師按學生的學習需要，制定適切的體育課程。目前，創新科技在精英運動上已廣泛應用 (林德佳與盧嘉琪，2019)，藉以理解特定運動員需要改進的範疇，相信廣泛推廣至普及體育也是指日可待。

正如中國教育家陶行知所說：「我們深信健康是生活的出發點，也就是教育的出發點。」以科技融入運動是近年的趨勢，隨着科技日益成熟，構建「數字體育」新格局能為學校的體育揭開新一頁。透過引入網上運動訓練、可攜式的運動裝置及虛擬訓練等，學校可進一步提升學生

對體育的興趣，讓他們按照自身的能力選擇不同強度及模式的體育訓練，再從數據了解自己的運動表現。科技更可指出學生的強項及弱項，包括分析手腳協調能力和平衡力，以及接球及跑步姿勢等，藉此幫助學生更好地理解和改進自己的運動技能，同時也提高了他們的學習動機和效能。

而在落實數字體育方面，教師培訓與資源分配亦是成功關鍵，學校需定期安排教師參與數字體育工作坊，並投放資源於器材與平台建設。而為配合新課程發展，學校可安排在校本專業發展日設立數字課程設計工作坊，讓體育與 IT 科組教師合作設計跨學科活動。同時，應用數字體育設施需配合學校的 IT 支援資源與教學行政配套，例如安排技術支援員協助處理設備維護與數據儲存，並建立數據管理守則，以確保師生能安心使用新系統。以上措施都需要學校行政管理人員協調和分配資源。在校長的領導下，這種數字體育的融合將有助於實現教育強國的願景。

數字體育革新校園教育，引領學生邁向時代尖端

南屯門官立中學重視體育科課程，致力通過多元化的體育活動促進學生的全人發展，激發他們的潛能。去年，我校引入「數字科技運動會」，設置各種互動遊戲和挑戰，以提升學生對運動的興趣。同時，我們開展了「AI 數字化互動智慧體育課程」，讓學生通過參與虛擬現實競賽，展示他們的運動技巧和競爭力。學生可與虛擬教練進行實時競技，增強訓練樂趣與投入感。課程中應用 iLO 智慧裝置，即時記錄學生心率、反應時間與動作完成度，透過系統分析報告指出學生在協調力與反應上的弱項，讓學生自行設定目標改善。本校更計劃建立 Smart Campus 系統，收集學生成長數據並進行分析。

本校亦另設閉環式數學化體育挑戰，如結合計步與幾何圖形探索的比賽，激發學生邏輯思維與團隊合作，並舉行室內數字化互動比賽 ，以避開模擬的天氣和地型限制，增加體育運動的趣味性。

去年，本人親自帶領 50 名師生遠赴重慶，舉辦「創新科技走進校園（重慶站）」活動，與姊妹學校重慶巴蜀常春藤學校合辦「數字科技」運動會，以促進兩地在體育科技發展方面的交流。此外，隨著本校健身室「南官健兒館」的落成，亦能鼓勵學生自主探索和體驗不同的運動技巧和策略，培養他們成為學習的主導者。校長的領導力在這一過程中扮演著關鍵角色，引導各科組充分利用數字科技，推動體育教育的創新，為學生的全面發展奠定堅實基礎，邁向教育強國的願景。

總結

「數字體育」是一個里程碑，它提供了一個互動和個性化的學習環境，讓學生能夠自主探索運動技能，對他們的全人發展起到了重要作用。在這個過程中，學校不僅可以幫助學生建立個人數據庫，讓他們與同儕進行良性競爭，還能透過強弱分析幫助學生找到適合的專長。另一方面，學生所積累的數據也有助於學校追蹤他們的成長和體能變化，從而制定促進學習的評估，優化教學策略，設計以學生為中心的體育課程。

我們能預視到，若更多學校採納數字體育模式，將有望建立全港性的大數據體育分析平台，協助政策制定，推進全民健康。數字體育的推行不僅帶來學與教層面的改革，也對學生的長遠發展與體育界帶來深遠影響。透過跨學科課程的開發，如體育結合統計、數學、甚至機器人程式設計，可培養學生綜合解難與科技應用能力。若能推動建立全港性學生體育數據平台，不但有助追蹤學生成長，更能支援教育局制定體育政策，發掘具潛質的運動員並提供針對性培訓。

在邁向教育強國的進程中，「數字體育」將在學校中扮演愈發重要的角色。學校應抓住這一機遇，把「數字體育」融入校本體育課程，這不僅能協助學生建立積極參與體育活動的習慣，還能推動中學體育的整體發展。在校長的領導下，這種融合將為學生的全面成長提供更多支持，為實現教育強國的目標奠定堅實基礎。

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「高瞻遠矚領群賢　宏揚中華正三觀」——談校長的視野與領導如何加強中華文化與價值觀教育

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摘要

優秀的校長是實現學校教育願景的關鍵。卓越的校長高瞻遠矚，價值觀正面，既能掌握時代脈搏，亦能配合學校特色，制定適宜的策略，帶領學校發展、進步，為《中國教育現代化2035》中強調的「以德為先」「全面發展」培育人才，為國家「人才強國戰略」作出貢獻。我校自創辦校長伊始已洞悉時代先機，令中華基督教會銘基書院成為香港陶藝教育的先驅，培養學生的創意和解難能力，學會堅毅和責任等品德。現任校長以學校的既有優勢，響應中華文化教育的大纛，賡續我國傳統優秀文化，深化我校學生的文化素養，加強其國民身份認同，成績斐然。由此可見校長的視野與領導是推動學校特色發展、培養學生品德和文化認同的根本。

關鍵詞

校長領導、陶藝教育、中華文化、價值觀教育

校長領導的核心價值與教育使命

校長作為學校的核心領導，對引領學校實現教育願景和使命，且堅守立德樹人、以學生為本的教育理念可謂重中之重。校長的領導是學校能否成功的決定因素，有效的領導有助於改善學校管理，促進成功的變革，提升學與教效能，進而增進學校的組織資本，提高整體效能（蔡宗河，2009； Amanchukwu, 2015；Dimmock, 2012；Riley, 2000）。領導風格結合了個人特質與性格，並透過特定行為展現個人的領導技巧。這並非一刀切的理論，而是一種需要視學校需求而選擇和調整的能力（Amanchukwu, 2015）。

在推動學校發展時，校長不僅需要豐富的教育理論知識，還要具備卓越的管理、課程領導和教學督導能力等專業素養，以優化管理模式，推動教師專業發展，激勵全校師生的活力，並營造促進協同創新的校園氛圍，令學校持續進步。因此，校長要具備遠見卓識，了解祖國和全球的發展現狀，配合校本特色與優勢，以制定與時俱進的策略，響應新時代教育的發展趨勢。

校本陶藝課程的發展脈絡與校長視野

一、回應時代需要

七零年代，香港輕工業發展逐漸蓬勃，學界亦開始推動實用藝術設計等相關課程。我校創校校長於一九七二年創辦陶藝科會考課程，成為全港第三所提供陶藝教育的中學。這項舉措展現了校長對時代發展的敏銳觸覺。自此除了開設公開試陶藝課程外，而歷任校長也認同陶藝課程的重要性，亦要求所有初中同學必修陶藝科，成為我校超過五十年的傳統。

一九九九年，香港藝術發展局開始重視文化產業發展。當時，我校每年約 15% 考生於陶藝會考科考獲 A 的優異成績。當時的校長了解陶藝作為我校獨特優勢，能回應社會日益強調的創意需求，因此即使在二零零零年的教育改革中，陶藝會考科宣佈將於二零零七年被取消並併入視覺藝術科，我校仍堅持開設校本陶藝課程，以確保所有學生仍有機會在初中階段接受相關科目。在高中階段，則透過陶泥作為媒介，提供立體藝術訓練，協助學生另闢蹊徑，備戰新高中視覺藝術科考試。因此，可見校長具有大局觀並在課程領導下配合校情。

二、校長領導與價值觀教育

除課程發展外，校長領導學校發展的另一關鍵在於合理調配資源以強化優勢項目。故此，歷任校長均不吝投放資源支持陶藝科發展。學校設有完善的陶藝室，並不斷升級硬件設備，如配備高於教育局標準的電

窯爐和拉坯機，以便創作大型的陶藝作品，並通過高溫燒製技術提升作品品質；更會聘請專業的陶藝室助理，專職負責處理教學以外的陶藝作品燒製工作。至今，社會仍廣泛重視創意思維，彰顯我校校長的洞察力以及對教育的承擔。

校長須因時制宜，緊隨國家的發展趨勢，配合校本特色以培養學生正確的價值觀。在香港近十多年的教育改革中，強調學校教育首要推動德育、公民教育與中華文化。我校素來重視價值觀教育，以「施比受更為有福」為校訓。我校歷任校長均認為推廣陶藝教育能讓學生建立正向的價值觀，正是配合政策的有效載體。香港前教育局局長吳克儉先生也公開支持推動陶藝教育，以陶冶學生性情（香港文匯報，2021），其主張與我校的教育理念不謀而合。

首先，陶藝有助培養堅毅的精神。與傳統的平面繪畫不同，陶藝是立體藝術，要求創作者具備三維空間的思維。這種藝術形式培養學生另一種思考方式，透過創作，學會無論是何種作品，都必須從多角度考慮，明白世間許多事物既多元而立體。這樣的訓練不僅讓他們在逆境中能夠以多元思維解決問題，培養出解難的能力，更重要的是不輕言放棄的堅毅精神。此外，陶藝亦是一種體驗學習的方式，體驗學習讓學生在認知的起點行為上配合了實體學習，令情意的起點行為興趣更濃、態度更積極、學習動機更強（付保芹，2009；李湘，2005）。通過動手製作：從一團濕陶土開始，經過搓泥、塑形、素燒、上釉等多個階段，歷時一星期至半個月不等。學生須謹慎處理每個步驟，等待陶土的變化、從無到有，培養耐性。再者，陶泥易於失手，亦易於重來。學生在塑造陶瓷作品時難免會遇到失誤，但正是這些挫折，讓他們學習堅持不懈，再三嘗試，讓學生培養沉着和毅力的品質。這樣的實踐體驗不僅豐富了學生的藝術感知，同時也培育了他們正確的價值觀。

其次，陶藝可以培養責任感。我校配置了攪泥機，要求所有學生在課後必須回收物資。學生在創作時亦需優先使用回收的陶土，從中體會到資源的珍貴，並貫徹循環再用的理念。這樣的做法不僅能在學生心中灌輸珍惜資源、保護地球環境的責任感，也在他們心中種下永續發展的種子。透過這種實踐，學生能從小開始學習如何透過具體行動支持環境保護，為香港、國家乃至世界的未來獻出一分力。

二零一七年，習近平總書記在黨十九大報告中提到：「文化興國運興，文化強民族強。」並多次強調推進文化自信自強。我校校長一向重視中華文化的傳承與推廣。自從香港教育局於二零二一年推出《價值觀教育課程架構》（試行版），闡明價值觀教育應以中華文化作為主幹，強調不同學科的學術元素應與中華文化有機結合。現任校長意識到這是

加強陶藝科與中華文化自然連繫的契機。在既有的技術下，加入中華文化元素，讓學生在製作中式陶藝的過程中，了解中國工藝美術歷史，感受中華文化的魅力，從而培養家國情懷，為文化身份認同奠定堅實基礎。

三、中華文化與陶藝課程的有機融合

我校現時的陶藝課程均系統地融入中華文化元素，初中例子如下：

中一級課程以手塑技法為核心，學習手捏成形、挖空、拼合及泥條盤築技巧等基礎技法，其中泥條盤築正是大汶口文化陶器的典型工藝，使學生在掌握技法的同時建立與古代文明的連結；而後探究兵馬俑雕塑技藝與先秦燒陶方法，從工藝演變角度理解中國陶瓷技術的發展脈絡；最後通過研習儺戲面具、三星堆青銅面具及京劇面譜，深入領會這些器物背後承載的民俗信仰與審美文化。

中二級課程聚焦陶藝釉藥的審美內涵，以唐三彩為核心探究對象展開系統學習：首先解析唐代鐵釉、銅釉與鈷釉的工藝原理，理解其色彩形成的技術邏輯與藝術表達；在此基礎上，透過駿馬、駱駝等典型器物的造型分析，體會盛唐時期開放包容的審美風尚；同時結合歷史背景探究其作為陪葬品的文化功能，認識其中蘊含的古代生死觀與社會等級觀念。

中三級課程緊扣中華茶與茶具文化，通過三重實踐深化學習：其一，指導學生設計中式茶碗，重點學習傳統鬥茶碗的製作工藝，在掌握傳統剔花裝飾技法的過程中，同時探究唐宋時期鬥茶文化的歷史淵源；其二，以十二生肖、中國神獸為創作靈感，完成中式茶壺的主題設計與製作，讓學生在器物創作中領會傳統符號承載的文化寓意。

高中階段則會在初中基礎上進一步拓展深度與廣度，聚焦不同風格的中式器皿製作技藝。通過系統化的理論學習與創作實踐，不僅能深入領略中國不同歷史時期的器物風貌，體察背後蘊含的時代文化特質，更能在親手塑造陶瓷器皿的過程中，體會中華文化的博大精深，深化對中華兒女身份的認同感。

校本陶藝課程在中華文化傳承與身份認同方面的成效，已在師生的實踐中具體呈現。此成效並非偶然，而是校長「以藝載道、分層浸潤」的教育理念通過課程設計與推行的必然結果。 從初中至高中的階梯式課程體系，讓學生在練習技法的過程中，逐步實現對文化的認知、理解與內化。

四、師生實踐反饋：從技藝到文化認同

不同學習階段的學生在課程中形成了層層遞進的文化體悟。中一學生製作陶塑面具時，透過探究安徽儺戲面具驅邪祈福的功能，結合祭祀、驅疫等古代面具文化的歷史語境，逐漸理解「**面具不僅是藝術品，更是古人對自然的敬畏與對生活的期盼**」。有學生分享其在親手創作動物面具時，「**從模仿紋飾到理解背後的『敬畏之心』，才真正明白中華文化蘊含的謙卑之道**」，這種認知已超越單純的技法學習。中二學生研習唐三彩時，從「**知道唐三彩是文物**」到「**理解它承載的盛唐氣象與生死觀**」，仿佛與千年前的工匠展開隔空對話，文化自尊也在技藝練習與歷史探究的交織中自然生長。

進入中高年級，學生的文化體驗持續深化。中三學生設計龍紋、玄武神獸茶具時，在研習與繪畫圖案時慢慢理解龍與玄武的吉祥寓意；非華語學生更在此過程中坦言：「**從對神獸符號感到陌生，到慢慢讀懂古人智慧，漸漸覺得自己對源遠流長的中華文化有了更深的理解。**」高中學生進行浮雕創作時，將寺廟、石窟的傳統技法與熊貓、祥雲等古今符號相融合，以此表達「**對古物的珍惜及對美好未來的期盼**」；而在陶杯上刻寫篆書的體驗，更讓學生體會到每一筆落刀都須全神貫注，這種細微處的把控恰是傳統書法與陶藝完美交融的體現。

任教老師從專業角度指出，校本陶藝課程能夠透過多元實踐與文化探究，讓學生深入體驗中華陶藝的文化底蘊與當代創新。在課程中，學生不僅學習陶泥特性與歷史淵源，更透過實際揉捏塑形、紋理創作等過程，培養藝術美感與創造力。課程巧妙融合傳統技藝與現代設計理念，引導學生在製作實用陶器的同時，思考傳統工藝的當代表達。特別是在面具製作單元，學生透過探究儺戲、京劇、粵劇等傳統戲曲中的面譜藝術，認識其作為非物質文化遺產的價值，並親手繪製面譜，深入理解戲曲道具的文化意涵。這種結合技藝傳承與中華文化理解的教學設計，不僅深化了學生的民族認同，更培養了跨越中華文化的藝術視野與創新思維。

結語：以陶育德，以文化人

陶藝不僅是一門技藝，更是一種文化傳承。「做人如做泥。」學生對陶泥的每一次揉捏和塑造，實質亦在逐步塑造個人價值觀、乃至中華民族身份認同的過程。這種文化的薰陶不僅是學術知識的傳承，更是民族情感的凝聚。每件作品都承載著匠人的智慧與堅持，而這正是中華傳統工藝中最珍貴的文化精髓。由此可見，校長的正確價值觀和帶領、支持校本陶藝的發展，讓傳統科目能在課程調適下，既培養學生藝術素養，更讓他們提升民族自尊感。

「百年大計，教育為本。」學校教育必須以為國家培育有擔當有能力的好青年為使命。而推動這一願景和使命的成功，有賴校長的真知灼見，對時代發展念茲在茲，善用校本優勢。同時，校長亦必須具備正確的價值觀，方能厚植愛國主義情懷，提升學生品德修養。最終為國家培育人才、造福人民，服務中華民族偉大復興。

【陶藝作品例子】

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Visionary Leadership to Inspire Excellence: Promoting Core Chinese Values and Perspectives——Discussing how the vision and leadership of school principals can strengthen education in Chinese culture and values

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Abstract

An outstanding principal plays a pivotal role in the realisation of the educational vision of a school. A visionary leader with upright values not only stays attuned to the pulse of the times but also formulates appropriate strategies that align with the unique characteristics of the school. In doing so, the principal guides the school towards continuous development and progress, contributing to the cultivation of well-rounded individuals in accordance with the objectives set out in China Education Modernisation 2035, particularly the emphasis on "moral development as a priority" and "comprehensive development". These efforts align with the national strategy of strengthening the country through talent development.

Since its establishment, CCC Ming Kei College has benefited from the foresight of the founding principal, who recognised emerging trends and positioned the school as a pioneer in ceramic arts education in Hong Kong. This initiative has nurtured students in developing creativity and problem-solving skills, while also fostering essential virtues such as perseverance and a sense of responsibility. Building upon this foundation, the current principal has drawn on the existing strengths of the school to promote education in Chinese culture. This ongoing commitment to preserving and enhancing traditional cultural heritage has deepened the cultural literacy of students and reinforced their national identity, achieving commendable outcomes.

The case clearly demonstrates that the vision and leadership of a principal serve as fundamental drivers in advancing school-based characteristics, nurturing the moral development of students, and fostering a strong sense of cultural identity.

Keywords

Principal leadership, ceramic arts education, Chinese culture, values education

提升新世代中層管理人員的領導力及執行力以邁向學習型組織

Enhancing Leadership and Execution Abilities in New Middle Management to Foster a Learning Organisation

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摘要

一所具效能的幼稚園，校長必須培育一群卓越的中層管理人員，培養團隊默契與建立共同目標，藉此提升整體的工作效能。近幾年，幼稚園教育界的流動性增加，不少幼稚園同時有原校新升任或他校轉職的中層人員，因而對中層領導力培育的需求持續上升。Y 世代人才逐漸成為中層管理人員，校長的領導模式亦需隨之轉變，改以學習型組織帶領學校繼續向前邁進。

關鍵詞

新世代中層管理人員、領導力、執行力、學習型組織

Keywords

New Middle Management, Enhancing Leadership, Execution Abilities, Learning Organisation

一、Y 世代的中層管理人員

新世代人才通常是指 Y 時代以後的年輕人，即為 1980-1990 年代出生的人，現在 Y 時代的年輕人已開始擔當中層管理人員了。我校近年團隊中的資深主任及級長調升至屬會其他幼稚園，加上移民潮的因素，校內的中流砥柱相繼離校，形成管理層斷層的情況。

本園立即重整架構，將團隊分為行政、課程及校務三隊，安排原校升任的行政主任、課程主任及輔導老師擔任管理的重任，並晉升三位教師為級長。「新」是我校近年的特色，不論中層人員或是級長也是新晉，而且大部分中層人員都是 Y 時代的年輕人。對本人而言，以往的領導模式在本學年好像失靈一樣，處處碰壁，但也提醒我需要跳出舊有的傳統領導模式，迎接另一番的挑戰和學習。

基於上述原因，本人開始閱讀有關新世代年輕人思維模式及工作態度的文章。現時社會對 Y 時代的年輕人，可能還抱有偏見，但不可諱言地，他們聰明，迅速掌握感興趣的範疇及接受新事物，尤其與科技有關的新事物。面對年輕中層人員的性格特質，校長及其他中層人員都要調整溝通及相處的模式。

二、新世代管理模式的轉變

原來，早在上個世紀 70 年代，學者 Paul Hersey 就提出領導者應該根據員工的成熟度，採用不同的領導風格。其研究發現，面臨千禧世代，領導的核心關鍵是如何針對性輔導員工成長，而不是「一紙命令」，也不是「事事過問」，因為千禧世代對「自我成功」和「被認同」的追求比較強烈。我以往多運用教練式領導，這模式通過識別中層人員的長處和短處，指導他們改進，同樣重要的是，教練需知道甚麼時候該退後一步，還予他們自主權。以往合作的中層人員認為學校的目標清晰，營造出動力十足的氛圍，且團隊成員各按其職，大家樂在其中。然而，教練式領導不適用於 Y 時代的中層人員。

隨着時代的推移，校長面對頗大的挑戰，需要改變領導模式，並學習如何善用、引導及管理新世代的中層人員。本人嘗試應用學習型組織的觀念及理論來培育校內中層人員。中層團隊是學校的主要命脈，各員要能共同學習、自我成長及建立學習分享文化，學校才能茁壯成長。

三、邁向學習型組織

學習型組織（Learning Organisation）將學習與產出結合在一起，不僅可以讓工作變得有趣、更可以讓工作效能事半功倍。在團隊中打造學

習型的組織，讓組織自然而主動地成長，而不是被動地等待教練來進行訓練。學習型組織的五個思考層次：

（一）建立共同願景 (Building Shared Vision)

校長與中層人員共同建立願景就是學校成員所共同持有的意義或景象，它會創造出成員一體的感覺。「建立共同願景」強調由下而上，必須由成員共同策劃，使成員的個人價值觀及其對於組織的關切與期望有表達的機會。透過彼此的互動與參與，凝聚共識，使願景既是組織的目標，也是每個成員的願望。大家發自內心為共同願景努力與奉獻。

（二）自我超越 (Personal Mastery)

建立中層人員自我超越，擴展個人的能力，成為學習型組織的精神基礎。自我超越的人，有積極的心態，要有追求突破、邁向卓越的想法，不以當前的成就或績效為滿足，能實現自己內心深處最想實現的願望。他們全心投入，不斷創造和超越，是一個真正的終身學習者。

（三）改善心智模式 (Improving Mental Models)

心智模式是深植於我們心靈的各種圖像、假設和故事，決定了我們對世界的看法，是一種根深蒂固的信念假設。改善心智模式需從發現個人的內在想法着手，隨時審視自己的思維，避免過度推論造成偏見；改變既定的思考模式，進行反思及探索，開放心胸，尊重參與，接納異議。

（四）團隊學習 (Team Learning)

團隊學習是指團體成員共同與相互的學習，透過深度匯談與討論，使全體成員進入學習狀態，一起思考交流，集合團體的智慧，進行整體搭配的行動，往組織目標邁進。

（五）系統思考 (System Thinking)

系統思考是指在面對複雜問題或事件時，應對問題或事件作整體考量，擺脫思考的隱蔽，摒除片段式思考，觀照整體，看到事件背後的結構、因素，及其間的互動關係，進而尋求一種平衡。系統思考是學習型組織的軸心，它可協助組織了解並因應外在渾沌的環境，將組織導向為一個有學習能力的組織。

Peter M. Senge 在《第五項修練》一書中提及，學習是人類的天性。在團隊中，一夥人以主動積極的心態一起工作，彼此信任、互補長短，共同為大目標全力以赴，會創造出超乎想像的成果（郭進隆譯，

1998），這就是學習組織的雛型。我校先組織一班志同道合的中層人員，建立共同願景及團隊學習文化，聆聽團隊各人想自我超越或突破的想法，建立一個學校「智囊團」。學校由以往的「教練校長」核心，轉化為「智囊團」核心帶領，團隊成員彼此信任及互補不足，成功推行計劃及引領學校渡過各種困難。

四、總結

本人學習在團隊中擔當觀察者及引導者的角色，舉辦一些自我認識的工作坊，如「白禮賓團隊角色理論」（Belbin Team Roles），讓團隊彼此認識各人的優點和缺點、共同成長及學習。學校重視建立穩定的團隊，以培養中層梯隊為目標，安排全體教師參與「高效能人的七個習慣」培訓課程，目的是建立共同協作平台，提升高效的互動、溝通和協調，達到同步達標的舉措。

其次，在「智囊團」策劃計劃或解決困難時，大家都需要耐心和時間，才能達到共識。故此，學校可舉辦一些有關培養解決問題能力及正向溝通的工作坊，如：六頂思索帽子或正向工作間（Positive Organisation）等工作坊，讓團隊建立共同的思維模式及溝通平台，彼此尊重，接納異議，營造 Y 世代中層人員期望的良好職場溝通氛圍，逐步建立高效能團隊。

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校本人工智能課程研究：提升學生的計算思維

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摘要

本研究旨在檢視校本小六人工智能課程能否學生提升計算思維及其技能水平，透過收集學生自評問卷、教師深度訪談及學生生成的人工智能作品來作出分析，計算思維能力將以五個關鍵因素(創造力、演算法思維、合作性、批判性思維及問題解決)的方式作出解釋，同時提出課程推行的關鍵因素包括規劃、教師、學校和外部環境，希望研究結果能協助不同學校的老師日後在設計和教授人工智能課程時需要特別留意的地方。

關鍵詞

人工智能課程、小學生的計算思維、校本課程設計、小學生的創作力、小學生的創造力

一、背景

在當今數字化時代，人工智能已成為各行各業的重要技術，教導小學生基本的 AI 知識和技能變得尤為重要。同時因應教育局於 2017 年 11 月出版的《計算思維—程式設計教育：小學課程補充（草稿）》所強調的提升學生運算思維的目標，本校不斷重塑我們的資訊科技課程。本校資訊科技科的其中一個發展焦點是利用人工智能作為工具來增強學生的計算思維技能。教育科技領域的教育工作者和專家強調了計算思維在 21 世紀的重要性 (Voogt, Fisser, Good, Mishra & Yadav, 2015)，同時，喚醒學生對人工智能應用及其影響的認識也是學生為技術變革做好準備的基礎 (Lin, Chai, Jong, Dai, Guo & Qin , 2021)。本校相信人工智能是學生在長大後應對複雜問題所需的基本技能，同時能激發學生的創造力，鼓勵他們思考創新解決方案，為面對快速變化的世界做好準備，並探索科技如何改善生活。

本校從 2021 年開始實施人工智能課程，旨在為學生提供基本的運算思維技能，並認識新興科技對人們未來生活的影響。我們的人工智能課程主要是根據 Barr and Stephenson (2011) 提出的架構以及《AI 中小學教學示範例：和 AI 做朋友》的教材設計，設想透過多樣化的學習體驗和實踐活動來讓學生學習及體驗人工智能。在 2023/24 年度，我們對人工智能課程作出了改變和調適，並希望透過混合研究法 (Mixed-methods research) 以量性和質性研究結果互相補充和解釋。專為 2023/24 學年設計的 12 節人工智能課程涵蓋三個主題：人工智能介紹、體驗人工智能和人工智能應用，課程教學重點可在附件一中找到。我們是次的研究題目是：小六校本人工智能課程能在多大程度上幫助學生提升計算思維及其技能水平？

二、研究設計與方法

為了研究上述問題，我們進行了學生定量的測試以及老師定性小組討論，收集的數據會結合學生作品一同作整體分析。因這人工智能教育課程為校內資訊科技科常規課程，所有小六學生（240 名學生）均參與是次研究，同時因參加研究的學生數量眾多，我們決定以問卷方式收集量化數據作分析，並參考外國已進行的一個研究作基礎來評估學生的計算思維及其技能水平 (Korkmaz, Cakir & Ozden, 2017) – 學者把計算思維拆解成五個關鍵因素（創造力、演算法思考、合作性、批判性思考和問題解決能力）合共二十九個項目。學生問卷以前測及後測方式進行，在施教有關課題前會完成前測，完成整個學習過程後則進行後測，兩者問題均為相同，而教師部份則在施教完成後進行。學生版及教師版的問題乃互相呼應，以達至比對學與教的效能。

為進一步了解教師在施教過程中的觀察，研究者會先分析學生版前後測及施教老師的問卷結果，然後向有關老師進行小組焦點討論，以收集質化結果作分析。本研究採用深度訪談法 (In-depth interview) 中「半結構式訪談」(Semi-Structured Interview) 進行，原因是在展開面談前，可利用相應的問卷結果引作為架構指引訪談進行，以確保面談內容貼近問卷問題的內容更具比較性，同時亦收集到一些意料之外的發現以供研究者參考 (林金定、嚴嘉楓、陳美花，2005)。

最後，在上述兩項研究過程完成後，將按問卷及訪談結果比對施教過程中學生的人工智能作品作分析，目的是驗證學生實際的學習顯證是否符合問卷及訪談結果，並從中找出一些新發現作為進一步分析。參與訪談的施教老師共有 4 位，下方列表為有關教師的背景資料：

教師代號	A	B	C	D
1. 任教資訊科技科年資	26 年	8 年	15 年	10 年
2. 任教與人工智能有關課題的年資	1 年	3 年	3 年	1 年
3. 任教與編程有關課題的年資	8 年	8 年	13 年	8 年

表一：受訪教師的背景資料

三、數據結果

學生問卷結果及人工智能作品評分表統計如下：

	TEST	平均數	標準偏差	標準錯誤平均值
創造力	PRETEST	22.8875	3.23306	.25560
	POSTTEST	23.4500	3.66489	.28974
演算法思維	PRETEST	12.6563	3.77853	.29872
	POSTTEST	12.6813	4.07380	.32206
合作性	PRETEST	12.6063	2.96117	.23410
	POSTTEST	12.4000	3.31985	.26246
批判性思維	PRETEST	11.0313	2.41437	.19087
	POSTTEST	11.2000	2.48467	.19643
問題解決	PRETEST	13.3125	2.71077	.21431
	POSTTEST	13.1500	3.29894	.26080

表二：按五個關鍵因素整理學生前測及後測數據的描述性數據

獨立樣本檢定

		Levene 的變異數相等測試		針對平均值是否相等的 t 測試						
		F	顯著性	T	df	顯著性（雙尾）	平均差異	標準誤差	95% 差異數的信賴區間 下限	95% 差異數的信賴區間 上限
創造力	採用相等變異數	1.254	.264	-1.456	318	.146	-.56250	.38636	-1.32265	.19765
	不採用相等變異數			-1.456	313.129	.146	-.56250	.38636	-1.32269	.19769
演算法思維	採用相等變異數	.725	.395	-.057	318	.955	-.02500	.43927	-.88924	.83924
	不採用相等變異數			-.057	316.217	.955	-.02500	.43927	-.88926	.83926
合作性	採用相等變異數	1.462	.227	.586	318	.558	.20625	.35169	-.48569	.89819
	不採用相等變異數			.586	313.932	.558	.20625	.35169	-.48572	.89822
批判性思維	採用相等變異數	.001	.969	-.616	318	.538	-.16875	.27389	-.70762	.37012
	不採用相等變異數			-.616	317.738	.538	-.16875	.27389	-.70762	.37012
問題解決	採用相等變異數	2.592	.108	.481	318	.631	.16250	.33756	-.50163	.82663
	不採用相等變異數			.481	306.479	.631	.16250	.33756	-.50172	.82672

表三：按學生前測及後測得出的獨立樣本檢定結果

學生人工智能作品評分		4 分	3 分	2 分	1 分
人工智能生成圖片	創造力	7.1%	64.5%	24.5%	3.9%
	批判性思維	47.1%	31.6%	11.0%	10.3%
人工智能生成文字（故事創作）	創造力	10.9%	52.7%	30.2%	6.2%
	批判性思維	32.6%	34.9%	28.7%	3.8%

表四：學生人工智能作品評分表統計

四、數據分析

根據表二及表三的學生自評問卷，創造力、演算法思維、合作性、批判性思維及問題解決能力上的評分並沒有顯著性差異 ($p > 0.05$)。由此可見，學生認為自己在學習學校人工智能課程後，自身的運算思維能力相若。然而，在綜合老師觀察和分析學生人工智能作品後，我們歸納出三個學生在課程前後顯而可見的改變。

學生解決問題能力及創造力

根據 Jonassen (2000) 和 Hmelo-Silver (2004) 的研究所指，有效的問題解決需要學生的主動參與和不斷的反思。在老師訪談中的 Q2 至 Q4 的訪問結果中反映這個觀點，無論是早期生成式人工智能軟件學習，抑或是較後期利用硬件配合編程的學習部份，這些學習軟件均能夠容許同學不斷反覆嘗試，教師亦表示不少受試學生在課堂上能夠主動修正自己的錯誤，顯示出解決問題的能力有所提升。另外，在 Q3 及 Q4 的訪問結果中顯示了不少學生下達的指令或生成的作品常常超出教師預期，亦展示了他們的創造力及複雜性亦有不斷提升 (表四)。訪談內容與學生作品表現一致，根據附件二，71.6% 的學生人工智能生成圖片作品及 63.6% 的學生人工智能生成文字的故事作品能在創造力的評分達到 3 分或以上（評分準則見附件二）。由此可見，大部分的學生所創作的人工智能圖片及人工智能故事能包含額外的元素，而這些元素除了與主題有所關聯，同時能豐富內容，例如一個製造出更突出意義的情景或令故事產生轉折。而在批判性思維的評分中，78.7% 的學生人工智能圖片作品及 67.5% 的學生人工智能故事作品能達到 3 分或以上。由此可見，大部分學生能按照題目要求，準確地輸入指令從而創作出合適的作品。

創造性思維在學習過程中是促進深度學習的重要因素，學生在人工智能生成的作品中嘗試結合不尋常的元素，展示了他們對技術的探索精神 (Runco, 2004; Sternberg, 2006; Robinson, 2011)。

而在 Q7 至 10 的訪問結果中發現，教師 B 認為配合學生同儕間分享及討論自己生成的作品內容，能夠促進學生主動作出進一步修正，使作品更具複雜性和原創性。雖然在課堂內大部份所使用的軟件及硬件均能個人使用，但如能配合合作學習的教學法，結果會是事半功倍，這如 Johnson & Johnson (1999) 所指吻合，小組討論被認為能促進更深層次的理解和結果，以提升學生的學習效能。

學生學習人工智能的信心

在校本課程早期的教授部份，都是先使用較為淺易的生成式人工智能軟件 (如 Poe)，然後才進入相關人工智能硬件應用及編程部份 (Husky

Lens)。在 Q1 的訪問結果中，受訪老師均認為這個學習編排提升學生學習人工智能的信心。另外，由於不少同學曾在課前使用過生成式人工智能軟件，這些生活經驗亦有助他們學習課堂內容。如 Bandura (1997) 所言，若同學能親自經歷成功的經驗，能夠有效提升自我效能，並且有助提升個人的動機、行為選擇和持續性。故此，以較淺易方式作為早期學習部份，能夠讓同學提供更加多成功經驗，以面對後來較陌生的人工智能硬件，從而產生較少抗拒心態學習，及增加其學習信心。而 Bandura (1997) 亦指出高自我效能感的學習者，往往可能設定較具挑戰的目標並努力達成，這與 Q1 中教師 C 所指「若課程能加入更複雜的軟件，可能會有助提升更多信心」符合。

學生運算思維能力

在 Q5 中教師 D 所言，由於所應用的學習人工智能的硬件大多數是以辨認物件為主，而相應的編程軟件中適用的相關編程碼較少，相對於以 Scratch 製作遊戲及 App Inventor 製作應用程式，後兩者所需要運用的指令往往會較多樣化。然而，筆者認為這並不可以因此斷言此校本課程不能提升運算思維能力。根據 Wing (2008) 定義：「運算思維」(Computational Thinking) 包括了其中兩個重要元素：「拆解」(Decomposition) 及「找出規律」(Pattern Recognition)。前者指把要完成的問題分為多個步驟去解決的思維，後者則為預計需要解決問題的規律後，尋找方法進行試誤思維。雖然在生成式人工智能軟件中，往往是使用關鍵詞 (Prompts) 而不是程式碼 (Code)，但事實上當學生利用關鍵詞來應用生成式軟件，往往都需要透過一系列的下達指令，並且因應結果再次修改，以提升作品的創造力與複雜性，這些都與 Wing (2008) 的想法有類似之處。由此可見，利用簡易入門的生成式人工智能軟件，能同時提升運算思維能力背後的理念。

限制

從 Q6 中教師 A 所言，是次採用的生成式人工智能軟件及 Huskylens 硬件較為符合 STEM 中的「T」及「E」元素，在整個學習過程中，較難看到促進「S」及「M」的元素，所以若把此課程視為提升完整的 STEM 跨學科學習整合能力，我們需要與不同學科合作。另外，在訪問 Q11-19 一些較難量度的學生情意改變問題，任教老師亦表示較難觀察而作出討論。畢竟這些方面往往受到個人主觀感受、環境因素和其他變數的影響，難以用量化方法精確地衡量 (Barrett, 2006 ; Gross, 1998)。

五、討論及分析影響課程成效的因素

i. 人工智能課程推行成效的關鍵因素

根據關之英 (2011)，影響推行校本課程成效的因素可分為四個：規畫因素、教師因素、學校因素和外界因素，而我們發現在推行校本人工智能課程時果真亦受著這四個因素影響：

課程教授的時間（規畫因素）

現時本校一個學年分為三個學段。在資訊科技的課程中，每一個學段會教授學生學習一個新的電腦程式或 STEAM 的工具。而人工智能課程被安排在小六第二學段教授，學生每週會上一節 30 分鐘人工智能課堂，並以十二個星期完成整個課程。教授的內容包括理解人工智能的定義、認識人工智能的運作方式、體驗人工智能應用程式（如：Siri、Poe 和 Artguru 等）及編程應用，當中有兩星期為模擬及正式的人工智能評估。由於人工智能課題對於學生來說是一個以往從未接觸的課題，而課程中所包含的內容十分豐富，十個星期的教學時間令教授過程變得非常緊湊。根據 Wedel (2021) 和老師訪談所得，額外的教學時間能令學生表現有所提升。相反，時間不足則可能導致學生未有足夠的時間吸收並消化所學習的知識，以致影響課程的成效。

教師與學生對人工智能應用的認識及觀感（教師因素和外界因素）

所有受訪老師任教人工智能課程的年資為一至三年，其中一半受訪教師是在 2023-2024 學年才第一次教授人工智能課程。由此可見，對於本校老師來說，人工智能教育仍可算是一個全新的課題及嘗試。根據 Newsome (1999)，教師對教學內容的瞭解程度和表達能力，是高效教學的關鍵因素之一。因此，老師在任教人工智能課題時，對教授學生人工智能課題的經驗較淺時，亦會影響教學的效能。此外，受訪老師在訪談中提出（Q11），現時人工智能應用在校內與其他科目的聯繫不大，學生就算已經學會了使用生成式人工智能工具，礙於小學生在家中使用電子工具的程度大多受家庭管教以及家長對人工智能認識程度所影響，當學生在生活處境遇上困難時，較難以利用人工智能為優先解決問題的工具，教師在這限制下較難就學生對人工智能運用和操作上作出評價（Q20），但相信未來人工智能的普及和普羅大眾對人工智能接受程度會整體逐漸提升，學生生活上對人工智能的經驗更豐富，屆時教授人工智能應會更為有效。

軟件及硬件的限制（學校因素和外界因素）

現時，本校教授人工智能課程所運用的主要是一些免費的人工智能應用程式（如：Poe 和 Artguru），這些程式的好處是讓學生和老師不

用付費便可以運用基本的人工智能功能，入門的門檻較低，但同時未能提供較新及較全面的人工智能功能（如：ChatGPT 4.0 等），這無疑會成為學生學習和教師教學的阻礙，如未能透過人工智能應用程式獲得準確及綜合的資訊。同時在硬件方面，本校運用 micro:bit 及 Huskylens 進行人工智能圖像辨識及物件辨識功能的編程教學。在老師的訪談當中，受訪老師提及 micro:bit 及 Huskylens 操作人工智能圖像辨識及物件辨識的能力仍有待改善，令學生運用這些硬件學習人工智能時會出現困難，例如：學生常常需要多次嘗試對同一物件進行採樣才能有較準確的辨識，但最後的結果不一定能合乎老師和學生的預期，雖然這些情況會影響學生的學習體驗，會亦能讓學生親身體驗科技的限制，不能盡信科技，反而要培養在善用科技時需懷有求證的精神，提升資訊素養。

人工智能在現今教學環境（特別在小學階段）的普及程度（外界因素）

人工智能現於香港教育的應用尚未普及。根據蔡若蓮（2023），現時教育局正研究於初中階段發展人工智能的課程，而在小學（高小）的階段則著重於編程和計算思維概念，透過學習編程以培養學生的計算思維。香港的教育環境把人工智能的學習主要集中在中學階段，大部份小學則暫時未有加入人工智能的體驗和應用，小學教師在專業培訓的配套尚未成熟，較難全面向學生教授人工智能相關知識和技能，以致學生未能充分理解人工智能在學習上和日常生活上的潛力與應用方式，較難把知識融入生活。

ii. 本校人工智能對於促進學生運算思考能力的優勢和限制

優勢（一）：增加學生對人工智能的認知及反思

本校的人工智能課程，除了會教授學生使用不同的生成式人工智能工具外，另一個的教學重點是教授學生認識人工智能的原理及定義，還會提供一些思想實驗的引導 (如：圖靈測試) 來促進學生思考「人工智能是甚麼？」及「人工智能與人類不同的地方」等涉及哲學性的問題，讓學生能夠思索人工智能的本質及其運用的方式可能衍生的倫理問題，藉此培養學生的批判性思維。同時，在教授學生使用生成式人工智能應用程式時，老師會提醒學生不要盲目相信人工智能所產生的內容，學生必須懂得查證和分辨人工智能所提供的資訊，才能真正成為自己的知識。

優勢（二）：提供更多平台予學生發揮創造力

在本校的人工智能課程中，學生學習透過不同的生成式人工智能創作不同的文字及圖像作品，這無疑能提供給學生更多的工具及更大的空間發揮他們創意。我們亦大膽嘗試以學生的創作成為評核的項目，既能

減少學生溫習資訊科技科的壓力，又能實戰人工智能所學，學生亦十分歡迎新穎的評估方法。此外，現時使用部分生成式人工智能入門門檻較低，操作的方式亦較容易，學生只需要輸入所希望產生作品的特點及相關的字詞，便可以產生不同的多媒體作品，令部分學生就算沒有進階的繪畫，寫作，作曲等技巧，亦能將自身的想法轉化為不同的多媒體作品，發揮創意。

研究限制（一）：個人學習活動為主

現時，本校的人工智能課程中，不少的學習活動是以個人形式進行，強調學生能完成個人的作品，因此提供較少機會讓學生之間有互動及合作的機會。雖然在教師訪談中，部分受訪教師曾觀察到在課程中，部分學生會向同學請教如何利用人工智能生成特定的作品，因而出現學生之間互動的情景，但這些互動亦只是促進學生完成個人作品的過程，未能在學生之間培養出共同合作完成同一目標的精神。

研究限制（二）：欠缺實際應用的層面

本次課題雖大膽以「未來城市」和「魔法圖書館」作為評估題目來創作人工智能圖片及文字故事，但在整個的教學過程中，教師較少教授學生將這些生成式人工智能運用在學習及日常生活當中，學生學習的指令例子有限，縱使學生能掌握生成式人工智能使用的技巧和方式，亦難以將其轉化為日常生活中能夠運用的實際技能，未來可多從學生生活設計和構思情境，例：送同齡朋友心思禮物的好介紹，主題寫作詞彙建議等。

六、結論和建議

本研究是按校情和社會實際需要來檢視新校本人工智能課程的設計，我們這團隊藉收集不同類型的數據（學生課堂前後所填寫自評問卷、老師半結構式的深度訪談及學生生成的人工智能作品［圖片及文字創作故事］）來加強研究的效度。雖然在學生自評問卷中未能得出明顯結果，但透過老師訪談和學生作品分析亦能歸納出學生解決問題能力、創造力、運算思維能力以及對學習人工智能的信心的提升。文中亦指出人工智能課程推行成效的關鍵因素包括規畫、教師因素、學校因素和外界因素，希望藉是次研究所得能協助不同學校的老師日後在設計和教授人工智能課程時需要特別留意的地方。

這次研究同時是本校老師建立專業學習社群和實踐設計循環的重要一步，特別是研究團隊和參與教授人工智能課程的老師們，我們經討論和修正後，將會修訂這人工智能課程的課時及加強跨學科合作。而是次

研究中學生嘗試了多種生成式人工智能軟件及對以應人工智能硬件結合編程進行學習，但老師們未能有效把人工智能的應用與學生的日常生活連繫，所以在往後的設計上會嘗試從其他學科中尋找實際例子來加強學生全面的認識，例如英文語音翻譯工具與英文發音，期望能加強學生對人工智能實用性的認同。

除此以外，這研究中的任教老師有互相觀摩課堂來交換教授人工智能的經驗，並花不少時間在備課會中討論人工智能的教學法和策略，十二週的課程不斷進行調適，過程除了能凝聚老師，也推動老師們更主動和積極的來參與討論，同時裝備老師們向其他老師分享的信心，有助教師持續的專業發展和培訓。

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附錄

附件一：小六人工智能課程 23/24 教學重點

Week	Theme	Key questions/ Content
PRE	-	Pre-test google form Q: What is AI? (Students' prior knowledge)
1	AI Introduction & Survey	Overview of the history and technology of AI Turing test Introduce Strong AI and Weak AI Q: What questions would you ask to differentiate human being and AI?
2		Observe and record the AI applications around you Students record observation and use of AI in daily lives (See/ Listen/ speak/ mechanical) E.g. Implement the detection of vehicles, bicycles, pedestrians, traffic lights and traffic signs
3-4	Image Processing Cases	Intro: Pictionary game Illustrate the Idea of Machine learning - Teachers provide examples of a dichotomy. - Students able to list out as many features as possible Game: Quickdraw
5	AI Experiencing	Try Google translate Try Google APP (E.g. Recognize music/ photo/ text)
6	AI Experiencing	Compare current mainstream translation software or platforms, such as Google translation, Baidu translation, and DeepL translation Try ChatGPT - POE
7	AI Experiencing	Use deep learning to achieve a drawing effect similar to Google's Deep Dream (A)AI art generator and Artguru (B)Google image search (C)Sora AI
8	AI Assessment	AI Assessment (Mock) 1. POE 2. Artguru.ai
9	AI (Application)	AI Assessment 1. POE 2. Artguru.ai

10-11	AI (Application)	***Husky lens*** Try face recognition - Try to collect a dataset of cats and dogs and using it to classify images - Beginner Level: US Presidents - Advance Level: Mirror Create an emotion detector
12	Conclusion	Discussion: Q1: What are the things AI is good at and not good at? Q2: What is the value of humans and the value of AI? Q3: Which professions are likely to be replaced by AI?
POST	-	Post-test google form

附件二：學生人工智能作品評分準則

學生人工智能作品評分		4 分	3 分	2 分	1 分
AI 圖片	創造力	圖片含有額外的元素並能組成一個有意義的情景。	圖片包含額外的元素，元素之間是有所關連，但未能組成一個有意義的情景。	圖片包含額外的元素，但元素之間並未能組成有意義的情景。	圖片沒有包含任何額外的元素。
	批判性思維	圖片中包含所有評估指引中必須產生的元素。	圖片中只包含評估指引中三至四項必須產生的元素。	圖片中只包含評估指引中一至兩項必須產生的元素。	圖片中沒有包含任何評估指引中必須產生的元素。
AI 文字故事	創造力	故事包含額外的元素，並能組成一個情景，令故事產生轉折。	故事包含額外的元素，並能組成一個有意義的情景。	故事包含項額外的元素，但元素之間並未能組成有意義的情節。	故事內容只描述圖書館並沒有包含任何額外的元素。
	批判性思維	故事中包含所有評估指引中必須產生的元素。	故事中只包含評估指引中三至四項必須創作產生的元素。	故事中只包含評估指引中一至兩項必須創作產生的元素。	故事中沒有包含任何評估指引中必須創作產生的元素。

附件三：教師訪談內容（撮要）

Q1：同學對使用人工智能類軟件創作比以往更有信心

教師代碼	評分	訪談內容
A	5	很多同學首次以 Husky Lens 進行 AI 學習，但他們在日常生活經驗曾接觸一些 AI 對話軟件 (如：POE 等) ，這些經驗令他們更具信心學習新課堂。學生首次以硬件方式學習感到新鮮
B	5	課程使用的軟件是入門級軟件，透過不斷試誤各樣的指令，最後也能達至心中所想，增加學習 AI 的信心 教師選擇的學習軟件對學生的學習信心有直接關係
C	4	同學基本上易於掌握這些入門級軟件，如教授更多更複雜的軟件，可能會有助提升更多信心
D	3	在軟件或硬件應用層面中具信心，惟在硬件結合 AI 與學習編程部份中，同學感到困難

Q2：同學在日常課堂中的解難表現 (如常識科) 更有層次

教師代碼	評分	訪談內容
A	4	學生下指令後遇到 AI 軟件提供的如果不符合預期，會主動行自我修正，以期望獲得更好結果，而「修正」本身是解難的重要一環的技巧
B	4	與 A 老師看法相近，而且認為透過小組討論更可以促進具有深層次的結果
C	4	沒有補充
D	3	沒有補充

Q3：同學所生成的作品比我預期更出乎意料

教師代碼	評分	訪談內容
A	4	雖然老師會教授一些基本指令，但同學同時亦會加入更多個人化指令，使作品多樣化比預期中更多
B	4	沒有補充
C	4	在使用圖像 AI 生成軟件時，同學會嘗試生成一些不在現實出現的事物 (如人和動物結合的樣子是怎樣 ?) [老虎人]
D	3	沒有補充

Q4：同學對人工智能下達的指令比我預期更出乎意料

教師代碼	評分	訪談內容
A	4	沒有補充
B	4	沒有補充
C	4	由於在課程的起始中有教授過圖靈測試的理論，同學會嘗試在對話式軟件中問一些易於分辨 AI 及人類的問題並觀察其反應，例如：給一些複雜的數學問題，或詢問對方性別
D	3	沒有補充

Q5. 同學在對人工智能使用編程碼比我更出乎意料

教師代碼	評分	訪談內容
A	4	沒有補充
B	5	一些具有編程認識的同學會額外增加編程碼，令作品內容更豐富
C	2	沒有補充
D	2	相對於 Scratch 或 AppInventor 等編程學習軟件，Husky Lens 的應用大多集中於「辨認」，所需要的編程碼反而比前兩者更少，故此未有看到學生在使用編程碼中有很大突破

Q6. 同學更能在人工智能中展現 STEM 的跨學科技能整合的能力

教師代碼	評分	訪談內容
A	4	較為符合 STEM 中「T」及「E」的元素，而「S」及「M」較少： 「T」：同學利用合適的硬件進行解決日常生活中的難題 「E」：結果如與預期中不符合，學生會不斷重覆使用及進行自我修正所下達自令，這些與「E」經常提及的「設計循環」中不斷優化的元素有相似之處
B	5	在日常的科學專題研習中未見有應用 AI 軟件 / 硬件
C	3	同意 B 老師講法
D	2	本課程主要教授日常應用 AI 的應用示例，較為表面，很難達提升至整合同學 STEM 各領域的技能或認知水平

Q7. 同學在進行人工智能學習下有更多不同交流

教師代碼	評分	訪談內容
A	5	與教師 B 意見相近
B	5	雖然是以個人方式進行，但同學會在完成作品後自行分享及討論內容，然後按其討論結果為作品進行修正 因提供學生的 Husky Lens 數目所限，B 老師在活動開始前先為各組同學分配不同的小組職責，學生需要互相合作才能完成任務
C	2	小組學生輪流使用 Husky Lens，較多跟從上一個同學的步驟進行而沒有進一步的討論
D	2	與教師 C 意見相近

Q8. 同學在同儕交流學習人工智能，使作品更具複雜性

教師代碼	評分	訪談內容
A	4	沒有補充
B	5	沒有補充
C	3	沒有補充
D	4	當學生完成作品後，觀察同學的作品更有趣時，會激發他重新下達指令，令作品內容變得愈來愈複雜

Q9. 同學在合作學習下的作品更具多樣性

教師代碼	評分	訪談內容
A	4	沒有補充
B	5	沒有補充
C	5	沒有補充
D	4	學生願意在完成作品後互相分享，比較當中不同且有趣之處

Q10. 相對於個人學習，同學願意以互相合作的方式進行活動

教師代碼	評分	訪談內容
A	4	同學在學習過程中不斷互相討論，以尋求更佳的提案進行學習任務
B	5	沒有補充
C	4	如同學在使用軟件及硬件中出現問題，會期望組內的同學可以提供意見以解決問題
D	2	沒有補充

Q11. 同學學習其他課題時的主動性比以往提高了

教師代碼	評分	訪談內容
A	5	沒有補充
B	5	認為 AI 課程能為學生提供學習新方法，尤其在其他科學習時遇到問題時，可嘗試以 AI 軟件協助學習，以取代過往方法，增加其學習動機
C	2	認同教師 D 看法
D	2	AI 的課題與其他科目的課題關連性不大，故未能看到有關方面提升

Q12. 同學更肯定地提出解決的方法

教師代碼	評分	訪談內容
A	4	認為較難觀察有關學習過程是否內化或轉移至學生解難方法，但相信是次學習過程是有意義，能夠提升同學解難能力
B	4	沒有意見
C	3	沒有意見
D	3	在常識科中也有課題討論人工智能與日常生活的關係，雖然學生可以說出一些日常應用例子，但他相信學生如自身遇上問題時，較難以利用 AI 為優先解決問題

Q13. 同學能表達出提出解決方法的原因或理據

Q14. 同學對自己提出的方法更為肯定或自信

Q15. 對於較為複雜或挑戰性的問題，同學比以往表示更有興趣

Q16. 同學比以往更易發現事物本身的問題

Q17. 同學提出的解決方法比以往更多樣化

Q18. 同學提出的解決方法比以往更有深度或複雜

Q19. 同學提出的解決方法比以往更有條理及系統化

教師代碼	評分	訪談內容 (綜合 Q13-19)
A	/	以上結果較難觀察，因為這些能力上提升可能是源自於其他學習或日常經驗，很難完全歸因於學習人工智能後出現這些變化 但同學在「如何問到一道好問題」方面有認識，認為學習對話式人工智能軟件或圖靈測試理論都是邁向這個目標
B	/	沒有意見
C	/	沒有意見
D	/	很難從日常觀察同學是否因此課題導致有以上的改變

Q20. (額外提問) 你認為是甚麼原因導致學生日常較少主動使用 AI 以解決生活問題？

教師代碼	評分	訪談內容
A	/	沒有補充
B	/	取決於技術流行性，當 AI 普及性變得更廣泛，或日常生活中大部份物件已把 AI 自然融合，學生亦不自覺是否應用了 AI，屆時學校不再介紹入門級的 AI 內容，取而代之是更進階的內容
C	/	取決於家庭因素，例如一些家庭本身已購置很多智能家居，所以導致部份學生會有更多機會應用 AI 解決生活問題，反之亦然
D	/	取決於社會整體的接受及發展程度，一些技術雖然在課題上有所討論 (如以 AI 作自動駕駛)，但現時只流於課堂上的討論或猜想，學生的日常生活經驗暫未容許可以用 AI 解決 因認知所限，學生未能肯定所使用日常科技產品背後的原理是否與 AI 有關

Evaluating the impact of mathematical modelling in a Hong Kong secondary school

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Abstract

The existing literature provides a strong endorsement for the idea of enhancing the accessibility and relevance of mathematics for students by incorporating real-world scenarios and data through mathematical modelling. In Hong Kong, mathematical modelling has emerged as a significant educational initiative. This study seeks to assess the effects of mathematical modelling within the context of secondary education. A research team developed a school-based project for 134 secondary two students focused on optimizing routes within the Disneyland theme park through a mathematical modelling. The instructional design was based on the Modelling Activity Diagrams framework, which encompass six stages: Reading, Modelling, Estimating, Calculating, Validating, and Writing. A case study methodology was employed to assess the impact of this initiative on the participating students. In order to develop a comprehensive understanding of the impacts, multiple sources of qualitative and quantitative data were utilized, including digital artifacts, questionnaires, interviews, documents, and classroom observations. The findings indicate that the majority of students were generally receptive to the exercise and performed well on the reading, calculation, and writing stages. Conversely, only a limited number of students performed well on the modelling and validation stages. The results suggest a refinement of instructional materials and the attitudes of teachers are necessary to enhance the effectiveness of teaching mathematical modelling.

Keywords

Mathematical Modelling, STEAM education, Secondary School

Introduction

The growing emphasis on mathematical modelling in mathematics education standards across countries like Sweden, Germany, the United States, and Australia underscores its recognition as a critical competency for students (Stohlmann, DeVaul, Allen, Adkins, Ito, Lockett & Wong, 2016). This emphasis is driven by the understanding that mathematical modelling activities are not only essential for developing mathematical knowledge, but also for nurturing life skills crucial for success in the 21st century (Stohlmann, 2013).

Defined as the application of mathematical principles to unravel real-world phenomena, assess hypotheses, and solve practical problems, mathematical modelling plays a pivotal role in equipping individuals with the tools to effectively address complex challenges. As contemporary society looks to mathematics educators to develop individuals capable of applying mathematical concepts adeptly in their daily lives, the cultivation of a positive attitude towards mathematics becomes essential (Yanagimoto & Yoshimura, 2013). This shift from fear to a deeper understanding and appreciation of the value and practicality of mathematics is key to fostering a new generation of problem solvers and critical thinkers.

In recent years, the Education Bureau in Hong Kong has made significant strides towards equipping teachers to incorporate mathematical modelling into their teaching practices through initiatives like the "Seed" Project[1], seminars, exchange tours and certificate courses. Additionally, the Chief Executive's Policy Address for 2023[2] emphasized the importance of mathematical modelling as a key educational initiative. To advance this objective, The Hong Kong Education Bureau (EDB) initiated a number of professional development programs have been offered to primary and secondary school educators to enhance their capabilities to teach mathematical modelling. Despite these efforts, the formal integration of mathematical modelling into the Hong Kong Mathematics curriculum documents is still pending (Curriculum Development Council, 2017). Stillman (2010) argued for the incorporation of modelling practices from the earliest stages of education, encompassing both primary and secondary

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1 Collaborative Research and Development ("Seed") Projects, initiated in 2001, aim to provide schools and teachers with the support which enables them to put relevant theories and principles with regard to the curriculum reform into practice, and also provide practical experiences and reference for refining the curriculum.

2 https://www.edb.gov.hk/tc/about-edb/legco/policy-address/2023_Panel_on_Education_Eng.pdf

schooling. While it is evident that a number of studies on mathematical modelling have been conducted around the world (Stohlmann et al., 2016), in Hong Kong, there remains a distinct lack of research on the use of modelling methods in mathematics teaching. Therefore, this study aims to explore the impact of mathematical modelling on secondary school classrooms in Hong Kong.

The importance of this research lies in its potential to enhance the existing body of knowledge regarding mathematical modelling within secondary education, particularly through the insights derived from findings derived from Asia. Furthermore, this study may furnish the EDB with research-based information pertaining to the integration of mathematical modelling into in real school settings. Additionally, this study may serve as a model for schools seeking to adopt mathematical modelling practices.

Literature Review

In the context of secondary education, mathematical modelling problems should be designed to be authentic and relevant to students, allowing their cultural backgrounds to significantly influence the learning experience (Suh, Burke, Britton, Matson, Ferguson, Jamieson & Seshaiyer, 2018). From this real-world viewpoint, Anhalt, Staats Cortez & Civil (2018) describe mathematical modelling as a process where students apply their understanding of everyday situations to engage in cycles of mathematical exploration. In modelling problems, it's common that not all of the data required to solve the problems is provided. Therefore, a person's knowledge beyond mathematics is crucial in order to allow them to seek out the necessary information, thereby demonstrating the value of personal experience and insight to the process. Therefore, the idea of mathematical modelling is that it is a process that incorporates mathematical elements that can help clarify real-life problems and scenarios (Abassian, Safi, Bush & Bostic, 2020).

Moreover, mathematical modelling differs from the more "traditional" types of mathematics typically taught in schools, where speed and accuracy are prioritized. Traditional mathematics is often of a lower cognitive level, which does not adequately challenge the ability of students to think (English, 2021). As noted by Wickstrom and Yates (2021), mathematical modelling is structured in a way that is more challenging yet manageable for students, more motivating and rewarding for learners, and encourages them to develop their own mathematical ideas rather than simply receiving mathematical knowledge in advance.

The literature has identified several categories of modelling problems (Suh & Seshaiyer, 2019). The four primary categories outlined below represent the most common types of modelling problems.

1. Descriptive modelling involves the utilization of real-world data to characterize, present, and analyse a particular situation, while also employing modelling techniques to elucidate potential outcomes, taking into account various assumptions and results.

2. Predictive modelling focuses on analysing relationships and/or trends within a dataset to forecast future data or outcomes.

3. Optimizing modelling is employed to identify the most advantageous option or strategy to achieve a specified objective.

4. Rating and ranking modelling involves the assessment and prioritization of different alternatives based on established criteria and data. In this process, students determine the weighting of the criteria and data, subsequently applying their rankings to inform their selection and/or decision.

In addition, it should be noted that mathematical modelling is frequently regarded as a cyclical process, characterized by a dynamic interplay between real-world phenomena and mathematical representations. While various frameworks exist for conceptualizing the structure of the modelling process, it is commonly accepted that this process can be segmented into distinct stages. Students typically progress through these stages sequentially, advancing to the next stage only after they deem their work on the current stage to be satisfactorily completed (Perrenet & Zwaneveld, 2012). Blum and Leiss (2005) framework has been extensively utilized to articulate the modelling process; however, it has proven challenging to employ as an analytical tool for explaining student work (Czocher, 2016). In response to the necessity of describing the modelling processes undertaken by students, Ferri (2007) introduced the concept of individual modelling routes, which sought to enhance the analytical scope of the modelling cycle. These routes are represented through arrow diagrams that illustrate the actions taken by the students within the theoretical framework of the modelling cycle. This process highlights deviations from the expected modelling process and the seemingly stochastic nature of student modelling behavior. Building on Ferri's contributions, Ärlebäck (2009) developed Modelling Activity Diagrams (MADs), which serve as bi-dimensional graphs to represent the various types of modelling activities that students engage in while addressing novel modelling challenges. Table 1 (below) details Ärlebäck (2009) stages of learning activities that comprise the MAD depiction of modelling process. In this research, to facilitate S2 students' comprehensive engagement with mathematical modelling, the MAD framework offers a clear and straightforward series of stages for students to follow.

Table 1. Description of the Stages of Arlebäck's (2009) MAD

Stage	Definition
R: Reading	Analyzing and comprehending the task.
M: Modelling	Simplifying and organizing the task in a mathematical framework.
E: Estimating	Conducting quantitative estimates
C: Calculating	Executing mathematical operations, which may include arithmetic calculations, manipulation of equations, and the creation of sketches or diagrams.
V: Validating	Interpreting, verifying, and validating the results, calculations, and the model within its real-world context.
W: Writing	Compiling the findings and results into a report, which includes a detailed account of the problem-solving process and the final solution.

Methods

Research Question

What are the key lessons learned from implementing mathematical modelling in secondary schools?

Research Design

This study investigated the impacts and challenges associated with the implementation of mathematical modelling within regular lessons during the 2023 – 2024 school year. To achieve this, the study utilizes the exploratory case study approach, which is an appropriate method for performing an in-depth examination of a particular phenomenon (Creswell & Creswell, 2017). The objectives of these lessons include (1) creating models, (2) solving models, (3) interpreting and validating models, and (4) assessing and enhancing models.

This study was conducted at the school at which the research team is employed. The school is located in the Sham Shui Po district of Hong Kong, and generally caters to students of average abilities. The participants in study comprised a group of secondary two students and four educators specializing in STEAM (Science, Technology, Engineering, Arts, and Mathematics) disciplines. The study involved four secondary two classes: Class 2A (33 students), Class 2B (33 students), Class 2C (34 students), and Class 2D (34 students), resulting in a total of 134 students. The students were between the ages of 13 and 15, and the learning capabilities of the students across the four classes were found to be relatively homogeneous.

This new initiative was created based on statistical data about students in S1 and S2 within the current mathematics curriculum. The project involves teaching mathematical modelling and assessment methods using PowerPoint slides and presentations. There are some notable differences compared to the traditional curriculum. All of the students participated in the mathematical modelling project, which employs a project-based learning approach to learning. The modelling project was delivered over a series of eleven lessons, each lasting 40 minutes, in which the focus was on optimizing the best route for a visit to the Hong Kong Disneyland park. To emphasize the real-life context, the following is the scenario designed to be the basis of the lessons:

> You and your teammates excelled in a STEAM competition and won the championship, earning a ticket to Hong Kong Disneyland. You have decided to meet on June 26 (Wednesday), the final day of exams, for lunch before heading to the park. Since you need to return home for dinner that evening, you only have three hours (from 2:00 PM to 5:00 PM) to enjoy the park. Each of you has a specific ride you want to experience together, so you all agree to find the quickest way to complete the rides, allowing for more time to shop on the main street before leaving the park at 5:00 PM. Therefore, you considered using mathematical modelling to optimize your route for this park visit!

Students were grouped into teams of three to four. To ensure the level of difficulty of the teaching materials were suitable for S2 students, two-way process were used. First, teachers developed topic specific PowerPoint presentations and worksheets for the sessions. Since this study was an EDB “Seed Project”, all of the teaching materials used were reviewed by the EDB curriculum development officers to ensure the appropriateness and suitability. Materials were modified and further sent for vetting if necessary. To encourage student participation, the top-performing group in the class entered an inter-class competition to showcase their modelling. The winning group received a trip to Disneyland to test their model. The timeline for the study is outlined in Table 2 (below):

Table 2. The Timeline for the Lessons and Data Collection

Week	Main Task	Description
Preparation for the lessons and lessons materials (March)		
1	Introduction	Providing background information, introducing the concept of mathematical modelling, and assigning homework to gather data on queue times
2 - 3	Queue up time for the facilities	Examining and presenting the data gathered from the homework and assigning homework to gather data on distance between the facilities.
4 - 5	Distance between the facilities	Examining and presenting the data gathered from the homework
6 - 7	Integration of the pervious works	Creating and verifying their own mathematical models while utilizing technology to enhance those models
8	Preparation for presentation	Create the PowerPoint presentation for the upcoming presentation.
9 - 10	Presentation	Every group showcases their models using PowerPoint presentations
11	Inter-class competition	The top-performing group from each class enters an inter-class competition to showcase their modelling
Gathering data for the research through interviews and questionnaires (July)		

Data Collection

"Thick descriptions" represent a qualitative research methodology that enables researchers to develop analyses that are both accurate and comprehensive (Yin, 2017). In order to generate these "thick descriptions," this study incorporates a number of data sources, including digital artifacts, questionnaires, interviews, documentation, and classroom observations. For this study, digital artifacts served the primary instruments for data collection to accurately capture the learning experiences of the students, while the other sources offered supplementary insights in support of the digital artefacts data.

Digital artifacts

The PowerPoint presentations made by students served as the primary digital artifacts for this study. To capture the learning outcomes, the titles of the slides and hints/guiding questions were formulated based on Ärlebäck (2009) MAD framework. Students were instructed to submit their PowerPoints through Google Classroom after their presentations. Table 3 (below) illustrates the alignment between the characteristics of each of the MAD stages and the slides. To ensure that students were aware of the expectations, a rubric has been developed and provided to them in advance.

Table 3. The Alignment Between the MAD Framework and the PowerPoint Slides.

MAD Stage/Step	Title of the Slides	Hints/Guiding Questions
Reading	Slide 1: The concept of Modelling Slide 2: Setting up the Problems Statements	Using your own words to briefly introduce mathematical modelling. Introduction to background information, exploration of issues and objectives.
Modelling	Slide 3: Assumption for the Route Design	What assumptions did you make at the beginning of the activity? What assumptions and principles did you have regarding the route design? What assumptions were made to collect more accurate data?
Estimating	Slide 4: Data Collection : Queuing Time Slide 5: Data Collection : Distance Between Facilities	How to use tools to collect the data (distance between attractions)? What is the accuracy level of the collection tools? What difficulties did you encounter during the collection process? How did you resolve them?
Calculating	Slide 6: Formulated the Mathematical Model Slide 7: Mathematical Model Computation	Show your mathematical model and introduce the elements and principles considered within it. Show how to use mathematical models to score six routes, the scoring criteria, and the final selection.

Validating	Slide 8: Artificial Intelligence Consulting	What questions did you ask the AI? Did you adopt its responses? Please introduce and provide screenshots.
	Slide 9: Mathematical Model Validation	Do you think the results of the chosen mathematical model are reasonable? Are there any aspects that are worth questioning? How can the model be improved?
Writing	Slide 10: Best Route Display	Route display, itinerary, and information. (For example, estimated arrival times at various locations, start and completion times, route options, distances and current waiting times, playtime, etc.)

Questionnaires

The student questionnaire includes three parts. The first part covered demographic information, including age, class and gender. The second part encompassed several aspects, including the level of interest in the subject of mathematical modelling, the appropriateness of the activity's difficulty, the potential for enhancing mathematical skills, and the applicability of the activity in utilizing mathematical knowledge and skills in a real-world STEM-related context. The last part included the open-ended questions soliciting feedback on the mathematical modelling activities. By contrast, the teacher questionnaire solely focused on evaluating the performance of the students based on their expectations and the requirements of the MAD framework. Additionally, both the student and teacher questionnaires incorporate a five-point Likert scale for responses, ranging from "strongly disagree" to "strongly agree."

Interviews

A protocol for conducting interviews with both teachers and students was developed, drawing upon the attributes and descriptions outlined in the MAD framework, to support semi-structured interviews. Additionally, the student and teacher interviews included questions derived from the students' PowerPoint presentations. Following the presentation lessons, four students were randomly chosen, along with all of the teachers involved in the study, to participate in the interview stage.

Class observations

The principal investigator conducted observations of four lessons, which included the presentation sessions for a single class, and recorded notes utilizing a predetermined protocol.

Documents

The documents included all the instructional PowerPoint slides and student worksheets.

Data Analysis

To examine the data from the digital artifacts, the analysis primarily focused on the factors directly related to the MAD framework, namely reading, modelling, estimating, calculating, validating, and writing. All of the qualitative data, including the analysis of digital artifacts, was gathered and analysed in Chinese and subsequently transcribed into English during the writing process. Subsequently, qualitative data from the questionnaires, interviews, documents, and class observations provided additional insights, which complemented the findings from the artifacts, were similarly evaluated and translated.

Trustworthiness

The trustworthiness of the study was ensured through rigorous procedures, which included using multiple data collection techniques, engaging with different informants, maintaining transparency in the research process, and addressing possible biases. Two researchers independently coded the transcripts, and any discrepancies in their coding were resolved through discussion to reach an agreement. The inter-rater reliability was above 80%. Additionally, the researchers informed all of the participants that any negative comments made during the interviews and surveys would not lead to any negative consequences, including on their academic performance. This assurance, which was explained prior to data collection, was intended to foster a trusting and open atmosphere, allowing students to freely express their genuine opinions without worrying about potential consequences.

Results

Demographic Information

Table 4 (below) summarizes the demographic information drawn from the questionnaires and Table 5 (below) lists the relevant information for the students and teachers who took part in the interviews.

Table 4. Summary of the Demographic Information Drawn from the Questionnaire

	2A	2B	2C	2D
The number of participants	33	33	34	34
Age				
13	27	26	28	30
14	6	6	5	4
15 or above	0	1	1	0
Gender				
Male	21	25	24	20
Female	12	8	20	14

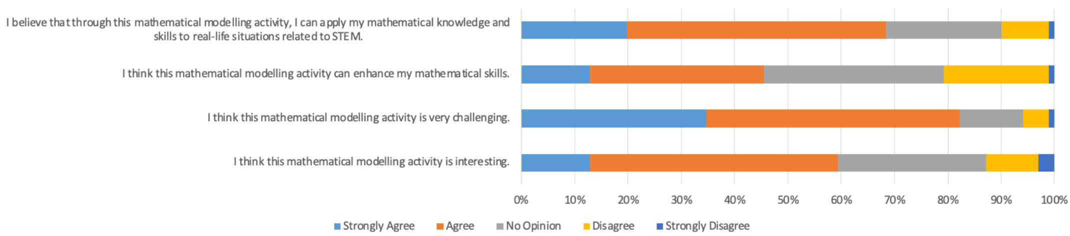
Table 5. Summary of the Demographic Information of the Interview Participants

Stakeholder	Participant Code	Descriptions
Student	ISA	Class 2A, male, 13 years old
	ISB	Class 2B, male, 14 years old
	ISC	Class 2C, female, 13 years old
	ISD	Class 2D, male, 14 years old
Teacher	ITA	Class 2A, Male, 3 years' working experience, Major in Physics
	ITB	Class 2B, Male, 5 years' working experience, Major in Mathematics, Chief teaching material developer
	ITC	Class 2C, Male, 20 years' working experience, Major in Mathematics & Information Technology
	ITD	Class 2D, Male, 3 years' working experience, Major in Information Technology

RQ: What are the key lessons learned from implementing mathematical modelling in secondary schools?

Figure 1 (below) illustrates the opinions of the students regarding mathematical modelling activities. According to the questionnaire results, a majority of students agreed that they can apply their mathematical knowledge and skills to real-life situations. However, they also acknowledged the presence of mathematical challenges, which may impact their interest in engaging with modelling activities. Overall, the students demonstrated a positive attitude towards the lessons.

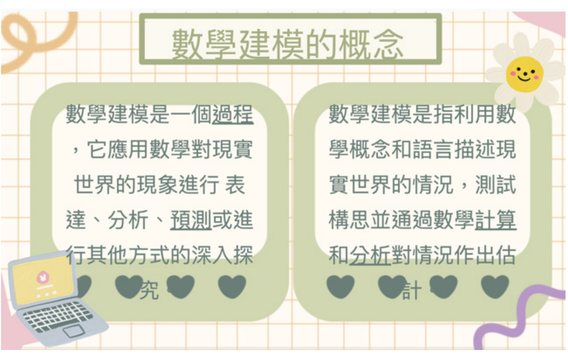
Figure 1. Opinions of the Students Towards Mathematical Modelling Activities



Stage 1 - Reading

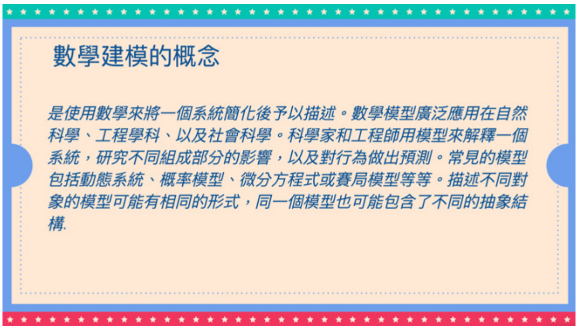
Most students could understand the concept of mathematical modelling. From the digital artefacts, it was evident that the students could use their own words to describe the definition of the concept (See Figure 2 (below)). A number of groups even included the steps in mathematical cycle. However, a few group identified mathematical concepts that were not in the syllabus, such as Dynamic Systems, Differential Equations, and Game Models (See Figure 3). During the presentation, students just simply presented their descriptions of modelling without any further explanation. From the teacher interview, two of the teachers (ITB, ITC) figured that a few students just copied the information from the internet.

Figure 2. The Concept of Mathematical Modelling 1 (Artefacts Group D8)



Mathematical modelling constitutes a systematic approach that employs mathematical principles to depict real-world phenomena. This process involves utilizing mathematical concepts and terminology to characterize various situations, evaluate hypotheses, and generate estimations through rigorous mathematical computations and analyses. It serves as a tool for exploration, analysis, and prediction within diverse contexts.

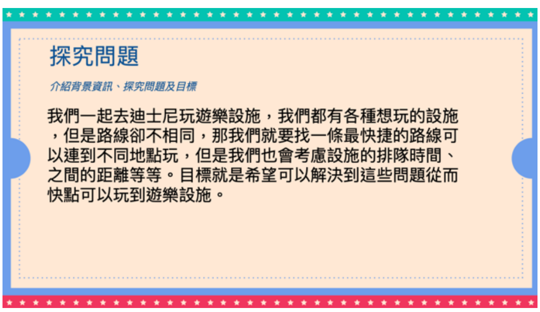
Figure 3. The Concept of Mathematical Modelling 2 (Artefacts Group D5)



A mathematical model serves as a representation of a system, employing mathematical principles to simplify its complexities. These models are extensively utilized across various fields, including the natural sciences, engineering, and social sciences. Researchers and practitioners in these domains leverage models to elucidate system dynamics, analyze the impact of various components, and forecast potential behaviors. Frequently encountered types of models encompass dynamic systems, probabilistic frameworks, differential equations, and game theory constructs, among others. It is noteworthy that models representing disparate entities may exhibit similar structural forms, while a single model may incorporate diverse abstract elements.

In one interview, teacher ITB revealed that the students initially believed that creating a theme park route was just a matter of being quicker than other teams. The teacher realized that more time was needed to clarify the concept of "Optimization" and sought to include various factors in the process. However, in their digital artefacts, most groups merely identified the issues and presented an optimized route without detailing the factors that went into their decisions. Only a few groups actually identified key factors, such as queue times, distance and interest (See Figure 4). During the interview, when the researcher prompted the students to elaborate on their statements, students ISB and 1SC were able to incorporate additional factors into the discussion.

Figure 4. Example Problem Statement (Artefacts - Group B4)



Let's go to Disney together to enjoy the rides. We all have different attractions we want to experience, but our routes are not the same. So we need to find the fastest route that connects different locations, while also considering the waiting times for the rides and the distances between them. The goal is to solve these issues so that we can enjoy the rides as quickly as possible.

Stage 2 - Modelling

Most of the groups were unable to make relevant mathematical assumptions and relied on common sense to answer the guiding questions, which often led them provide irrelevant responses. For instance, when asked about their initial assumptions for the activity, most students only mentioned factors like good weather or the number of people in the park, which they believed would increase wait times. For example, one groups explained:

> I visited the official website of Hong Kong Disneyland to examine the queue times. Additionally, we can hypothesize that weather conditions may contribute to a reduction in the number of individuals waiting in line, which would subsequently lead to a significant decrease in queue times.(Artefacts - Group A7)

Regarding the question about assumptions and principles related to route design, several groups stated that they aimed to minimize the time spent visiting each of the facilities. When asked about assumptions for collecting more accurate data, they simply noted that they used Google Maps because it is more reliable than other apps. From the interviews, it was clear there was an expectation for students to make more mathematically relevant assumptions, such as using the mean to estimate wait times. Only one group reported that teacher expectations were partially met, explaining:

> We once assumed that collecting more accurate data, such as considering when to collect queue times and taking into account the number of visitors to Disney each week, would be beneficial. (Artefacts - Group D4)

Additionally, all of the teachers admitted that they had not taught their students about making assumptions, considering it not to be a crucial aspect of the project. Several groups made assumptions that were not very relevant. Below are two such examples derived from their work:

> Assuming that some roads needed repairs at that time, alternative routes would be required, so the travel distance might increase. (Artefacts - Group B2)

> In the early stages of the event, we had many assumptions, such as assuming we are individuals with mobility difficulties, which requires us to consider walking speed. (Artefacts - Group C1)

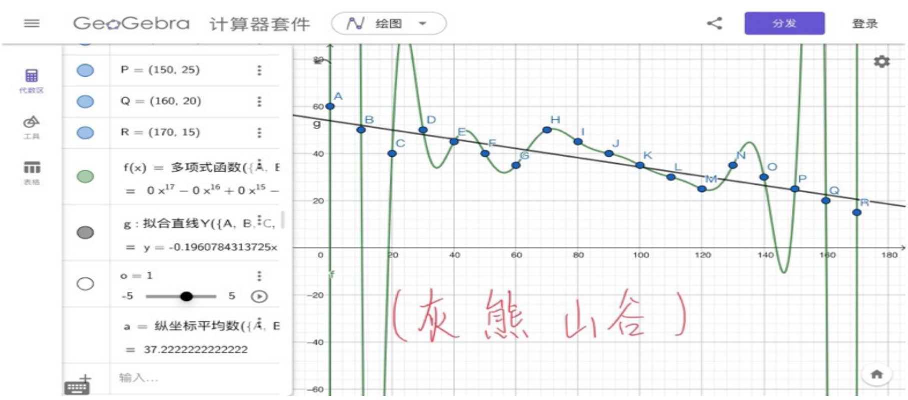
Stage 3 - Estimating

One teacher interview (ITB) revealed that the teachers had anticipated that the students would articulate their methods for data collection, the challenges they encountered, and the mathematical concepts employed to address these issues. For instance, due to the variability in queue times, students were expected to utilize the mean to estimate for these times and to reduce the time intervals for data collection. To assist students in analyzing the data, the teachers recommend the utilization of mean calculations, as well as polynomial or linear regression techniques. However, the analysis of the digital artifacts submitted by the students indicated that only a few groups provided partial responses. Specifically, only two groups acknowledged the use of the mean to estimate queue times based on data obtained from the Disneyland apps, and only a limited number of groups referenced the use of these applications for data collection. Additionally, a few groups merely noted the difficulties faced during data collection, which were not directly related to mathematical concepts. For example, one group noted:

> Difficulties encountered during the collection process 1. Can't understand the English on the webpage, 2. Unable to use the webpage and 3. It's so troublesome to constantly switch back and forth between pages. (Artefacts - Group C5)

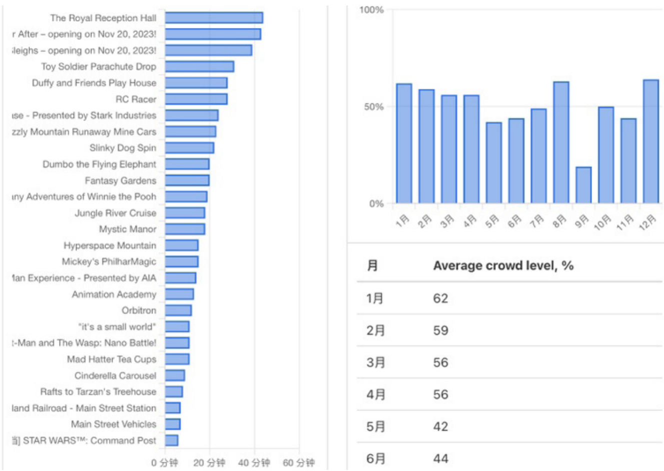
Surprisingly, a group employed GeoGebra to apply linear regression techniques for the purpose of estimating queue times (See Figure 5 (below)). However, the group did not specify the methodology employed to estimate the time.

Figure 5. PowerPoint Slide Depicting the Use of GeoGebra (Artefacts - Group C3)



Interestingly, three groups of students utilized internet data directly by capturing website content and pasting it onto their presentation slides (see Figure 6 (below)). This practice did not align with the original intent of the teachers. As a result, several groups did not fulfill the expectations set by the teachers. One teacher (ITB) indicated that, at that stage, it was anticipated that students would have comprehended the processes involved in data collection and data analysis. Rather, they presented only the estimated queue times without providing any calculations to substantiate their findings. Furthermore, a number of groups simply displayed a table from the student worksheet, lacking any further elaboration or analysis.

Figure 6. PowerPoint Slide Depicting Snip Copied from a Website (Artefacts - Group D3)



With respect to the distances between facilities, insights gathered from teacher interviews indicated that the teachers anticipated that the students would utilize Google Maps to assess the distances between the attractions and complete the designated table. The majority of groups performed satisfactorily in this task.

Stage 4 - Calculating

In the interviews, the teachers expressed reservations regarding the ability of the students to independently develop mathematical models. Consequently, in the instructional PowerPoint presentation, they offered three examples as references for student use (See Figure 7 (below)). Nevertheless, the teachers encouraged the students to create their own models. An analysis of the student PowerPoint presentations revealed that the majority of the groups predominantly utilized the models provided by the teachers. A few of the groups made only minor modifications, such as altering constants within the existing models (See Figure 8 (below)). Only one group successfully devised a distinct model (See Figure 9 (below)). In the application of the model, the majority of groups were able to input the values accurately, resulting in the correct numerical outcomes. Furthermore, the students were able to utilize these numerical results to ascertain the optimal route, necessitating critical thinking regarding whether to select the largest or smallest values (See Figure 10 (below)). Based on classroom observations, the majority of students effectively demonstrated their ability to apply the model to the given context. Notably, one group of students created a PowerPoint presentation to explain the various factors involved (refer to Figure 11 (below)).

Figure 7. Suggested Models Provided by the Teachers in the Instructional PowerPoint (Translated Version)

1. $$50-\left(\frac{\text{Total Distance}}{\text{Interval}}+\frac{\text{Total Waiting Time}}{\text{Interval}}\right)+\text{More Interesting Facilities}+\text{Other factors}$$

2. $$30-\frac{\text{Total Distance}}{\text{Interval}}-\frac{\text{Total Waiting Time}}{\text{Interval}}+\text{More Interesting Facilities}$$

3. $$\frac{1}{\frac{\text{Total Distance}}{\text{Interval}}+\frac{\text{Total Waiting Time}}{\text{Interveal}}}$$

Figure 8. Student Model 1 (Artefacts - Group D8)

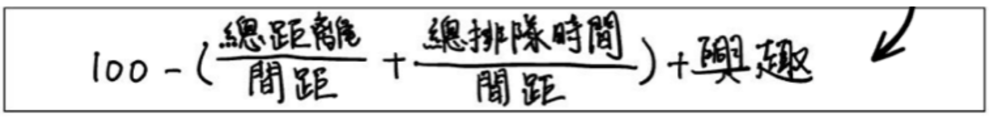
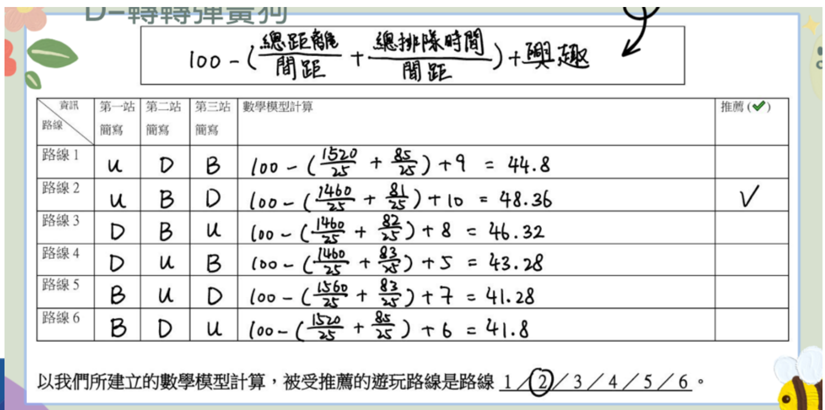


Figure 9. Student Model 2 (Artefacts - Group D2)

Figure 10. Table Presenting Student Calculations (Artefacts - Group D8)

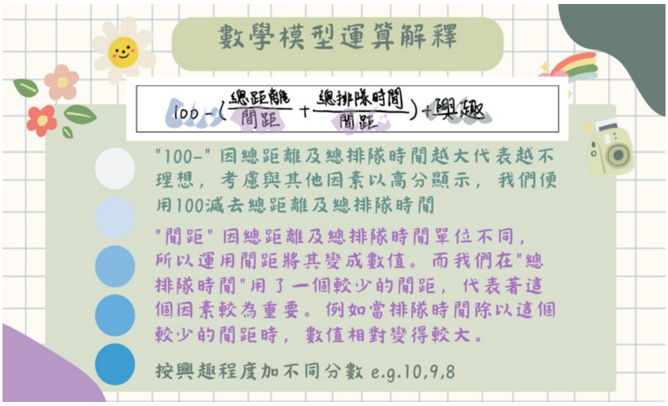


100 − (總距離/間距 + 總排隊時間/間距) + 興趣

資訊 / 路線	第一站 簡寫	第二站 簡寫	第三站 簡寫	數學模型計算	推薦 (✔)
路線 1	u	D	B	$100-(\frac{1520}{25}+\frac{85}{25})+9=44.8$	
路線 2	u	B	D	$100-(\frac{1460}{25}+\frac{81}{25})+10=48.36$	✓
路線 3	D	B	u	$100-(\frac{1460}{25}+\frac{82}{25})+8=46.32$	
路線 4	D	u	B	$100-(\frac{1460}{25}+\frac{83}{25})+5=43.28$	
路線 5	B	u	D	$100-(\frac{1560}{25}+\frac{83}{25})+7=41.28$	
路線 6	B	D	u	$100-(\frac{1520}{25}+\frac{85}{25})+6=41.8$	

以我們所建立的數學模型計算，被受推薦的遊玩路線是路線 1／(2)／3／4／5／6。

Figure 11. Detailed Explanation of the Model (Artefacts - Group D8)



The notation "100-" signifies that an increase in total distance and total waiting time correlates with a less favorable outcome. To account for various factors that contribute to a high score, we deduct the total distance and total waiting time from 100.

The variable "Spacing" is quantified numerically to accommodate the differing units of total distance and total queue time. A smaller spacing value is applied to "total queue time," reflecting its greater significance in the overall assessment. For instance, when the queue time is divided by this reduced spacing, the resultant value is proportionately larger.

Scores are assigned based on the degree of interest, utilizing a scale of 10, 9, and 8, among others.

Stage 5 - Validating

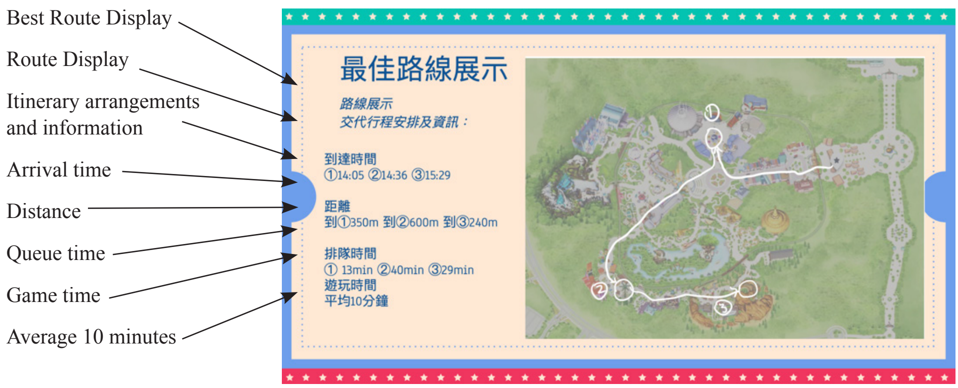
Teacher ITB anticipated that students would critically evaluate their findings, identifying areas of uncertainty and proposing potential improvements to the model. A limited number of groups expressed skepticism regarding their findings, citing concerns about the accuracy of the data collection; however, they were unable to propose alternative solutions. Conversely, several of the groups deemed their findings to be reasonable and did not provide any additional commentary in their PowerPoint presentations. Only two groups suggested the application of different models for further testing. Based on the interviews conducted with both the students and the teachers, the teachers had anticipated that the students would be able to provide a mathematical critique of their model. On the other hand, students ISA, ISC, and ISD all stated that they were unable to conceptualize how to accomplish this task.

As the students were expected to consult with AI as part of the process, teacher ITB encouraged students to utilize the Poe platform to identify potential enhancements for their projects. Students were instructed to document the responses generated by Poe and incorporate them into their presentation slides. Additionally, all of the groups were prompted to pose questions regarding other factors that could be critical to the model. Among the digital artifacts produced, it was observed that half of the students dismissed the suggestions provided by Poe, arguing that the proposed factors could not be integrated into their models. Conversely, the other half accepted the suggestions but did not incorporate any of the new factors into their existing models. The factors considered encompassed weather conditions, pedestrian traffic, catering services, and the needs of children. One student, (ISC), expressed uncertainty regarding the necessity of adding the suggested factors, while another student (ISD) indicated a lack of understanding regarding how to integrate the factors into the model. All of the teachers drew the conclusion that the students were unfamiliar with the effective use of AI, particularly in terms of questioning the methodology and validating the responses generated by Poe.

Stage 6 - Writing

In this stage, students were expected to present the route they had designed, itinerary arrangements, and any other relevant information. Based on the digital artifacts submitted, the majority of groups successfully demonstrated the route and itinerary (See Figure 12); however, a small number of groups neglected to include all of the necessary information.

Figure 12. The Best Route (Artefacts - Group A2)



Discussion

The majority of students demonstrated a satisfactory ability to comprehend the problem and formulate their own problem statements during the reading stage. Furthermore, they were able to construct mathematical models and apply the models to a real-world scenario in the calculation stage, as well as effectively present their recommended pathways and pertinent information in the writing stage. However, only a limited number of students satisfactorily demonstrated the ability to make relevant assumptions during the modelling stage. While the students proved that they were capable of collecting and analysing data, approximately fifty percent struggled to effectively present their findings in the estimation stage. Additionally, the students faced challenges in determining the appropriateness of their models and utilizing artificial intelligence for consultation during the validation stage.

Participation in the project significantly improved the ability of the students to comprehend the concept of mathematical modelling; allowing them to grow from a point where they were unsure of the concepts and their execution to a robust conceptual understanding of the ideas and applications. The experience highlighted the relevance of using mathematical modelling in a real-world context (Czocher, Melhuish, Kandasamy & Roan, 2021). Furthermore, some of the students enhanced their understanding of modelling by engaging with written descriptions available online and articulating these concepts in their own words. This underscores the positive impact that providing reading materials on modelling can have on enhancing the knowledge and understanding of the students. Additionally, the project contributed to the ability of the students to interpret mathematical results in an actual real-life situation, as opposed to merely focusing on the calculation phase, which corroborates the findings of Schukajlow, Kolter & Blum (2015).

Students demonstrated relatively poorer performance in the estimation and validation stages. This might reflect that estimation and validation stages were more difficult to grasp than the other stages. In addition, teachers were found to pay less teaching time to the two stages. Thus this might reflect a mismatch between students' need in learning and teaching focus.

Only half of the students reported that the project was engaging, which does not fully align with Smith and Morgan (2016) assertation that contextual relevance can serve as a means to promote student engagement with mathematics. A potential explanation for this discrepancy may lie in the fact that a number of student performed relatively poorly on the estimation and validation tasks, which could be attributed to issues related to teacher preparedness and student readiness, resulting in a disconnect within the stages of the mathematical modelling cycle. Educators often expect students to apply mathematical principles; however, many students tend to default to common sense reasoning, leading to irrelevant responses, particularly in the areas of making assumptions and conducting validations.

To address the existing gap in understanding, Vygotsky's concept of the Zone of Proximal Development (ZPD) offers valuable insights. The ZPD is defined as the range between a learner's potential development and their actual development (Riddle & Dabbagh, 1999). According to this framework, when a learning task is either too challenging or too simplistic for students—

falling outside their ZPD—they may experience feelings of anxiety or boredom. In this context, scaffolding serves as a strategic approach to assess proximal behaviors (Riddle & Dabbagh, 1999). Scaffolding is described as a “process that enables a child or novice to solve problems, carry out tasks, or achieve goals that would be beyond their unassisted efforts” (Wood, Bruner & Ross, 1976). Essentially, scaffolding is the practice where educators, or other knowledgeable adults, provide structured support to facilitate the cognitive development of the students. This support enables the students to reach the next level or stage, thereby optimizing individual learning outcomes. Consequently, when teaching mathematical modelling, it is imperative for educators to recognize the potential and the limitations of their students, particularly when they may lack experience or ideas related to modelling processes such as estimation and validation. However, it is also crucial to avoid excessive guidance from teachers, as this can lead students to become overly reliant on the models presented, which would ultimately hinder the development of the mathematical reasoning and creativity of the students, particularly the high achievers.

Overall, the results of this study indicate that the general experience of the students with mathematical modelling was positive; particularly in the areas of reading, calculating and writing, in which they performed well. However, the primary limitation of this study was the small sample size. In order to verify the results presented here, the study should be repeated with a larger sample size. However, to overcome some of the challenges faced during this study, a further refinement of the teaching material should be carried out, drawing from the existing attitudinal surveys that have been conducted in support of mathematical modelling.

Conclusion

This study demonstrated that the incorporation of relatable real-world contexts can facilitate the ability of high school students to understand and engage with mathematical modelling. Through this approach, students not only grasped the concept of mathematical modelling but also cultivated an appreciation for its relevance with respect to their personal experiences. Following the completion of the project, which included the PowerPoint presentations, students recognized the potential of mathematics, particularly mathematical modelling, as a valuable tool for addressing real-world problems, a perspective that had previously been associated primarily with scientific disciplines. This newfound understanding contributed to a positive shift in the attitudes of the students toward mathematics. Stillman (2010) advocated for the introduction of modelling at the earliest stages of education. This suggests that early exposure to mathematical modelling, within relatable contexts, may foster a deeper appreciation for mathematics and its practical applications earlier in the educational journeys of the students. Furthermore, to promote the integration of mathematical modelling in primary and secondary education, this study highlights the critical importance of teacher training. It emphasizes the need for a wide range of training activities, particularly with respect to the pedagogical content knowledge (PCK) related to mathematical modelling. Although teachers may possess mathematical knowledge, it is essential to equip them with pedagogical knowledge and skills to assist students of all abilities to understand the materials. For one, teachers should recognize the importance of each of the MAD stages and avoid paying excessive attention to the modelling stages. This approach can further enhance the abilities of the students to understand and appreciate mathematical modelling.

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Examining the Impact of an Inquiry-Based Science Education Programme on Secondary Students' Understanding of the Nature of Scientific Inquiry

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Abstract

This study investigated whether students' understanding of nature of scientific inquiry (NOSI), particularly three aspects of NOSI known to be difficult to develop (i.e., the key role of scientific questions, multiple scientific methods, and the relationship between data and evidence), can be developed in an inquiry-based science education programme that engages students in authentic scientific practices. It also explored student perceptions of the impact of the activities on their learning. Data sources included pre- and post-programme *Science Inquiry Maps constructed by student groups, student responses to the Views about Science Inquiry* (VASI) questionnaires, a study-derived written survey, and a student focus group interview. Mixed methods analysis revealed that, at a group level, students developed a better understanding of the scientific inquiry process, no longer viewing it as linear and regimented, but as complex dynamic interactions between the key steps. However, individual students showed only modest changes in their understanding of the three targeted NOSI aspects, despite statistically significant changes in their self-perception of understanding ($p<0.001$). Three features of the activities were perceived by the students as important in their learning. Two tensions in designing and implementing an inquiry-based science education programme aiming at improving students' understanding of NOSI are discussed.

Keywords

nature of scientific inquiry, inquiry-based science education programme

Literature Review

Understanding of the Nature of Scientific Inquiry as an Important Component of Scientific Literacy

Scientific literacy has long been an important goal of science education in Hong Kong and worldwide (Curriculum Development Council, 2017; OECD, 2023). Scientifically literate people must not only develop an informed understanding of the products of science (e.g., principles, laws and theories) (Roberts & Bybee, 2007) and be able to engage in the process of doing science but also participate in the public discourse on science (Roberts & Bybee, 2007). In their recent chapter published in the *Handbook of Research on Science Education*, Schwartz, Lederman, and Enderle (2023) reviewed extensive research related to scientific inquiry and made it clear that understanding the nature of scientific inquiry (NOSI) involves possessing *knowledge* about the processes of scientific inquiry. It refers to one's epistemological views "of the nature and rationale of the processes through which that knowledge is constructed and justified within the scientific community" (p. 764). It is not the same as the ability to do inquiry. They argued that "[t]he doing of science (skills of inquiry, doing scientific practices) are useful to a limit toward what we consider functional scientific literacy" (p. 764) and that "[h]aving knowledge about scientific inquiry as another *cognitive domain* pushes the individual beyond skills into meaningful understandings and abilities to interpret and evaluate scientific claims, including personal situations" (p. 764-765). Their critical review of the current state of the art of research on scientific inquiry brings to light the lack of empirical studies on students' understanding of NOSI and convincingly demonstrates the importance of addressing the relevant epistemic ideas about NOSI to facilitate the transition from *science* literacy to functional *scientific* literacy.

Secondary Students' Understanding of the Nature of Scientific Inquiry and Strategies to Improve their Understanding

One reason for the scarcity of empirical studies on students' understanding of NOSI is the lack of valid and reliable instruments to accurately assess these understanding. Recently, Lederman, Lederman, Bartos, Bartels, Meyer, and Schwartz (2014) developed and validated a questionnaire entitled *Views about the Nature of Scientific Inquiry* (VASI). This questionnaire identified several important epistemic ideas about NOSI for assessment. As a follow up, this researcher group in collaboration with many other research groups across the globe conducted two large-scale international collaborative surveys of students' understanding of NOSI, with the aim of establishing a baseline understanding of where students are before and after secondary school education (Lederman, Lederman, Bartels, Jimenez, Acosta, Akubo, Aly, Andrade, Atanasova, Blanquet, Blonder, Brown, Cardoso, Castillo-Urueta, Chaipidech, Concannon, Dogan, El-Deghaidy, Elzorkani, Ferdous, Fukuda, Gaigher, Galvis-Solano, Gao, Guo, Gwekwerere, Gyllenpalm, Hamed Al-Lal, Han-Tosunoglu, Hattingh, Holliday, Huang, Irez, Jiménez, Kay, Koumara, Kremer, Kuo, Lavonen, Leung, Liao, Librea-Carden, Lin, Liu, Liu, Liu, Mamlok-Naaman, McDonald, Möller, Morales, Mulvey, Neumann, Neurohr, Pan, Panjaburee, Penn, Plakitsi, Picholle, Ramnarain, Raykova, Rundgren, Salonen, Santibáñez-Gómez, Schwartz, Sharma, Srisawasdi, Takiveikata, Urueta-Ortiz, Vitlarov, Voitle, & Wishart, 2021; Lederman, Lederman, Bartels, Jimenez, Akubo, Aly, Bao, Blanquet, Blonder, Bologna Soares de Andrade, Buntting, Cakir, El-Deghaidy, ElZorkani, Gaigher, Guo, Hakanen, Hamed Al-Lal, Han-Tosunoglu, Hattingh, Hume, Irez, Kay, Kivilcan Dogan, Kremer, Kuo, Lavonen, Lin, Liu, Liu, Liu, Lv, Mamlok-Naaman, McDonald, Neumann, Pan, Picholle, Rivero García, Rundgren, Santibáñez-Gómez, Saunders, Schwartz, Voitle, von Gyllenpalm, Wei, Wishart, Wu, Xiao, Yalaki, & Zhou, 2019) .

Students from Hong Kong participated in the follow-up round of this international project (Lederman et al., 2021). Based on the responses of 100 first-year students who had studied science in secondary school at a local top university, several weaknesses in students' understanding of NOSI were revealed from their responses in VASI. For example, students did not understand that scientists use a variety of scientific methods. In addition, students tended to misunderstand that scientific investigations can begin with arbitrary questions rather than scientific questions. Finally, students conflated data with evidence and equated data only with numbers and statistics. While this study is valuable because it highlights aspects of NOSI that Hong Kong secondary students may struggle with, this and existing studies do not provide empirical evidence on whether these three epistemic ideas about NOSI (i.e., (1) the role of scientific questions; (2) multiple scientific methods and (3) the relationship between data and evidence) (Table 1) can be developed through targeted interventions. Critical questions still remain. For example, can these three aspects be improved by immersing students in inquiry-based activities that mirror authentic scientific pursuit? What are the features of the activities that can enhance students' development of these epistemic ideas?

Table 1. Three epistemic ideas in NOSI that challenges Hong Kong first-year university students.

The role of scientific questions	Scientific investigations involve posing and answering questions. For an investigation to occur, a question about the natural world must be asked. While traditional experimental designs often include a formally stated hypothesis, this is not required or typical for other designs, such as observational and correlational studies.
Multiple scientific methods	Scientists perform investigations by observing natural phenomena. Often, observational and correlational research methodologies are used to gather data. Students need to understand the variety of research methods used across and within scientific domains and recognize that scientists choose different types of investigations based on the questions they aim to answer.
The relationship between data and evidence	Data and evidence serve different purposes in scientific investigations. Data are observations collected by scientists during an investigation and can take various forms, such as numbers, descriptions, photographs, audio, and physical samples. Evidence, on the other hand, results from data analysis and interpretation, and is directly linked to a specific question and related claim.

Summary

In summary, the research studies have not only highlighted the importance of students' understanding of NOSI but also revealed the epistemic ideas that Hong Kong students struggle with. There is an urgent need to design and implement an inquiry-based science programme to improve Hong Kong students' understanding of NOSI. Such a study provides may shield insights on how an inquiry-based science programme can be designed and implemented to enhance Hong Kong students' understanding of NOSI. With this in mind, this study aims to investigate the effectiveness of an inquiry-based science education programme to improve secondary students' understanding of NOSI. The following research questions guide the conduct of the study:

RQ1. How do students' understanding of the nature of scientific inquiry develop as a result of participation in an inquiry-based science programme?

RQ2. What are the student perceptions of the usefulness of the activities in developing their understanding of the nature of scientific inquiry?

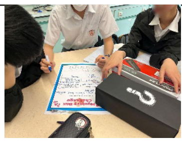
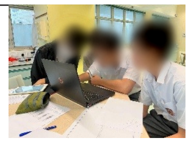
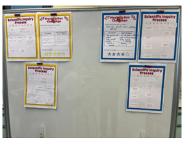
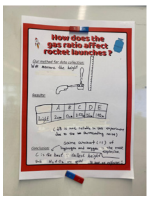
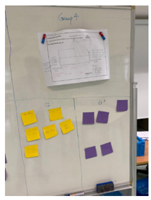
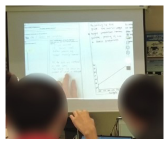
Context of the Research

The school-based science education programme aims to improve secondary students' understanding about science in general. It has been conducted since 2005 for 18 years. The previous programme assumes that students learn NOSI based on an implicit approach. Anecdotal evidence suggests that students found the programme enjoyable, but no systematic evidence has ever been collected to critically evaluate its effectiveness in terms of improving students' cognitive outcomes in terms of their understanding of NOSI.

This year, the programme was reconceptualised and re-designed to more specifically address the three epistemic ideas that are known to be difficult and challenging, but essential for Hong Kong secondary students' functional scientific literacy (see the above section). The new design was a collaborative effort between practitioners (i.e., science teachers in the secondary schools) and science education researchers (Gomoll, Hmelo-Silver & Šabanović, 2022). Researchers brought expertise in contemporary inquiry-based learning and epistemological frameworks, ensuring alignment with the program's goals. In turn, practitioners developed the curriculum and lesson materials tailored to the participating students.

The design and development of the program were informed by current literature on best practices for promoting science learning. For instance, students engaged in a series of inquiry-based science activities and were provided with conceptual tools to think critically and reflect on their experiences within an epistemological framework (Abd-El-Khalick & Lederman, 2000). The previous programme includes several inquiry-based activities such as *Mystery Tube* (Lederman & Abd-El-Khalick, 1998), *Brine Shrimp Investigation* (Dockery & Tomkins, 2000). These activities were modified to bring the three epistemic ideas related to NOSI to the students' attention in an explicit and reflective manner to foster their epistemological understanding of NOSI. The students conducted five guided-inquiry activities in various topics (Table 2). Each inquiry activity lasted about 90 to 180 mins. In general, students in each lesson formulated a research question in the inquiry, designed and conducted their investigations, and collected or analysed primary or secondary data.

Table 2. Investigative activities in the inquiry-based programme

Investigative Activity	**Mystery Box Challenge**	**Rocket Investigation**	**Sailing Stone Mystery**	**Brine Shrimp Investigation**	**Exploring Dataset**
Scientific question asked	What is inside the mystery box?	Which mixtures of hydrogen and oxygen burn most explosively?	What caused the rocks to move in Racetrack Playa?	Do brine shrimps prefer to live in light or dark?	What are the factors that influence an individual cardiovascular response to cold stress?
Scientific method(s) involved	Observational	Fair-testing	Modelling	Fair-testing	Observational Correlational
Brief description of how students collect data to make claims	Students focused on uncovering the contents of a mystery box without looking into the box through the inquiry process.	Students predicted the optimal volume ratio of hydrogen gas and oxygen gas to give a powerful explosion. They plan and design experiments to test their predictions.	Students focused on the mysterious natural phenomenon of sailing stones in the Racetrack Playa of the Death Valley National Park, which puzzled scientists for over a century.	Students investigated brine shrimp larvae's preference for different colors of light. They designed their own experimental design and evaluated peers' setup design for the investigation.	Students examined cardiovascular activity response to cold stress. They conducted the cold pressor test and investigated with a large data set for descriptive and correlational study.
Snapshot					
Student artefacts					

Research Methods

Research Design

The exploratory study adopts an action research approach in which the practitioners (i.e., science teachers) who designed and implemented the science programme collaborated with researchers to solve problems deemed important (Carr & Kemmis, 2003). The results are of local interest to the school, but can potentially generate interest outside the immediate environment.

Data Collection

A total of sixteen secondary two students, aged 13 to 14, voluntarily enrolled in the school-based science education program and were subsequently included in this study. These students demonstrated a significant level of motivation toward science and achieved scores within the top 20% in standardized assessments for integrated science. The students were reminded of their rights as research participants and that their grades would not be affected by participating in the research. The changes in the participating students' understanding of NOSI (i.e., RQ1) were investigated at both group and individual levels. The changes in group level understanding was based on the pre- and post-*Scientific Inquiry Map* (Xiang & Srinivasan, 2023) generated by students in groups. Specifically, at the first session of the programme, the students were given eight inquiry slips representing the main practices in the scientific inquiry process, as well as blank slips where they could write down the step(s) they considered important. In groups of four, they were asked to create a *Scientific Inquiry Map* by adding arrows or text between the slips to make their maps more intelligible to others. They were given the same instructions in the last session of the programme. To gauge changes in individual level understanding, the students completed the *VASI* questionnaire (Lederman et al., 2014) at the start and after the science programme.

For RQ2, students completed a study-derived written survey after the programme to describe how they perceived the programme in terms of developing their understanding of the NOSI (Appendix 1). The survey also contained questions that elicited students' perceptions of the usefulness of the activities in enhancing their learning (Appendix 1). A semi-structured focus group interview (47 mins 18s) was conducted with six students to obtain in-depth students' views. Students who demonstrated varying changes in their understanding of NOSI in the VASI were invited before the interview. The interview questions focused on (1) students' perceived learning from the programme, (2) features of the activities that facilitated their learning, and (3) potential improvements for the programme. The interview protocol can be found in Appendix 2.

Data analysis

Both group- and individual-level data were analysed to answer RQ1. Pre- and post-*Scientific Inquiry Maps* constructed by groups were analysed for the following foci. First, the maps were coded as depicting the SI process as either a linear or a non-linear process. Second, the total number of labels used, the total number of arrows that connect the major practices in key steps of the SI process, as well as the total number of labels with more than three arrows were counted and tallied. These analyses reflect the complexity of the SI process as well as the interconnection between the practices in the key steps of the SI process depicted by the students. Finally, the maps were also checked for evidence of understanding with respect to the three difficult aspects of NOSI in VASI. Specifically, the maps were analysed to see if they contained information about whether the SI process starts with a scientific question, the existence of multiple types of scientific methods, and whether there was a clear differentiation between data and evidence.

For changes at an individual level, student responses in the VASI questionnaire were analysed qualitatively based on Lederman et al. (2014). A scoring panel comprising three members was set up. The members first read examples of student responses showing various levels in the VASI questionnaire in published studies (Gai, Li, Zheng, Wei, Jiang & Lederman, 2022; Gaigher, Lederman & Lederman, 2014; Lederman et al., 2014; Wei, Jiang & Gai, 2021). Based on individual reading of the responses and a collective discussion, a scoring rubric in Appendix 3 was formulated drawing upon the rubric used in Gaigher et al. (2014) after analysing 10% of the data set. Panel members then independently scored the responses. Discrepancies were resolved through negotiation. The interrater reliability of 50% of the responses was 87% using the formula [Agreement/(Agreement + Disagreement) × 100] suggested by Miles and Huberman (1994), deemed to be acceptable based on Lederman et al. (2014). One team member then scored the rest of the responses, and the scoring was further verified by another team member. All discrepancies identified were resolved through discussion.

To answer RQ2, the mean and standard deviation of the students' perception of their understanding of the nature of scientific inquiry before and after the program were first analysed descriptively. Due to the small sample size, differences in the central tendency of the ranked data between the start and the end of the program were tested using a Wilcoxon signed-rank test (Shavelson, 1996), which is a non-parametric substitute for the paired *t*-test that is used on ordinal data that do not meet the normality assumption required by the paired *t*-test. The quantitative analysis was complemented by qualitative analysis of student views in interviews and written surveys. The fully-transcribed interview transcripts as well as the responses in the surveys were analysed qualitatively using thematic analysis in Appendix 4 with respect to two foci: (1) key features of the activities students perceived to be facilitative to their learning; (2) improvement of the programme. See Appendix 4 for the themes and subthemes identified from the qualitative analysis.

Several strategies were used to ensure the trustworthiness of the research. First, during the scoring of the VASI responses, the raters were blinded to the identity of the sample as well as whether it was pre- or post-test. Second, the student interview was conducted by an external researcher who was not involved in teaching the programme. The students were assured that the teachers did not get access to the data with identity so that the students could freely express their views.

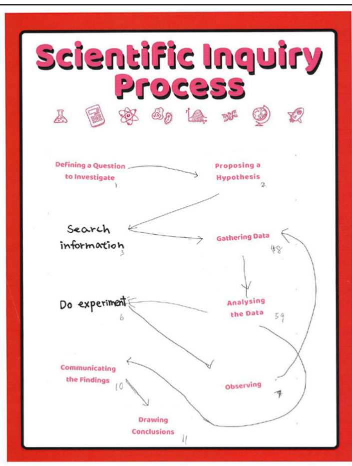
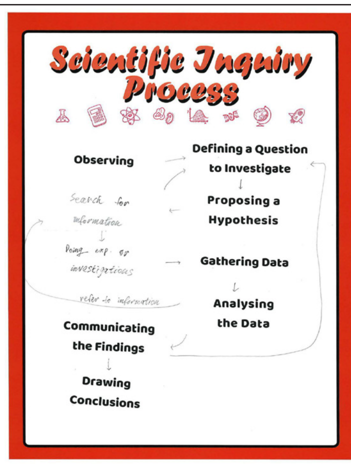
Findings

Changes in Students' Understanding of the Nature of Scientific Inquiry (RQ1)

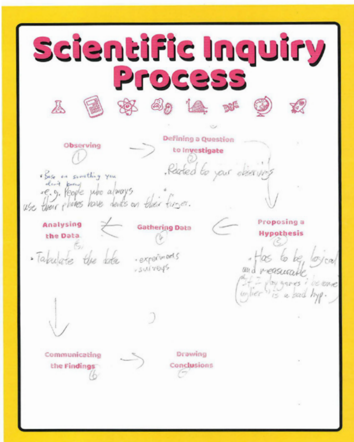
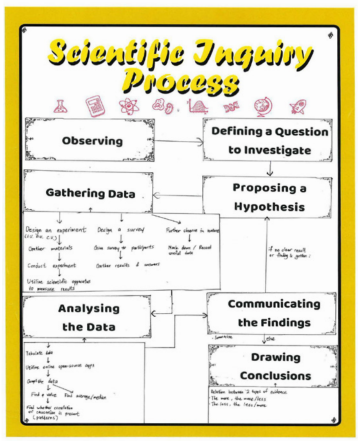
Changes at a Group Level

The possible changes in students' understanding of NOSI at a group level was investigated based on the pre- and post-SI *Scientific Inquiry Maps* (Figure 1). The analysis revealed that at the start of the programme, half of the groups (n = 2) conceptualised the SI process as linear and regimented, comprising steps with fixed orders. However, after the programme, all the groups (n = 4) saw the SI process as more complex and iterative, constituting a non-linear process.

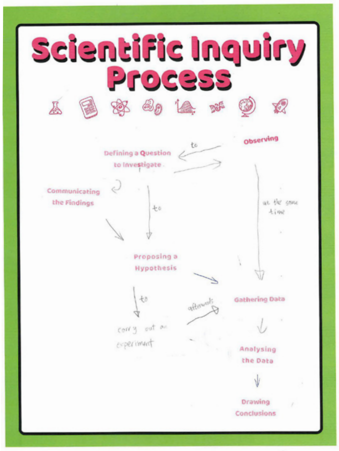
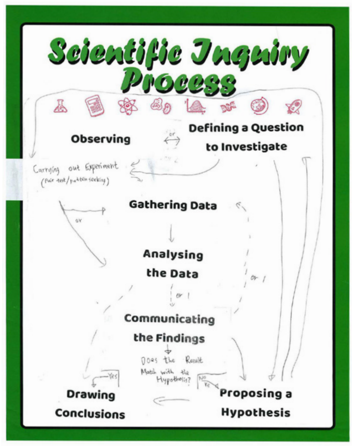
Figure 1. Scientific inquiry maps constructed by student groups at the start (pre-SI map) and near the end of the programme (post-SI map)

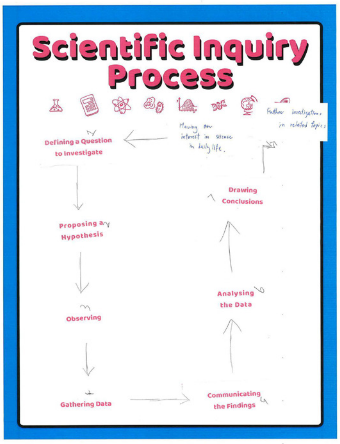
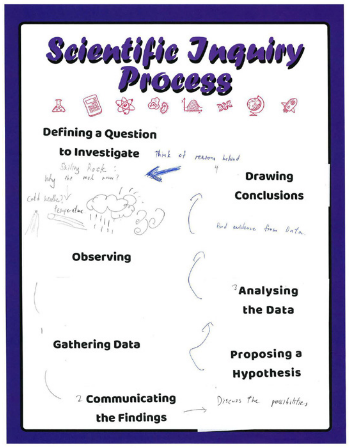
	Pre-SI Map	Post-SI Map
Group	1	
***Scientific Inquiry* Map**		

Overall process	Non-linear	Non-linear
Complexity & interdependence between steps	Number of arrows: 9	Number of arrows: 11
	Number of labels: 9	Number of labels: 10 (label added: Refer to information)
	Number of labels with 3 or more arrows: 1 (Analysing the data)	Number of labels with 3 or more arrows: 3 (Defining a question to investigate; analyzing the data; communicating the finding)
Specific aspects of scientific inquiry	Start with a question: Yes	Start with a question: Yes (theory- informed)
	Multiple methods: No	Multiple methods: No
	Evidence and data: No	Evidence and data: No

	Pre-SI Map	**Post-SI Map**
Group	2	
Scientific Inquiry Map		
Overall process	Linear	Non-linear
Complexity & interdependence between steps	Number of arrows: 6	Number of arrows: 9
	Number of labels: 7	Number of labels: 7 (More details in some labels)
	Number of labels with 3 or more arrows: 0	Number of labels with 3 or more arrows: 1 (Communicating the finding)

Specific aspects of scientific inquiry	Start with a question: No	Start with a question: No
	Multiple methods: Yes (experiment, survey)	Multiple methods: Yes (observation, survey, experiment)
	Evidence and data: No	Evidence and data: Yes

	Pre-SI Map	**Post-SI Map**
Group	3	
Scientific Inquiry Map		
Overall process	Linear	Non-linear
Complexity & interdependence between steps	Number of arrows: 11	Number of arrows: 18
	Number of labels: 8	Number of labels: 9 (label added: Does the results match with the hypothesis)
	Number of labels with 3 or more arrows: 4 (Defining a question to investigate; observing; proposing a hypothesis; gathering the data)	Labels with 3 or more arrows: 6 (Defining a question to investigate; carrying out experiment; gathering the data; analyzing the data; communicating the findings; proposing a hypothesis)
Specific aspects of scientific inquiry	Start with a question: Yes	Start with a question: Yes
	Multiple methods: No	Multiple methods: Yes (fair test, pattern seeking)
	Evidence and data: No	Evidence and data: No

	Pre-SI Map	Post-SI Map
Group	4	
***Scientific Inquiry* Map**		
Overall process	Linear	Non-linear
Complexity & interdependence between steps	Number of arrows: 8	Number of arrows: 9
	Number of labels: 8	Number of labels: 9 (labels added: Find evidence from data, discuss the possibilities; labels removed: having an interest in science in daily life, further investigations in related topics)
	Number of labels with 3 or more arrows: 0	Number of labels with 3 or more arrows: 0
Specific aspects of scientific inquiry	Start with a question: No	Start with a question: No
	Multiple methods: No	Multiple methods: No
	Evidence and data: No	Evidence and data: Yes

Students also developed a more nuanced understanding of the relationships between different steps in the SI process. Although the total number of labels did not change for most groups, their post-SI maps were more complex and contained more details. Except for Group 4, the number of arrows in the maps increased considerably. For instance, Group 1's map showed an increase from 9 to 11 arrows, Group 2's from 6 to 9, and Group 3's from 11 to 18. Moreover, the number of labels with more than three arrows also increased in all groups except Group 4. An interesting observation can be seen in the maps of Groups 1, 2, and 3. In the pre-SI maps, none of these groups connected the "communicating findings" label to more than one other label. However, in the post-SI maps, they all connected this label to multiple labels. For example, in Group 2's post-SI map, "communicating findings" was connected to "proposing a hypothesis," suggesting that communicating findings may lead to reformulating the hypothesis. Similarly, Group 3 connected "communicating findings" to both "gathering data" and "proposing a hypothesis," indicating that students became more aware of how the social process of scrutinising the data presented may lead to the realisation of the need to gather more data or adjust the original hypothesis.

Regarding specific NOSI aspects, in the pre-SI maps, only Group 2 mentioned multiple scientific methods, including surveys and experiments as the methods used in the SI. In the post-SI maps, this group added "observation," and Group 3 indicated "fair testing" and "pattern seeking" which reflect their understanding of the existence of multiple scientific methods. In the pre-SI maps, none of the groups mentioned both "data" and "evidence." However, in the post-SI maps, two groups (Groups 2 and 4) started to differentiate between these two ideas, with Group 4 clearly stating "find evidence from data." However, there appears little change in terms of how the groups see the role of scientific questions in the SI process.

Changes at an Individual Level

Apart from changes at a group level, we investigated individual students' changes in understanding of three epistemic ideas about NOSI at the start and near the end of the programme based on their responses in the VASI questionnaire. Table 3 displays the results. The following describes the students' performance in the three targeted aspects.

Table 3. Number of students and percentage frequency (%) categorised as holding naïve, mixed, and informed views before and after the programme across three aspects of NOSI.

	Begins with a question			Multiple methods			Scientific data are not the same as scientific evidence		
	N	M	I	N	M	I	N	M	I
Pre (n=16)	2(13)	14(88)	0(0)	6(38)	8(50)	2(13)	1(6)	8(50)	7(44)
Post (n=16)	2(13)	11(69)	3(19)	7(44)	6(38)	3(19)	0(0)	9(56)	7(44)

Notes: N = Naïve; M = Mixed; I = Informed.

Scientific Investigations All Begin with a Question and Do Not Necessarily Test a Hypothesis. In the pre-test, the students either held mixed views (88%) or naive views (13%) and none with informed views on this aspect. Typically, students believed that investigations do not need to begin with a scientific question, as illustrated below:

> *"I agree with the student who said "no". Because scientific investigation does not need to start with a question, it can start with an opinion, a theory, a thought and other things." (Student 5, Pre-, Naïve)*

In the post-test, three students advanced to informed views on this aspect. Consider the responses of Student 9 below:

> *"Yes, [the investigation is scientific]. He observes the relationship between beak shape and the type of food birds eat and prove[s] they are [correlational], by many observations which are evidence." (Student 9, Post-, Informed)*

> *"No, [it is not an experiment]. [Because] an experiment should be a fair test, with dv, iv, cv and controlled set-up. Experiment[s] can be a kind of investigation. However, the investigation above is just observing and finding evidence, which's not seen as [an] experiment." (Student 9, Post-, Informed)*

> *"Yes, [investigations should start with a question], as scientific investigation always start[s] from things that are unknown, so we always need something to wonder [about] in order to find out the answer. We wonder and ask what the shape of earth is, and we can do scientific investigation on it." (Student 9, Post-, Informed)*

Note that Student 9 was not only able to identify the different types of scientific methods, including observation and experimental studies, but he was also able to describe the key role of question in guiding the process of a scientific investigation. However, such informed responses are rather rare within the samples. A majority of students still held mixed views (69%) after the programme. Their responses reveal some misconceptions that were resistant to change, as exemplified by the following statements:

"No. It can be a question that [is] interesting." (Student 14, Pre-, Mixed)

"I agree [with] no. It may begin with the curiosity of the scientist. Can be just a[n] interesting fact and try to investigate it." (Student 14, Post-, Mixed)

These students appear to believe that scientific investigation can begin with any interesting questions rather than valid scientific questions. Apart from this misconception, some students were found to conflate observational studies with fair-testing and wrongly believed that observational studies involve manipulation of variables for hypothesis testing, as illustrated in the following responses:

"Yes. Because we can do a variety of experiment[s], such as feeding experiment[s] in [the] wild to collect data and compare. And then, find out [if] the person's hypothesis [is] correct or not. It is possible and necessary to do some experiment[s] and not only do research." (Student 15, Pre-, Mixed)

"Yes. Because he can focus on the type of bird we need by doing experiment[s]. Also it is a better method than finding birds in the wild." (Student 15, Post-, Mixed)

There is No Single Set and Sequence of Steps Followed in All Scientific Investigations (i.e., There is No Single Scientific Method). Before the programme, only two students held informed views (13%) and recognised that observation can be an alternative scientific method, other than experimentation. The majority of the students held mixed (50%) or naive views (38%). For example, these students mistakenly believed that scientific investigations must involve experiments or hold the misconception that there is only one single scientific method. The following shows some typical examples:

"Yes. Because he tried to divide the bird['s] beak shape. Also, he has concluded and he ha[s] do[ne] some experiment[s], although he doesn't consider other variables." (Student 8, Pre-, Naïve)

"No, the only way to conduct a scientific investigation by doing lots of experiment to collect proves that can support

the investigation, this is the only way to conduct a scientific investigation because this is the only way which can collect proves and understand the truth of the scientific investigation" (Student 5, Pre-, Naïve)

The total number of students with mixed or naive views (pre: 88%; post: 82%) remained nearly the same after the programme. A closer analysis of their statements reveals some changes in their responses - none of the students believed there was only one scientific method in the post-test. However, students still struggled to distinguish between different types of scientific methods, such as observational and experimental methods. Rather than describing the multiple methods used by scientists, students often described the possibility of using different procedures to achieve the aim in an investigation, as illustrated by the following statement:

"Yes, when we are doing the rocket experiment (in [Integrated Science Gifted Programme]), we need to [find] which type of fuel supported the rockets. My group measured the height of the rocket, while Sammy (pseudonym)'s group measured the loudness of the explosion. Our methods are different! However, we get similar results. This proves scientific investigations can follow more than one method." (Student 1, Post-, Naïve)

It appears that students were not very clear about the various types of scientific methods and why scientists make use of multiple scientific methods.

Scientific Data are Not the Same as Scientific Evidence. Students fared reasonably well in this targeted aspect even in the pre-test. Almost half of the students (44%) could give an acceptable explanation as they could identify scientific evidence as the product of data analysis. Slightly more than half of the students held mixed (50 %) or naive views (6%). The following shows some typical responses:

"Data is the result of observations or experiments which can be wrong, and evidence is a kind of data which proves something correct or wrong, so evidence is always right." (Student 10, Pre-, Mixed)

"Data is different number of the experiment. It is for make the experiment better if the last time is not successful. Also, it is the result of the experiment. Evidence is text that to let people know why the experiment result is this. It is for proving and explain the result and make the conclusion be more people trust." (Student 12, Pre-, Mixed)

"Information that we find but may not useful or cannot [prove] our hypothesis." (Student 16, Pre-, Naive)

These responses reveal that students held several misconceptions about data and evidence. Similar to the Hong Kong university students in a previous study (Lederman et al., 2021), the students also believed that data can only be in the form of numbers. They also did not realise that evidence is an interpreted form of data. They mistakenly believed that evidence is always correct and ignored that evidence can be biased or incorrectly analysed. As a result, they believed that the role of evidence is to prove the results rather than to support or refute a scientific claim.

The number of students who held mixed views and informed views remained similar before and after the programme (pre: 94 %; post: 100%). The students still believed that data can only be in the form of numbers, but not in other forms such as qualitative observations, and that evidence was used to prove a hypothesis or conclusion rather than to support or refute a claim, as the following typical responses show:

"Data is different from evidence as data can be wrong due to errors in experiments and evidence is always proving something right." (Student 10, Post-, Mixed)

"[D]ata is messy, without filtering and only number. Evidence is filtered with personal [effort]." (Student 12, Post-, Mixed)

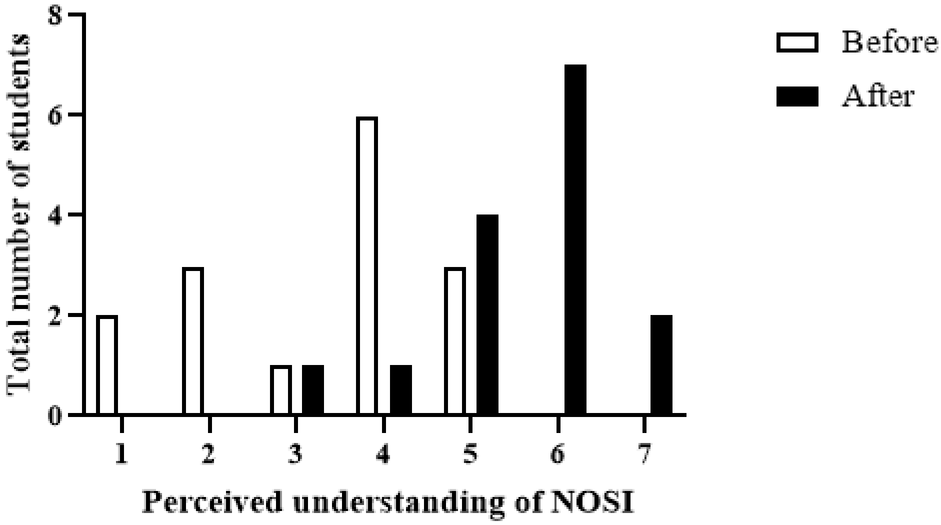
Summary of Findings of RQ1

Analysis of the changes in student responses in the *Scientific Inquiry Maps* and the VASI questionnaire revealed some patterns of change in students' understanding of NOSI. First, based on the group-level data, students developed a more sophisticated understanding of the SI process. They viewed the SI process as a more complex and iterative process, with more intricate relationships between the important steps. Students also became more aware of the existence of multiple scientific methods and the distinction between data and evidence. However, when zooming in on changes in each student's understanding of NOSI in the VASI questionnaire, only modest progress was seen in the three targeted aspects of NOSI. This suggests that students have not yet developed a nuanced understanding of these three epistemic ideas.

Students' Perceptions of the Usefulness of the Activities (RQ2)

Perceived changes in understanding of NOSI

Figure 2. Students' perceived understanding of the nature of scientific inquiry before and after the programme



(1 = very bad; 2 = bad; 3 = fairly bad; 4 = neutral; 5 = fairly good; 6 = good; 7 = very good)

Figure 2 shows the students' perceived understanding of NOS at the start and after the programme. At the start of the programme, more than one-third (n = 6) of the students perceived their understanding of the nature of SI as ranging from very bad to fairly bad (i.e., 1 to 3), with none rating their understanding as good or very good (i.e., 6 or 7) (M = 3.4, SD = 1.4). After the program, only one student perceived their understanding to be fairly bad (i.e., 3) while 10 students rated their understanding as good or very good (i.e., 6 or 7) (M = 5.7, SD = 1.1). The change in students' perceived understanding of the nature of scientific inquiry between the pre- and post-programme assessments was statistically significant (p = .000). This data suggests that students perceived that the programme was useful in enhancing their understanding of NOSI.

Activities perceived to be most useful to their learning

Table 4. Students' perceived usefulness of the activities in enhancing their NOSI

Activity		Perceived usefulness	
		Mean* (SD)	Score# (No.)
(a)	Mystery Box Challenge	4.3 (0.9)	27 (12)
(b)	Rocket Investigation	4.1 (1.0)	17 (9)
(c)	Sailing Stone Mystery	3.3 (1.3)	12 (6)
(d)	Brine Shrimp Investigation	4.2 (0.8)	23 (12)
(e)	Exploring Data Set	3.7 (1.2)	17 (9)

*1 = very not useful; 2 = not useful; 3 = neutral; 4 = useful; 5 = very useful
The students chose three activities that they perceived to have contributed most to enhancing their understanding of NOSI. The top-ranked activity was given a score of 3.0, the second-ranked activity was given a score of 2, and the third-ranked activity was given a score of 1. The number in the brackets refers to the number of students who chose this activity as one of the three top ranking activities.

The students also rated the usefulness of each activity in the programme for enhancing their understanding of NOSI on a scale of 1 (very not useful) to 5 (very useful) in terms of usefulness. Table 4 shows the ratings. *Mystery Box Challenge* (Rating = 4.3), *Brine Shrimp Investigation* (Rating = 4.2) and Rocket Investigation (Rating = 4.1) received the top three ratings. A majority of students ranked these three activities as one of the top three contributing activities in enhancing their learning of NOSI. Typical reasons for high ratings of these activities were as follows:

> *"[Brine Shrimp Investigation is] very interactive, the take-home experiment of growing brine shrimp is fun, which helps me understand the lesson." (Student 6, Exit survey)*

> *Let us do more hands-on experiments like rockets. (Student 11, Exit survey)*

Sailing Stone Mystery (Rating = 3.3) and *Exploring Data Set* (Rating = 3.7) received lower ratings. These results suggest that students generally perceived investigations with secondary data source less engaging when compared to activities involving hands-on experiences, as exemplified by the following:

"More experiments, less data investigat[ions]" (Student 4, Exit survey)

"This programme let us contribute in activities, boosted our knowledge about NOSI, but some activities may be little boring, such as exploring datasets…" (Student 5, Exit survey)

Features of the activities facilitative to learning

Several features of the activities that students perceived to enhance their learning can be identified based on their responses. Consider the following responses:

"I feel that conducting experiments hands-on has taught me the most. Through the reading of IS textbook, we might only know that pop sound could be heard if hydrogen is ignited, but we don't know, if oxygen is added into hydrogen, there will be a bigger explosion, like rocket. Therefore, I believe that we can get a better experience only by doing it once by our own hand." (Student 13, interview)

"We need to explore and do different experiments to get different results and compare with others. Because you experience the experiment process first-hand, you learn more about it rather than just reading or listening." (Student 15, Interview)

In the above quotes, students described the importance of hands-on experiences in enhancing their learning as evident in their sayings – "get a better experience by doing it once by our hands", "you learn more about it rather than reading or listening". Indeed, such hands-on experiences were rather unique from the students' perspective as they are not simply following a prescribed protocol or procedure but one that has some degree of openness, as well-illustrated by the comments below:

"The science taught in this program is much more interesting than what is taught in science textbooks. In textbooks, they only tell you how to test for something. But here, you can actually ask questions, then set up and test things yourself." (Student 13, Interview)

"Usually in science class, the teacher will offer some already-set-up experiment and then teach you to find somethings, but this time we can design the experiment ourselves and then test things, just like that lesson that investigate rocks, at the beginning we will... Actually, there are many other things like brine shrimps that will make us think at the beginning. How do you think we can test it? For example, which type of light they are interested in? It would not just follow the experiment procedures that they already set, we can think of how to test it ourselves, and how to make things more accurate." (Student 9, Interview)

Notice the stark contrast between what students typically experience in their science lessons (e.g., being *told* how to test something) and the activities in the programme (e.g., setting up and testing things themselves). Moreover, their comments also highlight that such openness is not exclusive to a single stage of the SI but is a usual feature in all the stages of the SI process, including posing questions, designing and conducting experiments, as embedded in the above responses.

The students also pointed out another salient difference between what they normally experience in their science classes and the activities in the programme.

"In the final class, when we tested the relationship between BMI and blood pressure, initially, I thought that, maybe by reading textbook, that we can only conduct experiment to perform scientific investigation and to obtain good results. However, after completing the test, collecting data, and plotting them on a chart, I realized that we could understand that as one thing rises, the other might also rise, indicating a relationship between the two." (Student 13, Interview)

"I used to think science was boring. I thought it was boring always doing those experiments like using a Bunsen burner or mixing solutions. But after attending this scientific program, I found the different experiments, different types, like rockets or experiments with brine shrimp, I found them very interesting. It's much more entertaining than before, compared to before in regular lessons." (Student 8, Interview)

It can be seen that the students appreciate the diverse scientific methods used in the activities of the programme. Such experience is not common to their school science learning, offering them a more insightful understanding of the process of how science is done.

Improvement to the programme

Although students are highly positive about the programme, students did express some views on how the programme could have been improved, as illustrated below:

> *"The time for discussion and experimental design was not enough... I remember when we were building the rocket, we didn't get enough oxygen and tried four times." (Student 9, Interview)*

> *"Maybe each experiment can focus on a particular step in a scientific inquiry. Maybe one is about how to use data, while another is about how to set up experiment. Maybe one experiment only focus on one step." (Student 10, Interview)*

The first comment highlights the time constraints faced by the students during the programme. The limited time for discussion and experiment hindered their progress in delving deeper into problem solving and refining their methods. Also clear in the views of the second comment is the lack of focus on specific epistemic ideas from the perspective of the students. The student opined that it would be more instructive to focus on a narrower set of epistemic ideas in each learning experience. There is initial evidence that the students experienced cognitive overload when bombarded with too many epistemic ideas about science.

Summary of Findings of RQ2

In summary, the students rated the programme very positively. Students favoured activities where they could gain first-hand experience to collect primary data. Three main features were perceived as critical to their understanding of NOSI: (1) hands-on, reflective experience of authentic science; (2) openness of inquiry-based activities; (3) inclusion of diverse types of scientific investigations. Two areas that could be improved are (1) better time management and (2) a narrower focus on specific epistemic ideas in each activity.

Discussion

The purpose of this study is to empirically investigate the effectiveness of an inquiry-based science education programme in improving secondary students' understanding of NOSI. Despite the highly positive comments and views of students confirming that the learning experiences were more open-ended, complex and engaging, consistent with a more authentic version of science education, the learning data showed only subtle changes at the individual level in relation to their NOSI. Two important tensions related to designing and implementing inquiry-based programmes emerge from our analysis:

First, while the programme was able to help students recognise that there is not just one scientific method, it did not help them distinguish between different types of scientific methods. Therefore, apart from familiarising students with the different types of scientific methods, more emphasis needs to be placed on the reasons why scientists use a variety of scientific methods to achieve a particular epistemic goal need to be emphasised more. Furthermore, while students recognised the benefits of learning different scientific methods, they preferred hands-on activities and considered non-manipulative methods less motivating and engaging. This points to the tension between how best to incorporate a variety of scientific methods, other than traditional manipulative experimental designs, in a motivating and engaging way.

Second, because authentic scientific practices are inherently complex and involve a certain degree of openness and require a great deal of time for cognitive processing and reflection. Not only is it difficult to fit this type of experience into the normal teaching timetable with short class periods, but more importantly, the rich inquiry- experiences can inadvertently open up opportunities for students to connect their experiences to a diverse set of NOSI aspects. If they are not sufficiently focused in their reflections, their revision of naive ideas about specific epistemic ideas can be superficial and lead to partial changes in their understanding. It is incumbent upon teachers to navigate the tension of providing students with rich experiences while providing sufficient structure and guidance to focus students' attention on particular epistemic ideas through reflective discourse.

Conclusion

Designing and implementing an inquiry-based science programme that reflects a more authentic and realistic version of science to improve students' understanding of NOSI can be a complex undertaking.

This study provides empirical evidence that while students appreciate some key features of the programme and that students' understanding of NOS has changed at the group level, change at the individual level is difficult to initiate. In this context, the study highlighted two important tensions that need to be considered and addressed. Such explicit management of the identified tensions could help science teachers to develop these critical epistemic aspects of science in students so that they achieve functional scientific literacy which is crucial for their future success.

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Appendix 1. Exit survey

1. One of the goals of this program is to improve your understanding of the nature and **characteristics of the process of scientific inquiry** (i.e., NOSI). On a scale of 1-7, please indicate your understanding of NOSI before and after participating in the programme.

   (1 = very bad; 2 = bad; 3 = fairly bad; 4 = neutral; 5 = fairly good; 6 = good; 7 = very good)

   *Before:*____

   *After:*____

   Explain the ratings above.

2. What aspects about NOSI did you learn ***after*** participating in the programme?

3. (a) Rate the following activities in terms of their usefulness in enhancing your understanding about NOSI. *Put an '✓' into the appropriate boxes below.*

   (1 = very not useful; 2 = not useful; 3 = neutral; 4 = useful; 5 = very useful)

Activities		1	2	3	4	5
a.	Mystery Box Challenge					
b.	Rocket Investigation					
c.	Sailing Stone Mystery					
d.	Brine Shrimp Investigation					
e.	Exploring Datasets					

   (b) (1) Rank the top three activities that you think contributed most to enhancing your understanding of NOSI.

Rank	***Activities***
1.	
2.	
3.	

(2) Explain how each of the activities mentioned above contributed to your understanding. (Provide specific examples or moments that contributed to your learning, if applicable)

Rank	***Activities***
1.	
2.	
3.	

4. How can this programme be improved to enhance your understanding of NOSI?

5. Apart from NOSI, what else is the most important thing you have learnt from this programme.

6. Overall, would you recommend this programme to your classmates? Why?

7. Do you have any further suggestions for improving this programme.

Appendix 2. Interview Protocols

1. What do you think is your most important/impressive learning from the programme? Why do you think so?

2. Given you learnt science methods and scientific inquiry before, what are some of the things that you found surprising to learn from this programme?

3. What are some of the features of this programme that you think is facilitative to your learning of understanding of scientific inquiry?

4. To improve your understanding of SI, what else can the programme do?

5. If you know need to tell your classmates the following what would you say:

    (1) How does the process of scientific investigations look like?

    (2) What are the methods scientific use to investigate the world?

    (3) What are the criteria of a good scientific question? What questions are not scientific?

    (4) In science, what do data and evidence mean?

Appendix 3. Scoring rubric of VASI response

Question number and epistemic ideas about NOSI	Naïve	Mixed	Informed
1a, 1b, 2. A scientific investigation should begin with a question, not necessarily a hypothesis	All three answers are inappropriate 1a: it is not scientific 1b: yes, experimental. 2: Investigation should start with a hypothesis; also, questions are not essential	No more than one of the following types of mistakes: 1a: it is not scientific 1b: yes, experimental. 2: no, it does not necessary start with a question	All three answers must be appropriate. 1a: Yes, the investigation is scientific as it aims to explain some aspect of the natural world 1b: No, it is not an experiment as there is no manipulation/ control of variables/ testing 2: A question is the fundamental reason why an investigation is undertaken, a driving force
1b, 1c. Scientific investigations can follow different methods	Both answers are inappropriate 1c: Only one scientific method Or any two/ more mistakes, e.g.: 1b: yes, experimental and 1c: similar examples	One answer is inappropriate 1b: Yes, it is an experiment Or 1c: one general method Or 1c: both examples are experimental or non-experimental	Both answers must be appropriate. 1b: No, it is not an experiment as there is no manipulation/ control of variables/ testing 1c: Yes, investigations can follow different methods: experimental/ practical/testing as opposed to nonintrusive/ nonexperimental/ research/ investigation/ observation/ theoretical/ not-practical Two suitable examples required: one experimental and the other non-experimental
4. Data are not the same as scientific evidence	There is no difference between data and evidence	Evidence differs from data; unclear/wrong/no explanation	Evidence is generated from data, to support a claim/ conclusion

Appendix 4. Thematic analysis of students' responses in the interview and the exit survey

(1) Key features of the activities students perceived to be facilitative to their learning

Theme	Sub-theme	Main findings	Students Quotes
Hands-on and reflective experience	Hands-on experience	Students highly valued the hands-on experience, which allowed them to actively engage in experiments and learn through doing. This method was seen as more effective and enjoyable compared to traditional learning.	We need to explore and do different experiments to get different results and compare with others. Because you experience the experiment process first-hand, you learn more about it rather than just reading or listening. (Student 15, interview) This [Rocket] investigation [was] not [about] just talking with data, but can let us do the experiment by ourselves. (Student 8, Exit survey)
	Reflection	Reflection prompted by the task or teacher instruction reinforced students' learning.	The poster is quite good because you can summarise all your set-ups, conclusions, results, data, and everything else, making everything clearer for you and your team. (Student 9, interview) [For Exploring Data Set], Mr Wong compared the posters of two poster[s] to explain the different between data and evidence and teach how to get evidence by analysing data (Student 16, Exit survey)
Openness of the inquiry-based activities	Openness in asking question and formulating hypothesis	Students valued the freedom to propose their own hypotheses and questions. This freedom to explore their curiosity was perceived as different from their previous science learning experiences.	I thought the "hypothesis" would only appear in the exam paper. But in this program, I can propose my own hypothesis and ask questions. (Student 13, interview) The science taught in this program is much more interesting than what is taught in science textbooks. In textbooks, they only tell you how to test for something. But here, you can actually ask questions, then set up and test things yourself. (Student 13, interview) [For Mystery Box], I learn how to propose hypothesis about unknown things and the solution. (Student 7, Exit survey)

	Openness in designing and conducting experiment	Students valued the freedom to design and conduct experiments based on their own questions and interests, rather than strictly following prescribed procedures. This approach might allow them to engage more deeply with the material and develop critical thinking skills.	In books, they prepare all the experiments, the procedures, and the equipment for you, but here you can truly create, maybe think I want to try this first and then that, everything is possible. (Student 13, interview) That's the experiment we did in Form One and Form Two. The procedures were provided for you, like first, you need to light the Bunsen Burner, then do this and that. But now, you have the opportunity to write down the steps yourself, it's not handed to you by others. (Student 8, interview) I think the most important thing is to actually try it out. Usually in science class, the teacher will offer some already-set-up experiment and then teach you to find somethings, but this time we can design the experiment ourselves and then test things, just like that lesson that investigate rocks, at the beginning we will... Actually, there are many other things like brine shrimps that will make us think at the beginning. How do you think we can test it? For example, which type of light they are interested in? It would not just follow the experiment procedures that they already set, we can think of how to test it ourselves, and how to make things more accurate. (Student 9, interview) [For Mystery Box], I know that I have to be creative. Like when I measure the angle needed for 1 object to fall and find the object. (Student 15, Exit survey)

Inclusion of diverse types of scientific investigations	Diverse experiments	Students were engaged and interested in the variety of experiments in the programme which might have maintained their enthusiasm and curiosity.	I used to think science was boring. I thought it was boring always doing those experiments like using a Bunsen burner or mixing solutions. But after attending this scientific program, I found the different experiments, different types, like rockets or experiments with brine shrimp, I found them very interesting. It's much more entertaining than before, compared to before in regular lessons." (Student 8, interview)
	Diverse methods of investigation	The program was not limited to conducting controlled experimentation but comprised investigations using different scientific methods. Students appreciated the diversity of scientific methods used in the investigations within the programme.	In the final class, when we tested the relationship between BMI and blood pressure, initially, I thought that, maybe by reading textbook, that we can only conduct experiment to perform scientific investigation and to obtain good results. However, after completing the test, collecting data, and plotting them on a chart, I realized that we could understand that as one thing rises, the other might also rise, indicating a relationship between the two." (Student 13, interview) [For Sailing Stone Mystery], It taught me how to use the data given, connect evidence and conclude a solution to the hypothesis. (Student 4, Exit survey) By the exploring datasets, I understand the difference between data and evidence. (Student 10, Exit survey)

(2) Ways to improve the programme

Theme	Main findings	Students Quotes
Better time management	Students felt there was insufficient time for discussions and experimental design. Extending the program duration or optimizing lesson times might enhance the learning experiences.	The time for discussion and experimental design was not enough... I remember when we were building the rocket, we didn't get enough oxygen and tried four times. (Student 9, Interview) I think the programme can be like 8 days in order to have enough time to finish the lesson tasks. (Student 10, Exit survey) More lessons, too short :((Student 2, Exit survey)
Narrower focus on specific epistemic ideas in each activity	Students suggested that each activity in the program could focus on a specific step of scientific inquiry.	Maybe each experiment can focus on a particular step in a scientific inquiry. Maybe one is about how to use data, while another is about how to set up experiment. Maybe one experiment only focus on one step. (Student 10, Interview) I think that the programme can use 1 lesson for each step of actions in the NOSI to focus more on helping us understand the NOSI. (Student 4, Exit survey) To state a clearer relation between the topic and aspects of NOSI. (Student 16, Exit survey)

GET(Geography Economics Tourism) SET GO 結合生涯規劃元素的人文學科(地理、旅款及經濟科)跨課程學習(禮賢旅行社)—探討學生透過認識、觀察與實踐與旅遊相關的行業對自我認識和學習效能所帶來的影響

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摘要

根據《學校生涯規劃教育推行策略大綱便覽》指出：「有效的生涯規劃教育及升學就業輔導應與學校的課程聯繫」，有見及此，是次課程設計以中四修讀旅款科的學生為研究對象，主題為「禮賢旅行社」，課程以旅遊從業員或與旅遊相關的工作為切入點，透過不同的考察活動、講員分享，讓學生經歷認識、觀察、實踐、以至反思的過程，讓學生加深對自我的認識，從中了解在個人的能力、性格和興趣上是否適合相關的工作。另外，透過這次課程，從中希望探討對學生的學習動機及跨學科知識的運用所帶來的影響。

關鍵詞

生涯規劃 創新教育 地理 經濟 旅款

1. 研究背景

1.1 符合多元跨學科的時代趨勢

近年，在後疫情時代全球競爭變得激烈的情況下，香港由國際金融中心發展成除金融業外的多元產業城市，香港政府把生物科技、人工智能 (AI)、智慧城市及金融科技列為具有優勢的四大發展範疇。這些產業要求學生發展多元及跨學科技能，更多跨學科課程應運而生。例如大學大專的金融科技學課程要求學生在商業知識和電腦程式上有高度的能力，而入讀創業與醫療管理學科的學生，無論在營商知識和生物學上，均需有一定的心得。本校選擇跨學科課程的畢業生亦愈來愈多，例如在 2023 年聯招放榜中，有中六學生獲派廚藝及管理、屋宇設備工程及可持續發展學士等跨學科課程。因此，升學及工作範疇變得多元，一方面為學生提供更多可能性，另一方面對學生在不同範疇的知識、能力要求亦提高，因此，若學生自小開始便習慣多角度、多範疇、跨學科地研究不同課題，對自身升學就業亦能開拓更闊視野和更多選擇。

因此，在「三三四」新學制下，學生選科靈活性大增，不限於文理商分割，在這有利條件下，這次 GET SET GO 探究結合了地理科 (Geography)、經濟科 (Economics) 和旅遊與款待科 (Tourism and Hospitality Studies) 跨學科知識，要求學生以不同角度分析荔枝窩、吉澳和鴨洲的生態、旅遊及經濟價值。

1.2. 回應成熟的生涯規劃氛圍，鼓勵學生繼續追夢尋夢

本校多年來在不同級別推行生涯規劃課程，大部分學生對生涯規劃活動頗感興趣，本校亦曾於 2017 年有幸憑著生涯規劃課程取得香港基督教服務處及香港輔導教師協會的「關愛校園獎勵計劃」得獎學校之一，學生普遍願意敞開心扉說夢追夢，師生關係亦融洽；另外，在上年度 KPM「生涯規劃—資訊搜尋」項目中，本校學生的指標為 116，高於全港水平，或多或少表示學生頗為願意為自己的發展和出路進行資料搜尋。我們在以上有利的生涯規劃氛圍下，進行這次 GET SET GO 計劃，盼望學生在積極參與活動後，對自己和一些特色或新興行業有更深的認識。

1.3. 回應生涯規劃發展大趨勢

宏觀環境瞬息萬變，職涯發展一日千里，根據教育局〈學生生涯規劃教育推行策略大綱便覽〉，中學生需不斷經歷自我認識與發展及事業探索來完善不同階段的事業規劃與管理，簡單來說一方面要知己，即從不同經歷中認識自己的性格、價值觀及能力等，另一方面要知彼，即不斷從外界獲取最新的資訊，來加以反思，並作出合適自己的生涯規劃決定。

在「GET SET GO」活動中，學生可多次經歷知己知彼及反思的流程。例如在活動前，學生需要回答一些關於自身性向及工作認知的問卷問題，而在完成活動後再回答另一些對比的問卷問題，分析學生有否透過此次活動更認識自己，或者對某些工種有更深層的認識，從而決定是否考慮相關行業為將來自我的理想職業，是否成為自我努力的目標。

2. 文獻探討及教育研究的價值

2.1 下列圖表將會展示現有 (與生跨課程) 相關的文獻資料及本教育研究的研究焦點：

現有文獻資料來源	現有文獻內容	本研究報告的研究焦點
教育局、不同的大學、「賽馬會鼓掌·創你程計劃」、香港輔導教師協會、香港教育城等	• 內容主要圍繞生涯規劃在全校策劃和實踐的情況 • 課程如何與不同的價值觀連繫和對學生不同技能的訓練 • 學生透過參與生涯規劃的活動所帶來的感受和轉變等。	• 生跨課程對學生的學習效能帶來的影響。 • 生跨課程對學生的自我認識所帶來的影響。

2.2 教育研究的價值：

- 過去的跨科課程大都是由上而下，由教師設計，將學科內容在課堂當中教授，因此，這次研究會嘗試探討即使學生沒有同時選修三科，他們能否以自學的方式去處理不同學科的課程內容。
- 過去有關生跨課程的成效，大部份都是集中展示學生最終的反思，然而，是次研究除了會展示學生在不同階段的反思，亦會透過質性問卷，了解學生如何在過程中加強對別人的觀察，從而加強自我的反思能力和認識。

3. 課程推行日程及研究對象

研究對象為 30 位中四級旅款科學生，他們有不同選修科目的組合。學生分為 5 組，分別以地質、飲食文化、圍村、科技及文創為主題，參加以「香港故事」為主題的行程設計比賽。在 3 日 2 夜的行程設計中，每組學生必須以荔枝窩、吉澳、鴨洲作為其中一個景點，其他景點不限。以參與及預備比賽形式，為學生安排跨科活動及考察，期望同學能結合跨科知識以影片形式展示學習成果。

中四旅款組學生選修科目的組合：

學生1	經濟	化學	旅款
學生2	經濟	企會財	旅款
學生3	經濟	物理	旅款
學生4	歷史	企會財	旅款
學生5	經濟	企會財	旅款
學生6	經濟	企會財	旅款
學生7	歷史	地理	旅款
學生8	經濟	中史	旅款
學生9	生物	企會財	旅款
學生10	歷史	地理	旅款
學生11	歷史	地理	旅款
學生12	歷史	地理	旅款
學生13	歷史	化學	旅款
學生14	生物	地理	旅款
學生15	經濟	地理	旅款

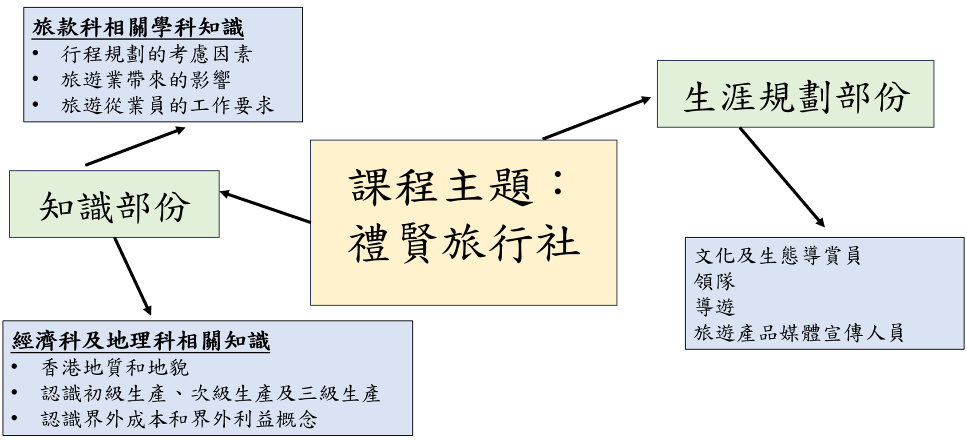
學生16		中史	旅款
學生17		資通	旅款
學生18		企會財	旅款
學生19		資通	旅款
學生20		資通	旅款
學生21		資通	旅款
學生22		企會財	旅款
學生23		企會財	旅款
學生24		企會財	旅款
學生25		資通	旅款
學生26		地理	旅款
學生27		資通	旅款
學生28		企會財	旅款
學生29		資通	旅款
學生30		企會財	旅款

結合生涯規劃的跨課程學習，有以下三方面設計理念：

第一，以實地考察形式及導賞員的第一身分享讓學生於荔枝窩現實環境中加深對課程內容的理解及跨學科知識間的連結；

第二，提供自學材料讓學生提前掌握原有課程中尚未提及的內容以提升於對課程概念於現實環境中的情況；

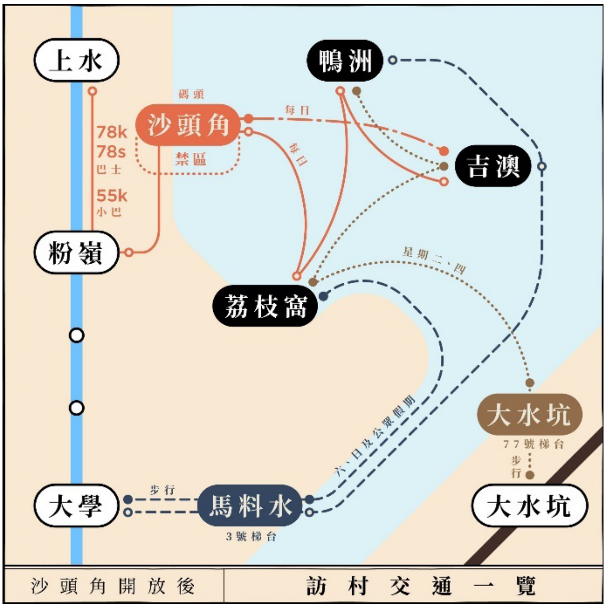
第三，運用以上兩項及其他資源製作影片並參與行程設計比賽讓學生展示學習成果及跨學科知識的連結。



本課程橫跨 2024 年 3 月至 5 月，以下為本課程的日程摘要：

日期	內容	目的
13/3	• 山林動力負責人鍾澤垣先生 (鍾 sir) 到校於旅款科課堂中與學生分享創業經過、帶團要求和注意事項	• 讓學生了解同一職業所需的技能需同時涉獵多個不同學科的知識及對有荔枝窩有初步理解。
4 月	• 學生自習由三科 (地經旅) 老師上載的自學材料，挑選與該組主題相關的概念 • 自行搜集與行程設計相關的資料	• 讓學生提前掌握各科課程中尚未提及的內容 • 激發學生思考如何在行程當中展示、運用及結合不同學科跨科知識 註：所有參賽學生均有選修旅款科，而並非所有學生都有參與選修地理科或經濟科。因此在荔枝窩考察中，每組都可邀請與選修地理科或經濟科的同學一同考察
10/4	• 鍾 sir 到校與學生分享不同題目的行程設計要求	• 進一步對不同主題行程提供意見
17/4	• 鍾 sir 初步就學生的行程提出建議 • 學生於課堂進行行程匯報 • 由鍾 sir 及同學投票評分	• 藉鍾 sir 及同學的回饋，讓同學到荔枝窩考察前修訂方向，令當天資料搜集更聚焦
20/4	• 荔枝窩、吉澳、鴨洲考察及導賞	• 參與導賞，讓學生親身體驗導賞員職業除了制定行程（旅款科知識），亦需於講解導賞中解釋地貌形成（地理科知識）及農業生產及貿易（經濟科知識）等不同內容
21/4-9/5	• 設計行程 • 製作影片 • 就各科知識內容諮詢相關老師	• 整理所見所學，結合跨科知識，設計行程 • 於行程中展示跨科理念
13/5	• 提交參賽影片	• 學習成果展示分享
28/5	• 學生於周會分享 • 全校投票	• 學生展示成果（影片播放及匯報形式） • 收集全校師生意見
18/6	• 學生前往元朗廈村祠堂，訪問文化古蹟導賞員鄧妙薇女士	• 讓修讀旅款的學生可以第一身訪問了解文化導賞員的工作
19/6	• 生態導賞員 Stony sir 前往本校，接受同學的訪問	• 讓修讀旅款的學生可以第一身訪問了解生態導賞員的工作
20/6	• 向大會提交比賽最終影片	/

學生於 2024 年 4 月 20 日從馬料水碼頭至荔枝窩、鴨洲和吉澳的考察路線 [1]



4. 研究焦點

4.1. 生跨課程對學生的學習效能所帶來的影響。(見本文第 5 部份)

4.2. 生跨課程對學生的自我認識所帶來的影響。(見本文第 6 部份)

5. 研究設計、方法及教育理論

- 焦點問題 1：生跨課程對學生的學習效能所帶來的影響。
- 學習效能的定義：相關研究會探討生跨課程對學生的答題技巧和以自學的方式處理跨學科知識的表現
- 課程設計教育理論：鷹架理論 [2](Scaffolding)

1 村里故事（2024）。《沙頭角開放後的訪村交通一覽》。於 2025 年 1 月 11 日擷取自 https://ruralcommon.hk/story/%E6%B2%99%E9%A0%AD%E8%A7%92%E9%96%8B%E6%94%BE%E5%BE%8C%E7%9A%84%E8%A8%AA%E6%9D%91%E4%BA%A4%E9%80%9A%E4%B8%80%E8%A6%BD/。

2 何世敏編著（2024）。《讓學生成為學習的主角：自主學習四學架構的理論創新與學校應用》。香港：智能教育。

下列表格展示在不同階段如何將研究方法與鷹架理論的特徵結合：

階段	鷹架理論 (Scaffolding) 特徵	研究方法及工具	
第一階段	隨機應變 (contingency) • 教師對學生能力進行診斷，給予學生與他們水平相稱或比他們水平稍高的支援	• 各組初步向同學匯報其設計的行程。在行程設計當中，簡單運用過往所學的兩項旅款學科知識，並輔以例子說明。	• 教師制定匯報的評分準則 • 初步了解學生運用過往所學的學科知識與真實情境的結連程度
第二階段	逐步移走 (gradual withdrawal) • 隨著學生能力發展進度，減少支援的數量	• 教師因應學生在第一階段的表現，於第二階段進一步減少支援的程度和數量。 • 2024 年 4 月 20 日 (星期六) 當天合共有五十位中四同學前往荔枝窩、鴨洲和吉澳。隨即在 4 月 22 日 (星期一) 當天，教師在旅款的課堂當中設計了以下兩道問題，教師讓學生自行細閱課本及相關課題筆記內容，進一步以自主學習的方式，要求學生將學科知識與真實情境結合。	• 教師透過課業設計，透過學生的答題表現了解學生對旅款學科知識的掌握程度 • 此階段的研究會再利用六月份的考試成績與 4 月份學生在考察後的答題表現作出比對
第三階段	• 責任轉移 (transfer of responsibility) • 在逐步移走鷹架的過程中，教師將調控學習的責任由教師轉移到學生身上	✓此部份研究會分為兩部份：第一，訪過問卷調查了解有前往考察的學生，對跨學科知識的掌握程度；	✓問卷調查
		✓第二，透過學生影片拍攝的學習成果，過程中分析學生對地理、經濟和旅款科學科知識的掌握程度。	✓教師設計相關的評分指引 (評分當中了解學生運用不同學科知識的能力)

- <u>第一階段研究過程和結果：</u>

  ＞鷹架理論特徵：隨機應變 (contingency) (相關理論詳見本文 5.3 部份)

  ＞學生成果展示方式：在課堂當中匯報 3 日 2 夜行程設計的初步構思

<u>匯報評分紙</u>

評分項目	上	中	下
合作(10%)	8-10 從匯報過程展示各人的分工清晰	5-7 匯報過程嘗試展示各人的分工	1-4 匯報過程中未能展示各人的分工清晰
設計行程主題名稱的創意度(10%)	8-10 行程主題展示高度創意	5-7 行程主題尚能展示創意	1-4 行程主題欠缺創意
指出從荔枝窩、吉澳和鴨洲的行程有哪些景點可達致行程的主題。(20%)	16-20 指出兩個荔吉鴨景點，並貼合行程主題	10-15 指出兩個荔吉鴨景點，嘗試貼合行程主題	1-9 嘗試介紹荔吉鴨景點，但未能貼合行程主題
介紹兩個荔枝窩、吉澳和鴨洲以外的景點，並切合行程主題（20%）	16-20 指出另外兩個景點，並貼合行程主題	10-15 指出另外兩個景點，嘗試貼合行程主題	1-9 指出另外兩個景點，但未貼合行程主題
過程中展示學科概念(20%)	16-20 展示兩個學科概念，並緊扣相關情景	10-15 嘗試展示兩個學科概念，尚能扣連相關情景	1-9 未能將學科概念應用到相關情景
鍾 sir 評分/同學投票（10%）			
時間管理及準時(10%) 準時在 17/4/2024　8:07 或以前將檔案上載至 VLE			

• 研究結果：

<u>各組學生在運用學科知識部份得分</u>

組別	學生組別成績平均排名(以上學期成績計算)(全班人數：30 人)	此階段得分(滿分：20 分)
第一組	16.9	18
第二組	14.25	15
第三組	12.8	13
第四組	12.3	20
第五組	5.7	18

> 研究分析：

<u>根據鷹架「隨機應變」特徵，學生於此階段能運用上學期所學的旅款學科知識於不同的景點當中：</u>

> 就上結果所見，在第一階段當中，在五組的得分當中，未看到同學在運用旅款學科知識的部份有明顯的差異。即使是能力稍高的第五組以及其他組別，在得分上亦與其他組別的分數非常接近。

> 原因：因為只要求同學運用兩項旅款學科知識，對於同學來說較易掌握，而且，各組同學可以有其自主性，選擇運用他們能掌握的學科知識扣連至他們所設計的行程之內。

<u>同學在其他組別匯報過程中所摘錄的筆記</u>

組別	同學匯報內容筆記摘錄
第一組 地理、大地聯繫生命	學科知識：旅客行為守則 -風水林（植物多樣性） -鴨眼海蝕拱（馬斯勞）-西貢
第二組 食飽你、飲食文化	學科知識：消樂、旅遊動機 -鴨頸、鴨眼 -有農作物 -沙頭角
第三組 隱居於村林的景點	學科知識：文化旅遊、行為守則 -故事館：客家歌曲、服飾 -西貢白腊村（營）、民俗館 （難去）
第四組 科技、創新	學科知識：求知欲、生理需求 -智能公廁 -故事館 -科學館 -科學園（金星）

組別	同學匯報內容筆記摘錄
第一組	風水林 — 旅客行為守則 ↳生物多樣性　鴨眼海蝕拱、 ↳可持續發展　馬斯勞需求理論
第二組 「食飽你」	消遣旅遊動機　當地美食 消樂　當地午餐 自由時間　客家菜為主
第三組	體驗村落文化（客家）　-文化旅遊 打卡位為主　-旅客行為守則 了解原居民的生活
第四組	智能公廁　電子支付 以科技了解客家文化　馬斯勞需求理論-生理需求 虛擬導覽　消遣旅遊動機-求知慾

- <u>第二階段研究過程和結果：</u>

> 運用鷹架理論特徵：逐步移走（相關理論詳見本文 5.3 部份）

- 時段一 (4/2024)

  ✓ 問題一：

就考察當天所見，你認為導遊的工作是否做到工作的要求？試運用書本的學科知識及當天所見的例子作說明。

不同能力學生的答題表現：

學生能力 (上學期考試排名)	學生作答表現
第二名	就當天考察所見： 第一，當天的導遊考慮到目標顧客方面的因素，他清楚知道客人的旅遊動機是為了考察而講解了很多有用的學科知識。 第二，當天的導遊在具體安排方面顧及了食行遊方面，安排了午餐以及準備了船隻前往荔吉鴨，不用坐街渡前往，避免了跟人擁擠的情況，亦有去到傳統的旅遊景點安排了仔細的講解介紹。 第三當天的導遊非常了解旅遊目的地的地理方面，他可以跟目的地以外的地理知識扣連，對當地的地理特點了如指掌，知道當地的水土以及植物的生長環境及趨勢。
第十六名	我認為當天的導遊已做到了工作的要求。 首先，在策劃旅程時需要考慮的因素中的目標顧客方面，他們應在預算費用作出一個合理的價錢；而我認為當天的行程價錢非常合理，只需大約一百五十元。 其次，在旅行規劃者的工作概況中的服務範圍方面，他們應了解顧客的旅遊需要，並安排各項預訂工作；而我當天在船上休息和在餐廳吃飯均可以體驗到上述的服務。 最後，在產品知識的地理方面，他們應了解目的地的地理特點，並進行介紹；而當天的導遊也有詳細介紹地質生態，符合上述要求。
第十四名	我認為當時的導遊的工作能做到工作的要求。首先行程安排完全符合客人要求，在不會太累的情況下儘量安排更多的景點。 其次，符合目標旅客方面客人的旅遊動機，我們的旅遊動機是設計行程。而當天導遊有為我們講解如何更好更合理的設計一個行程也可以用當天行程作參考。 再者，當天的導遊重視與客戶溝通技巧，在我們不懂景點的含義時，會以引導的方式耐心的為我們講解，講解的也十分詳細。在我們不懂景點之間的相距時也會為我們講解。
第二十九名	我認為導遊的工作能做到工作的要求。 根據書本的學科知識，「要做好規劃的工作，旅行社從業員不單要有好的產品知識，也要有良好的客戶溝通技巧。」引用當天所見的例子，導遊在過程中進行了很多的講解，例如地貌、建築等。
第二十七名	我認為當天的導遊做到產品知識當中的旅遊目的地的地理方面，他可以介紹到那些地形和岩石，例如鬼手和鴨洲地形。當天的導遊也可以做到旅程交通當中的交通安排，包船。也可以做到旅規劃者工作概況，協調行程，當天鴨洲的天氣傾盆大雨，立即作出協調，更改行程直接回程。

✓ 問題二：

你認為從荔吉鴨的旅遊業發展可以看到對旅遊業帶來甚麼影響？(論述題題型)

學生的答題表現：

第一名學生：

② 2024年4月20日，當我親身前往荔吉鴨後，我認為旅遊業对社会的影響是正面的。首先改善生活方式，旅遊業具有促进社会發展的潛能，包括創造就業机会，由於許多遊客喜愛享用荔吉兩地的茶果或其他小食，從而令不少當地人投身於相关行业，令不少當地老年居民可重新就業去製造相关小食，為當地創造就业机会以及帶來收入。

其次於文化方面，我認為是正面的，可加強文化保育，旅遊業可促进傳統文化及歷史保育，保護當地文物，復興本土文化，而本次前往荔吉兩地各有不同的「故事館」，記錄著以往當地居民們生活、文化、飲食以及產业形成等，可令外來旅客更了解當地的文化，使當地文化，可被可令更多人認識，從而令其減少失傳的机会，也可使文化更有生氣力，更廣泛地流傳下去。

第十六名學生：

#2 在2024年4月20日，当我親身前往荔吉鴨后，我认为旅遊业对社会和文化的影响是改善生活方式。因为在荔吉鴨这三个地方居住的市民通常較为窮困，加上在地理位置的问題，居民可能不会经常外出，而需靠自己去耕作而賺取金錢。但有了旅遊业后，有更多的遊客去到荔吉鴨三个地方，而因他们的到訪会增加当地居民的收入，从而改善他的生活方式。因为有遊客的到訪，他们可以经營一些售买当地别具特色的小食，从而令到当地生活水平提高，改善当地生活方式。

另外，旅遊业对荔吉鴨社会和文化的影响是可以加强文化保育。因为有旅遊业的推扩，可以令荔吉鴨去有足够的资金建立当地的故事館去宣当地的传统文化，以及让遊客去了解当地传统歷史。而因旅遊业建立的故事館可以保留传统文化。

第二十九名學生：

學習彼此的文化與習俗。培育自豪、欣賞、明白、尊重和接納彼此文化的態度。

旅客人數過多，造成阻塞。遊客與本地人共用一些公共娛樂設施可能導致發生衝突。敵意和誤解，旅客過多造成阻塞令當地居民感到不滿。

- 時段二 (學生下學期考試表現)(6/2024)
- 下學期考試題目：

卷一：資料回應題

(c)	兩個旅行團行程均有安排失當的地方。試就每個行程指出其中一項失當之處，並加以說明。	(2 分)
(d)	參考資料，指出並解釋旅遊業對香港文化帶來的兩項好處。	(2 分)

卷二：論述題

粉嶺禮賢會中學修讀中四旅款科的同學於今年四月二十日，一同前往荔枝窩、吉澳及鴨洲。是次行程是為了讓同學更能了解香港的旅遊業發展。除此以外，修讀旅款科的同學將會參加一項全港行程設計比賽，勝出的組別將於本年七月前往台灣作實地考察。		
(a)	根據赫曼（Hudman）的旅遊動機模式，指出並解釋五個較適用於「吸引遊客到荔枝窩、鴨洲和吉澳」的旅遊動機。	(10 分)

- 研究分析

運用鷹架理論逐步移走的特徵，學生在自主學習的情況下，課業當中能高度顯示學生能掌握單一的旅款學科知識，透過分組的行程設計技巧，在考試的作答表現當中亦有助學生掌握答題技巧。考察活動亦有助學生在答題方面運用不同的例子說明。

在四月的課業當中，學生以自主學習的形式，嘗試處理兩道題目：當中包括：導遊的工作要求，以及旅遊業所帶來的影響。當中的可以看到，能力高及中的學生能透過考察活動，詳盡地闡述在考察當中所觀察到的例子，相反，在上學期考試排名較後的學生於例子運用方面的說明會較為簡短。

在六月份的下學期考試當中，教師再次問及旅遊業發展帶來的影響，但以另一資料回應題 (d) 題的出題形式考核學生 (在時段一學生需要以論述題的形式作答)，題目分數所佔比例較低，在 2 分滿分的題目當中，整體的平均分為 0.64 分，若以題型的作答篇幅而言，在時段一題目的論述題作答要求相對較高，而學生的整體表現反而更為理想，分析當中的原因：第一，學生親身前往實地考察，因此，在答題當中可以運用更多的例子作說明。相反，對於學生來說，在考核的題目當中，他們未曾前往該地方，這亦影響了他們的作答表現，由於在題目當中問及大館、藍屋等地方，對部份學生來說，他們未曾到過相關地方，對於學生來說，對相關地方的認知會較為抽象。

相反，就另一 (d) 題學生整體的學習作答表現，相比 (c) 題為高，在 2 分當中的整體分數為 1.1 分。究其原因，學生在生跨課程當中的確需要真實去設計行程，對於他們來說，即使未真正親身前往考核內容當中的景點，但在過程中，亦提升了同學在行程設計上需要留意的地方 (如時間管理、行程要切合主題等)。

另外，在卷二的論述題當中，教師在三個月後問及學生考察活動是否有助同學去處理答題。100% 的學生皆指出考察有助他們去處理答題要求更高的論述題，他們指出實地考察讓他們認識本身不熟悉的香港景點。部份學生在考測當中的個人反思當中指出，即使在答題當中對自己的作答表現並不滿意，但是考察加強了他們對抽象景點的了解程度。

<u>學生就考試題目的論述題的反思</u>

2. 對於你來說，前往「荔吉鴨」進行實地考察是否有助你去處理以上題目？為什麼？

有，可了解當地景點，及遊玩特色，有助我去代入遊客心態，知道其[illegible]旅遊動機.

2. 對於你來說，前往「荔吉鴨」進行實地考察是否有助你去處理以上題目？為什麼？

有助，因為在答題中會幾重新記起考察時的記憶，有助引導我記起各種動機

2. 對於你來說，前往「荔吉鴨」進行實地考察是否有助你去處理以上題目？為什麼？

是，因為實地考察後可以令我更清楚知道該地的環境，會有一個印象在腦裏，在作答時就可以聯想起關於該地的東西。

- 第三階段研究結果對學生的學習帶來的影響：

  > 運用鷹架理論特徵：責任轉移 (運用三科不同的學科知識) (相關理論詳見本文 5.3 部份)

  ✓ 此部份研究會分為質性和量化的研究：

  - 量化研究方面：訪過問卷調查了解有前往考察的學生，對跨學科知識的掌握程度；(前往考察除了修讀旅款的學生，當中亦有另外二十位同學選修其他學科)
  - 質性研究方面：透過學生影片拍攝的學習成果，過程中反映學生對地理、經濟和旅款科學科知識的掌握程度。

- 問卷結果

1. 以實地考察形式及導賞員在考察過程中的分享讓學生於荔枝窩現實環境中加深對課程內容的理解及跨學科知識間的連結

(a) 實地考察

實地考察方面，問卷於考察約兩星期後收集學生對沒有選修的學科的概念能否有一定印象，以分析學生能否以考察形式學習從未接觸的知識。本問卷撇除了學生已有修讀的學科以減低學生因自習或其他形式曾接觸該概念的干擾。另一方面，隨社會需要改變，不同職業更需要來自不同學科的知識，學生將來亦有需要接觸、自學甚至運用從未修讀的學科知識。因此，本問卷旨在分析學生於未有修讀的學科知識提升。以下為問卷回應摘要：

科目	沒有選修該科的人數	能舉出考察中學到該科概念的人數及比例	學生回應概念舉隅	自評考察能否提升該科的認識 （平均分： 0分為沒有增加認識，2分為深入增加認識）
旅款科	17	13(76%)	● 如何用不同方式來吸引遊客，宣傳本地特色帶動遊客量 ● 領隊技巧 ● 客家飲食文化 ● 生態旅遊 ● 圍村生活	1.12
經濟科	26	11(42%)	● 免費的物品不是免費的 ● 機會成本 ● 成本效益 ● 農業初級生產 ● 荔枝窩推行復村計畫以推動荔枝窩經濟	0.65
地理科	25	13(52%)	● 向岸風 ● 紅樹林可以防止氾濫 ● 岩石風化 ● 河口生態價值與保育 ● 沉積岩 ● 不同的地理位置可以藉助自然環境抵禦山泥傾瀉	0.92

根據以上問卷回應，有以下兩點分析：

- 實地考察有助學生學習從未接觸的學科知識
  學生在旅款、經濟、地理等未修讀的學科中，能夠通過考察活動獲得一定的概念認識。當中旅遊科知識的學習成效最佳，其次為地理科和經濟科的學習成效，部分學生舉出的概念亦具深度

- 學生不太重視考察學習對未修讀學科的認識提升
  學生對考察活動對未修讀學科知識的增進效果評分較低，這表明學生可能未完全意識到考察學習在拓寬知識方面及涉獵其他學科對生涯規劃的重要性。

(b) 導賞員在課堂及考察過程中的分享對旅款科學生帶來的影響

在本課程中，學生有機會與三名導賞員作深入交流，當中鍾 sir 扮演了重要角色。他分享了創業經過、帶團要求和注意事項，讓學生了解到同一職業需要涉獵多個不同學科的知識，為後續的跨科學習鋪墊。因此，修讀旅款科的同學更有意識在實地考察中留意其他學科的知識，在考察後能舉出經濟科 (11 名) 及地理科 (13 名) 概念的同學中，均有 9 名是有修讀旅款科，可見導賞員分享及提醒有助學生提高對跨科學習的意識。

2. 提供自學材料讓學生提前掌握原有課程中尚未提及的內容以提升於對課理概念於現實環境中的情況

- 根據負責老師觀察，學生未能有效運用自學材料的情況方面，分析如下：

  學生未能充分利用自學材料，但仍具一定自學能力根據學生回應及影片內容，可見學生未能善用老師提供的自學材料。但這並不代表他們缺乏自學能力，有部分學生反映自學材料太多、篩選需時，因此更傾向於網上搜尋，能更快速獲取所需資訊。然而，學生對自學材料的利用效率較低，反映資料篩選能力仍需進一步培養。

- 自學材料設計有待改善

  學生反映自學材料內容較多，不能有效針對他們的學習需求。考慮每組學生的行程主題不同，自學材料內容難免較多。不過，本課程反映學生資料篩選能力不足，同時傾向於網上搜尋資料。因此，設計自學材料時，應著重於教授學生如何分辨網上資料的真確性及搜尋技巧。而老師則繼續以顧問形式協助學生。

3. 運用以上考察及導賞員在課堂的分享及其他資源製作影片並參與行程設計比賽讓學生展示學習成果及跨學科知識的連結

學生在製作行程設計影片的過程中，能夠有效運用知識，根據各自主題完成作品。透過影片內容及周會分享，學生於本課程有以下學習成果：

- 運用跨學科知識設計行程

  學生能夠整合旅款、地理、經濟等不同學科的知識，設計出富創意且切合主題的行程，影片中展現了學生對各景點的了解及其吸引之處，例如介紹景點時能提出該景點的地質獨特性及經濟價值。

學生在課程完結後反思內容

Subject knowledge	經歷了這次「GET 跨科學習」後，你認為從中如何透拍攝影片/自學形式而學懂了一些額外的跨學科知識？ 在網上搜尋資料時會學到了一些地理科的知識，去吉澳和鴨洲時都會看到一些岩石奇觀，明白了岩石是如何形成，知道了有關地理科形容岩石的一些專有名詞，加深了對地理的認識。

Subject knowledge	經歷了這次「GET 跨科學習」後，你認為從中如何透拍攝影片/自學形式而學懂了一些額外的跨學科知識？ 透過影片直接看到這些知識，例如地理的地貌，可以學懂地理知識。（例如鴨洲的海拱，荔枝窩的風水林等。）

- 自主學習攝影剪輯技巧

學生除了運用跨科知識外，更能自學拍攝、剪輯等影片製作技能。影片剪接流暢，配音清晰，反映出學生的自學能力不受課程設計所限。未來可考慮跨科課程適當地結合科技教育學習領域課程，有助學生展示成果有更多樣的形式。

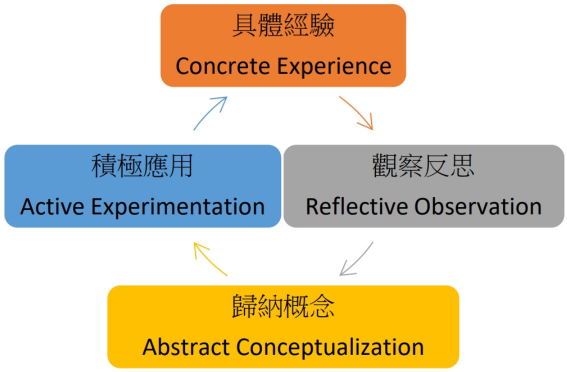
Subject knowledge	經歷了這次「GET 跨科學習」後，你認為從中如何透拍攝影片/自學形式而學懂了一些額外的跨學科知識？ 懂了剪片這一個額外的跨學科知識，因为在生活当中較少时间可以剪片，也是一个比较难得的机会。

- 生涯規劃元素：行業認識

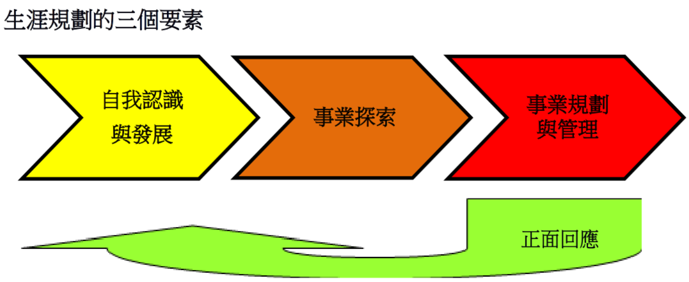
學生自行搜集資料於周會介紹了與行程相關職業，包括：可見學生在這個項目中展現了出色的自學能力。透過主動搜集和整理相關職業資訊，學生可加深對不同職業所需的跨學科知識的認識。在周會上介紹更有助學生訓練的表達和溝通技巧。

6. 研究焦點 2：生跨課程對學生的自的認識所帶來影響

- 研究目的：探討在生跨課程中如何在不同階段加強對自我的認識和反思
- 研究方法：通過質性的問卷、學生的互評，從旅遊從業員的工作當中讓學生加強對我的認識。
- 研究理論：本部份將探討由美國教育理論學者大衛・庫伯（David Kolb）提出的體驗式學習法，而當中涉及具體經驗、反思、抽象概念化及主動實驗四個循環階段。相關的理論與教育局生涯規劃的「自我認識和發展」的元素互相呼應，強調學生透過反思，觀察他人的表現，加強對我的認識程度，從中讓學生更了解未來的發展路向。



經驗學習法(Kolb, 1984)



(教育局：生涯規劃的三個要素)[3]

運用體驗式學習理論，透過旅遊從業員的工作，分析在不同階段學生的反思能力的轉變。

3 教育局。《學校生涯規劃教育 推行策略大綱便覽》。於 2025 年 1 月 11 日擷取自 https://lifeplanning.edb.gov.hk/uploads/page/attachments/Framework_TC.pdf。

<table>
<tr><td>階段一 (2024 年 4 月 17 日)</td><td>生跨課程任務：</td></tr>
<tr><td>具體經驗
- 學習者需要親身經歷事件，感受自身的反應</td><td>學生於課堂上向同學匯報行程設計內容</td></tr>
<tr><td colspan="2">從學生問卷所得的結果：就問卷的結果所見，少於 50% 的同學認為自己對旅遊相關的行業感到有興趣。然而，在同學匯報的過程當中，他們透過觀察同學的匯報內容，對自己的匯報表現進行了不同範疇的反思，過程中，學生了解到個人的表達技巧、協作能力、行程中的時間管理都是十分重要的事情。</td></tr>
<tr><td colspan="2">(a) 對行程的規劃進行了反思：

在匯報的過程中，我認為我的組別/我自己要改善的地方是行程次序和時間安排，如沙頭角放到最先參觀的景點，坐船時間等，扣題食物的揀。

在匯報的過程中，我認為我的組別/我自己要改善的地方是行程安排可以改變一下順序，行程也要再緊扣飲食主題及指出飲食背後的故事。

(b) 對匯報的技巧和內容 / 行程宣傳的吸引力作出反思：

在匯報的過程中，我認為我的組別/我自己要改善的地方是要採訪相關店鋪的店主，了解他們創業的故事。

在匯報的過程中，我認為我的組別/我自己要改善的地方是時間控制，PPT多字，PPT要更精細，寫上分工，科技關聯要更多硬件什麼的。

在匯報的過程中，我認為我的組別/我自己要改善的地方是行程太粗略，沒有不夠仔細說明行程如何，分工有不夠公平，有些組員工作不平均，匯報時太緊張，咬字和速度可以再改善。</td></tr>
</table>

<table>
<tr><td>階段二 (2024 年 4 月 22 日)</td><td>生跨課程任務：</td></tr>
<tr><td>反省觀察
當取得具體經驗後，學習者需要反省事件的因果</td><td>學生透過在 4 月 20 日在荔吉鴨的考察活動，從鍾 sir 的講解，學生以第一身的身份了解旅遊從業員的工作。</td></tr>
</table>

研究結果：在考察完成後，教師在課堂上透過質性問卷調查，讓學生自的檢視是否適合旅遊從業員的工作，而在此階段，學生認為自己對相關行業有興趣的百分比雖然減少。然而，在過程中，學生對旅遊從業員的工作有更進深的認識。

(a) 你認為作為導遊需要有甚麼技能？就考察當天觀察所得，以例子說明。

學生A	隨機應變的能力，因為當天天氣變化很大，時而下雨，時而晴天，導遊需要就當是天氣情況決定改變/取消行程或繼續導覽，再者當天導遊介紹時有很多人問了問題，導遊需要即時給出回應，都很考驗導遊的應變能力
學生B	我認為作為導遊需要對各地十分了解，在為大家介紹景點的時候可以為旅客帶來更多當地的知識，如當地特產如何製作，當地景物的由來等等。
學生C	需要很有耐性，做導遊需要介紹景點的有關資料，可能需要耐心來提前準備景點的東西，亦需在旅程中詳細地講解
學生D	需要非常熟悉當地的歷史文化和地理環境。並且在行程途中如發生任何突發事件，例如暴雨；要有很強的隨機應變能力，否則行程有機會以失敗告終。並且一個好的導遊應該與旅客有一定的互動，例如答問題。

(b) 你認為自己是否適合相關工作？為什麼？

學生A	我認為自己不適合做導遊，因為每逢遇到危機的事情或是不知道的問題，我都答不出來或者不懂解決，我只適合解決我曾遇到的事情，不擅長隨機應變
學生B	不認為。因為我沒有足夠的勇氣去面對眾多的參加者，還有我沒有足夠的講解能力。
學生C	不適合，當導遊需要在車程的時候講述歷史故事，需要不停地講，而我話較少。加上當導遊要記住很多歷史，比如年份，我的記性不是特別好，我也不喜歡重複的工作，即重複講述這段歷史故事。因此我不適合做相關的工作。

階段三	生跨課程任務：
總結經驗 / 演繹總結 學生在過程中，將他們觀察所得，轉化為知識和理論。	2024 年 5 月，學生完成影片拍攝，完成 3 日 2 夜的行程設計，並於周會當中向全校同學展示。過程中，同學需要在影片當中融入地理、經濟和旅款的學科知識。
相關的學生課業及反思詳見本報告焦點問題 1(第 17-19 頁)	

階段四	生跨課程任務：
實踐應用 生活情況中嘗試實踐	學生透過前往台灣，各組學生透行程設計所學的技巧，在台灣的行程設計當中實踐出來。

1. 對於你來說，在整個考察團當中,最有滿足感的事情是….
• 對於你來說，在整個考察團當中,最有滿足感的事情是能夠成功帶領大家前往基隆，及在遇到困難時能立即作出調整，有充足的事前預備。 • 最有滿足感的便是與組員一同規劃行程，再透過一天的帶隊實行這個行程，看到自己與組員從零開始規劃的行程實行後，覺得很有成就感。
2. 對於你來說，你認為最感困難的事是….
• 對於你來說，你認為最感困難的事是於基隆乘搭交通工具，因為當地的交通稀疏，無法靠google map 預計班次，需要熟悉當地巴士路線以便在需要時作出調整 • 關於這一次考察團，讓我最困難的就是我們要擔任一個規劃行程和一個小領隊的職位，我發現當領隊是真的挺難的，在交通方面和旅程方面要有多方面的考慮，而且作為一個優秀的領隊，也得想一個備用的方案，像是交通延遲怎麼辦這些問題都是得要領隊來解決，這讓我知道了一個領隊的困難和艱辛。
3. 對於你來說，你認為自己最值得欣賞的地方是…
• 對於你來說，你認為自己最值得欣賞的地方是即使第一次到達基隆港口，在人生路不熟的情況下成功達成正確的巴士，及在壓力底下仍然能夠作出正確的抉擇，在事前預備充足 • 對於我來說，我認為自己最值得欣賞的地方是在帶路前一晚不斷找路線，只爲找尋一條穩定的路線。 • 敢找當地人聊天，因為很多景點在網上可能找不到最佳的觀賞時機，或者難以找到，便需要主動找當地人問路，例如當時跟博物館的爺爺聊天後，知道在彩虹樓看日落很好看
4. 對於你來說，你認為在考察過程中提升了你哪些軟技能？（如解難、協作、溝通、時間管理、靈活性等）
• 在考察過程中，我認為提升了我的判斷力、解難及靈活性。帶領大家前往基隆的時候遇到很多不可預計的情況，鍛鍊我的應變能力。 • 對於我來說，我在整個考察過程中提昇的時間管理的技能，我需要規劃時間的使用，除此之外，更提昇了靈活性，因為如果有意外就要靈活變通，需要具備好後備方案。 • 對於我來說，我覺得我在考察過程中提升了一些我的溝通跟協作能力方面，像是我其實以前我是不怎麼喜歡和隊友之間有任何的溝通或者交往，但在這一次，我確確實實跟他們有討論關於行程的安排等等，所以我覺得這確實是我跨出的第一步，在這兩方面我覺得我是有稍微的提升的。 • 溝通能力，在旅程中跟當地人溝通問路，或是跟組員溝通調整行程都需要用到溝通能力。靈活性，由於旅途瞬息萬變，需要按照當下的情況決定行程是否改變，是否需要改變逗留時間等。時間管理，需要在一天內盡可能豐富行程，但也不可以令同學感到太累，也需要時刻注意時間，以防錯過活動

7. 總結：

7.1 生跨課程的學習成果

是次的生跨課程作為本校創新課程的一個試點，將生涯規劃和跨科課程兩項元素結合。過去本校均有推行不同範疇的跨學科課程，因此，是次的創新課程，希望在已成熟跨學科課程發展當中，與生涯規劃的活動加以連繫。目的是希望學生透過真實的情境運用，將學科知識與生活連繫，而在教育研究的結果當中，可以看到同學在學習效能和動機的提升，以及提升自我認識，有利學生未來的職場探索當中，更清楚自己的目標，朝著自身的目標進發，呼應了是次跨課程的主題— set go。

7.2 生跨課程讓本校學生對不同行業有更進深的認識

在設計課程之初，最先的課程內容主要是希望讓學生認識與旅遊相關的行業，然而，在過程中，學生有機會認識更多不同的行業。例如當學生前往荔枝窩，他們有機會認識不同產業，例如茶餐廳、士多等行業，又認識當地居民如何利用在地特色發展不同出路，例如利用獨特的地理特徵發展生態旅遊、利用合適的天氣種植特色咖啡和製作不同農產品、利用環境發展民宿，讓學生體驗香港人的靈活和企業家精神，滿足他們在創業和生涯規劃上的好奇心。

另外，在學校周會上，我們要求學生在其所屬分組上，搜尋與他們組別有聯繫而又感興趣的行業或人物與其他學生分享，結果，傳統文化組選擇了獅頭紮作師傅、文創組選擇了荔林咖啡創辦人、科技組選擇了無人機策展負責人、美食組選擇了 YOUTUBER，最後生態組則選擇了生態導賞員，我們希望藉此讓學生在活動尾聲時，運用他們追夢之心，搜索和介紹一些平時較少為人知的行業，以增強其對相關行業的認知，盼望奠下學生繼續搜尋職涯資訊、為自己規劃人生的基礎。

7.3 課程的延展性和未來發展

經過是次生跨課程的試驗，未來會繼續拓展「禮賢旅行社」的運作，是次生跨課程主要是讓學生認識旅遊從業員的工作、亦讓學生以拍片的形式展示學習成果。在新學年當中，除了旅款和地理科，將會加入歷史科和資訊科技科的參與，當中會由學生運作模擬的旅行社，過程中，教師透過觀察學生不同的專長 (如剪片、表達能力、攝影技巧等)，讓學生可以嘗試不同的旅遊工作 (如旅遊應用程式設計員、本地文化及生態導賞員、領隊、導遊等)，過程中，希望學生繼續運用不同的跨學科知識，在不同行業的經歷當中加強對自我的認識和共通能力。

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附錄一：校本版反思 (FRCSS 為本校的簡稱)

粉嶺禮賢會中學

中四級旅款科 GET 跨科學習反思

姓名：______________ 班別：__________(   ) 日期：8/7/2024

甲部：自我反思

Feeling	對於你來說，在 GET 跨科學習的過程中，你認為最有滿足感的事情是甚麼？試分享一件事情。
	對於你來說，在參與 GET 跨科學習的過程中，你認為最感困難的事情是甚麼？
Reflection	經歷了這次 GET 跨科學習，在於你個人來說，你認為自己有甚麼值得欣賞的地方？
Co-create	在過程中，你最欣賞哪一位同學？為甚麼？試分享當中一個片段。
Skills	經歷了這次「GET 跨科學習」後，對於你個人來說，你認為下列哪一項軟技能最為重要？為什麼？ -獨立、協作力、解難能力、時間管理、溝通能力、創意、靈活性
Subject knowledge	經歷了這次「GET 跨科學習」後，你認為從中如何透拍攝影片/自學形式而學懂了一些額外的跨學科知識？

附錄二：學生在生跨課程完結後的分享：

在訪問中，我印象最深刻的是May姐記得好多事，多久前的事都記得，並且在每次的回應問題中，他都很詳細的述說那些事例，我最深刻May姐提到的「使命感」，因為我聽到這個很有共鳴，我在學校中擔任社幹事的職位，我從做上社幹事的那一刻，也有使命感，所以我很印象深刻，我最欣賞May姐的堅持和負責.	要發掘興趣 ， 再把興趣發展成相關的職業，就算有些職業看起來跟本來想做的職業不一樣，但是還是有一定的關聯性。另外，要把握每次的機會，不要害怕跟別人交流，把創新的想法運用在職業當中，嘗試不同類型的職業才能有一個良好的職業生涯。
就我所知，鍾sir以前選修的科目以理科為主，我認為大部分理科都是需要面對數字，沒有感情的或者不需要太大情感共鳴，但是鍾sir在投身IT業後卻轉戰旅遊，社工等這類需要與人溝通或者需要很強情感溝通的能力，讓我明白選的科目不一定會影響自己未來的出路，反而可以用科目中學到的知識作為輔助，去幫助自己有能多能力	訪問過後，在這次訪問生態導賞員的過程中，最令我印象深刻的是導賞員分享大自然的細節和專業的知識，以及，他對大自然的熱愛和保護環境的決心深深打動了我。面對我們的提問，他都表現出了極大的耐心和專業。他的熱情體現了對工作的投入，這次訪問讓我對生態保護有了更深的理解和認識，也激勵我在日常生活中更加關注和保護我們的自然環境。
我聽完講解後，認識到了現在要做旅遊業是不容易。除了要俱備旅遊知識外，其他不同學科的知識也很重要。就例如剛才所說的IT，原來要做好旅遊業是要多才藝的；亦都聽到做旅遊業是非常之辛苦，因為聽到他說要在五到六年之內走遍整個香港。並且他開旅遊公司也是經歷過不同的失敗才成功，所以對我的啟發是做旅遊業是不容易的，同埋要作出新的嘗試才會有機會成功。	鍾sir在內地做機械師的時候被內地人取代，但是鍾sir回到香港之後也沒有放棄，只是換了另一份工作去學習然後去實踐並花了10年，我覺得這個很啟發我，一開始我是覺得如果我真的失敗了，我只能找一家餐廳做服務員，但是鍾sir的經歷啟發我就算失敗，還能自己找出路，要是放棄了，就沒有出路了。

The Impact of School-based Career and Life Planning Program on Career Adaptability and indecision of Students with Visual Impairment.

WONG Park Lam

Ebenezer School

Abstract

There is a raising concern about how to help the students, especially those with visual impairment, in the present rapidly changing world. The present study focuses on investigating how a tailored school-based career and life planning program including regular career lessons and individual career counseling impacts the career adaptability and indecision of the students with visual impairment in Hong Kong. To understand the effect of the school-based career and life planning program on the secondary school students with visual impairment (S3 to S5), the pretests and posttests are conducted to assess visual impaired students' career adaptability and decision-making difficulties. Meanwhile, the qualitative data are collected through the regular interviews during individual counseling sessions. The result shows that the school-based career and life planning program have significant impact on boosting students' career adaptability and reducing students' career decision-making difficulties. More importantly, it also reflects that regular career lessons and individual career counseling sessions have a complementary role to each other. These two elements should be integrated when designing a school-based career and life planning program for students, especially those with special education needs.

Keywords

career and life planning, school-based program, students with visual impairment, career adaptability, career decision making difficulties

Introduction

Career and life planning is a significant element for the present youngsters (Education Bureau, 2021). Since the advancement in technology and media, people tend to become more doubtful about their future plan because of the redundant career information (Savickas, 2013). According to Super's career theory (1990), adolescents and young adults are experiencing the exploration stage which is a significant point of their career development. It is believed that students with special education needs (SEN) will have much more difficulties dealing with the mentioned Super's growing process. The report from Inclusive Employment of People with Disabilities in Hong Kong (2021) indicates that the unemployment rate people with disabilities is about 11% compared with 5.8% of people without disabilities. Job seekers with visual impairment have identified challenges in the job search process as a significant career barrier (Donaldson, 2017). The Hong Kong Blind Union (2018) further indicates that individuals with visual impairment face an even steeper unemployment rate of 18.9%, underscoring a substantial employment gap between people with and without disabilities. This disparity in employment rates reflects significant challenges faced by individuals with disabilities, including limited access to education, skills development, and reasonable accommodations. Given the above situation, it is crucial for educators to equip students with special education need, especially those with visual impairment, early for their career planning. By providing the necessary support and resources, we can help them navigate their futures more effectively and overcome the challenges they face. The present study will investigate whether the school-based career program which integrated by regular career lessons and individual career counseling in Ebenezer School, which providing educational services for students with visual impairment, would be able to prepare students for career adaptability and confidence in decision making regarding their careers.

Literature Review

Career Adaptability

According to Super's (1990) career development theory, an individual's self-concept forms a fundamental cornerstone in their career progression. As they go through the stages of growth, exploration, establishment, maintenance, and decline, they sculpt their self-perception, shaping both their personal and professional growth. Adolescents and young adults, particularly focus on the Exploration stage, find themselves at a critical juncture in their career journey. Savickas (1997) underscored the paramount significance of incorporating career adaptability into Super's theory, emphasizing the dynamic interplay between individuals and their surrounding environment.

The emphasis on the intricate relationship between personal attributes and external influences align closely with the Social Cognitive Career Theory (SCCT). SCCT emphasizes that how personal factors such as disabilities and environmental aspects like school-based support profoundly impact students' self-efficacy and decision-making processes regarding their careers (Brown & Lent, 2017). In 2005, the concept of career adaptability was conceptually refined into four distinct elements: career concern, career control, career curiosity, and career confidence (Savickas, 2005). Career concern means an individual's keen interest in their future career development, while career control signifies their proactive role in shaping their career trajectory. Career curiosity highlights active engagement in career pursuits, including the exploration of self-cultivation strategies and employment avenues. Career confidence embodies an individual's resilience and belief in overcoming obstacles to realize their career aspirations.

Moreover, Savickas and Porfeli (2012) underscore the pivotal role of career adaptability as a psychological resource, empowering individuals to navigate through career challenges, responsibilities, and transitions adeptly. Scholarly endeavors by Beveridge et al. (2002) and Szymanski & Vancollins (2003) have delved into the experiences of students with Special Educational Needs (SENs) through the lens of super's career development theory. Salimi, S., Nilforooshan & Sadeghi (2022) also highlighted that career adaptability is an influential factor in addressing career-related issues, such as job satisfaction, particularly among individuals with visual impairment.

Career Decision-Making Difficulties

Various studies (Gati & Saka, 2001; Mau, 2004 & 2001; Camp, 2000) have underscored that career decision-making difficulties play an essential role in students' career development. Failure to make career decisions or handling them inadequately is more likely to have adverse effects on students' well-being, quality of life, and job satisfaction (Akpochafo, 2020). The focus on career indecision has also gained attention within the realm of vocational psychology (Amir & Gati, 2006). According to Gati, Krausz & Osipow (1996), the theory of career decision-making comprises three primary components: lack of readiness, where individuals encounter challenges before the decision-making process; lack of information, where individuals face a dearth of knowledge regarding themselves, occupations, and the steps necessary for decision-making; and inconsistent information, involving contradictions from significant others and unreliable or ambiguous data. Individuals with disabilities often feel that the support they received in school was inadequate, which discourages them to make a concrete decision of pursuing the standard educational qualifications which is necessary for university admission (Martin, 2004). Shah (2005) emphasized the significance of providing support to young disabled individuals as they navigate their educational and career transition decisions. Individuals with visual impairment who lack information about the world around them often experience difficulties in career decision-making and feel a lack of control in their lives, which significantly hinders their job-seeking and career development efforts (Wolffe, 1996). Addressing these decision-making difficulties early on and providing appropriate support and guidance can significantly impact students' career trajectories and overall satisfaction with their chosen paths.

Career Adaptability and Career Decision-Making Difficulties

In the current study, our focus will center on two key elements: career adaptability and career decision-making difficulties. Some researchers have proposed a close relationship between decision-making difficulties and individuals' adaptive responses (Rudolph, Lavigne & Zacher, 2017; Savickas & Porfeli, 2012). For instance, Kulcsár, Dobrean & Gati (2020) view career adaptability as a precursor to career decision-making. Exploring the interplay between these factors can provide valuable insights into how individuals navigate challenges in making career choices and the role adaptability plays in shaping their decision-making processes.

The School-based Career and Life Planning Program

When students with visual impairment struggle to develop adequate career adaptability and decision-making skills, their journey through academic and vocational paths becomes challenging. This struggle often manifests in difficulties selecting a career path and integrating into society effectively in the future. Recognizing these challenges, we have devised a comprehensive set of school-based career and life planning programs at Ebenezer School, a special school for VI students in Hong Kong.

The career and life planning team at Ebenezer School has spearheaded the creation of a holistic school-based career and life planning program. This program integrates regular career lessons and individual career counseling sessions as key interventions. The school-based career and life planning program is designed with the purpose of offering students with visual impairment opportunities to enhance their self-understanding, engage in career-related experiential learning activities, and gain crucial insights into potential career pathways, which in turn bolsters their career adaptability and alleviates career indecision.

The Goal of Present Study

Through this research endeavor, we seek to evaluate the efficacy of our school-based career and life planning program initiatives specifically tailored for students with visual impairment. By gaining insights into the impact of these programs on students' career adaptability and decision-making capabilities, we aim to refine and optimize our program, serving as a blueprint for future initiatives that foster the growth and development of students with visual impairment.

Research Question

How does the implementation of the school-based career and life planning program, which consists of regular career lessons and individual career counseling sessions, impact the levels of career adaptability and career indecision among students with visual impairment?

Methodology

In the forthcoming study, a mixed-method approach incorporating both quantitative and qualitative methodologies, as advocated by Creswell (2015), will be employed to comprehensively evaluate the impact of a school-based career development program on students with visual impairment. The research will focus on assessing changes in participants' levels of career indecision and career adaptability through a quasi-experimental design, aiming to establish a causal relationship following the intervention.

For the quantitative component, a quasi-experimental design will be utilized, with pre-test and post-test evaluations conducted at the beginning and end of the academic year by using the paired sample t-test in SPSS. This method will enable a systematic examination of the effectiveness of the intervention on participants' career decision-making difficulties and adaptability, providing valuable insights into the program's outcomes.

To measure the levels of career indecision and adaptability, the Chinese Version of the Career Decision-Making Difficulties Questionnaire (CDDQ) and the Career Adaptability Scale (CAAS) from the Education

Bureau's "CLAP for Youth - My Life Planning Portfolio" will be employed. Additionally, participants' psychological backgrounds related to their ability to handle career issues will be collected through pre-test and post-test assessments.

In the qualitative component, data will be gathered through students' reflections on their career situations during four individual career counseling sessions. Two open-ended questions will be posed to elicit insights from the participants: "What situations or issues have you been facing in your career planning recently?" and "In terms of your career development, what are you currently focusing on or emphasizing?" This qualitative data will provide a deeper understanding of students' perspectives and experiences regarding their career development journey.

The intervention will consist of regular career lessons and individual career counseling sessions conducted throughout the 2023-2024 academic year. These sessions, totaling 28 lessons (refer to the appendix 1), are designed to foster students' self-awareness, enhance their career-related skills, and offer essential academic and career-related information to guide their future paths.

In conjunction with the regular lessons, the Clap Life Design (trial version) booklet (2019) will be utilized during four individual career counseling sessions. These sessions are structured to facilitate engagement, promote self-understanding, explore career paths and opportunities, and support students in planning and managing their careers effectively. The CALP life design booklet has already been used for individual career counseling in six secondary schools in Hong Kong as a trial before.

Findings

Initially, we invited eight students from forms three to five to participate in the school-based career program. However, one student had to withdraw in December due to medical reasons. As a result, we collected data from the remaining seven students, five male and two female and aged between 16 and 20 years old, who remained in the program for its entirety.

The effect of the school-based career and life planning program have been investigated through assessing the students' career adaptability with CAAS and career decision-making difficulties with CDDQ by using the paired sample t-test in SPSS.

The level of career adaptability increased from M = 3.15, SD = 0.76 to M = 3.8, SD = 0.49, indicating significant improvement after participating in the school-based program with $t(6) = -4.45$; $p < 0.01$; $d = 1.68$. Four elements of Career Adaptability, including concern, control, curiosity, and confidence, showed significant improvement.

The Career Adaptability

The effect of the school based program (including the career lessons and individual career counseling) will be assessed by the pair sample t test via SPSS.

The level of career adaptability increased from M = 3.15, SD = 0.76 to M = 3.8, SD = 0.49 which indicates an significant improvement after participating in the school based program with $t(6) = -4.45$; $p < 0.01$; $d = 1.68$. There are four elements of Career Adaptability including concern, control, curiosity and confidence shown significant improvement. For career concern, result showed significant increase from M = 3.0, SD = 0.88 to M=3.67, SD = 0.54 with $t(6) = -4.09$; $p < 0.01$. For career control, a significant improvement is found $t(6) = -2.64$; $p < 0.05$ from pre-test M = 3.24, SD = 0.89 to post-test M = 3.86, SD = 0.66. For career curiosity, the curiosity level is increase from M = 3.04, SD = 0.8 to M = 3.67, SD = 0.67 with $t(6)=-3.36$; $p < 0.05$. Last but not least, the career confidence has been raised from M = 3.33, SD = 0.82 to M = 4.04, SD = 0.41 with $t(6)= -3.87$; $p < 0.01$.

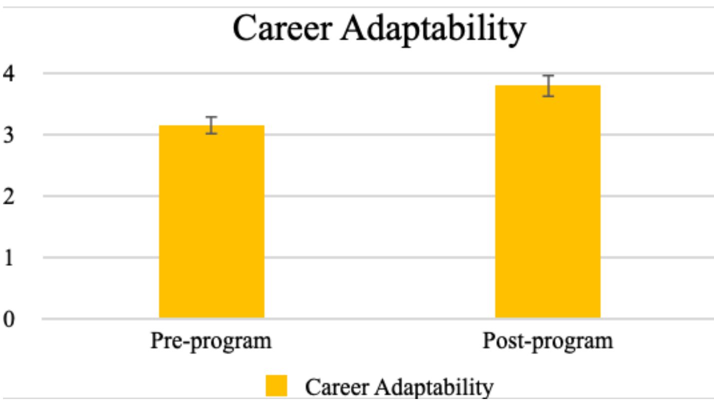

Figure 1: Career Adaptability (by CAAS) means and 95%CIs associated with the pre- and post-program conditions

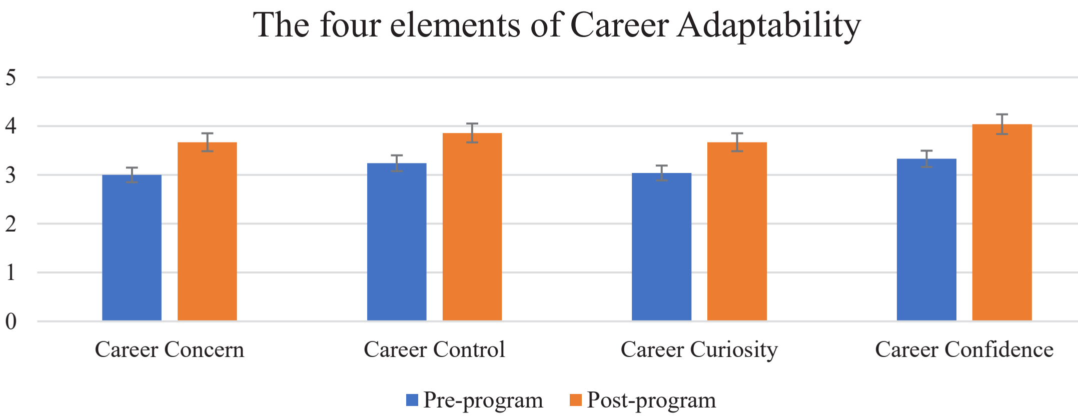

Figure 2: The four elements of Career Adaptability (by CAAS) means and 95%CIs associated with the pre- and post-program conditions

The Career Decision-Making Difficulties

The level of Career decision-making difficulties decreased from M = 5.22, SD = 0.81 to M = 4.14, SD = 0.62, which showed an reduction after joining the school based program with $t(6) = 5.51$; $p < 0.01$; $d = 2.08$. Two sub scale of career decision-making difficulties including lack of information and conflict of information has also showed significant reduction from M = 5.22, SD = 1.57 to M = 3.61, SD = 0.95 with $t(6) = 3.32$; $p < 0.05$ and from M = 5.3, SD = 1.12 to M = 3.91, SD = 0.7 with $t(6) = 4.5$; $p < 0.01$ respectively. However, the level of readiness which is a sub-scale of Career decision making difficulties which showed no significant difference with $t(6) = 0.68$; $p = 0.52$, comparing M = 4.9, SD = 0.55 with M = 4.8, SD = 0.59.

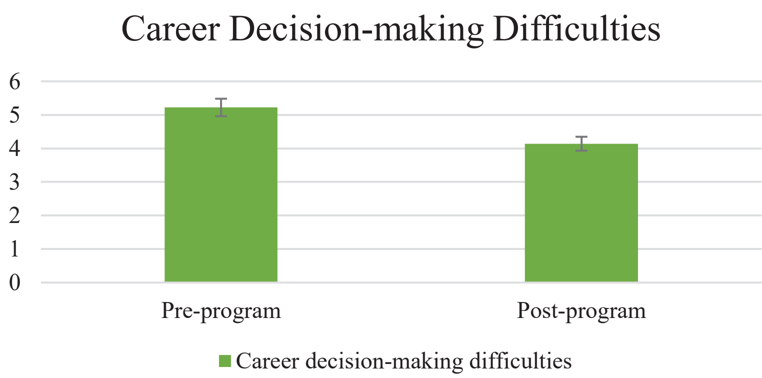

Figure 3: Career Decision-making Difficulties (by CDDQ) means and 95%CIs associated with the pre- and post-program conditions

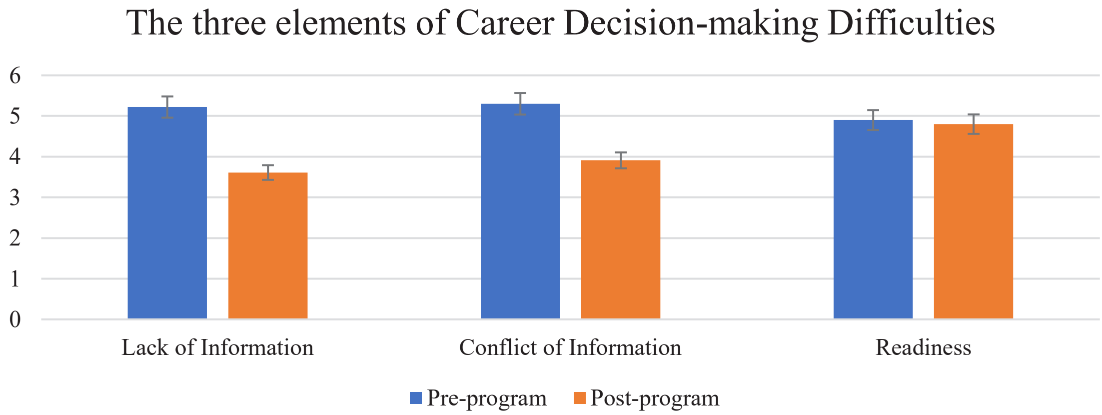

Figure 4: The three elements of Career Decision-making Difficulties (by CDDQ) means and 95%CIs associated with the pre- and post-program conditions

The Highlights of Students' Feedbacks

Student A:

Initially, when I received the career Holland code assessment, the suggested occupations such as printing manager or bar captain made me feel confused. This was because I am blind and use braille as my medium, making it impossible for me to pursue those related careers. However, with the guidance of my teacher, I understood that I could slightly adjust the direction of my aims, such as becoming a manager or supervisor in a Braille Production Department. Additionally, the assessment helped me realize my interest in management-related occupations. Now, I am focusing on studying hard so that I can have more options in the future.

Student B:

Now, I understand that I hope to work in the business-related settings after attending the school-based career and life planning program. My goal is to choose economics or accounting-related elective subjects in high school, so that I can meet the basic entry requirements for a university business school. Additionally, due to my visual condition, I also need to work harder to learn how to use different document processing programs, such as Excel, for my accounting studies. I believe I can choose from a variety of business-related jobs if I can achieve good grades in DSE and at university.

Student C:

After the participating in the regular career lessons, I have come to understand that I could also make a living by creating art-related products. Although I am now completely blind, I can still create different types of art products and successfully sell them to the public. I want to learn how to make more diverse handmade products in the future. Therefore, I plan to pursue subjects related to art education. Additionally, I have learned about different educational paths from the regular career lessons, and given my situation, I hope to pursue my university studies back in Chinese Mainland.

Student D:

During the mid-stage of regular career lessons, I once felt 10 out of 10 confused due to the overwhelming amount of information I had received, unsure of which pathway I could pursue. For example, I enjoy studying Japanese, information and communication technologies, and music. Fortunately, through individual career counseling sessions with the guidance teacher, I was able to better understand how to develop a relevant path by leveraging my strengths and interests.

Student E:

In the future, I hope to work in a business-related job such as investment banking or accounting. Therefore, I am currently focusing 100% on studying subjects like Business, Accounting and Financial Studies (BAFS) and English, so that I can develop in these fields. Through individual career counseling sessions, I also understand that the path towards becoming an accountant would not be easy, but I am committed to working hard to achieve my goals.

Student F:

I once thought that my visual impairment would prevent me from becoming a baker, but during the regular career lessons, I saw some seniors who worked in related professions and were able to commute from home to work with the assistance of guide dogs, which gave me hope for the future. I also hope to connect with more visually impaired seniors to understand their experiences in the workplace.

Student G:

I discovered that my interests and strengths lay in the arts after the assessments, but due to my visual impairment, I think I need to focus on clerical tasks. After participating in the school-based career and life planning program, I now have clear and diverse career options. For instance, I can focus on strengthening my document processing skills and also develop my abilities as a translator of Braille music transcription.

Discussion

Career Adaptability

The ability of career adaptability of the students with visual impairment fostered by the comprehensive school-based career program which comprising regular career lessons and personalized counseling sessions. It has significantly enriched them for navigating the complexities of the world. This discussion will delve into the improvements observed in the facets of career concern, career control, career curiosity and career confidence. Each of them has been markedly refined through the structured school-based career program by empowering students with visual impairment to approach their futures with confidence and purpose.

To begin with, the marked improvement in students' career concern is a noteworthy outcome of the program. The consistent exposure to career lessons and individual counseling sessions has heightened students' awareness of the critical nature of career-related issues. As posited by Carini, Kuh & Klein (2006), prolonged engagement in a particular field increases attention and engagement. It is in line with one of the factors in the career concern that is about the students' awareness of educational and vocational choices. Themes such as "my career code and future" and "my career pathway" in the regular career lessons (see appendix 1) have encouraged introspection and forward-thinking, fostering students' contemplation and preparation for their impending professional journeys.

Moreover, the elevation in students' sense of career control is unmistakable, particularly evident in the lessons centered around setting "SMART" goals and the completion of activities like the multiple pathway worksheet (refer to appendix 2) during individual counseling sessions. Consistent with research by Guan, Wang, Dong, Liu, Yue, Liu & Hua (2017), the emphasis on goal-setting and recognizing multiple pathways has positively impacted students' perception of agency in improving students sense of career control. By instilling a sense of direction and purpose, these initiatives have empowered students with visual impairment to take ownership of their vocational paths with confidence and determination.

In terms of career curiosity, students have benefited significantly from engaging in activities such as the "Six Career Code" lessons and participation in the campus internship program. By exploring their Holland code (Holland, 1997) through tools like the Career Interest Inventory (CII), which reflects their career personality styles encompassing realistic, investigative, artistic, social, enterprising, and conventional traits (RIASEC) and with its sub-categories including job categories, interest clusters and work personality environments, students with visual impairment have gained insights into their innate strengths and career preferences (see appendix 3). Besides, during the internship program in the regular career lessons, students have had the opportunity to experience various work environments aligned with these personality styles. The experiential learning of the RIASEC exposure encourages students with visual impairment to have deep self-reflections based on their personal traits, strength and limitations, fostering a deliberate decision-making process and enhancing their ability to navigate the diverse array of career options effectively, which in line with one of the question in the career curiosity category "CA8 figure out choices before making a choice." Students with visual impairment has nurtured by the school-based career and life planning program to consider and evaluate different options available carefully before making decisions.

The program has also significantly bolstered students' career confidence through experiential learning opportunities, exemplified by the campus internship program. Instances such as that of student C, who expressed a desire to further develop skills following a successful experience in selling handmade products (see appendix 4), highlight how positive experiences can fuel students' self-assurance in their abilities. By providing platforms for practical skill development and celebrating achievements, the program has instilled a sense of self-belief and competence in students with visual impairment, equipping them with the confidence to confront future challenges head-on. This implied that the successful experiences are critical on development students' career confidence. Career teachers should be responsible to create a successful learning environment for students especially those with special educational need, who generally are less confident, to develop their career confidence.

In conclusion, the multifaceted approach of the school-based career program has enhanced students with visual impairment career adaptability and has also nurtured them to have a holistic understanding of their vocational aspirations, capabilities, and potential pathways. By addressing crucial elements such as career concern, control, curiosity, and confidence, the school-based career program has equipped students with the essential skills and mindset to navigate the dynamic landscape of the career lives with resilience and purpose. Through a blend of theoretical knowledge, practical experiences, and introspective activities, the program has laid a strong foundation for students with visual impairment to excel in their future endeavors, shaping them into empowered and forward-thinking individuals who ready to embrace the challenges of an ever-evolving job market.

The present study would be a reference for the career and life planning team in different schools to have the continuous evolution and refinement of the school-based career program that will undoubtedly further enhance students' career adaptability, ensuring. Thus, students, especially those with special education needs, are well-equipped to thrive in the fast-paced and competitive world of work. The school-based career and life planning program should be designed with the concept of fostering a culture of self-discovery, goal-setting, and experiential learning, which allow the students to be ready to adapt to different setting and make meaningful contributions to the workforce and society.

The Career Decision-Making Difficulties

The school-based career program has proven to be instrumental in mitigating career decision-making difficulties among students with visual impairment. Students are more likely to feel confident and become proactive towards planning their career and life pathways. By engaging in the school-based career and life planning program, students with visual impairment have demonstrated a marked reduction in challenges associated with making career-related decisions, showcasing enhanced abilities to think critically and plan strategically for their futures.

Research findings by Ferrari, Nota & Soresi (2010) underscore the significance of students' future time perspective in influencing their career decision-making processes. Present study shows that the students with visual impairment tend to be more confidence in making career related decision after joining the school-based career and life planning program which requires them to think more about their own future pathway. The present result proved that through participation in activities that stimulate deeper thought and planning, students with visual impairment have not only gained a clearer understanding of their aspirations but have also developed the foresight to anticipate and address potential obstacles early on.

The present study showed that the school-based career and life planning program effectively addresses students' career indecision with three key components: lack of information, inconsistent information, and readiness.

For solving the problem of lack of information, the school-based career program has organized a variety of elements in the regular career lessons. By incorporating themes such as "the six career codes assessment," "various walks of life," and "my VASK" into the curriculum, students with visual impairment are provided with a comprehensive framework to explore their future prospects through the lens of personal values (V), attitudes (A), skills (S), and knowledge (K). This structured approach equips students with the tools to align their individual VASK profiles with potential career paths. They could receive a variety information about their career pathway during lessons, such as The Guangdong-Hong Kong-Macao Greater Bay Area educational pathway, facilitating informed decision-making and promoting clarity in their career choices. For example, students C said that he/she decided to study in the university in Chinese Mainland after graduated in the secondary school. Thus, the fruitful information about future including the educational and working path would help the students to have less difficulties in making career-related decision.

In addressing inconsistent information, the program integrates experiential learning opportunities such as job shadowing and interviews with individuals, including those with visual impairment, working across diverse fields. The present study confirmed with the studies by Garcia & Lartz (2019) suggest that individuals with disabilities tend to find resonance and inspiration in role models who are with similar disabilities because they have a strong sense of belonging and empowerment within their respective communities. For example with the feedback from students F, "I once thought that my visual impairment would prevent me from becoming a baker, but during the regular career lessons, I saw some seniors who worked in related professions and were able to commute from home to work with the assistance of guide dogs, which gave me hope for the future. I also hope to connect with more visually impaired seniors to understand their experiences in the workplace." By providing students with firsthand experiences and insights from individuals facing similar obstacles, the interview sessions in the regular career lessons enable students with visual impairment to navigate decision-making dilemmas with greater confidence and clarity.

Despite the marked improvements in addressing lack of information and inconsistent information, the level of readiness for career decision-making did not show a significant difference following the completion of the year-long school-based career program. It can be explained by analyzing the feedbacks from students' interviews. It revealed a prevailing sentiment that students are more likely to prioritize and put attention in their educational pathway, rather than work related pathway, at their current stage of development. For example, from the feedback from Student B, he/she articulated the belief that focusing on academic excellence in the present moment was crucial, even though they possessed a clear understanding of their career aspirations. This emphasis on academic pursuits before delving into career/work-related decisions indicates that students with visual impairment put motivation and effort towards laying a strong academic foundation as a precursor to achieving their dreams. According to the Career Decision-making Difficulties Questionnaire (CDDQ), the readiness assessment within the program largely focuses on evaluating students' readiness for job-related choices rather than educational decisions. For example, there is a question states "Work is not the most important thing in one's life and therefore the issue of choosing a career doesn't worry me much".

The present study reflects a hesitation among students to prioritize immediate career decision-making. Instead, students tend to concentrate on excelling in their studies and gaining admission to a preferred university, recognizing that education serves as a crucial stepping stone towards realizing their long-term aspirations. For example, Student A's feedback underscores this sentiment, stating, "Now, I am focusing on studying hard, so that I can have more options in the future." This saying focus on academic achievement as a means to expand future opportunities highlights the students understand the present actions of putting effort in study would be the most important milestone in their journey towards realizing their career aspirations. Students with visual impairment tend to put attention in getting ready for educational related pathway at the first priority while upholding the ultimate goals, job related aim, in their mind.

Overall, the school-based career and life planning program serves as a transformative platform for students to enhance their decision-making abilities, instilling them with the skills and perspectives necessary to navigate the complexities of career planning effectively. Through a multifaceted approach by the school-based career and life planning program, students are empowered to make informed and proactive choices, setting a solid foundation for their future professional endeavors. As students continue to engage with the program and leverage the knowledge and experiences gained, they are well-equipped to embark on their career journeys with confidence and purpose.

Implications

The present study underscores the critical importance of integrating both school-based career lessons and individual career counseling into the school-based career and life planning program to enhance students' career adaptability and decision-making processes. Rather than focusing solely on one approach over the other, this research advocates for a holistic strategy that combines the benefits of structured career lessons with individual career counseling. By harmonizing these two elements, students, even those with special educational needs, can derive maximum support and guidance to navigate the complexities of career planning effectively. When the students received a huge amount of information during lessons. For example of student E, "I once felt 10 out of 10 confused due to the overwhelming amount of information I had received, unsure of which pathway I could pursue. Fortunately, through individual counseling with the teacher in the end, I was able to better understand how to develop a relevant path by strengthening my strengths and interests." It is necessary to offer students an individual career counseling after offering the career lessons, which provide lots of information about their future. The individual career counseling can provide guidance for the students to categorize and prioritize the different choices while evaluating each pros and cons which required a higher order thinking. An essential aspect highlighted by this study is the synergy between career lessons and individual counseling, where each component complements the other. This testimonial underscores the invaluable role that personalized guidance plays in steering students towards coherent and meaningful career choices.

Moreover, the study highlights the significance of providing specialized counseling support, particularly for students with special educational needs, who may require tailored assistance beyond the standard lesson assessments. Student A's feedback exemplifies this need, " Initially, when I received the career Holland code assessment, the suggested occupations such as printing manager or bar captain made me feel confused. This was because I am blind and use braille as my medium, making it impossible for me to pursue those related careers. However, with the guidance of my teacher, I understood that I could slightly adjust the direction of my aims, such as becoming a manager or supervisor in a Braille Production Department."(see appendix 5) Through individual counseling, the guidance teacher assisted Student A in reframing the suggested job roles to align with achievable alternatives. Subsequently, Student A realized that a printing production manager could also encompass a braille production manager. Illustrating the transformative impact of tailored guidance on reshaping career perspectives. The present study finds out that the individual guidance on interpreting assessment report, which was designed for the students in normal school, is crucial to prevent feelings of frustration and anxiety among students with disabilities, which can impede their pursuit of suitable career paths. This confirmed that the design of the school-based career program should be a holistic approach including both career lessons and individual career counseling.

Furthermore, the present study also raised up the awareness of the secondary school in Hong Kong to put more attention in developing a holistic school-based career and life planning program. By incorporating these elements, students are likely to exhibit greater adaptability and experience fewer challenges when making career decisions. The 2019 report on the "Review of the Effectiveness of Career Planning Education in Hong Kong Secondary Schools" revealed that the most common forms of career-related support provided to students included alumni sharing, individual counseling, workplace visits, and work experience opportunities. Surprisingly, the report indicated that regular career lessons were not widely implemented across schools in Hong Kong. Building upon this insight, the current study acts as an example about the importance for the integration of both regular career lessons and individual career counseling within the educational framework of schools, especially the special schools, in Hong Kong. The present study is also in line with the Curriculum Guidelines for Special Schools (2024) issued by the Education Bureau that emphasize the unique needs of students with special education need. It mentioned that educators in special schools should particularly focus on the development of transitional progresses, such as from secondary school to post-secondary school or work places. Recognizing the distinctive needs of these students, it becomes imperative for schools to provide targeted support and resources to facilitate their successful transition into further education or the workforce.

Conclusion

The present study not only aims to investigate how to enhance career adaptability and reduce career decision-making difficulties of students with visual impairment through the school-based career and life planning program, but also seeks to serve as an exemplar for both mainstream and special schools catering to students with special educational needs.

More importantly, the present research emphasizing the significance of offering both regular career lessons and individual career counseling as the career and life planning program. This study offers a blueprint for schools to create comprehensive development programs tailored to students especially those with special education needs. By designing a tailored school-based career and life planning program that addresses the unique needs of students with disabilities and promotes a supportive environment for all students, schools in Hong Kong can put attention in equipping students with the knowledge, skills and attitudes necessary for success in their future endeavors.

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Appendix 1:

2023-2024 School-based Career and Life Planning Lessons

Topic	Content
Understanding personal traits	Introduction to the six career codes
Six career codes	Assessment
Career values education - Responsibility	My career role
SMART goal	Setting my career goals
What activities do I enjoy? What am I capable of?	My shining moments
What activities do I enjoy and am capable of?	My good traits and skills
My VASK	My values, attitude, skills, and knowledge
How has visual impairment limited my career development?	My help and hindrance
Campus internship program - Realistic type I	Understanding the characteristics and careers of realistic type
Campus internship program - Realistic type II	Job shadowing day
Campus internship program – Artistic type I	Understanding the characteristics and careers of artistic type
Career values education – Resilience	Finding my career resilience
Career values education – Diligence	Actualizing my career to-do list
Various walks of life	Different job experiences, salary and skills
My career pathway	My academic pathway
My career code and future	My multiple academic and career pathway
Campus internship program – Investigative type I	Understanding the characteristics and careers of realistic type
Campus internship program – Investigative type II	Job shadowing day
Campus internship program – Social type I	Understanding the characteristics and careers of realistic type
Campus internship program – Social type II	Job shadowing day
Campus internship program – Enterprising type I	Understanding the characteristics and careers of realistic type
Campus internship program – Enterprising type II	Job shadowing day
Developing practical skills	Learning how to make and sell a production
Campus internship program – Conventional type I	Understanding the characteristics and careers of realistic type
Campus internship program – Conventional type II	Job shadowing day
Review	The importance of career transition

Appendix 2:
Multiple Pathway Worksheet

Example 1

生涯規劃組
個別生涯輔導
生涯路徑 多元出路

學生:
職業

出路	**1. 營運銷售相關行業** ***(網上教授粵語)***	**2. 迪士尼樂園相關工作 (例如: 演藝人員 / 其他工作)**	**3. 按摩**	**4. 酒店服務**
學涯	展亮技能發展中心 A. 科目: 數碼商店營運(TBC) B. 入讀要求: 職評及面試 C. 畢業: 為畢業生提供 12 個月就業支援服務	獲迪士尼聘請後，機構會提供全面的培訓	香港盲人輔導會 A. 科目: 按摩培訓課程 B. 入讀要求: 成為盲人輔導會會員 C. 畢業: 有機會在盲人輔導會按摩中心工作	應用教育文憑 DAE [香港專業進修學校] A. 科目: 酒店服務 B. 入讀要求: 年滿二十一歲
預備	1. 職業輔導科訓練	2. 與教會朋友保持連絡，了解聘請相關職位情況	1. 參與按摩師體驗活動 2. 影隨或訪問視障按摩師	1. 應用學習酒店服務相關課程 2. 影隨或訪問酒店服務員
VASK	**價值** 創意 **態度** 富好奇心 有耐性 注重細節 **技能** 創造性思維 **知識** 社交媒體運作	**價值** 分析能力 工作的多樣性 **態度** 願意合作 思想開明 **技能** 表演 適應 **知識** 藝術相關	**價值** 才能應用 身心健康 **態度** 積極主動 堅持不懈 **技能** 人際交往 **知識** 健身相關知識	**價值** 自律 責任感 **態度** 注重細節 有耐性 樂於助人 **技能** 服務技巧 **知識** 酒店服務知識

Example 2

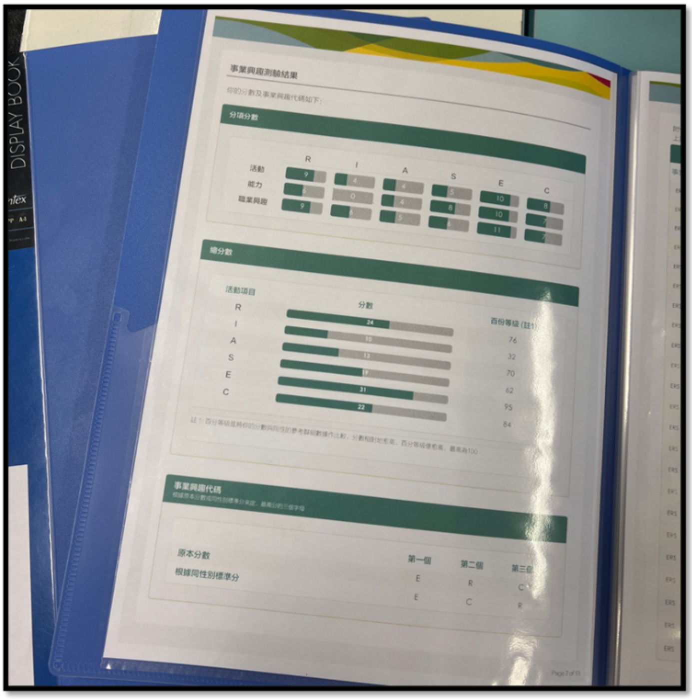
生涯規劃組

個別生涯輔導

生涯路徑 多元出路

出路	**1. 辦公室實務**	**2. 點字樂譜轉譯**	**3. 藝術、設計、表演藝術及創意媒體 (表演與故事創作)**
學涯	展亮技能發展中心 A. 科目: 辦公室實務(TBC) B. 入讀要求: 職評及面試 C. 畢業: 為畢業生提供 12 個月就業支援服務	心光音樂學院 A. 完成中六/其他文憑 B. 完成點字轉譯樂譜課程(高級)	賽馬會特教青年學苑 A. 科目: e-樂團創演課 1.0
預備	1. 職業輔導科訓練	1. 完成點字轉譯樂譜課程(基礎) 2. 應考樂理	1. 多參與藝術相關活動，以培養其興趣及能力
VASK	**價值** 獨立 責任感 **態度** 積極主動 注重細節 **技能** 行政/文書的技能 **知識** 文書處理 行政和管理	**價值** 責任感 自律 **態度** 嚴謹審慎 注重細節 **技能** 閱讀理解 **知識** 點字樂譜	**價值** 分析能力 **態度** 富好奇心 願意合作 **技能** 表演 **知識** 藝術相關

Appendix 3:
Career Interest Inventory (CII)



Appendix 4:
Campus internship program examples

1. Making the products (Artistic)

2. Selling the products (Social)

Appendix 5:
The suggested jobs by Holland assessment (Student A)

C. 香港職業

事業興趣代碼	中文名字	英文名稱
ERC	印務經理	Printing Production Manager
ERC	酒吧領班	Bar Captain
REC	中藥配劑員	Dispenser
REC	平車車工	Lockstitch Sewing Machine Operator
REC	打樁工	Piling Machine Operator
REC	校工	School Worker
REC	泳池事務工作員及泳灘工作員	Swimming Pool/ Beach Officer
REC	洗房工人	Laundry Laborer
REC	洗碗員	Dishwasher
REC	清潔員	Cleaner (General)
REC	紙樣放碼師傅	Pattern Grader
REC	車輛清潔員	Cleaner (Vehicles)

徵集論文

《教研學報》第四卷以「推進教育科技人才一體發展」為主題，內容以教育研究、教育行動研究及教學經驗分享為主，請於 2026 年 2 月 27 日或之前投稿。歡迎教育界同工就主題或以下課題投稿[1]。本刊之詳細徵稿辦法可參閱《投稿須知》。

《教研學報》亦歡迎大家就以下各教育議題投稿：

- 課程的設計理念、實施模式和評估方法
- 創新的教學法設計理念、實施模式和評估方法
- 創意教學
- 家長教育
- 校本教職員培訓，包括教師入職培訓及輔導
- 校本管理
- 學生支援及學校風氣，包括輔導及諮詢
- 學生培訓
- 教育改革評議
- 比較教育
- 高等教育
- 幼兒教育
- 特殊教育
- 美術教育
- 音樂教育
- 教育史

[1] 有興趣參加「教育研究獎勵計劃」的教師可至教師及校長專業發展會網頁（https://www.cotap.hk/index.php/tc/t-share/educational-research-award-scheme）閱覽有關詳情。

Call for Papers

The main theme of the HKERJ (Volume 4) is "Promotion of the integrated development of education, technology and talent". The deadline for submission of papers[1] on areas pertaining to educational research, action research and teaching practice in schools is 27 February 2026. For submission requirements, please refer to "Notes for Contributors".

The HKERJ also welcomes papers covering the following aspects:

- Curriculum design, implementation and evaluation
- Design, implementation and evaluation of innovative pedagogy
- Creative teaching
- Parent education
- School-based staff development, including teacher induction and mentoring
- School-based management
- Student support and school ethos, including guidance and counselling
- Student development
- Critique on education reform
- Comparative education
- Higher education
- Early childhood education
- Special education
- Fine arts education
- Music education
- History of education

[1]Detailed information pertaining to participation in the Educational Research Award Scheme can be found on the website of the Committee on Professional Development of Teachers and Principals (https://www.cotap.hk/index.php/en/t-share/educational-research-award-scheme).

投稿須知[1]

1. 中、英文稿件兼收。稿件字數以不少於 6 000 字及不超過 8 000 字為限。摘要、正文、圖表、參考文獻、附錄均計算在內。
2. 文稿請附以下資料之中英文版本，包括題目、作者姓名、所屬機構、摘要及關鍵詞 3 至 5 個。中文摘要以 200 字為限，英文摘要則約 150 字。作者通訊方法（如郵寄地址、電話、電郵）請另頁列明。
3. 所有稿件均須經過評審，需時約半年。凡經採納之稿件，當於下一或二期刊出。編者得對來稿稍予修改或請作者自行修改，或不予採用。稿件一經定稿，請勿在校對時再作修改或增刪。稿件刊登與否，均無稿酬。
4. 各文稿之言責概由作者自負，其觀點並不代表教育研究獎勵計劃工作小組之立場。
5. 英文來稿之格式及附註，請遵守美國心理學協會編製之《出版手冊》（2019 年，第 7 版）指引。
6. 請將稿件及作者通訊資料電郵至 eras@edb.gov.hk，註明投稿於教育研究獎勵計劃工作小組秘書處收。
7. 《教研學報》版權屬教育研究獎勵計劃工作小組秘書處所有，非得許可，不得轉載任何圖表或 300 字以上之文字。
8. 所有稿件在評審期間，不得同時送交其他學報評審或刊登。

[1] 有興趣參加「教育研究獎勵計劃」的教師請參閱有關教育局通函。

Notes for Contributors[1]

1. Manuscripts can be written in English or Chinese. The length of submitted manuscripts should be between 6,000 and 8,000 words. Abstracts, main text, tables & figures, references and appendices will be counted in.
2. All manuscripts should be accompanied with the following information in both English and Chinese: title, author's name, affiliation, abstract and 3 to 5 keywords. The English abstract should be around 150 words, and the Chinese abstract should be not more than 200 words. Author's correspondence (i.e. postal address, telephone number, email) should be provided on a separate page.
3. All submissions will go through an anonymous review that usually takes about 6 months. Accepted manuscripts are normally published in the next issue or the issue after next. The Editors reserve the right to make any necessary changes in the manuscripts, or request the contributors to do so, or reject the manuscripts submitted. Once the final version of manuscripts has been accepted, contributors are requested not to make further changes during the proof-reading stage. No royalties or money will be offered for any submission.
4. The views expressed are those of the authors and do not necessarily reflect position of the Working Group on the Educational Research Award Scheme.
5. English manuscripts submitted should conform to the style laid down in Publication Manual of the American Psychological Association (7th ed., 2019).
6. Manuscripts and author's correspondence should be emailed to the Secretariat of the Working Group on the Educational Research Award Scheme (email address: eras@edb.gov.hk).
7. All copyrights belong to the Secretariat of the Working Group on the Educational Research Award Scheme. No graphics, tables or passages of more than 300 words can be reproduced without prior permission.
8. Once the review process of this Journal begins, contributors shall not send the submitted manuscript to other journals for review or publication.

[1] Teachers interested in participation in the Educational Research Award Scheme may make reference to the relevant Education Bureau Circular Memorandum.

徵募評審員

我們誠邀教師、校長及教育界同工加入成為《教研學報》的評審員。有興趣參與有關工作的同工，請以電郵（eras@edb.gov.hk）提交下列資料，以供聯絡。如有任何查詢，歡迎致電（(852) 3698 3698）與教育研究獎勵計劃工作小組秘書處聯絡。

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興趣範圍：＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿

Invitation for Reviewers

We invite teachers, principals and fellow education workers to join us as reviewers. If you are interested in reviewing journal papers, please submit the following information by email (eras@edb.gov.hk) to us. Should you have any enquiries, please contact the Secretariat of the Working Group on the Educational Research Award Scheme at ((852) 3698 3698).

Name: (Dr / Mr / Ms) ________________________________

Serving School / Affiliation: ________________________________

Contact Tel. Number: ________________________________

Email: ________________________________

Field(s) of Interest: ________________________________