

**Towards Developing an  
Interconnected 3H Collaborative Triple Leadership Framework  
and the STEAM Ecosystem Theory  
for Effectively Promoting, Managing, and Implementing  
STEAM Education in Hong Kong Schools**

Lee, Tak Man Anna Lisa, BA (Comm), MBA

Supervised by: Dr. Eddie Yu, Dr. Andrew Chan

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## Abstract

In the face of rapid technological advancement, a global shift towards STEAM education is prompting, it is being viewed as a critical pathway for preparing students to thrive in the technology-driven futures. Despite its transformative potential, traditional education systems struggle to keep pace, STEAM faces barriers including definitional ambiguity, limited teacher preparation, curriculum constraints, and resource shortages. Hong Kong features a distinctive educational system characterized by its unique combination of the Eastern and Western instructional principles, in which students have to learn both English and Chinese, making STEAM learning more complicated. In Hong Kong, STEAM implementation faces significant challenges rooted in its exam-oriented culture, rigid curriculum structures, and systemic inequities across school bandings. Teachers often lack pedagogical confidence and support, while students are discouraged from inquiry-based learning due to high academic pressures. These barriers raise critical concerns about the feasibility and equity of STEAM integration within Hong Kong's traditional education framework.

By conducting semi-structured in-depth interviews with principals, and frontline STEAM teachers of various school types, rich and nuanced data are obtained from their stories, emotions, and insights. Through thematic analyses of data, the research explores leadership styles, management strategies, and practical solutions that contribute to effective STEAM integration. The study also investigates the underlying causes of implementation inefficiencies and examines how model schools of STEAM education have achieved success, aiming to discover findings that will provide practical insights to advance equity, to overcome cultural and systemic roadblocks, and to enhance the sustainability of STEAM education in Hong Kong. The research findings highlight widespread support for Hong Kong STEAM education's role in fostering creativity, innovation, and problem-solving skills among students. Notably, leadership of the Hong Kong Education Bureau, principals, teachers, and students emerged as one of the key factors contributing to the program's success through distributed and collaborative leadership models. However, the effectiveness of implementation varied significantly across school types, and their challenges encountered became increasingly diverse.

To overcome the challenges, holistic and human-centered strategies are needed. The research based on the 3H framework, encompassing the cognition of head, the emotion of heart, and

the action of hands to offer a holistic approach that encourages collaboration among the EDB, school principals, and STEAM educators in unified efforts to elevate STEAM education. A new conceptual framework was developed and introduced under the name: Interconnected 3H Collaborative Triple Leadership Framework. The framework promotes a balanced development of intellectual capabilities, emotional intelligence, and practical skills among the EDB, school principals, and STEAM teachers. It encourages educators to collaboratively design learning experiences that are meaningful, values-driven, and action-oriented for the benefits of students. The framework aligns with key leadership theories to offer a comprehensive lens for managing educational transformation. Leadership must be redefined to inspire and empower collective action for fostering STEAM's inclusive learning environments. However, leadership is not the sole influencer that leads to STEAM's success. By viewing education and innovation as interconnected systems, this research introduces a novel theoretical framework known as the STEAM Ecosystem Theory, which emphasizes holistic development, fosters creativity, and promotes cross-disciplinary synergy. The theory synthesizes seven foundational theories to illuminate the design, implementation, and sustainability of interdisciplinary education. It conceptualizes STEAM education as a dynamic, multi-level system in which learning is inquiry-driven, socially embedded, and culturally grounded, it emphasizes the importance of strategic partnerships, resource negotiation, and planning to foster enduring interdisciplinary innovation. By mapping interactions across levels, the STEAM Ecosystem Theory offers a robust model for implementing and scaling STEAM initiatives in diverse educational landscape of Hong Kong. The research provides evidence-based and practical insights that can navigate policymakers, educators, students, and stakeholders to make well-informed decisions to embrace the technological future. Different techniques are employed to enhance the study's credibility and reliability, such as in-method triangulation, and detailed transcription. The generalization of this research is considered achievable, and its findings have the potential to be transferable to other studies with similar attributes and contexts.

Keywords:

Hong Kong STEAM education, in-depth interviews, distributed leadership, thematic analysis, complementary educational theories, Interconnected 3H Collaborative Triple Leadership Framework, STEAM Ecosystem Theory

## **Declaration**

This work has not previously been accepted in substance for any degree and is not being concurrently submitted in candidature for any degree.

Signed: Lee, Tak Man Anna Lisa

Date: 1<sup>st</sup> December, 2024

## **Statement 1**

This thesis is the result of my own investigations, except where otherwise stated. Where correction services have been used, the extent and nature of the corrections is clearly marked in a footnote(s). Other sources are acknowledged by giving explicit references. A list of references is appended.

Signed: Lee, Tak Man Anna Lisa

Date: 1<sup>st</sup> December, 2024

## **Statement 2**

I hereby give consent for my thesis, if accepted, to be available for deposit in the University's digital repository.

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Date: 1<sup>st</sup> December, 2024

## **Dedication**

Dedicated to my beloved parents, Paul and Amy,  
to my dearest husband, Herman,  
and to my cherished children, Samson and Sarah.

## Acknowledgement

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## List of Acronyms

AI	Artificial Intelligence
CDC	Curriculum Development Council
D&T	Design and Technology
DSS	Direct Scheme School
EDB	Education Bureau
EduHK	The Education University of Hong Kong
EMI	English as Medium of Instruction
GBA	Greater Bay Area
HKBSA	Hong Kong Budding Scientists Award
HKDSE	Hong Kong Diploma of Secondary Education
HKFEW	Hong Kong Federation of Educational Workers
IDT	Information and Technology
IMC	Incorporated Management Committee
Intel ISEF	Intel International Science and Engineering Fair
IVE	Hong Kong Institute of Vocational Education
KLA	Key Learning Area
MOI	Medium of Instruction
PS1HKAT	Pre-Secondary One Hong Kong Attainment Test
QEF	Quality Education Fund
QTN	QEF Thematic Network
RDT	Resource Dependence Theory
SEN	Special Educational Needs
SDG	Sustainable Development Goals
SNDas	School Nominations Direct Admission Scheme
SPN	School Principal's Nominations
SSB	School Sponsoring Body
STEAM	Science, Technology, Engineering, Arts, and Mathematics
STREAM	Science, Reading and Writing (or Religion), Technology, Engineering, Arts, and Mathematics
TE	Technology Education
VTC	Vocational Training Council
3H	Heart, Head and Hands
4C	Creativity, Critical Thinking, Collaboration, Communication

## **Chapter 1 Introduction**

The rate of technological development in the 21<sup>st</sup> century is many times faster than the educational system's changing pace. STEAM education is gaining popularity and recognition in classrooms, and has become the worldwide focal point of interest for educational reform. STEAM is a comprehensive, exploratory, and multi-disciplinary framework of education, encouraging students to combine their physical, artistic, and creative thinking skills to create new values (Kitamura, 2020). The main goal of STEAM education is to help students become more scientifically and technologically literate. It does this by combining classroom learning with real-world application of practical skills. STEAM education integrates problem-solving, project-based, and inquiry-driven approaches to enhance teaching and learning. Through this method, teachers and students demonstrate their critical thinking, creative problem-solving, communicative skills, and team work spirit in the cross-disciplinary intersections of Science, Technology, Engineering, Arts and Mathematics. STEAM was originated from STEM which is initially introduced by the U.S National Science Foundation in 2001, for the purpose to better-equip students with essential scientific knowledge and competencies before they receive postsecondary education or enter the workforce, and it has become the largest education reform movement since it was launched. (Daugherty, 2013; Hallinen, 2021). STEAM is critical to the future. The internet of things, automation, cyber-physical systems, creative and artistic computer applications, and other remarkable advancements are radically transforming how we work, live and learn (Matter & Form, 2020).

### **1.1 Background of STEAM Education**

STEM implementation was historically revolutionised from the ages of Thomas Edison and Henry Ford, it had gone through the eras of industrial revolution. Past inventors applied the knowledge of STEM to create an evolutionary trend of inventions, although they were not taught formally in classroom settings to learn about physics, engineering, and other science disciplines (Badmus & Omosewo, 2020). In the 21<sup>st</sup> century, the scope of STEM extends towards covering the arts element by inserting an 'A' into the original program to make it becomes STEAM. By adding in the arts ventures, the program covers not only the visual art, but also includes media arts and performance arts like music, drama and dance; and in broader terms, covering also non-science subjects such as history and humanities (Kitamura, 2019). In some countries, language arts are also inserted by adding 'R' into the learning of STEAM to

make it become STREAM, the alphabet ‘R’ refers to the first letter of reading and the ‘r’ in writing (Kim, Chung & Chung, 2021). Traditional science education was used to be carried out in conventional ways, often relied on the transmission of theoretical knowledge, the replication of existing technologies, and assessment-driven learning. In contrast, the evolution towards STEAM education shifts the focus to problem-solving, real-world application, creativity, hands-on experimentation, teamwork, and entrepreneurship thinking (Marmon, 2019). STEAM education specifies open-endedness and collaboration as the nature of creative design, and induces reflective thinking (Park et al., 2016). STEAM provides heterogeneous students with more unprejudiced opportunities to learn how to learn, through the process of experiencing collaborative and self-directed hands-on activities (Massa et al., 2011; Park et al., 2016; Hughes, et al., 2022).

STEAM education fosters dynamic learning experiences through problem-based, project-driven, and inquiry-led approaches, these learning momentums were viewed by many countries as propellants for actively solving real-world problems, and to facilitate communications for global economy integration (Massa et al., 2011; Freeman, Marginson and Tytler, 2019). STEAM encourages creative thinking to deal with world issues, such as enabling seawater desalination with 3D printing components to provide fresh drinking water (Khalil, Ahmed and Hilal, 2021), and creating renewable energy sources to achieve carbon neutrality (The Government of the Hong Kong Special Administrative Region, 2021). STEAM is locally relevant, and also culturally appropriate. It fosters community-based decision-making, promotes environmental stewardship, cultivates an adaptable workforce, and develops the quality of life (Taylor & Taylor, 2019). Jung and Hong (2020) summarized the characteristics of convergence in STEAM education as being learning-oriented, dialectical in nature, and incorporating diverse educational methodologies.

At the heart of quality STEAM education lies cognition, which was defined as the process of learning through novel experiences and perceptions. It involves exposing students to a broad spectrum of ideas, concepts, and sensory stimuli, fostering deeper understanding and intellectual growth (Dell’Erba, 2019). STEAM education should be implemented with high quality, clear objectives, and well-defined teaching and learning standards. In addition to providing rigorous scientific training for students, it should also support teachers by enhancing their ‘professional development and capacity on cross-curricular planning and instruction’ (Bush and Cook, 2019; Legislative Council of Hong Kong SAR, 2023). Consequently, teachers will be empowered to strengthen their leadership capabilities to ‘enhance school effectiveness

through collaboration and collegiality, and driving positive change within the school community' (Harris & Muijs, 2002). Effective implementation of STEAM in schools requires the development of a collaborative leadership model with principal leadership for reformative advancement (Yang, 2013), and with teacher leadership to guide interdisciplinary practices (Wenner & Campbell, 2017). Beneath the frontline leadership, deeper structural influences from school supervisors and the Incorporated Management Committee (IMC) play a critical role in shaping the decisions and practices of both principals and teachers (Walker, 2004). Successful school turnarounds require essential cognitive frameworks and foundational strategies aimed at fostering collaborative achievements. These efforts must be recognized and supported by teachers, students, parents and all stakeholders within the school community (Cisneros, 2010). Pedagogists have proposed a range of educational strategies to enhance teaching and learning, with the goal of fostering attitude shifts and promoting self-awareness of personal capabilities among both teachers and students (Zaruba et al., 2021).

Dell'Erba (2019), along with researchers worldwide, have identified numerous barriers and challenges to effective STEAM implementation. To ensure its sustainability within the education system, educators, pedagogists, policy makers, and governments must actively work to overcome these obstacles through coordinated effort and strategic reform. The most common barriers to STEAM implementation include the lack of a universally accepted definition of what STEAM education entails; insufficient professional development and inadequate preparation for teachers and school leaders; rigid curriculum structures and the absence of effective assessment tools for evaluating STEAM project outcomes; and, limited institutional capacity, such as inadequate time for collaborative planning and teaching, as well as insufficient funding.

## **1.2 Hong Kong STEAM Education**

In 2015, the Hong Kong's Curriculum Development Council (CDC) released the 'Promotion of STEM Education – Unleashing Potential in Innovation' (The Government of the Hong Kong Special Administrative Region, 2015). It was the first policy address that STEM was proposed, aimed to strengthen students' interests in fostering innovation of technology for the purpose to enhance Hong Kong's economic competitiveness, allowing students to adapt early in a technology-led society. The promotion was further supported by the 2016 Policy Address (Ali, 2021). However, the STEAM program is not conceptualized, there is no specific and standardized

curriculum and implementation plans, most stakeholders are bewildered by the cross-disciplinary approach of teaching and learning, but confused with the right kind of strategies that should be taken; lacking of STEAM-specific knowledge, resources and interdisciplinary communication are common (Lee, Chai & Hong, 2019; Yu, 2021). A report from the South China Morning Post revealed “the findings of 2019 Trends in International Mathematics and Science Study<sup>1</sup>”, significantly indicated that Hong Kong students are degrading in performance of science and mathematics, falling behind Singapore, Japan, South Korea and Taiwan. There are various reasons leading to Hong Kong’s students’ inefficacies in science performance.

Hong Kong’s STEAM education is promoted to all primary and secondary schools. When STEM education launched in Hong Kong since 2015, a high majority of teachers showed little confidence in teaching STEM subjects (Chiu, 2017). The research of Geng, Jong and Chai on “Hong Kong teachers’ self-efficacy and concerns about STEM education” showed that there was only 5.53% of 235 surveyed teachers concerned themselves as well-equipped for embracing STEM teaching (Geng, Jong & Chai, 2019). Many teachers expressed their worries of not being professionally trained for teaching STEM (Cheng & Yeh, 2022). The shortage of competent and accountable STEM teachers is lagging Hong Kong behind in scientific performance. Educational reform typically reveals underlying societal needs, signaling areas in need of transformation or support (Chung & Li, 2021). Evaluating Hong Kong’s STEM education demands a clear view of its strengths and weaknesses. Despite the EDB’s sustained emphasis on enhancing teachers’ technological competencies since 2016, gaps in practical application and systemic support persist. Optimistically, student feedback on the launch of STEM programs at schools was largely positive, valuing its novelty and potential (Ng, 2022), prompting the EDB to thoughtfully address the STEM launching challenges.

In 2023, the EDB continues to actively promote STEM education by disbursing Life-wide Learning Grants to support Hong Kong primary and secondary schools for taking STEM forward, and Arts was added to the scheme to make STEM becomes STEAM. The Hong Kong Government outlined an Innovation and Technology Development Blueprint, with 16 targets and 42 initiatives to fit with the National 14<sup>th</sup> Five-Year Plan to better equip students through science and education, enabling them to unlock their potential, strengthen their competencies, so they can compete effectively on a global scale (Legislative Council of Hong Kong SAR,

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<sup>1</sup> The study is conducted globally every four years, targeted to Primary Four and Form Two students. Comparing to the result of 2015, Primary Four and Form Two students had dropped ten to eleven places respectively in the ranking of science.

2023). The Blueprint emphasized curriculum optimization in science and I&T learning for all, and will collaborate with the Hong Kong Academy for Gifted Education to provide extra learning opportunities and enhancements for gifted students with STEAM potential. Teachers' professional capacities in e-learning should be strengthened, while students' positive values and attitudes towards digital media and information literacy must also be cultivated. The EDB will offer support to diversify STEAM learning activities, providing additional resources for both on-site and off-site school-based STEAM education. A working team by the name 'Standing Committee on STEAM Education' was formed by the EDB to ensure effective implementation and continuous improvement of STEAM education across Hong Kong schools. The major duties of the committee include providing schools with a well-defined understanding of STEAM education, accompanied by illustrative examples of feasible school-based projects. Furthermore, the committee collaborates closely with teachers by sharing up-to-date information on emerging technologies and offering access to professional development opportunities. Moreover, the committee oversees schools by ensuring that each appoints a STEAM program coordinator responsible for organizing training opportunities for curriculum leaders and teachers, and for strengthening their capacity to plan and implement STEAM education. The committee also explores the feasibility of establishing regional STEAM resources centers staffed by experts to provide on-site support services to frontline STEAM educators.

In Hong Kong, support for the STEAM program extends beyond government efforts, it is also reinforced by tertiary institutions, professional bodies and a range of information and technology organizations that provide training opportunities for both teachers and students. Young (2023) reported in the South China Morning Post that the University of Hong Kong (HKU) had revised one of its flagship Master of Science Programs from 'Information Technology in Education' to 'Technology, Design and Leadership for Learning'. The program was updated to align with the current education system to fulfill the needs of Hong Kong. As mentioned in Young's article, HKU and EdUHK<sup>2</sup> had both updated their postgraduate courses, mainly for the purpose "to equip educators with relevant skills to meet with the growing demand of scientific knowledge". Many organizations in Hong Kong are serving as social partners, supporting the government in funding and sponsoring STEAM initiatives aiming at nurturing future talent.

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<sup>2</sup> EdUHK is the abbreviation for The Education University of Hong Kong.

### **1.3 The Hong Kong Education System and Inherent Educational Culture**

Hong Kong has consistently aimed to cultivate a strong talent pool to support the city's sustainable development and reinforce its role on the international stage. Its pursuit of quality education remains a top priority. However, before addressing the challenges of launching STEAM initiatives, it is essential to acknowledge the characteristics of Hong Kong's education system and its deeply-rooted educational culture. The Hong Kong government maintains rigorous quality control over its education system, principals and teachers are well-trained, and each school's incorporated management committee seeks to govern the school through well-defined policies and strategic goals aimed at promoting quality education. There are different types of schools in Hong Kong: the local government public schools and aided public schools, Direct Subsidy Scheme (DSS) schools, and private schools including private institutions such as international schools, private independent schools and English Schools Foundation (ESF) schools. The government public grant schools are directly managed by the Hong Kong Government, whereas the aided schools are operated by religious, charitable or clan organizations (Education Bureau, 2022b). The Government provides 12 years of free and compulsory schoolings for Hong Kong citizens to attend local public primary and secondary schools. Public schools in Hong Kong are government-operated, and therefore required to follow the curriculum prescribed by the EDB. Direct Subsidy Schools receive partial government funding, allowing them to charge school fees while enjoying autonomy in curriculum design and management. DSS schools may operate dual educational streams to cater diverse student needs, students may either attend the local stream and sit for the Hong Kong Diploma of Secondary Education Examination (HKDSE) in pursuit of university placement, or they may enroll in the International Baccalaureate Diploma Programme as a preparatory pathway for university admission (Education Bureau, 2023b). Hong Kong private schools are not funded by the Hong Kong government. International schools and private independent schools have curricula which are indifferent from local schools, offering alternative learning opportunities. ESF schools in Hong Kong are run by the English Schools Foundation, offering English-medium curricula and learning environment. These schools are permitted to design their curricula, and students enrolled in these schools are required to pay tuition fees. For the purpose of this research, the focus will be on interviewing participants from public local schools and DSS schools, both of which are fully or partially funded by the Hong Kong government.

Hong Kong's education system is heavily exam-driven. With a core focus on university placement. Excelling in examinations is widely regarded as a decisive factor in shaping a student's academic and professional future. In some schools, students are still being requested to adopt the rote learning technique by memorizing learning materials based on repetition, and then providing model answers in assessments, these learning styles even exist in science and mathematics. In order to outperform imaginary competitors for achieving high test scores, the competitive atmosphere becomes fiery. Participating in various forms of afterschool private tutoring classes is the norm of Hong Kong, and this kind of supplementary education is commonly known by Byun (2014) as shadow education. Under the atmosphere of competitiveness, Hong Kong students avoid collaborating with fellow classmates in academic learning and experience sharing, sealing themselves up in enclosed learning environment. As a result of these isolated, passive and negative learning styles and spoon-feeding education, many students experience high levels of anxiety while struggling with low self-esteem (Ho, 2006; Xu, 2023). Hong Kong students are streamed into three bandings according to the Secondary School Places Allocation system. Band 1 schools rank highest in the hierarchy and their students are being viewed as high-achievers in academic performance. English serves as the primary medium of instruction in these schools, and their students have higher chances to get admitted into universities. Each band is further divided into three slots of A, B and C, categorizing students into top, middle and bottom. Crawford, Hui and Heung (2000) commented the system as an 'assumed ability grouping', students are allocated into different groups 'across schools, within schools, or even within classrooms' to engage in different levels of rigor testing, but their true abilities are not reflected in the assessed results. Lee and Manzon (2014) introduced the terminology of 'equity and quality' to discuss of Hong Kong's education system, aiming to shift public focus from the relentless pursuit of academic excellence toward the broader advocacy for educational quality. Different individuals might have dissimilar reasoning or interpretation of the term 'quality education', as it is vague and non-standardized, but the current researcher opted to comply with the perspectives of Lee and Manzon that equal learning opportunities should be given to all students regardless of their socio-economic unequal background. Equity implies 'fairness and inclusion', all students should be able to achieve their own potential in an equitable learning environment. Besides ordinary students, disadvantaged students are also needed to be supported and treated with equality in education, rather than being labelled as incompetent in learning. STEAM education is seemed to be an effective approach to bridging cultural gaps within Hong Kong's education system and fostering changes in students' learning styles.

The future workforce is likely to be predominantly occupied by artificial intelligence, smart technology, engineering and applied science. These bodies of scientific knowledge and competencies require workers to be creative, communicative, analytical, practical, and be equipped with the knowledge to apply them across emerging domains of work. Furthermore, they are needed to be collaborative, be skillful in business and management, and always getting ready to solve new world problems (National Society of Professional Engineers, 2013; Dell’Erba, 2019). From this stance about the future prerequisites of jobs, education plays a significant role in shaping students’ future by inspiring their choice of career. Hong Kong’s expenditure in research and development was on an uprising trend since 2011; however, the city’s R&D<sup>3</sup> expenditure is only accountable for 0.97 percent of local gross domestic product, with Hong Kong government contributed the most, next was the highest education sector, and the business sector showed sluggish growth in R&D spending (Textor, 2023). Hong Kong has not paid sufficient attention to nurturing professionals, educators, and students to meet up with the global endeavor of scientific competitiveness (Tam, 2020). Ng (2015) stated that, quality education emphasizes holistic development of students, they should be equipped well with appropriate skills and knowledge to survive in the future world. The Hong Kong government established the Quality Education Fund (QEF) in 1998 to support initiatives aimed at enhancing the quality of education, beneficiaries include kindergartens, primary and secondary schools, and special schools (Quality Education Fund, 2014).

Despite the EDB’s ongoing efforts to promote STEAM education in all schools, Hong Kong faces critical challenges marked by a significant decline in student enrollment coupled with an escalating shortage of qualified teachers. One of the primary factors contributing to the decline in school enrolment is the persistently low birth rate, a demographic challenge that has troubled the city for over a decade. The under-enrolment problem leads to the reduction of classes and closure of schools becomes inevitable. Moreover, the widespread emigration of individuals pursuing opportunities overseas has deepened the crisis. The outflow includes both teachers and students, intensifying the strain on the local education system (Yu, 2021; Davidson & Lin, 2023). For the academic year of 2022-23, 19 secondary schools were in high risks of mandatory closure for not able to meet with the EDB’s minimum class count requirement for primary one and secondary one levels. That means if a school initially offers four primary one or secondary one classes, it must at least maintain two. If they fail to sustain at least two classes in two

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<sup>3</sup> R&D stands for Research and Development.

consecutive years, they may result in mandatory closure, unless they can submit an effective ‘survival plan for staying alive’ (Yu, 2023). The statement of ‘waiting to die’ in the title of Yu’s report had sounded a clear alarm for school leaders of under-enrolled secondary schools that strategical actions must be taken swiftly for securing at least three secondary one classes in order to avoid mandatory closure. Same situation appeared in primary schools, especially in the North District of Hong Kong, a district where parents of Mainland China used to send their children to study cross-border in Hong Kong. However, in recent years, they have reversed their decision and opted to continue their children’s education in China. Consequently, the number of primary one classes declined significantly (Mingpao, 2021). Looking on the optimistic side, many officials had proposed to the EDB and the Hong Kong government that it is an opportune moment to reduce class sizes and implement small-class teaching (Yu, 2021). According to Liang and Fung (2023), Hong Kong has long been promoting small-class teaching in public schools, supporting student-centered learning while fostering closer teacher-student interaction and stronger relationships. In 2009, small-class teaching was formally introduced in Hong Kong, its educational philosophy closely matches with that of STEAM education. STEAM education necessitates a student-centered learning environment where students have ample chances to co-construct interdisciplinary knowledge. The study of Liang and Fung (2023) illustrated how STEM or STEAM lessons can be taught in small classes and students can maximize their learning experiences in an environment of small-class size. Therefore, the Hong Kong government should allow schools more time, rather than two years, to adopt measures that will drive up enrolment numbers.

#### **1.4 Research Problems, Research Aims, Research Objectives, and Research Questions**

STEAM education is widely regarded as a strategic pathway for cultivating students’ innovation and technological literacy. It is the Hong Kong government and school leaders’ responsibilities to establish a resilient education system that can launch the STEAM program efficiently and implement it effectively to ensure long-term sustainability. However, education was referred by Powell (1980) as a ‘fundamentally uncertain profession’, especially when the future of teaching and learning in the context of STEAM is unpredictable. The STEAM education system is remained to be ambivalent with inexplicable challenges not clearly explained. The study of Geng, Jong and Chai (2018) indicated that Hong Kong STEM education is facing with three orders of barriers: first-order barrier of time, resources and support; second-order barrier of educators’ beliefs in their readiness for change; and the third-

order barrier involves the redesign of curriculum to fit with STEM teaching. Weng, Jong and Chiu (2020) had also identified teachers' lack of self-efficacy in STEAM teaching, stemming from insufficient pedagogical content knowledge, and inadequate external support. From STEM to STEAM, teachers are facing difficulties in understanding how to properly design STEAM activities. Beyond these obstacles, there lies the weaknesses of the Hong Kong education and school systems. The prevailing exam-oriented culture in Hong Kong emphasizes academic achievement, grades are prioritized over nurturing curiosity and scientific inquiry. For Hong Kong students, trial and error comes at a high cost, they cannot afford the risks of lower grades in exchange for exploring innovative but uncertain ideas. Rote learning is a safety measure for them to achieve high, but against the spirit of STEAM learning. Moreover, the bandings system of Hong Kong has drawn criticism. The intense pressure placed on students to gain admission into top-band schools has heightened their levels of stress and anxiety. Such conditions undermine the foundational principles of STEAM education, which thrives on confidence, creativity, and equitable access to learning opportunities.

Provided that all bandings of schools are having the same problems of insufficient teachers, inadequate implementation time, and overloaded curriculums, under the conditions of inequity in school positionings and inequality of resource disparities, will lower-band students have equal opportunities to benefit from STEAM education? And as well, is STEAM be able to fit into an education system with deep-rooted cultural biases which is under critics?

The heterogeneity in contemporary conceptions of educational strategies and strategic leadership highlights the growing complexity and unpredictability in the dynamic relationship between evolving educational reforms and leadership practices (Cheng, 2010). STEAM educational reforms have posed significant challenges for principals to lead transformational change, reorganize schools, and evolve their leadership practices (Szeto, Lee & Hallinger, 2015). Principals' decision-making mindset and execution abilities for achieving STEAM-oriented goals become the 'heart' of educational management (Bush, 2007). Nevertheless, contemporary school management do not fall squarely on principals' shoulders to design and assess curriculum change, but teachers are getting more active to engage in leading, managing, and formulating solutions (Tse, 2006). Strategic leaders are required to fully exploit the schools' current strategies and create new ones to maintain the effectiveness of management (Aydin, Mehmet & Pisapia, 2015). School leadership encompasses a variety of leadership styles, each with its distinctive significance for attaining specific school performance (Pan & Chen, 2020). Strategic leadership is never straightforward, but requires the leader to make the experiential

decision of what leadership styles are to be adopted, in relevance with divergent situations and the people involved (Reynolds, 2022).

The current researcher made a bold hypothetical assumption that the successful and effective implementation of STEAM in Hong Kong schools hinges on the strategic application of leadership skills to advocate for transformational change. This process is further reinforced by holistic strategies that are leveraged within a well-developed STEAM ecosystem, one that fosters collaboration, innovation, and equitable access to interdisciplinary learning opportunities. The assumption is needed to be cautiously verified through in-depth interviews with front-line educators, not only to learn from them the ‘what’ of leadership styles to apply and ‘how’ to employ strategically, but to acquire new knowledge from informants about STEAM implementation tactics which had not been divulged in past research. Most importantly, the researcher aims to gain insights from successful STEAM-implemented model schools of how they achieved outstanding outcomes, the ways in which these efforts have brought positive impacts on both institutional development, societal advancement, and the sustainability of the STEAM ecosystem. Moreover, the study will uncover and examine the underlying factors contributing to the inefficiencies in STEAM implementation. These insights will inform the development of targeted remedies aimed at driving transformational change, removing systemic barriers, and fostering sustainable solutions for successful STEAM integration.

In view of the research problems being not best examined, the contextual gaps are needed to be investigated in greater depth for filling up the knowledge blanks, hence making the research significant. The researcher expects to uncover potential differences between the existing bodies of knowledge and to discover new dimensions in the current newly-designed study. The interview topic is thematized to gear towards four directions. Firstly, there is a need to understand how Hong Kong educators perceive STEAM education, since their acceptance or resistance represents two different directions. Secondly, to tackle the challenges and barriers that hinder the efficient implementation of STEAM at Hong Kong schools. Thirdly, to identify the key domains essential for managing the STEAM program effectively. Finally, for pursuing STEAM’s sustainability, a comprehensive management and implementation approach is needed to be established. The reflective and interrogative thinking processes generates the following research questions for qualitative enquiry:

1. What are Hong Kong educators' perspectives and purposes for implementing STEAM?
2. What are the key challenges of implementing STEAM education in Hong Kong schools?
3. What are the key domains for effectively launching and implementing STEAM education in Hong Kong schools?
4. How can a holistic approach be developed for effectively promoting, managing, and implementing STEAM education in Hong Kong schools?

The research questions initiate the starting point of research, and form the structure and direction of the current study. The research questions called for an extensive literature review to encircle relevant literature of educational management, strategic leadership theories, strategic planning, and the heart-head-hands holistic model for effective managing, and transformative learning and teaching under change.

*Table 1.1 Research Problems, Objectives Aims, Research Objectives, and Research Questions*

<b>Research Problem</b>	<b>Research Aims</b>	<b>Research Objectives</b>	<b>Research Questions</b>
STEAM education remains insufficiently integrated and inconsistently implemented across Hong Kong schools, limiting its potential to enhance student engagement, creativity and problem-solving skills.	1) To investigate the current state and effectiveness of STEAM education in Hong Kong schools.	1) To explore educators' conceptual understanding, motivations, and attitudes toward STEAM education in the context of Hong Kong.	1) What are Hong Kong educators' perspectives and purposes for implementing STEAM?
	2) To identify key challenges and opportunities in implementing STEAM education.	2) To identify and analyze the systemic, pedagogical, and psychological barriers that hinder STEAM implementation across diverse school typologies of Hong Kong.	2) What are the key challenges of implementing STEAM education in Hong Kong schools?
	3) To investigate the systemic factors and strategic conditions that influence the successful integration of STEAM education in Hong Kong schools	3) To determine the critical components necessary for effective STEAM management, such as leadership styles, resource allocation, curriculum design, and teacher training.	3) What are the key domains for effectively launching and implementing STEAM education in Hong Kong schools?
	4) To propose actionable strategies for enhancing STEAM education delivery in Hong Kong schools.	4) To develop a holistic strategic framework that synthesizes both conceptual model and theoretical foundation that integrates leadership, school culture, and policy support for sustainable STEAM implementation.	4) How can a holistic approach be developed for effectively promoting, managing, and implementing STEAM education in Hong Kong schools?

## 1.5 Thesis Structure

The thesis structure serves the functions of expository, informative and structuring for the study, and provides a clear outline for the researcher to follow. The present research consists of seven chapters: Introduction, Literature Review on STEAM Education, Theoretical Framework, Research Methodology, Interpretation and Analysis of Findings, Discussion and Implications Addressing the Research Questions, and Conclusions.

Chapter one presents the Introduction of the worldwide and Hong Kong STEAM education background. In particular, framing the statement of problems that contextualize Hong Kong's STEAM implementation difficulties from practical and theoretical perspectives. The research problems indicate how the problematic issues were neglected in past studies and stressed the importance of why these issues are needed to be addressed to. The research aims to propose more effective strategies to tackle the problems and to fill up the knowledge gaps. Research objectives generate research questions, and derive from them the method of inquiries for making knowledge claims. The relevance of research questions, problem statements and research objectives all contribute to the significance of study, explaining how important the research is to the field of existing literature, and how the research will benefit the Hong Kong educational field. Finally in the last section, the thesis framework is structured.

Chapter two presents the Literature Review of STEAM Education. The review scrutinizes related literatures of STEAM education to build up a connection between past literatures and the current research, so the knowledge gaps that were omitted in previous studies can be identified; as a result, the significance of the current study and the research direction can be articulated. Different researchers' perspectives will be compared and contrasted, and disagreements or debates over arguable issues will be discussed. The literatures with similar conclusions will be grouped together for discussions.

Chapter three presents the Theoretical Framework, which introduces the theories for explaining why the research problems exist, states the corresponding assumptions that the researcher adopted, and demonstrates the conceptual and analytical approaches for filling the research gaps. An intertwined set of related ideas, such as educational and strategic management concepts, the styles and theories of educational leadership and strategic leadership, Vygotsky's Sociocultural Theory, the Change Theories, and the Ecosystem Theory are going to guide the research. Furthermore, the holistic 3H framework of Heart, Head and Hands is conceptualized from a synthesis of past literatures to reflect the multi-dimensional, integrative, and experiential

nature of the transformative processes of STEAM education. Deep engagement of school management bodies is revealed in the unity of their affective, cognitive and psychomotor domains of teaching and learning while teaching. Finally, critiques of the reviewed material will be presented for evaluating the accuracy or incorrectness of existing knowledge and methodologies adopted, and to determine the areas of uncertainties or disagreements that are worth debating on.

Chapter four presents the Research Methodology. It introduces the philosophical paradigms of ontology and epistemology that underpin the research and interprets how theoretical underpinnings affect the choice of methodologies adopted. The research design section discusses about the scope review of STEAM-related literatures to determine the research direction, data collection approach, and the analyzing method. For inquiries, the qualitative in-depth interview method is selected for collecting primary data in form of words from targets of interest, aiming to investigate their opinions, behaviors and attitudes towards Hong Kong STEAM education. Pilot studies, interview design, development of interview instruments, research ethics, sampling design, actual interviews, and thematic analysis of data are all outlined. Finally, the issues of validity, reliability, and generalization of data are also under discussion in the chapter.

Chapter five presents the Interpretation and Analysis of Findings, which is the core of the study. The backgrounds of interviewees will be described and summarized in a table. The data organizing method, coding system and the thematic analysis approach will be delineated. The transcriptive data is analyzed for identifying thematic patterns, and these concurrent themes are labelled as the findings of the research. The themes are then to be grouped, categorized and presented in a manner to address the research questions.

Chapter six presents the Discussions and Implications Addressing the Research Questions of the study. It gives an overall summary of the research findings in response to the problem statement, objectives and research questions. Implications will be discussed in both practical and theoretical ways guided by the complementary theories, the 3H domains, and the STEAM ecosystem.

Chapter seven presents the Conclusions with the contributions and limitations of the study, implications for future research are entailed by the findings, and numerous suggestions and

recommendations will be made to call for actions, and forward-looking directions for future research are also proposed.

## **1.6 Chapter Summary**

Chapter one introduces the background and history of STEAM education, and explains how and why the program is revolutionized from STEM to STEAM. Its importance for the 21<sup>st</sup> century is interpreted with elucidation of how it works within the context of school systems.

This research focuses in examining the STEAM education of Hong Kong, a city which is distinguished by its unique educational culture and a system characterized by distinctive features that set it apart from other regions. An overview of Hong Kong's educational structure and the societal attitudes towards learning is provided to establish the contextual foundation for the research. Hong Kong is having difficulties to implement STEAM effectively due to numerous reasons, and these barriers and challenges that hinder STEAM education's implementational success are needed to be identified. For STEAM education to sustain, overcoming these hurdles are essential, and this objective determines the purpose of the research.

The research problems clearly state the multiple barriers of Hong Kong STEAM education. Key challenges were particularly evident in the limited time, insufficient resources and support, gaps in teachers' instructional competence, and structural constraints within the curriculum. The researcher posits that leadership skills are essential for effectively advancing STEAM implementation, assuming that leadership skills are foundational within the STEAM ecosystem in facilitating collaboration, driving innovation, navigating complexity, and empowering others. The STEAM ecosystem fosters dynamic synergy among educational policy, teaching strategies, and classroom practice, creating a collaborative environment where innovation and interdisciplinary learning can flourish. Four research questions have been strategically formulated to steer the direction of the study and illuminate previously unexplored contextual gaps within the research landscape.

## **Chapter 2 Literature Review on STEAM Education**

Literature review presents a backward-looking view of the scholarly literatures about the topic under research, aims to identify themes, arguments and gaps, forming the background of the study. For the purpose to investigate how STEAM education can be launched and implemented effectively in the context of Hong Kong, the affecting issues have to be surfaced and problems have to be brought to light. The existing sources of knowledge and arguments are needed to be summarized and synthesized to bring out identifications, evaluations, correlations, comparisons and contrasts to map with the newly emerged knowledge revealed by the informants of interviews. At the stage of knowledge establishment, the current researcher posits bold assumptions that leadership styles, educational strategies, and educational management are critical drivers of successful STEAM implementation; these assumptions resonate with the complex interrelations among components within the STEAM ecosystem. These constructs will form the basis of the study's conceptual framework, and the framework of STEAM ecosystem will be used for examining how interdisciplinary collaboration and leadership influence implementation, it will as well outline the roles of stakeholders, and how resources are shared and utilized across diverse educational settings. Literature review will provide evidence and scholarly grounding for the constructs.

### **2.1 STEAM Teaching and Learning**

STEAM education is an instructional method, requiring students to actively involve in the self-directed inquiry process by developing products in problem-based projects (Sahin, 2013). The problem-based learning model challenges students' ability to develop solutions for solving real-world problems. By using experimental methods, students can improve their scientific concept of understanding through conducting technological explorations to acquire scientific knowledge (Pratiwi et al., 2019). Developing students' reasoning skills thus become a major teaching task to help students better understand, evaluate and learn scientific content knowledge (Wulandari & Shofiyah, 2018). The inquiry-based learning method requires students to initiate their own thinking minds to raise questions out of curiosities, it's a student-centered pedagogy designed to enhance engagement in skill development, and foster deeper connections with scientific concepts (Sánchez & Cortés, 2019). Inquiry-based teaching requires teachers' collaborative involvement in transdisciplinary plannings of instructional materials, and be prepared to tackle the challenges of formulating and responding to effective, high-quality inquiry-based questions (Gutierrez, 2015). Project-based learning requires students

to produce actual and meaningful products for solving real-world problems. It is an effective learning approach that integrates scientific disciplines through project-based activities, enabling the practical application of knowledge in real-life contexts. This method aims to elevate the learning capabilities of both students and teachers, while fostering technological creativity (Sahin, 2013; Henriksen, Mehta & Mehta, 2019; Sigit, Ristanto & Mufida, 2022). Teachers have to introduce the pedagogical concept that guide students toward achieving shared goal through collaboration in project-based learning (Kokotsaki, Menzies & Wiggins, 2016).

## **2.2 Challenges of STEAM Implementation**

To address the research problems of the current study, it is essential to review and examine the multifaceted challenges and barriers associated with problem-based, inquiry-based, and project-based STEAM teaching and learning. Numerous challenges associated with STEAM implementation were identified from the studies of past researchers. Belbase et al. (2022) had identified various types of challenges related to teachers' preparation, school leadership, integration cost, and management of resources. On top of the list were teacher incompetency in STEAM teaching and absence of collaboration. These views were supported by Herro, Quigley and Cian (2018) that teachers generally lacked sufficient planning time to design STEAM-integrated lessons, and received inadequate training and professional development to enhance their transdisciplinary teaching skills. Herro, Quigley and Cian had also recognized that the pacing and limited time allocated to STEAM instruction were insufficient to effectively spark students' interest and deepen their understanding. Teachers felt stressful when they found STEAM teaching took longer time to plan, deliver, and refine, so they have to compress the projects to allow time to prepare students for regular disciplinary tests and exams. The shortened project time span resulted in students' struggle to understand the STEAM concepts and were having difficulties to keep pace with the process, especially for those who were underprivileged and were weak in self-directed inquiry learning ability.

### **2.2.1 Inadequate STEAM Knowledge and Professional Trainings**

Effective STEAM teaching has been perceived by both primary and secondary school teachers as challenging tasks, since the educational system is in short of instructional strategies to deal with this project-based, problem-based, and research-based learning approach (Sánchez & Cortés, 2019). As Chu et al. (2017) claimed, the 'project-based collaborative inquiry learning

model prioritized targeted learning outcomes; however, educators were insufficiently prepared to implement the approach effectively'. Some teachers over-simplified STEAM as a series of scientific activities, instead of interpreting it as a holistic and sustainable learning approach (Boice et al., 2021). Many teachers completed their preservice trainings long before the introduction of STEM education, so they are in lack of the necessary experience or skills for executing STEAM effectively (Shernoff et al., 2017). Consequently, teachers showed negativism in picking up the new STEAM teaching approach as they have low efficacy in the ambiguous interdisciplinary areas, such as technology integration into traditional subjects, an area where they had never acquainted before (Jamil, Linder & Stegelin, 2018; Herro, Quigley & Cian, 2018). Meanwhile, they were reluctant to share ideas openly across disciplines, this phenomenon indicated a lack of trust and mutual respect in collegueship (Connor, Karmokar, Whittington, 2015). Confusion towards scientific-inquiry teaching aggravated teachers' scepticism in personal capabilities, and the ill-conceptualized image of STEAM teaching augmented teachers' psychological resistance (Zimmerman, 2016; Herro, Quigley & Cian, 2018). The lack of pedagogical content knowledge in STEAM education hinders teachers' commitment to instructional tasks, leading to strong demands for targeted professional development and external support (Weng, Jong & Chiu, 2020). Skilful and trained teachers are needed for implementing STEAM successfully, and novice teachers should be given the opportunities to get apprenticed into STEAM practices (Zimmerman, 2016; Silva-Hormanzábal & Alsina, 2023). In Asia, literatures also revealed that there were challenges in teacher preparation and professional development for STEAM education (Lee, Chai & Hong, 2019). China also faces the persistent challenges of not having sufficient qualified STEAM teachers, especially in primary schools. Most Chinese teachers received subject-based trainings, so they were not able to carry out meaningful interdisciplinary teachings. Consequently, some schools could hardly sustain their STEAM programs (Li et al., 2022). On the contrary, South Korean teachers received intensive professional development trainings for STEAM teaching, and they found the STEAM coaching practices in development lessons specifically helpful. As a result, their confidence was strengthened and that affected students' performance in both cognitive and affective learning (Kang, 2019).

### **2.2.2 Lack of Teacher Collaboration**

The STEAM approach requires teachers to work collaboratively across disciplines to achieve a shared common goal for the ultimate benefits of students. However, as stated by Costantino

(2018), interdisciplinary collaboration constitutes logistical and intellectual challenges. Logistically, teachers have to pick up extra workload to design best-fitted STEAM learning schedules to align with students' daily routines. Intellectually, teachers have to get out of their self-contained silos to cooperate effectively with fellow STEAM team members, they have to put aside their inherent knowledge and beliefs to support the value of interdisciplinary teaching. Profound communications, consensus, trust, and mutual respect are the key building blocks for creating a goal-setting platform where teachers can share ideas about the true purpose of STEAM teaching, design meaningful projects, plan for long-term program growth, and support one another in avoiding isolated and standardized teaching approaches (Rabalais, 2014; Falls, 2020; Belbase et al., 2022). Teachers' involvement in promoting the STEM-to-STEAM movement signifies that they have to teach in the dual modalities of inquiry. The scientific mode focuses on deriving solutions through systematic investigation, and the artistic mode centers on conceptual understanding and critical questioning to foster both rigor and creativity (Ghanbari, 2015). Cooperative teaching of the arts-science program can help to resolve the conflicts that arise between the two opposed modes of artistic inquiry and scientific inquiry. Cooperative teaching involves two or three teachers sharing responsibility for teaching the same group of students, this practice helps to prevent disciplinary fragmentation and supports a more integrated and holistic learning experience during project-based work (Li et al., 2022). However, co-teaching or team-teaching can be challenging. The teachers have to communicate whole-heartedly with each other, share similar philosophies in teaching, be willing to devote time for planning, and are having broad minds to decline own ideas to go with others' opinions (Murdock, Finneran & Theve, 2016). The relationship of the co-teachers or team-teachers plays a critical role in influencing the success or failure of the program, especially in the case of the STEM-to-STEAM movement, where science intersects with art.

### **2.2.3 Extra Workload and Time Constraint**

STEAM is an emerging educational paradigm that demands extensive multidisciplinary collaboration among teachers to effectively plan and implement. However, arranging time to plan collaboratively became one of the most significant challenges for teachers (Jho, Hong & Song, 2016; Park et al., 2016). Even when teachers were asked to plan independently, the added workload was generally unwelcome, as they remained unconvinced of any meaningful personal benefit (Boise et al., 2021). Several studies have revealed a significant gap between teachers' conceptual understanding of STEAM and their actual classroom implementation. Although

most teachers recognized STEAM as essential, only a small proportion actively incorporated it into their classroom practices (Park et al, 2016). Teachers' buy-in to the STEAM concept and then uptake the novel pedagogy will directly influence their teaching behavior in the STEAM classroom (Jamil, Linder & Stegelin, 2018). Time constraints are multifaceted, affecting various aspects of planning, coordination, collaboration, professional development, and implementation. Li et al. (2022) proposed a STEAM education model comprising the theoretical frameworks of multi-teacher cooperative teaching, project-based learning, scaffolding, and collaborative learning; the model was proven to be validated. The model proposed extending instructional hours, and advocated for a multi-teacher cooperative strategy to mitigate the teacher shortage problem, and to alleviate individual workload. The burden of STEAM-related tasks is not exclusive to only teachers, students and parents have also expressed concerns. Li et al. (2022) recommended embedding STEAM into the formal curriculum. This approach seeks to eliminate the need for after-school enrichment classes and alleviate the associated grievances.

#### **2.2.4 Insufficient Resources to Meet with STEAM Needs**

Some studies had reported that many schools around the world were in lack of sufficient resources to implement STEAM effectively (Park et al., 2016; Sánchez & Cortés, 2019; Belbase et al., 2022; Lavicza et al., 2022; Pearson, 2022). STEAM education requires a wide range of resources, including curriculum resources and materials, STEAM classroom resources, STEAM-related education resources, qualified teachers and support staff, modern educational technologies, financial support, and robust school infrastructure.

Curriculum resources include textbooks, workbooks and teaching materials, they should be provided by schools to enable teachers' effective instruction in STEAM classrooms (National Academies of Sciences, Engineering, and Medicine, 2022); and as a resource, quality curricular knowledge has direct relationship with teachers' responsive instructions (Robertson et al., 2021).

STEAM classroom resources include lesson plans, teaching and learning tools, activity kits, and the like. For instance, in the research of Marques et al. (2023), the school under studied used a science cartoon video to act as an 'innovative science communication resource to provide mathematics students the experience of STEAM learning.

STEAM-related education resources include specialized STEAM training courses designed to enhance teachers' professional development and instructional effectiveness, establishing social platforms enables teachers to exchange STEAM ideas, share practical classroom experiences, and stay informed about the latest news, trends, and developments in STEAM education. Education resources also include the materials which can be used for helping teachers and students to better integrate STEAM into their daily teaching and learning. Soroko et al. (2020) introduced a Ukrainian educational electronic platform in their study, on where the 'STEAM-oriented educational environment' was built, so students, teachers and pedagogists could communicate, share experiences, and learn from each other.

Human resources for STEAM implementation extend beyond principals and STEAM teachers, encompassing all school staff who collectively contribute to supporting the STEAM teaching and learning ecosystem. Creative teachers collaborate closely with industry experts to plan and co-develop STEAM activities may practically bridge up the gap between education and the evolving world (Hong, 2017). Qualified teachers in STEAM are in short supply, same as the challenges faced by entrepreneurs in the business world, where they also struggle to recruit talents with strong STEAM competencies. (Ainslie & Huffman, 2019). These kind of teachers or employees were labelled by Kang (2019) as 'talents in convergence', as they were capable to generate new ideas and create new products by adopting interdisciplinary or multidisciplinary ways of thinking. According to The Government of the Hong Kong Special Administrative Region (2022), Hong Kong schools are experiencing a growing demand for additional teachers to support the implementation of coding education in upper primary levels, and artificial intelligence instruction in junior secondary schools. The Education Bureau had launched a pilot scheme in 2022 to provide the aided schools with flexibility to employ their own teachers with STEAM-related experiences to assist in executing the STEAM program. Moreover, the Government will sustainably provide professional trainings to enrich STEAM human resources.

Educational technology resources encompass platforms, apps, hardware and software tools which can assist teachers and students to teach and learn science in novel ways. Technological tools can be in electronic, digital or physical form, such as virtual reality and augmented reality devices, educational knowledge online apps, communication platforms, and learning management systems. There are various challenges and barriers to the effective integration of educational technologies in schools and classrooms, such as teachers' resistance to change, insufficient professional trainings, lack of inquiring skills to operate, limited financial resources,

underdeveloped school infrastructure and facilities, internal competition for educational needs, school administrators fail to recognize the urgency or necessity for change (Laferrière, Hamel & Searson, 2013; Dotong et al., 2016; Johnson et al., 2016; Herro, Quigley & Cian, 2018; Rahiem, 2020).

Inadequate financial and funding resources is a significant obstacle that hinders STEAM education to be implemented effectively, as it limits the access to learning materials, teacher trainings, educational technologies, and infrastructure establishment (Saldanha et al., 2023). Resource deficiencies combining with disciplinary egocentrism of school panel leaders will impact STEAM's effective launching (Connor, Kamokar & Whittington, 2015). Securing entrepreneurial funding through strategic partnerships and collaborative projects empowers schools to accelerate their STEAM implementation efforts (Belbase et al., 2022).

### **2.2.5 Instructional Challenges**

In pursuit of effective STEAM implementation, students were encouraged to assume leadership roles in collaborative projects. However, many teachers encountered difficulties in planning and guiding students effectively towards achieving STEAM-related goals (Quigley and Herro, 2016). Teachers who participated in professional development workshops reported greater confidence in their ability to deliver STEAM instruction effectively. However, the absence of a clear and consistent framework for designing and implementing the STEAM curricula continued to create challenges in developing effective cross-disciplinary learning experiences (Wang et al., 2011; Herro, Quigley & Cian, 2018). Teachers faced considerable challenges in balancing the delivery of regular science lessons with the planning of STEAM activities. In addition to the management of dual responsibility, teachers were also responsible for ensuring that students do not only develop solid understanding of fundamental scientific concepts, but the prerequisite standards required for effective engagement in STEAM projects were also met (Herro & Quigley, 2016; Jamil, Linder & Stegelin, 2018).

Instructional challenges and barriers were specifically found in the teaching method of mathematics. The National Council of Teachers of Mathematics disagreed with the rote learning method of memorizing mathematical formulas and procedures, and criticized on the excessive repetition of practices (Caton, 2021). The Indonesian Council proposed to call for a change to align teachers and students in forming transdisciplinary teams, so they may foster shared goals and skill development in the learning of mathematics and science. However, many

parents and educators resisted this reform-oriented approach, preferring that students be taught through traditional methods similar to those they themselves experienced. Many Indonesian teachers also claimed that mathematics is the most difficult subject to integrate with STEAM, due to its characteristics that it is not related to real-life application (N Diana, Turmudi & Yohannes, 2021).

When STEM becomes STEAM, the instructional challenges became more intense, as many educators believed that knowledge should be taught in a concentrated and focused manner, instead of mixing all disciplines into one subject (Bush & Cook, 2019). STEAM instructional practices require the integration of multiple disciplines, which poses significant challenges for many teachers, especially those who are new to the profession. They must first learn from a transdisciplinary standpoint to understand how diverse forms of content knowledge align with the instructional methodologies across different disciplines, with the aim not only to convey curricular concepts to students, but also to collaborate with them for solving complex real-life problems (Quigley et al., 2020)

### **2.2.6 Gender Stereotyping Challenges**

In terms of achieving minimum proficiency levels in STEM learning, UNICEF (2020) had conducted a study about ‘gender equality in STEM from school to work’, the organization reported that girls in schools are equal, or even better than boys in achieving the proficiency levels, and they also showed ‘similar cognitive and behavioral skills’ as boys in science learning. These perspectives were supported by Pregaldini, Backers-Gelliner and Eisenkopf (2020) that girls on average outperformed boys in mathematics pursuance. Altarawneh (2023) also agreed that gender disparities were not significant in his research on math learning within STEAM-based challenges. However, the study of Kahn and Ginther (2017) about women and STEM education argued that female’s STEM-related gender differences were rooted in early school years. Girls’ performance might be influenced by the gender inequality or equality culture, the role modeling effect of teachers, and the independence of familial involvement. Although girls’ mathematics test scores showed minimal gender-based variations in their early age, the gender gap broadened in high schools. The UNICEF (2020) report indicated that in countries of low- and middle-income, girls are deprived of the opportunities to participate in scientific skill-learning, including STEM. UNICEF further claimed that even the top female performers in academia who enjoyed and valued the scientific approaches of inquiry learning, fewer female than male pursued careers in science, technology, or engineering. UNICEF

concluded that the gender gaps found in the discipline of STEM were shaped by ‘gender norms, stereotypes and bias’. Women were tended to be paid less on STEAM- or STEM-related jobs when comparing to their male counterparts (Lim, 2016). Japan is also encountering inequality of female gender gap in STEAM learning, Japanese female is underrepresented in STEAM-related education and careers, they show lower self-efficacy level in science learning and find harder to cope with experimental failures (Kijima, Yang-Yoshihara & Maekawa, 2021). On the other hand, Taiwan researchers perceive STEAM as a solution to close the gender equality gap by introducing arts to STEM (Lin, Huang & Lin, 2021).

Skolnik (2015) had also identified two challenging factors that affect female’s participation in STEM learning. Firstly, there has been a longstanding perception that science is more suited to men than to women. Secondly, women’s participation in science discussions was comparatively lower, they felt uncomfortable and reluctant, and eventually feeling marginalized. Conversely, in Skolnik’s same 2015 study, the researcher had included some supportive and encouraging factors of how professors of post-secondary institutions showed interest and support to help female students in persisting their STEM learnings, and parents also played supportive and motivated roles to attain their girls’ success in STEAM education.

### **2.2.7 Critiques Against the Art-Based Reformation of STEAM Education**

STEAM with the ‘A’ was first conceptualized by Yakman in 2010, whose study examined how the principles of science and mathematics could be explored through the integration of arts, aiming to dissolve the traditional silos within STEM disciplines. However, the arts-based reform had never been found easy, since pedagogists believed that arts should not be interplayed with science, and the lack of teacher collaboration across disciplines was the major obstacle inhibiting successful integration of arts into science subjects (Rabalais, 2014). Mejias et al. (2020) even commented that by adding ‘A’ to STEM had made STEAM an ‘often disputed term’. The arguments for or against integrating arts into STEAM caused widespread discussions among scholars and researchers. Land (2013) considered arts-integrated project-based learning as an effective approach to cultivate students’ divergent skills, such as applying physical technologies to new media literacies, performance arts and artificial intelligence simulations. Ghanbari (2015) argued that arts should be treated as equal to other subjects and should not be viewed as supplementary. Henriksen (2017) favored the design thinking concept incorporated in arts and believed that teachers might be able to design STEAM-based lessons

more flexibly. Sanz-Camarero, Ortiz-Revilla and Greca (2023) tried to evaluate the arts-integration effect from a reverse angle. The researchers investigated the STEAM-integrated effect on arts competencies, instead of the arts-integrated effect on STEAM education. However, after conducting a systematic literature review, the researchers discovered that investigations on artistic competencies were scarce. On the other hand, Liu et al. (2021) recruited experts to examine 62 STEAM-related arts activities to determine if the arts-integration effect was significant. Results indicated that in the areas of engineering, technology and creativity, students attained deeper knowledge when arts is incorporated; whereas in the disciplines of science, mathematics, contextual understanding, and arts learning, the acquisition of STEAM-related arts knowledge is limited. To adopt a positive and optimistic view about arts being integrated into science, Pugh and Girod (2006) explored in their study about the artful side of science and investigated how a science pedagogy could be constructed with aesthetics. The authors commented that while today's academic emphasis is on universal standards, proficiency assessments, and world comparisons, many educators overlook the transformative power of science to enhance everyday life, energize learning experiences, and provide mankind with aesthetic satisfaction. Pugh and Girod suggested that students should acquaint science through transformative and aesthetic experiences, empowered by creativity and engaged in their own ideas, and arts should be used as the media to transform students' relationship with the world.

### **2.2.8 STEAM Education is Not on the Hong Kong School Curriculum**

Australia, Singapore, South Korea and China are some of the countries that had already embedded STEAM education in their schools' regular curricula or set up as afterschool enrichment programmes (Belbase et al., 2021). However, not all schools in Hong Kong treated STEAM education as a structured curricular course and it is not even on their schools' long-term development plans. This wait-and-see attitude of schools is owing to the absence of consensus among school stakeholders and decision-makers to determine the proper content knowledge that should be included in the STEAM curriculum, and how STEAM activities were supposed to be manipulated (Falls, 2019; Wu, 2022). The actual meaning of the STEAM-integrated curriculum had not yet been clearly defined, and there is no official and standardized interdisciplinary curriculum framework for educators to use as reference. Therefore, many schools are still found bewildered of not knowing how to plan and design the program, and STEAM was being treated as a passing fad (Tenaglia, 2017). Taylor and Taylor (2019) argued

that educators should have the moral responsibility to develop transformative STEAM curricula for flourishing students to become socially responsible citizens, to help resolving world crises with their learned transdisciplinary skills. Perales and Aróstegui (2021) shared supportive view that educators and school administrators should get ready to ‘embrace a more social and democratic notion of schooling’ by transforming and moving education towards a more humanistic realm of well-rounded education through complementing arts and science. Design thinking is a key element for the planning of a practical and creative STEAM curriculum, and school leaders’ support is important for providing teachers with learning opportunities, solutions and problem-solving skills to break through the design barriers (Henriksen, 2017).

### **2.2.9 Insufficient Support from School Leaders and Government**

Enthusiasm of teachers alone is not enough to pursue STEAM implementation success, but the support of school leaders is crucial for building up teachers’ confidence to overcome barriers. A school with supportive culture is more likely to allow teachers to mitigate challenges with implementation, and always gives teacher the freedom to try adopting new approaches (Boice et al., 2021). If the STEAM program is in lack of school leaders’ driving force to develop learning opportunities for teachers, motivate collaboration, grant resources, and approve all the expenses, this highly-structured and collaborative program would not be able to sustain. Therefore, STEAM plannings and implementation are in need of school leaders’ participation and support (Tenaglia, 2017). However, the research of Han et al. (2023) uncovered contrasting views about the STEAM education in Korea. Korean stakeholders, including principals, STEAM head teachers, school administrators, directors of the STEAM education division, and policymakers, held conflicting perspectives on STEAM education, stemming from professional disparities and a lack of shared understanding regarding its true purpose, thus leading to ineffective STEAM policy execution. Han et al.’s study agreed with the past views of Holmlund, Lesseig and Slavit (2018). The researchers had also identified professional dissimilarities and variations in different role groups’ conceptualizations about STEM education, and the vision of educators were directly influenced by these groups. Therefore, collective ‘sense-making’ of STEM education among these professionals and policymakers should be conceived as part of the ongoing planning process for STEM implementation. The research of Coburn (2005) fully reflected and demonstrated how school leaders could shape teachers’ sensemaking to enact policies. School leaders play the role to guide teachers towards understanding the new policies through their lens of pre-established knowledge and practices.

### **2.3 Chapter Summary**

This chapter delves into a comprehensive review of literatures for achieving deeper understanding about the challenges in putting STEAM education into practice, involving inadequate STEAM knowledge and professional training, lack of collaboration among teachers, additional workload and time constraints, and insufficient resources. It also reviews the issues of instructional challenges, gender stereotyping, critiques against the art-based reformation of STEAM, its exclusion from the Hong Kong curriculum, and the lack of support from school leaders and the government.

## **Chapter 3: Theoretical Framework**

The theoretical framework provides a forward-looking perspective by identifying theories, models and concepts to connect with direct experiences of research participants to fill up the gaps highlighted in literature review.

### **3.1 Strategic Educational Management and Leadership**

In order to develop a positive future for STEAM education, school leaders need to integrate supportive and effective management strategies into the STEAM implementation system, adopting effective policies and practices to co-create the project-based, problem-based, and inquiry-based curriculum with teachers by engaging them in management, allowing them to facilitate onward improvement, and to ensure the sustainability of transformational changes. There is an extensive belief that qualified leadership made significant differences in school performance and student outcomes. However, there were diverse perspectives and competing debates over which leadership styles or behaviors tend to be more appropriate and productive for generating favorable outcomes to fulfil the aims of education (Bush, 2007). The causal relationships among various factors, events, and processes involved in effective STEAM integration are complex and challenging to navigate. While the cause-and-effect relationships of the anticipated phenomena may appear predictable at the outset of the research, the accumulation of knowledge obtained through in-depth interviews often reveals new dimensions. As a result, the initial theoretical framework guiding the study may require revision, and the planned methodology must be adjusted to align with emerging theoretical insights (Valsiner et al. eds., 2009).

#### **3.1.1 Educational Management**

Educational management inherently involves an organizational hierarchy, characterized by structured delegation of responsibilities. It entails the assignment, acceptance and bearing of responsibilities for the seamless operation of the educational institution, in which other stakeholders participate and contribute (Connolly, James & Fertig, 2017). As a field of study, educational management is grounded in diverse theoretical underpinnings that draw from organizational theory, leadership models, and sociocultural perspectives. Educational management encompasses forecasting, planning, decision-making, policy developing, and strategy formulating, and through the processes of evaluating, coordinating, and supervising

manpower and material resources, educational management aims to achieve predefined educational goals (Okpiaifo, 2021). For more effective and higher-level school management, schools should set an on-going long-term transformational plan by adopting strategic educational management skill to improve the quality of education, develop strategies, and allocate resources effectively to achieve the goals. Strategic educational management is the key to raise educational standards, improve education quality, and to sustain the improvements (Latorre-Medina and Blanco-Encomienda, 2013).

In order to bring positive changes to schools, efficient strategic planning is necessary for bringing educational partners with shared visions together, unleash collective intelligence to set common goals to help students fulfilling their potential. The strategic plan explains how goals can be achieved by using accessible resources, and the strategic implementation plans should involve the support of government, especially in terms of fundings. Practically and legislatively, schools have to act in concert with the strategic plans of government to facilitate change (Mathias, 2023).

### **3.1.2 Strategic STEAM Management**

Douthit (2021) had conducted interviews with school leaders, and many of them expressed a shared belief in the necessity of sustained professional development throughout the implementation of the STEAM program. Professional development is not only limited to STEAM-related teachers, but other faculty members are also needed to receive STEAM development trainings for gaining better understanding of the program, so they may share similar perspectives when making decisions. Effective STEAM implementation requires the complement of teaching and learning strategies.

In a student-centric classroom of STEAM, teachers have to apply creative and innovative teaching approaches to impart scientific concepts to students for fulfilling their unique inquiries. However, it is very common that teachers will adhere to their accustomed and preferred lecture-based teaching methods, and ignore the demands of the STEAM curriculum. It is a pity that lecture-based teaching fails to develop students' problem-solving skills, creativity, critical thinking, and reasoning abilities. If the teaching method is inappropriate for teaching STEAM, it would end up bringing frustrations to both teachers and students (Connor, Karmokar & Whittington, 2015). Mondal and Majumder (2020) studied about the factors affecting teachers' choice of teaching strategies. When knowledge was presented in complex ways, some highly-

receptive students would still be able to comprehend and perform well. Students' well performance would inspire teachers to stick with their routine instructional method which they determined to be the best teaching strategy and would resist change. In real life, teachers are in fact having difficulties in making decisions to select the appropriate teaching strategies for students. In terms of learner performance, learner engagement, and learner comprehension under studied, learner performance was found to be the most predominant measuring stick to determine teaching strategy (Mondal and Majumder, 2020).

Learning strategies are thoughts and activities in which learners engage and participate in, with the intention to influence their motivational state of mind and encoding processes, so they may choose, acquire, coordinate, and integrate new knowledge; the approach has significant implications for teachers to learn how to teach students to learn (Weinstein & Mayer, 1983). As mentioned by Nisbet and Shucksmith (1986) in their book, the most significant knowledge is self-knowledge of knowing one's capabilities and feelings; and the most important lesson of learning is to learn how to learn. The opinions and views of these authors pointed out the essential characteristics and spirit of STEAM education, applying to both teachers and students.

### **3.1.3 Theories of Leadership**

In the realm of innovative learning and teaching of STEAM, thinking critically and creatively are skills that educators should encompass in order to support collaborative problem-solving, and both teachers and students are needed to be nurtured to develop these skills (Dumitru, 2019; Khanom, 2023). For promoting effective student learning, strategic school leadership plays a key role in facilitating teachers' knowledge acquisition in transformational teaching (Slavich & Zimbardo, 2012; Pan & Chen, 2020).

To successfully launch new programs in education transformation, traditional approaches to training school leaders for conventional management roles must evolve into innovative formats that prepare them for emerging leadership demands. These training initiatives should extend beyond principals and administrators to include all practitioners who are actively engaged in the reform process (Barron, Henderson & Martha, 1995). There has long been an expectation that school leaders have to undertake multiple roles. Apart from traditional principalship, they have to fulfill managerial, instructional, and political responsibilities (Cuban, 1988). Principal behaviors have direct and indirect impacts on students, teachers, and school performance. Principals play critical roles in advancing teaching and learning. By applying leadership strategies with flexibility and pragmatism, they can foster a positive school climate and drive

meaningful educational outcomes (Liebowitz & Porter, 2019). Managing the process of transformative change requires the exceptional skills and synergistic power of school leaders to establish the atmosphere in which all school staff's collective consciousness gets ready for the change (Wong & Cheung, 2009). School leaders do not only act as role models to inspire followers, but their empowering behavior enable teachers to buy-in for educational changes. Trust-building between leaders and followers creates a synergy of mutual recognition, reliability, partnership, and righteousness, leading to the successful implementation of new school policies (Tsung, 2020). When executing new policies, the agreements and actions of school leaders affirm teachers with psychological support and adequate resources; as a result, the implementation of transformation is reinforced (Fullan, 2015). Principals' abilities and leadership styles have direct impacts on teachers' attributes, such as teacher efficacy, engagement level, job satisfaction, and school climate (Salinitri & Smith, 2021). However, certain researchers felt that studying on leadership styles was not at all important, but supporters tended to think that well-performed schools were significantly influenced by the styles of school leaders (Witziers, Bosker & Krüger, 2003; Oco, 2022). Dimitrijević (2023) agreed with the perspective of Oco that educational leadership has become a major subject of contemporary scientific inquiry, and it becomes a crucial element of many educational reforms. Dimitrijević had delineated a distinctive line between manager and leader. Managers have to maintain the stability of organizations by setting short-term goals, allocating resources, delegating responsibilities, planning activities, solving problems, and assigning tasks to different people. On the other hand, leaders have to set long-term goals, anticipate and plan activities, and concern with advancements and progressions. In past researches, numerous traditional and contemporary leadership theories had been used to examine the leadership philosophies that were used in education. Jovanović (2022) revealed the presence of various models of educational leadership in contemporary education, including transformational, strategic, instructional, pedagogical, transactional, and distributed leaderships. In addition to the leadership styles identified by Jovanović, the present researcher will like to include the situational leadership and educational leadership theories for exploration. Different leadership styles will be reviewed in the subsequent sections.

### **3.1.3.1 Transformational Leadership**

The fundamental concept of the transformational leadership theory lies in the capability of leaders, who are having strong emotional intelligence, flexibility, and ability to inspire,

motivate, influence, and stimulate subordinates to perform beyond their anticipations (Bass & Riggio, 2006). Transformational leaders enhance the maturity level of followers, motivating them to perform along their pursuit for success and self-actualization, they will start considering holistically about the society, the organization, and other people's well-being as a whole (Bass, 1999). Transformational leaders are also good listeners, willing to communicate, participate, and always be supportive (Cherry, 2023). Leaders with these leadership traits focus on encouraging collaboration and cooperation among colleagues, fostering creativity, mobilizing actions, and cultivating followers' personal development to shape their behaviors, beliefs, values, and attitudes towards change (Pennell, 2023). STEAM education is game-changing, school leaders have to restructure their schools and improve school conditions to adapt to the reformational changes. However, these tasks are not the leaders' sole responsibilities, good transformational leaders are able to inspire and articulate their visions to followers for achieving the goals (Denaker, 2020).

School leaders' transformation management includes the management of values, programs, projects, developmental trainings, organizational change, strategic planning, and risks during the transformation process of an organization (Uhl, 2012). The transformation management of STEAM places effective teaching practices in the key position, fostering teachers to plan and work collaboratively together by considering human, environment, and technology as a whole (Amoli & Aghashahi, 2016; Yaakob et al., 2019). Strategic planning requires strategic thinking as prerequisite. A decade ago, Leshkar and Bolouki (2013) had already identified three organizational success factors that schools should include in their strategic plans: human resources, exploitation of modern technologies, and organizational culture. Planning in schools is considered as an endeavor or a daily process, a comprehensive qualified school with process-based management should incorporate strategic planning into everyday operations (Okwukweka Chukwumah, 2015).

Henricks, Young and Kehoe (2020) discovered in their research the correlation between transformational leadership and the state-readiness for change. Research results show that, in face of organizational change, the longer the time for adaptability, the state-readiness for change will become more apparent. However, on the other hand, the trait-resistance for change demonstrated stability over time, meaning that resistance to change can be constant. The research findings of Henricks, Young and Kehoe significantly provided practical implications that there was a direct relationship between transformational leadership and followers' state-readiness to adapt to change. Schein (1996) studied about Kurt Lewin's change theory applied

in the field of education, the author indicated that every learning and transformation process begins with certain degree of discontent or frustration. According to Schein, the change theory introduced the concept of “unfreezing”, drawing attention to the state of “quasi-stationary equilibria” in human behavior. When individuals are situated in circumstances of change, they will create a quest for maintaining their stability and equilibrium, therefore the driving force towards change will be called off by the restraining counterforce against change. The concept has an important implication that if the restraining force of resistance can be removed, then the equilibrium can be easily maintained, as positive driving forces are already existed. However, the alteration of force fields is not straightforward, since it has to go through complex psychological minds. The change theory can be applied to individuals, but most of the time, it focuses more on group transformation.

### **3.1.3.2 Strategic Leadership**

Strategic leadership is required for carrying out school plans methodically. The practice of strategic leadership is grounded on the base of the leaders’ continuous learning ambition, so they will value learning and be able to create a sustainable learning environment. As effective strategic leaders, they have to ensure that all current strategies are fully exploited and new tactics are constantly developed (Aydin, Guclu & Pisapia, 2015). The key task of strategic leaders is to set goals and directions for the organizations. Strong strategic leaders possess the qualities of having eloquent and captivating visions to direct subordinates of ‘where to go’, and consistently energizing followers of ‘how to go’, until their vision cope with the organizational culture (Hill, Jones & Schilling, 2014). The term ‘strategy’ is frequently related to planning, used to characterize a broad range of leadership activities, and to represent specific actions taken by members in an organization (Eacott, 2008). For strategically focused schools, a holistic and rigorous framework including strategic approaches, processes and leadership skills must be developed. Strategic leaders have to be skillful to act proactively to deal with contextual changes, conduct detailed analysis of the changing environment, head the action plans, and monitor the progress (Carvalho et al., 2021). Strategic management of STEAM entails transformational management. Educational transformation is a structural and strategic approach to significantly alter the form and structure of the existing school system, transiting individuals, teams and the organization from the present state to the future desirable state (Amoli & Aghashahi, 2016).

### **3.1.3.3 Instructional Leadership**

Two of the most researched theories of educational leadership were the transformational leadership and instructional leadership, as these theories focused on how school leaders and teachers could enhance teaching and learning (Stewart, 2006). Instructional leadership was used to be dwelled in skeptics and critics in the last century. However, it had evolved recently to be the new paradigm for education, and resurrected to become a new form of concept – the leadership for learning (Hallinger, 2010). Ng (2019) elaborated various practices of instructional leaders. Principals of primary schools commonly implemented instructional leadership, instructional leaders are distributed leaders, principals tended to demonstrate a wider range of instructional leadership disciplines, and if the learning outcomes are satisfactory, predecessors will choose to continuously adopting instructional leadership style. Instructional leadership proposed three dimensions, including the establishment of school missions, the oversee of curriculum, and the fostering of a supportive and positive school-learning environment. As noted by Gupton (2003), principals can exercise instructional leadership via direct or indirect actions, but they are not the only ones who can practice instructional leadership. There are multiple levels of instructional leadership in schools, more than just the level that principals are ascribed to (Crowther, Kaagan & Ferguson, 2002). As stated by Ng (2019), instructional leadership is distributed. The outcomes of successful school leadership are identified in the quality of pedagogy contributed by teachers and the involvement of students engaged in the learning process (MacNeill, Cavanagh & Silcox, 2003).

### **3.1.3.4 Distributed Leadership**

Traditionally, the principal is used to be the sole person in charge of the entire operation of the school. Over the course of the last century, managerial expertise had played a prominent role in this capacity (Portin et al., 2019). In recent years, numerous studies had been conducted to discuss about the distributed leadership concept and how it can be applied in educational institutions. As Göksoy (2015) stated, educational institutions are complex, the distributed leadership approach challenged the notion that there should not be only one individual to take charge of the lead to assure change, but leadership should be distributed and delegated to the schools' official hierarchies of leaders for achieving better results; especially when school activities stretch across periods of uncertainty, the leadership tasks become more complicated, and individual competencies are not able to meet with the challenges (Spillane, Halverson & Diamond, 2001). Distributed leadership, closely related to teacher leadership, is a hybrid form

of leadership style where teachers practice alongside the school leaders in formal or informal way to achieve one common goal (Diamond, 2013). The notion of distributed leadership in academia has evolved to the extent that it is now being recognized as a legitimate aspect of raising students' academic achievement, and the caliber of pedagogical advancement in educational contexts (Okiri & Hercz, 2023). However, there was an argument from Harris and Muijs (2002) that the concept of distributed leadership is primarily focused on the responsibilities and duties of the head teacher, but tasks were not dispersed to other teaching staff at schools. Harris (2003) further argued that when leadership was distributed among multiple teachers and tasks were shared, each of them would only fulfill individual's separate roles and performed at an interdependent level. Later in 2003, Muijs and Harris (2003) raised the same issue again to affirm that there was a significant shift towards teacher leadership, in which teachers collaborate to build up collective expertise for instructing specific kind of knowledge, and improvement was shown through empowerment; therefore, distributed leadership was also known as collective leadership. According to worldwide studies, the teacher professional identity had been found to be an essential element in achieving educational improvement (García-Martínez & Tadeu, 2018).

### **3.1.3.5 Transactional Leadership**

Burns (1978) drew a clear distinction between transformational and transactional leadership, emphasizing that transformational leaders inspire both themselves and their followers to pursue elevated levels of moral development, to become more intellectual, revolutionary, reformative and heroic. On the other hand, transactional leaders take the initiatives to communicate with followers for the purpose of exchange, mainly for fulfilling one's own purpose. Transactional leadership based on the concept of exchange, transactional leaders use rewards and penalties to incentivize followers to behave as desire (Sternberg, 2020; Cherry, 2023). According to the path-goal theory of House (1996), an effective leader would establish a leader-initiated structure to clarify with followers about the path that they should take in order to accomplish a specific organizational goal. According to Vroom's expectancy theory of motivation, followers' effort can be determined based on an individual's expectancy that their actions will lead to a successful outcome, assuming that sufficient effort is applied. Their effort is influenced by instrumentality, they believe that success will lead to specific rewards (Latham & Pinder, 2005). While contingent rewards are being perceived as positive reinforcements, penalties or punishments for correcting subordinates' behavior might lead to negative outcomes such as

demotivation, emotional disturbances or mental stress. Although the transactional approach can be adopted under some circumstances, it will not foster creativity, innovation, and followers' loyalty (Moss, 2019; Cherry, 2022in Patrick, 2023). Transactional leadership is ineffective at empowering and inspiring followers to go beyond the predetermined goal, and not be able to enhance personal growth; as a result, followers will easily become demotivated, and fail to address the transformational changes of school improvements (Khan, 2017).

### **3.1.3.6 Situational Leadership**

Teachers' voluntary turnover is a threatening challenge to all schools, affecting the schools' abilities to operate effectively, and past studies showed that the styles of school leaders were the key factor affecting the turnover rate (Rheanna, 2021). The situational leadership theory indicated that leaders should be flexible in response to the changing situations and environment, always be ready to modify their communication methods with followers, and adjust to their needs (Meier, 2016). Situational leaders in education are flexible, fluid, and adaptable to different situations, always encourage collaboration between teachers and students, they are supportive and allowing both teachers and students to develop individually and to grow with confidence. Moreover, situational leaders will modify their behaviors to suit with individuality, rather than adopting a single approach to handle all followers and circumstances (Walls, 2019). Effective situational leaders are able to master diverse leadership styles and apply them appropriately under different circumstances, at the right time and at the right place (Tabrizi & Rideout, 2019). According to Kubiak (2012), there are six styles of situational leadership identified: visionary or authoritative, coaching, affiliative, democratic, pacesetter, and commanding or coercive. The first five qualities are more motivational, whereas the commanding or coercive style is having similar effect as transactional leadership, it will damage the morality of subordinates.

### **3.1.3.7 Pedagogical Leadership**

Meyer and Bendikson (2021) described pedagogical leaders as those who viewed all facets of teaching through the pedagogical lens, they place strong emphases on the interactions between teachers, students, families and communities. Fonsén and Lahtero (2024) pointed out that pedagogical leaders should have the awareness about the quality of pedagogy under implementation, be knowledgeable in multi-dimensions, with the ability to lead transformations, and always be alert to raise arguments for pedagogical change. Aman (2023)

identified four important pedagogic practices that pedagogical leaders should execute, including curriculum modification and enhancement, continuous development of teachers, involvement of the community, and collaborative planning for teachers and learners. Pedagogical leader prioritizes the creation and management of knowledge over the pure dissemination of learning material, it offers more comprehensive, holistic, and strategic approaches for developing and sustaining a productive learning environment (Male & Palaiologou, 2012). These practices of pedagogy are essential for impacting the improvement of teaching quality. However, for contemporary education, it is equally important to include the theory and practices of educational leadership.

### **3.1.3.8 Educational Leadership**

Educational leaders, like school supervisors and principals, do not only work in academic settings, but they can also be education officials of the government who collaborate with different schools to drive positive outcomes through the formulation and achievement of transformative goals. Educational leaders should provide the schools with frameworks, structures, procedures, and connections, so school leaders will be able to exercise their leadership skills with clarity and conviction. Furthermore, good educational leaders should make provisions to offer schools holistic approaches and comprehensive strategies for effective school management, so teachers can be motivated to engage fully in achieving the schools' common goals (Amanchukwu, Stanley and Ololube, 2015).

### **3.1.3.9 Laissez-Faire Leadership**

Laissez-faire leadership, also known as delegation leadership, is characterized by a hands-off approach in which leaders grant followers substantial autonomy to make decisions and act independently. This style can be particularly effective in empowering employees who are creative, self-motivated, and capable of working without constant supervision (Wong & Giessner, 2018). However, critics emphasized that laissez-faire leaders could be destructive by causing low productivity and negative effects, especially in environments that require clear direction and consistent oversight (Skogstad et al., 2007).

### **3.1.4 Leadership Formation and Professional Growth**

For the improvement and long-term sustainability of school quality, there is a widely held consensus that the primary responsibility rests with school leaders. In view of this,

comprehensive leadership development and continuous capacity building for school leaders have grown significantly important in today's trend of education (Huber & Schneider, 2022). Fortunately, school leadership is a capacity that can be cultivated and strengthened, as affirmed by Amanchukwu, Stanley & Ololube (2015), 'leaders are not born, but made'. At various times throughout the day, school leaders have to change constantly to fit with situational demands and thereby transitioning their leadership from role to role, ranging from managerial and administrative roles to curriculum leadership, instructional guidance, coaching, and beyond. However, the transitioning roles require delicate, but difficult balancing acts to respond to the demands (Alam, 2012). As stated in the study of Tingle, Corrales & Peter (2017), school leaders considered executive leadership trainings are having direct relationship with human capital plannings, strategic operations, and their proficiencies in leading their schools effectively. School leaders are not only responsible for hiring the best talents to align with the school culture and values, but they are also accountable for supporting school staff in developing their career pathways and fostering professional growth. In cases of turnover, they should always have plans to deal with the changes. Furthermore, the research of Huggins, Klar and Andreoli (2021) also pointed out that leadership coaching provided by experienced school leaders can effectively support their less-experienced counterparts in driving continuous school improvement.

### **3.2 The 3H Holistic Framework**

For the successful launch and effective implementation of STEAM education in Hong Kong, the educational system must undertake comprehensive transformational changes by involving relevant stakeholders at all levels. The domains of heart, head and hands encompass a holistic and system-centered approach which is essential for the transformation of education in the modern era, especially in ensuring the successful launch of STEAM education. The 3H framework is aimed to assure a developmental balance of 'emotional intelligence, intellectual capabilities, and practical skills' (Tan et al., 2020) within a highly interactive educational system comprising educators, students, external stakeholders, and the government.

Historically, in the early development of educational systems, the notion of head, heart and hands was first articulated by Johann Heinrich Pestalozzi in his idealistic vision of schooling. As an influential education reformer, Pestalozzi introduced the 'psychological method of instruction', emphasizing holistic development through intellectual, emotional, and practical

learning. Through intellectual education, Pestalozzi suggested to allow students to follow their own interests in learning, and let them draw their own conclusions without fixed answers given. Pestalozzi aimed to foster students' holistic development by enhancing their observation power, judgement and reasoning skills, and to cultivate a balanced development of students' intellect, emotions, and practical skills (Smith, 2008). Pestalozzi indicated that education encompasses more than the attainment of requisite learning objectives, it also involves the holistic development of the whole person (Brühlmeier, 2010).

The head, heart and hands (3H) model was originated from the transformational learning theory in education, it was interpreted as a model of profound, meaningful, and substantial learning approach that goes beyond mere information acquisition, while empowering students to purposefully shape meanings in their lives (Simsek, 2012). The head represents cognitive functions, encompassing how a person thinks and processes information. The heart incorporates emotions, feelings, attitudes, and other affective aspects. The hands symbolize psychomotor skills, translating ideas into purposeful actions (Sipos, Battisti & Grimm, 2007). The cognitive, affective, and psychomotor domains are all equally important and crucially significant in holistic learning, the approach has considerable impact on how schools are coordinated and organized for supporting the learning of all students (Gazibara, 2013). The 3H model emphasizes the importance of the learning context, and also demonstrates the multifaceted nature of the transformative learning process (Singleton, 2015). Sipos, Battisti and Grimm (2007) advocated for the advancement of the head, heart and hands in response to Orr's (1992) assertion that 'we must not believe education alone will save or advance humanity; rather, it is a specific kind of education that will lead to true progress'. According to Sipos, Battisti and Grimm (2007), the strategy for transformative learning is simple: educators just need to integrate the learning process into students' heads through cognition and engagement, enable values and attitudes in students' heart by translating beliefs into behaviour, and enact theoretical learning through developing practical skills by hands.

Beyond nurturing the whole child in education, the 3H holistic framework also serves as an effective management approach, capable of helping organizations address people-related and organizational challenges more efficiently. By embracing the 3H mindset and integrating all its domains, leaders cultivate intuitive capabilities for strategic planning and effective implementation (Yu, 2021). The 3H approach can be taken as a change driver for leaders to adopt in transformation. The head looks forward, creates a vision for the future, and concentrates on overcoming long-term barriers; the heart shapes the empowering culture,

demonstrates care, and inspires people to go beyond one's comfort zone; and hands implement amid the evolving environment to generate improvement (Hemerling, Kilmann & Matthews, 2018).

Various theories were found relative to the 3H attributes in past literatures. Yu (2021) identified the relationship between the head domain and organizational structuring, strategic thinking, strategic planning, and strategic management; the heart-related attributes can be found in literatures about organizational behavior, leadership styles, transformation management, and management of change, which can be articulated through the Theory of Change; moreover, Yu recognized that the hands domain was related to studies about functional practices, strategies, competency, and competitive advantages of organizations. The head domain can be represented by Bass's Transformational Leadership Theory (Bass, 1995; Avolio & Bass, 1995; Bass, 1997; Bass & Riggio, 2010), the heart domain can be conceptualized through Lewin's Change Theory; while the hands domain aligns with Barney's Resource-Based Theory (Priem & Butler, 2001).

### **3.3 Theoretical Foundations of STEAM Education**

Perignat and Katz-Buonincontro (2019) outlined five prevailing frameworks for combining disciplines within STEAM education: interdisciplinary, transdisciplinary, multidisciplinary, cross-disciplinary, and arts-integration. Each model represents a distinct level of pedagogical complexity, given that the transdisciplinary approaches offer the most comprehensive and cohesive learning experiences. Holbrook, Rannikmäe, and Soobard (2020) argued that the transdisciplinary focus in STEAM education reflects a broader philosophical and pedagogical approach rather than a single theory. They indicated that STEAM was drawn upon multiple established theories, such as constructivism and inquiry-based learning, but it repositions itself as a transformation of conventional practices, emphasizing skills development, social relevance, and integrated thinking across disciplines. Drawing on a systematic review of 124 STEAM-related articles, Irwanto and Ananada (2024) highlight the critical importance of strategic planning, leadership cultivation, and educator preparation in ensuring successful implementation. Their findings suggest that STEAM education must rely on robust institutional support and consistent professional development to achieve long-lasting impact.

Despite its growing importance, STEAM education remains theoretically fragmented, lacking a universally accepted framework. Aguilera and Ortiz-Revilla (2021) indicated that both STEM and STEAM approaches manifest in diverse forms across theoretical and practical domains,

making it difficult to standardize implementation across contexts. Yeomans et al. (2025) introduced a theoretical classification system to strengthen the theoretical foundation of STEAM education, in response to the fragmented conceptual base. Their work encompassed 26 distinct frameworks drawn from diverse academic sources, and these frameworks were organized into four major categories: experiential real-world engagement, psychological and cognitive development, social, spatial, and material interconnectivity, and cultural and equity considerations.

The major insight of their work contributes to the promotion of a relational ontology, which views knowledge as inherently interconnected and shaped by context, challenging the conventional STEAM models that position arts as merely supportive or decorative in STEAM learning, but it actually plays a more integrated and meaningful role within STEAM education.

### **3.4 The Case of Hong Kong Education and STEAM Implementation**

Among all studies about STEAM education, U.S.-based educational research accounted for 65% of studies, while Asia Pacific countries such as China, Japan, Korea, Taiwan, Singapore, Malaysia and Hong Kong accounted for only 8.5% of published articles (Cheng, 2022). The study of effective STEAM launching is transnational, but Hong Kong's unique cultural and historical backgrounds bring significance to the present research to freshen up readers' intrinsic views about various STEAM launching methods of Hong Kong, and to gain new understandings of the city's distinctive STEAM launching motives.

Hong Kong has a well-developed educational system which is constantly under reformation, adopting a centralized decentralization approach to correspond with different reformational goals (Ng & Chan, 2008). According to Ng and Chan (2008), Hong Kong had chosen to adopt a 'new managerialism philosophy and decentralization of power' in its school system to encounter global challenges. The Hong Kong government is both sensible and pragmatic in designing the educational system. It exercises centralization for strategic control, but allows schools to operate independently with autonomy under the school-based management system. Each school has to develop its own customized educational plan to fit with its unique characteristics and special needs. Execution of plans require joint collaboration of school supervisors, principals, teachers, parents, and alumnae (Cheng, 2000). In 2002, Hong Kong started a meticulously crafted ten-year education reform plan to cover the primary, secondary, and tertiary education. The prime objective was to support students' holistic growth and to

develop their mindset for lifelong learning, in order to prepare them comprehensively for the modern workplace and life in a rapidly changing world. The reformation covered changes in curriculum, assessment methods, pedagogy, and as well wide-ranging structural changes, such as introducing the Direct Subsidy Scheme schools and the ‘through-train’ mode of continuing studies from primary to secondary schools without the need to sit for open exams; and moreover, the introduction of the Hong Kong Diploma in Secondary Education (HKDSE) was most significant (Poon & Wong, 2008; James, 2021). The reformation aimed to develop a novel approach of learning, shifting from dissemination of knowledge to acquiring the skills of how to learn. Key areas of learning involved generic skills, attitudes, and values. Generic skills include critical thinking, creativity, communication, collaboration, problem-solving, self-management, numeracy, information technology, and study. Students should cultivate values as the core principle of their behavior and for decision-making, and instill positive attitudes for performing tasks well (Wong & Cheung, 2009). The attributes and concepts promoted in the curriculum reformation had striking similarities to the advocacy of STEAM today, they can be perceived as the foundation of the STEAM transformation. Hong Kong’s education system has been transforming consistently to look for individuals best aligned with the mission to attain quality education in the fast-changing social, economic, and political conditions of the society (Szeto, Cheng & Sin, 2019). For the purpose to attain student-centered and quality education, the Hong Kong Education Bureau introduced school-based management by granting schools greater autonomy in daily operations, resource management, strategic planning, and performance evaluation. The Government provided schools with additional resources for the implementation of school-based management and development of programs, and empowering the schools’ Incorporated Management Committees with the responsibilities to formulate educational policies, oversee school planning and improvement, manage financial and human resources, align the visions and missions of the sponsoring bodies, and comply with government education policy requirements (Education Bureau, 2019).

Hong Kong stands at the crossroads of Western and Confucian cultural traditions. By looking at education from an oriental perspective, Walker and Hallinger (2015) stated that the primary roles of principals in Asia have possessed both the managerial and political tendencies. Hallinger, Walker and Gian (2015) also indicated that school leaders in Asia are very often acting as the “officers” of the government, conforming with the orders of high authorities. However, the Hong Kong education system is distinguishable from other East Asian educational systems. Way back in 1991, the Education and Manpower Branch and Education

Department of Hong Kong<sup>4</sup> had released a School Management Initiatives report stating that Hong Kong was in lack of accepted management structure and proper processes to manipulate the schools' daily operations. Some school principals were inadequately accountable for their posts, as they were acting like "little emperors" with dogmatic power to exercise control over all school matters, but show little interest to learn how to run their schools in a righteous manner (Walker, 2004). These accusations thus led to the introductory formation of the school sponsoring bodies (SSB) and incorporated management committee (IMC) of schools. The reform was partly intended to recalibrate the power dynamics between schools and the Hong Kong government, while also addressing the entrenched social hierarchies within the school system. Under the new system, there is a high degree of structural decentralization, it is the SSB that offers educational services in Hong Kong, instead of the Education Bureau. As Hallinger and Ko (2015) defined, SSBs are independent foundations or groups connected to religious bodies, clan-based associations, non-profit making societies, or community-based organizations; and IMC is established and registered under the Hong Kong Education Ordinance, composed of school supervisor, principals, teachers, parents, alumnae, and independent third parties (Education Bureau, 2024a). According to the Education Bureau, the functions and powers of SSB include formulation of the school's mission and vision, drafting the constitution of the IMC, providing general guidelines for educational policy development, monitoring the IMC's performance, determining the mechanisms for securing government grants and aids, issuing directives for fundraising and contract management involving non-governmental sponsorship, and appointing principals and teachers to sponsored schools under specific conditions. Meanwhile, the general duties of IMC include overseeing school management, formulating school policies in alignment with the sponsoring body's mission and vision, reporting school performance to both the Permanent Secretary and school sponsoring body, ensuring the effective execution of the school's mission, coordinating and supervising financial and human resources, promoting students' educational development, planning and guiding the school's self-improvement initiatives, recruiting teaching and non-teaching staff as needed, and determining the terms and conditions for negotiation.

In light of the evolving school context, school leaders face significant challenges, as these transformations are likely to redefine student development goals, regardless of whether students require special educational support (Szeto, 2016). School leaders are expected to take the lead in guiding their schools to provide equal and equitable learning opportunities for

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<sup>4</sup> The Education and Manpower Branch and Education Department of Hong Kong is the former EDB.

students from diverse backgrounds, while being prepared to respond effectively to the challenges arising from the diverse physical and intellectual needs of students (Szeto, Cheng & Sin, 2019). However, as Lam (2003) mentioned earlier, Hong Kong school principals were entangled between the opponent forces of stability and change, and they were ambivalent in addressing school reforms. To successfully integrate STEAM into Hong Kong's educational framework, its education system needs to undergo a comprehensive transformation that actively engages stakeholders at all levels in the program's implementation. Research conducted by Chow (2014) on transformational changes within Hong Kong's education system revealed a 70% failure rate among the initiatives implemented, as educators were not aware and familiar with the change-related theories and approaches that could be adopted when initiating change; and moreover, the pace of change outstripped school leaders' capacity to adapt and learn. While numerous approaches to change management exist, selecting the right strategy is essential for achieving sustainable organizational success (Burnes, 2007). The concept of group dynamics introduced by Lewin (1939, in Burnes, 2007), indicated that focus of change should not be relied on individual behavior, but instead the collective behavior of all stakeholders should be taken into consideration. The concept of group dynamics explains how organizational members behave when influenced by forces within their group, and how tension can serve as a catalyst for change. When the field theory is applied to group settings, these forces can be identified, highlighting the critical role of collaboration and participation among group members in driving effective change (Hermann, 2015).

Cheng (2000) identified different Hong Kong principal leadership characteristics. The author indicated that Hong Kong principals' leadership styles are shaped by the interplay of their personal attributes and the influences of school context and social culture, especially within the frameworks of school-based management and the pursuit of quality education. The first characteristic of leadership is found in principals' high tendencies to influence the performance and behavior of students and followers, the second characteristic is related to principals' goal-setting and pursuance of achievement, and the third is related to principals' transformational objective in shaping an alternate school culture and a personal-defined organizational mission. Nevertheless, the study of Walker (2004) revealed that there was another stream of deep leadership structure existed in the schools of Hong Kong which were related to the constitution and traditional culture of the school system. As Walker explained, constitution referred to the formal features of organization and system governance; whereas culture referred to the shared norms, values, and beliefs that seemed to be prominent throughout a system or collection of

groups, and are influencing the behavior of both groups and individuals. Walker explicated that the deep structures within schools are endogenous, potentially influencing principals' responses to government policies by fostering resistance to challenges and transformational changes in the education system. The impact of deep leadership structure in Hong Kong is significant, as it involves the institution of principal selection and the empowerment problems of teachers and parents. This internal organizational structure is actually a reflection of the customs that were created through a combination of issues, including the colonial government policies established before 1997<sup>5</sup>, the traditional values of Chinese culture, the implementation of government's non-intervention strategy, and the dispersed governance structure. According to Walker (2004), the Chinese culture traditionally emphasizes a morally grounded social structure to achieve harmony among individuals within organizations. When a person is being placed on top of the hierarchy, one is given the right to take the lead and get involved in any field of endeavor. Followers should not criticize their leaders in public; and on contrary, leaders should also protect their followers and not to criticize them openly. Any conflicts should be avoided, as these will distort harmony. These traditional Chinese values are stored in the deep structures of leadership.

Besides selecting principals, SSBs have to appoint school supervisors to perform school supervising duties, such as monitoring school operations, working close with principals to establish policies and curriculum, assisting principals to recruit school staff, supporting principals and teachers, watching over students' progress, and ensuring that the schools are operating effectively within the bounds of law and regulation (Education Bureau, 2024b). School supervisors may be appointed through various channels, including specific church communities or religious orders, business leaders, principals from affiliated SSB schools, and individuals connected through familial, clan or business ties (Walker, 2004). Supervisors are all subject to considerable legal obligations, but undertake their roles on a voluntary, non-remunerated bases. The role of school supervisors is to facilitate positive change within schools and the school system; and by playing the strategic leadership role, they are able to articulate their vision and creativities for improving the school outcomes (Barron, Henderson & Martha, 1995). As the immediate line managers of principals, school supervisors take on multifaceted responsibilities. In instances where principals experience stress and burnout due to policy changes, they have to show support to reduce principals' emotional exhaustion (Beausaert et

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<sup>5</sup> 1997 was the year that Hong Kong was returned to the People's Republic of China from the rule of United Kingdom.

al., 2016). On the other hand, if supervisors hold strong status and significant authority, they tend to dominate reform-related decision-making. Principals, irrespective of their agreement, they often comply with senior instructions to preserve institutional harmony.

Despite the vigorous promotion of STEAM education by the EDB, many schools and parents continue to prioritize academic achievement, viewing university admission as the primary objective of learning. As a result, the development of essential skills such as critical thinking, creativity, collaboration, and communication, particularly within the context of scientific inquiry, is often overlooked. The emphasis on examination success has marginalized the recognition of vocational and technical competencies, leading to the persistent undervaluation of holistic student development. The learning in Hong Kong is highly focused on the cognitive domain of head, such as in rote repetition and memorization, rather than adopting the heart and hands domains to learn and practice. In Hong Kong, learning assessment primarily relies on extensive written examinations, emphasizing student accountability for individual scores, benchmarking performance against predetermined standards, and grouping students accordingly based on performance. Instead, assessment for learning should be recognized as a formative process for guiding instruction to enhance both teaching and learning (Yan & Brown, 2021). Hong Kong failed to provide a positive image of ‘true learning extends beyond scoring’, but it conveys a high-pressurized message that ‘learning in Hong Kong is driven by the pursuit to achieve high academic scores’. Thriving within a holistic education system that does not prioritize scores is essential for students to rediscover their intrinsic love for learning. One of the critical elements in enhancing the quality and effectiveness of contemporary education is the promotion of learning through the integration of head, heart, and hands (Basome et al., 2017). Basome et al. further claimed that for enhancing holistic education, the responsibilities must be shared among all educational stakeholders. In the academic context of Hong Kong, educational stakeholders include a broad spectrum of participants, such as policy makers, school supervisors, principals, teachers, all school staff, students, parents, families, members of the wider communities, advocacy groups, media, and business sectors. Jackson (2009) emphasized that, educators should seek partnerships with entrepreneurs and organizations to drive improvements in the school system, aiming to replenish the deficiencies in both resources and professional capacities.

There is an urgent need to establish a holistic and human-centered strategy to foster inclusive and student-focused educational practices. School leaders and policy makers play important roles in inspiring, empowering, and leading stakeholders of all levels to first understand what

STEAM is, how it works, and then provide plans for effective implementation. Related stakeholders do not involve only principals and teachers, but also include the IMC, all school staff, students, parents, and most importantly, the Hong Kong Government.

### **3.5 Chapter Summary**

Various leadership theories are reviewed in this chapter, including transformational, strategic, instructional, distributed, transactional, situation, pedagogical, educational, laissez-faire, and leadership crafting. The review of the 3H holistic framework highlights a well-rounded and balanced educational strategy that fosters emotional, intellectual and practical skills. STEAM education is advancing through diverse theoretical frameworks, with transdisciplinary approaches offering the most integrated learning. Recent research emphasizes the need for strategic planning, educator preparation, and a relational ontology that integrates arts meaningfully across disciplines. Finally, the chapter reviews through literatures the specific circumstances of Hong Kong's educational system, along with the challenges and opportunities associated with introducing and implementing STEAM education in Hong Kong.

## **Chapter 4: Research Methodology**

Methodology is ‘an articulated and well-informed theoretical approach for literature study, data generation and critical analysis of data’ (Ellen, 1984; Rehman & Alharthi, 2016). For the purpose to attain knowledge about the world, researchers have to be clear with the methods of how knowledge is to be attained. Through research, scholars can articulate their beliefs about the nature and scope of reality, thereby shaping their research paradigm (Rehman & Alharthi, 2016). Methods of research can be informed by methodology and determined by research design (King, Horrocks & Brooks, 2018), and the choice of research approaches can be informed by the philosophical assumptions and theoretical frameworks.

### **4.1 Theoretical Underpinnings and Interpretive Frameworks**

Before initiating research, it is essential for researchers to understand how the philosophical assumptions are embedded within the study’s interpretive frameworks. This foundational awareness facilitates a more nuanced understanding of data and guides the interpretation of its underlying structures and patterns (Creswell, 2012; Trent & Cho, 2020). Qualitative researchers are keen to identify the inherent and defined characteristics of their concepts under study. Goertz and Mahoney (2012) stated that, concepts formation will propose ontology issues as they specify the inherence and importance of the empirical phenomena represented by the concepts. Researcher’s perspectives of knowledge and social reality affect how and what they can do for uncovering knowledge about the relationships among emerged phenomena and social behavior (Mack, 2010). As an inquirer, the researcher had to make assumptions to decide on the stance that the research will be embedded in, clear with the philosophical underpinnings for determining research questions and methodologies to be adopted (Grix, 2004). Ontological and epistemological assumptions will together constitute the qualitative paradigm of research.

#### **4.1.1 Ontological Underpinnings**

In metaphysics, ontology is about the “nature and roles of beings, a specification of conceptualization, a pursuit for reality” (Gruber, 1993). As interpreted by Guarino, Oberle and Staab (2009), conceptualization is a comprehensible perspective of the world, on which defined knowledge is based. Ontology studies interpret what might exist, and how they are categorized; it is more than a philosophical inquiry, it serves as an effective instrument for establishing and organizing knowledge into various territories or communities with different senses, such as

computational sense in engineering science, and philosophical sense in social science (Smith, 2003; Guarino, Oberle and Staab, 2009). By recruiting right informants to participate in ontological studies, their multiple views and precise opinions will provide the researcher fundamental realities about the research topic. For educational studies, the researcher has to base on participants' interpretations to examine a range of phenomena, the essential contexts of actions and their structural properties are needed to be understood. However, according to Scott (2014), some informants' activities might be "designed and have intentions behind their actions. These actions might be motivated by unconscious forces, or they were compelled by intended drives to behave in certain ways, so the researcher has to examine their intentions and to determine how these intentions bring impact to the decisions they made", this is the quest for reality.

This research is grounded in a constructivist view of reality, asserting that knowledge and meaning emerged through the lived experiences, interpretations, and social interactions of individuals within Hong Kong's educational contexts. The concepts of leadership and the STEAM ecosystem are perceived as dynamic and context-sensitive, continuously shaped by collaborative processes among key stakeholders in Hong Kong schools. This ontological position supports an in-depth exploration of how leadership models and systemic approaches are perceived and enacted in practice.

#### **4.1.2 Epistemological Underpinnings**

Epistemology is the study of knowledge, includes studying its origin, identifying its occurrence in different domains, and building up a relationship between it and the practical interests of real life (Pollock, 1968). Epistemology is important to be understood before research starts, since it influences researchers in their development of research frameworks. The purpose for getting close to research participants is to discover knowledge or to create knowledge from their social realities. The nature of social science study is to use people to "identify, describe, and explain patterns (Sheppard, 2020). However, "what is knowledge and how do we know what we know?" (Steup & Neta, 2005; Abbott, M. L. & McKinney, 2013) is a question we have to seek answers before deciding on the research design. According to Plato's Theory of Knowledge, it believes that "knowledge is achievable, invincible, objective, true and certain" (Wedgwood, 2018) and the Theory of Forms sought "to identify the source of true knowledge" (Cornford, 2003). Locke's epistemology claimed that "all ideas originate from experience and knowledge comes from the connections between ideas" (Odegard, 1965). Kant's epistemology believes in

“merely having innate ideas and concepts without perceptions do not make up knowledge; nevertheless, perceptions without concepts are also sightless, knowledge cannot be constituted from mere experiences, experiences have to be structured and organized to become knowledge” (Dicker, 2004). Russell’s epistemology claims that “modern science can be justified by appealing to sensory experience, knowledge can be acquainted from our sense data through the perception of colors and sounds; on contrary, the rest of knowledge can only be reasoned from inferential and indirect descriptions” (Russell, 1911; Fumerton, 2004)

From an epistemological standpoint, the study is guided by an interpretivist paradigm, which views knowledge as inherently subjective, collaboratively constructed, and deeply embedded within specific social and cultural environments. Instead of pursuing generalizable findings, the research aims to explore the meaning-construction processes of principals and STEAM teachers as they navigate the processes of promotion, management, and implementation of STEAM education. By employing in-depth interviews and thematic analysis, the research aims to generate rich and descriptive insights that reflect the ecosystem development, and the complexity and diversity of leadership practices within Hong Kong’s educational landscape.

#### **4.2 Research Paradigm and Qualitative Approach to Inquiry**

Before data collection, researchers must have understandings of how well their chosen methodology and methods are justified to be best-related to the purpose and rationale of the study. For the present educational research, the researcher chose to act as an objective explorer and observer, immersing into the school contexts as an active participant, becoming “part of the social reality being researched” (Grix, 2004). In view of the embeddedness of human behavior and context, the researcher abides and spends time in the education field to become an insider, able to ‘analyze the reality as a network of elements bounded by multiple perspectives’ (Creswell & Creswell, 2022; Cunliffe. 2010). Out of curiosity and the desire to seek solutions for answering the research questions, the researcher will attempt to obtain insights from the lived experiences and perspectives of interviewees through qualitative in-depth interviews. The researcher will then document the commonalities that participants shared when they experienced the same phenomenon. This research will adopt the qualitative approach of phenomenology to describe what participants had experienced during their interactions with STEAM education.

### 4.3 Research Design

Research design refers to the overall structure and general planning of the study, involves intersection of philosophies and strategies of inquiry, leading to the adoption of specific research methodologies (Cresswell, 2008). Research is a studious inquiry involving the processes of collecting, interpreting and analysing data for the purpose to address the research problems in consistent, systematic, organized and logical ways (Mafora & Lebeloane, 2001; Thakur, 2021). Social research studies mankind by referring to their beliefs, behaviour, cultures, interactions, established institutions and perceived values (Khan & Reza, 2022). Social problems are uncovered by researchers through in-depth studies which are characterised by data soliciting and analysing, in order to understand more thoroughly and comprehensively about the prevailing situations. The newly emerged knowledge and theories will help societies to progress and accommodate change (Lawai, 2019). Qualitative research is a form of social responsive action that stresses on how people interpret and make sense of their experiences to understand the social reality of individuals, in order to gain a deeper understanding of the surrounding circumstances (Flick, 2014). It is also a multi-perspective approach for describing and interpreting social interactions, giving meanings to participants' discourse (Schulze, 2002).

Under the assumptions of epistemology and ontology, the present research adopted a qualitative inquiry approach to explore the realities by means of in-depth interviews. Multiple realities and insights were explored under the interpretive framework of social constructivism. The present research followed the seven steps of interview investigating procedures proposed by Kvale & Brinkmann (2008), by first thematizing the interview topic, then designing the interview, conducting interviews, transcribing audio recordings, analyzing the data, verifying the truthfulness of data, and reporting of research findings. By using the research questions as guidelines, the researcher interviewed the participants in a free-flow but guided conversational configuration with in-depth probing. The researcher controlled the direction and objective of interviews, in order not to stray away from the main issues in question, but interviewees were allowed to disclose emerged phenomena which were related. By asking participants the "how, why and what" questions about the epistemological issues, the depths of meaning from experiences and standpoints of interviewees are stimulated' (Rutledge and Hogg, 2020). The findings were grounded on participants' individual historical and cultural backgrounds in the academia context, and realities in multiple forms were revealed.

### **4.3.1 Review of Literature**

Before interviews started, the purpose of the study and the concept of the investigated topic were clearly defined. By conducting a systematic and comprehensive literature review on the global status of STEAM education, the researcher gained a broad understanding of both existing and emerging knowledge relevant to the topic. This review was further enriched by the identification of pertinent theories, conceptual models, and research methodologies. After meticulous consideration, the contextual research gaps were identified, and there were plausible reasons leading to the determination. According to the study of Li et al. (2020), the researchers had scope-reviewed 144 journal articles published between 2000 and 2018, studying the status and trends in STEM education research during the period of time. The study was multi-dimensional, including studying the patterns of STEM publications across different journals, the countries or regions that the STEM articles were originated, the main topics that had been studied, the research methods adopted, and the amounts of journals contributed to publications in each area regarding STEM education. They classified the past researched topics about STEM education into seven categories, including K-12 STEM teacher education and professional development; STEM education leadership; post-secondary STEM teaching; K-12 learners and learning environment; and STEM curriculum, policy, assessment and evaluation methods. Furthermore, there were history, perspectives and epistemology of STEM education, and finally, issues about gender, social and cultural contexts were also investigated. The last category received most of Li et al.'s attention. On their list of 'Top 10 STEM journal articles authorship countries or regions', Hong Kong was not on the list of 641 publications. Another research by Perignat and Katz-Buonincontro (2019), the authors reported that among the 44 pieces of STEAM-related articles they had reviewed, there were 18 empirical research papers, 12 of them employed the qualitative research method to gain a depth of understanding about STEAM education. Qualitative research is considered as a key studios inquiry for education researchers (Muzari, Shava & Shonhiwaw, 2022). These exploratory findings ensured the fact that, the adoption of strategic approaches for effectively promoting, managing, and implementing STEM or STEAM education in Hong Kong were not deliberately studied, and the employment of qualitative research method was a meaningful approach.

### **4.3.2 Interview Design and Instrument Development**

The current researcher selected the inquiry approach of in-depth interview to be the investigation technique was mainly due to the following reasons: firstly, the complexity and

depth of the study's central themes in STEAM education may exceed the analytical scope of quantitative research; secondly, the subjective perspectives and insights of participants within the education sector are expected to yield novel contributions to the generation of new knowledge on STEAM education in Hong Kong; and thirdly, the theoretical research framework of this qualitative study is anchored on hermeneutical phenomenology. Phenomenology describes research as an orientation towards lived experiences of participants, and in the science of hermeneutics, the researchers tend to communicate, understand, and interpret the data in respondents' actual wordings (Creswell, 2006; Muzari, Shava & Shonhiwa, 2022). Within the phenomenological framework, the current researcher was interested in studying the life texts of participants, collecting data from individuals who had experienced the phenomena, and to capture the essence of their shared experiences and practices in order to analyze how the promotion, management, and implementation of STEAM education are influenced. In-depth interviews have currently been considered as the most-adopted method in social science research (Rutledge and Hogg, 2020).

The in-depth interviews conducted in this study were guided by a series of open-ended questions, each designed around a range of thematic categories. These questions were partially predetermined, semi-structured, and were developed around a diverse range of themes or guiding topics to elicit meaningful insights from interviewees. The researcher followed the protocol of interviews by first introducing oneself and the topic, and then interpreting the purpose of research. The rights of participants were clearly informed and they were duly notified that their responses would be recorded via mobile devices for the purposes of transcriptions and analyses. The interview guide could be provided to interviewees as a reference upon request. For this research, two distinct sets of interview guides were developed to address the specific roles of respective respondent groups, one set was for principals, and the other set was for teachers. The guides encompassed all essential items, thoughtfully prepared in advance, and served as prompts during the interview process to help the interviewer recall key topics of interest. The guides had undergone pilot testing, and the questionnaires were continuously refined by removing unnecessary questions, and replaced by more objective-oriented ones. The guides were texted in dual languages of English and Chinese for respondents' easier understanding. The interview process began with descriptive questions aimed at eliciting baseline information from the interviewees, and then more specific questions were inquired for 'understanding more in depth about the phenomena, and delved on the how

and why of particular issues' (Dworkin, 2012). The researcher allowed respondents to freely express their opinions, and would not interrupt them with time limits.

#### **4.3.2.1 Research Ethics**

A voluntary informed consent form was prepared for informing participants of who the researcher is, the purpose of research, and to notify them of their autonomy to participate, to withdraw, or to omit any uncomfortable questions, and their personal information were kept as high confidentiality which would not be disclosed to any outsiders or placed in text. The methods employed for data collection and reporting were also disclosed, so as to provide interviewees with the 'derived rules of what are permitted, obligated and prohibited' (Kalichman, 2012). The consent forms were signed by participants before interviews started.

Safety risks were carefully considered for both interviewer and interviewees. Meeting setup was carefully designed and scheduled, the interviews would not be arranged at late evenings, and meeting venues were considerably chosen to be safe and easily reached. These security and protection measures induced trust and confidence in interviewees, ensuring them that the researcher was 'bounded by ethical norms for professional conduct' (Lynch, 2003), and their personal safety was protected.

The researcher assumed the role of interviewer to guide the data collection process. For being an active participant in this qualitative and interpretivist study, the researcher has to maintain awareness of positionality and its potential impact on objectivity. Objectivity is not about detachment, but rather about reflexivity, transparency, and methodological rigor (Finlay, 2002; Humphreys et al., 2021). The researcher acknowledged her positionality and engaged in ongoing reflection on how her values, assumptions, and interactions could influence the research process; rather than striving for detachment, the researcher embraced the principle of critical subjectivity, recognizing that objectivity is not attained by removing personal influence, but by making it visible, transparent, and accountable throughout the study. This stance allows the researcher to approach the research with methodological rigor while honoring the interpretive nature of qualitative inquiry.

#### **4.3.3 Sampling Design**

The interviewees were purposefully selected to fit with the thematic topic by using a non-probability sampling strategy. Although these participants were not representative, they were

the purposive samplings of a particular population (Rabiee, 2004). Participants were purposefully chosen for their demographic alignment as pedagogical educators in Hong Kong, occupying influential positions in the strategic planning, policy-making, and practical implementation of STEAM education. School supervisors, principals, vice principals, assistant to principal, STEAM head teachers and subject teachers were invited to participate in the study as primary respondents. Educational pedagogists and academia management experts were invited to serve as pilot interviewees and triangulators, with the aim of assessing the feasibility of the inquiry approach and verifying the validity and generalizability of the collected data.

For qualitative sampling, the researcher adopted a four-point approach proposed by Robinson (2014) for interview-based research:

#### *Determination of Study Population*

Inclusion criteria were established to define the attributes of eligible interviewees. Prospective participants consisted of individuals engaged in the pedagogy of STEAM education within the Hong Kong educational context. The primary interview targets included supervisors, principals, and teachers from both primary and secondary schools across all three bandings<sup>6</sup> within the Hong Kong education system. They serve as frontline practitioners responsible for promoting, managing, and implementing STEAM education within their respective schools. School types include public government schools, public grant schools and direct subsidy scheme (DSS) schools. The secondary targets include STEAM-related pedagogists and management experts in education. These secondary targets served as triangulators to offer complementary perspectives and evaluative feedback that strengthened the reliability and interpretive validity of the research outcomes.

#### *Determination of Sample Size*

In order to get more reliable results, the sample size has to be carefully considered. Dworkin (2012) claimed that there had been debates among scholars concerning what sample size was considered to be appropriate for the endeavors. Arguments fell mainly on the concept of data saturation, which is the guiding principle affecting the sample size in qualitative research (Mason, 2010). According to the conclusion of Mason's study, doctorate students should be aware of the saturation concept and their supervisors should be able to make proper informed

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<sup>6</sup> Hong Kong's bandings system divided secondary schools into three bands in order of their prestigiousness in academic performance, with Band 1 ranking highest. Students attending higher-ranking schools represent better chances to enter universities.

decisions to close their students' analyses, rather than doing a comparatively large number of interviews for the purpose to play safe at examination, and to ensure that the data collected are defensible. When data collection reaches a point where all important matters or noteworthy insights get exhausted from data, signifying that the conceptual themes and categories have already reached the point of thematic saturation and the sample size is sufficient for the phenomenon to be studied (Hennink & Kaiser, 2022)

For the present research, the recruited samples were experienced and knowledgeable educators who aligned with the underlying criteria of the research topic, having in-depth insights about the STEAM execution processes and with profound understanding of where the challenges lied. Furthermore, most of them were decision-makers who were responsible to make transformative decisions for the effective reformation and enhancement of STEAM education's implementation system. The population under study was homogeneous and the phenomenon was not broad, thus the sample size could be determined by depending on the intrinsic factors of the research. The present researcher set the sample size to be at least 20, and had kept in mind of the saturation principle that more repetitive data obtained did not lead to the acquisition of more useful information.

### *Selection of Sampling Strategies*

Once the sample population was determined, the current researcher employed the non-probability purposive sampling method to sample participants who had the expertise and knowledge in the topic of interest, and were willing to share their practical experiences and insights. Several considerations needed to be addressed prior to the commencement of the sampling process. Research problems determined the types of information required, the researcher needed to be knowledgeable about the culture, history and the implementation systems of STEAM education, in order to identify the right informants to answer the research questions. Furthermore, it is essential for the researcher to establish and uphold specific criteria regarding the attributes and qualifications of eligible participants. For this study, the non-probability sampling method of purposive sampling was employed to align with the predefined criteria relevant to the research questions and objectives. The selected participants of this sampling method may not be fully representative of the broader population. Unlike probability sampling, in which participants are randomly selected with equal chances of representing the broader population; or representative sampling, which is commonly employed in quantitative research with larger sample sizes, and involve using random or stratified methods. Purposive

sampling focuses on selecting individuals based on specific characteristics relevant to the study's objectives; therefore, it is necessary to define a purposive sampling frame with parameters to narrow down the population of interest, and ask the right questions within the frame to avoid judgmental biases (Rai & Thapa, 2015). Among different purposive sampling methods, the expert sampling strategy is more relevant to align with the purpose of this research. Expert sampling, also known as judgement sampling, is described by Rudra et al. (2017) as 'sampling the wisdom of crowds'. Experts of the current research were selected for serving two different purposes. Firstly, they were school supervisors, principals, head teachers, and teachers showing high level of demonstrable knowledge about education, and they had possessed experience in the field of STEAM education. Secondly, another group of experts served the purpose to validate and triangulate the research methods and data, they were not necessarily be skillful in the field of STEAM education, but they were embodied in the trait of education culture, so they were named as 'cultural experts' (Kitamaya and Cohen, 2010). Purposive sampling method is judgmental (Vehovar, Toepoel & Steinmetz, 2016), it relies on the judgement of the current researcher to identify the types of schools most suitable for addressing the research aims, to identify appropriate school experts with diverse characteristics and backgrounds to contribute to the research questions, and to determine the types of experts required for providing supplementary insights to validate and triangulate the collected data and results.

#### *Sourcing of Samples and Snowball Sampling*

Once the sample population, sample size and sampling strategies were determined, the primary focus shifted to identifying participants with clearly defined qualities and qualifications, and to evaluating their competencies and reliability. The researcher leveraged existing networks to identify appropriate targets, and also source participants through initial participants' acquaintances with relevant expertise within the academic community. This is a purposive snowball sampling strategy, where initial participants were selected based on predefined criteria and subsequently referred additional suitable candidates within the academic field. Snow-ball sampling is a non-random purposeful method that can be used when samples with target characteristics are not easily reached (Naderifar, Goli and Ghaljaie, 2017)

#### **4.3.4. Pilot Studies**

Pilot studies are crucial to be conducted before actual interviews begin, allowing the researcher to pretest the efficacy of interview instrument and to justify the feasibility of the full study. Pilot studies reveal the weaknesses of the data collection method and the efficacies of the research instruments (Teijlingen, 2001). Researchers are better informed and have greater awareness of the challenges that might arise in the actual study, so they are prepared to address the problems (Malmqvist et al., 2019). Before conducting pilot studies, interview guides were constructed in dual languages of Chinese and English, and the voluntary informed consent forms were also prepared. The researcher had to determine how the questions were to be presented, in what tone and manner, and the time and venue for the studies were also considered.

Data gathered in pilot study provided the researcher with guidelines for better enhancing the research plan and design. The research questions might need to be refined if they were not effective in evoking necessary information, the inadequacies of the research instrument were needed to be replenished. The researcher had to justify whether the interview length was appropriate, too lengthy would induce fatigue, or too short for not covering all the necessary contents. With preliminary data collected from pilot interviews, the effect size information should be able to obtain (Teijlingen & Hundley, 2001; Connelly, 2008).

#### **4.3.5 Interview Method**

In-depth interviews are one-on-one social interactions between the interviewer and interviewee, aimed to apprehend rich descriptive data for “making meaning to unfold social contexts” (Warren, 2019) and evoke depth of information. In-depth interviews are flexible, interactive, deep-dwelling, and the new knowledge acquired are generative.

Information about participants was obtained in advance, and the researcher’s extrinsic information related to the research was also provided to interviewees, close rapport was necessary to be built up prior to interviews, and the power of rapport induced sense of confidence and safety.

The time and venue for interviews were carefully chosen for avoiding risks that might appear before or after interviews. Voluntary informed consent forms were prepared for advising participants the purpose and objectives of the research, and to advise them of their rights to seize or stop the interviews at any time when they felt uncomfortable. The form further ensured

participants that their personal information, including names, job titles, institutions they worked in and discussion details on audio recordings, would all be kept as confidential. The duration of interviews would be carefully monitored to avoid tiredness.

The researcher played the role as interviewer for the present research, and followed the Elton Mayo's Method of Interviewing for conducting interviews (Mayo, 1933 in Kvale & Brinkmann, 2008). Attention was focused on listening to the participants rather than doing too much talking. Advices would not be given and arguments would not be provoked, the researcher allowed interviewees to express freely, and let them stop anytime as they wished to. The researcher carefully made a summary from time to time to affirm the participant's sayings.

The interviews followed a semi-structured format, incorporating open-ended questions to encourage rich and reflective responses, and participants were allowed to express their perspectives freely. The interview guide was only be used as a reminder of the general plan instead of being an actual guide of conversational orders. Questions were asked from general to specific, and factual questions were asked before opinion questions, the researcher always kept in mind to ask the key predetermined questions that form the thematic framework of research, as they were the topics to be explored in-depth, and close-ended questions were also asked for narrowing responses for deep exploration. The interview might consist manipulative dialogue, they were the questions with hidden agenda predetermined by the researcher for obtaining information that interviewees might not be aware of what the interviewer was actually looking for. The present researcher perceives manipulative dialogue not as neutral data, but as a space where ideas and power are actively challenged and shaped. As a researcher, her role is to carefully examine how this kind of language works, question what it is trying to achieve, and reveal how it influences meaning and power, either by reinforcing control or by creating space for resistance and alternative voices. Besides the questions on interview guides, both the researcher and interviewees were free to delve deeper into any areas of interest that emerged abruptly in the conversations, for the purpose to generate novel knowledge for benefitting the study.

#### **4.3.6 Triangulation of Data**

For the present research, the researcher adopted the 'triangulation within a method' approach to address the same research questions with triangulators for enhancing the validity and credibility of research findings, and to lessen the likelihood of research biases arising in the

collected data. The triangulators were independent data sources with in-depth understanding of STEAM education and having educational management experiences, who might be able to verify the opinions of principals and teachers, and to validate the trustworthiness of data. However, there were arguments from past researchers that the triangulation metaphor of mutual support was missing from the approach (McFee, 2006). In spite of the drawbacks, the current researcher continued to adopt this approach to gain alternative viewpoint and understanding of the collected data, not only to ‘capture the complexities of the real world’ (Bhandari, 2023), but to validate their reliability.

#### **4.4. Thematic Analysis of Data**

Due to the descriptive nature of the qualitative research approach, researchers have to construct a comprehensive and multidimensional picture of the research topic in the natural environment, the thematic analysis method is able to capture the essence of the revealed phenomena (Nolen & Talbert, 2011). Thematic analysis is a method for identifying, analyzing, and interpreting themes within data (Braun & Clarke, 2008). Sutton and Austin (2015) suggested researchers to do the compiling of data by undertaking the transcriptions themselves, instead of buying services from providers, so the researchers are able to familiarize with the data intimately after repetitive readings.

##### **4.4.1 Transcription, Coding, Theming, and Categorization**

The amount of qualitative data collected from one-on-one in-depth interviews was large, the current researcher was patient to focus on understanding the underlying meanings of participants’ interpretations and illustrative quotes. The meanings are systematically described by means of assigning successive parts of transcribed materials into categories and forming thematic coding frames’ (Warren, 2011; Schreier, 2012).

The dialogues of in-depth interviews were recorded on audio devices, and the researcher adopted the manual transcription method to convert the audio recordings into written texts, so the researcher was able to interpret and analyze the collected data more effectively. Furthermore, the “edited transcription” method was also employed to eliminate unnecessary repetitions and mutters, allowing the researcher to concentrate in transcribing clear core messages, unless those redundancies had strong representable meanings.

The researcher adopted both the deductive coding and inductive coding approaches. Deductive coding is theory-driven, it begins with a predefined set of codes based on existing theoretical concepts drawn from literatures. This coding scheme is especially found in studies of latent content nature; therefore, intensive and careful readings are necessary to include common and ordinary areas for substantial understanding of data (Potter & Levine-Donnerstein, 1999; Gibbs, 2007). Inductive coding creates codes from the textual data sets, codes and themes are directly derived from data (Linneberg and Korsgaard, 2019). The researcher combined the deductive and inductive coding by first started with a deductive framework of predefined codes, and then use these codes as a guide for initial data analysis, ensuring that they aligned with the study objectives. The researcher remained open to inductive insights, identifying patterns, concepts, or themes that emerge from the data. New codes were created to capture these unexpected findings, even if they are not in the original framework. The initial codebook was revisited and it was revised for incorporating both deductive and inductive codes. Overlapping codes were merged, definitions were clarified, and consistency across the data set was ensured. Both types of codes were simultaneously applied during analysis, and data was interpreted through the deductive lens of existing theories while also exploring inductive themes that inform or challenge those theories. This dual approach strengthens both the depth and relevance of research findings.

By going through the transcribed texts, the thematic patterns were identified. These passages were broken down into distinct excerpts, and codes were assigned. Codes are the anima of thematic analysis, they are the tools for data organizing, and are labeled by unique highlighted colors. When thematic patterns recurred with consistency, they were grouped into categories by multiple coders. Related categorized codes are similar to each other in concepts, and can be described by their specific themes. Themes are described as ‘the final products of data analysis, and multiple realities are going to be discovered behind the data’ (Vaismoradi and Snelgrove, 2019). The complex textual data were being converted into analytical and theoretical forms, making it easy for understanding, and the components that associated with the research questions became meaningful. In the reflection of Braun and Clarke (2019), the researchers interpreted ‘theme’ from another perspective. They indicated that ‘themes are creative and evocative stories about the data, being developed at the intersection of the researcher’s theoretical assumptions, their data analysis capabilities, and the data themselves’. The codes, themes, and categories were then stored in a codebook, which was a code memos and organizer, from which systematic analyses of findings could be based on.

#### **4.5 Validity, Reliability, and Generalization of Data**

Social science studies provide insights on social incidents within given contexts; through inquiries, they uncover the ‘latent and manifest aspects of social realities’, aim to create or validate existing social theories through collection and analyses of data (Lawal, 2019). Guest, Namey and Mitchell (2013) described qualitative data as ‘comprehensive field notes, detailed observation reports, stories of realities and insightful reflection’. Quantitative social science research requires valid and reliable measuring instruments to involve in quantifying human behavior (Drost, 2011), same standardized criteria also apply to qualitative study when the research is based on ‘interpretative, subjective and contextual’ data analyses (Thomson, 2011). Trent and Cho (2020) defined interpretations as ‘socially-constructed persuasive arguments grounded with evidence’, involving researchers’ personal imprints, thus giving meanings and senses to the data after analyses. Subjectivity of a study is influenced by the researcher’s personal beliefs, values, cognitions, and perspectives, and is commonly found in qualitative research (Ratner, 2002; Bumbuc, 2016). Researchers need to be cautious when dealing with subjectivity in research, safety measures are needed to be undertaken. Thematic analysis is a methodology based on epistemological and ontological assumptions, it involves the identification, organization, and interpretation of data retrieved from multiple interviewees of different situations, with social, cultural, historical, economic, political, religious and philosophical insights underlying in their contexts. A modest sample size is appropriate for thematic analysis in qualitative research, particularly when the goal is to gain rich, in-depth insights into specific settings or experiences. Reaching thematic saturation often signals that the sample size is sufficient. The adequacy of the sample depends less on quantity and more on the diversity, relevance, and depth of the data collected (Vasileiou et al., 2018; Subedi, 2021)

There had been arguments over years for the usage of the terms ‘validity and reliability’ in qualitative studies, many researchers questioned the usefulness of the concepts, and some even suggested to abandon the terms (Smith, 1983; Wolcott, 1990; Hayashi Jr, Abib & Hoppen, 2019). Past researchers had identified seventeen terms related to the validity concept, and numerous researchers had discussed extensively for years to determine the appropriate definitions for these multiple terms. However, the definition of validity had not yet been unified and the term was still being viewed from different perspectives (Dellinger and Leech, 2007). Same as validity, reliability is also under question whether it is relevant to credibility assurance when qualitative research is evaluated (Noble & Smith, 2015). Likewise, it is contentious that

generalization is prohibited by the designs of sampling in traditional in-depth interviews; as a result, researchers chose to select non-probability sampling to overcome the challenges; and in fact, the sample size will not affect generalizability (Lucas, 2012).

Staller (2021) considered validity, meaningfulness, and insights as three key issues in qualitative studies. Validity in qualitative research refers to the rigor of research in nature, appropriateness of research instruments used, suitability of methodologies adopted, and the accuracy of results that match with researcher's situation, prediction and expectation (Creswell & Poth, 2013; Leung, 2015; Hayashi Jr., Abibi & Hoppen, 2019), and also represents the trustworthiness of qualitative findings (Whittemore, Chase & Mandle, 2001; Schwandi, Lincoln & Guba, 2007). Maxwell (1992, as cited in Thomson, 2011) introduced five ways to justify the validity of qualitative research, includes descriptive validity, interpretive validity, theoretical validity, generalizability, and evaluative validity. To ensure descriptive validity, the interviewer needs to be a good facilitator and be objective to maintain respectful neutrality on describing data and information received from respondents. Moreover, the researcher has to assure that all research participants are real members of the field under studied, ethical recruitment will generate accurate and valid results. Interpretive validity will arise if the researcher accurately captures participants' real meanings in conversations and behaviors, and able to report their thoughts proficiently in their own viewpoints. The value of interpretative research is found in the trustworthiness of the study (Altheide & Johnson, 1988). Theoretical validity seeks to evaluate how well a researcher is able to fit the concepts and theories into collected data to explain about emerged phenomena, and the degree of accuracy in the researcher's explanation of the phenomena (Thomson, 2011). Generalizability refers to the ability to generalize the theories derived from particular research to other studies. The issue of generalizability in qualitative research is always under question, if the theories are situational and are developed from repeated themes and patterns of a specific research with unique characteristics, applicability of these theories to other situations can be affected, the research findings can only be generalized to studies with similar attributes (Auerback & Silverstein, 2003; Maxwell, 1992, as cited in Thomson, 2011). Evaluative validity refers to the assessments of evaluations drawn by researchers in their studies, to assess if the evaluations are from researchers' own understandings or they are figured out from data.

There are additional techniques which can be applied for enhancing rigor in qualitative studies. Respondent validity, also known as member checking or internal validity, is one of the techniques which may be employed to testing initial results by asking respondents again the

same question to see if identical answers appear and findings are still true in other repetitive situations; besides checking for the trustworthiness and fittingness of data, this method also helps to refine the researcher's understanding of original responses (Birt et al., 2016). Triangulation is another technique which was frequently used by educational researchers for evaluating the effectiveness of learning and teaching methods. The current research adopted data triangulation to obtain comprehensive perspectives from alternative data sources other than the selected samples for better understanding of the research objectives and research questions. When data is collected from different respondents, places or times, the results obtained can possibly be generalize to other contexts or situations (Carter et al., 2014; Noble & Heale, 2019). For the current research, two pedagogists with abundant experiences in Hong Kong's educational management and policies were invited to serve as triangulators. Furthermore, by establishing appropriate recording procedures, taking field notes, and texting detailed interview transcriptions can also be used as essential means to enhance validity and reliability of qualitative research, the recurring thematic patterns emerged will promote the validity and reliability of findings (Franklin, Cody & Ballan, 2010 in Thyer, ed. 2010). Reliability in qualitative research based on the stability and consistency of responses (Drost, 2011; Leung, 2015), and when the sample size is large enough, responses from participants will become more consistent across samples, then the collected data can be considered as reliable.

## **4.6 Empirical Data Collection Procedures**

The following sections elaborate on the data collection procedures as applied in practice.

### **4.6.1 Sampling**

The researcher reached out to a particular sampling frame in the population who share common and specific characteristics of being educators within the Hong Kong educational system. Purposive sampling is a non-probability method which best serves the purpose of the current study, and this sampling approach is subdivided into various methods for meeting the objectives of the research. The current researcher adopted the methods of expert sampling, homogeneous sampling, and snowball sampling. By using expert sampling, experts in the field of STEAM education were chosen as participants, as they were all specialized in or familiarized with the program, and were potentially having enhanced and profound understanding of the topic, so they could offer more insightful commentary. Under homogeneous sampling, the

researcher selected participants based on their similar characteristics, shared traits, or relevant work experiences. As the interviews progressed, interviewees referred their acquaintances who are widely recognized as professionals and experts with significant experience and achievements in the field of STEAM education through snowball sampling. Consequently, twenty-five educators from twenty-one schools were invited to share their insights and experiences regarding Hong Kong STEAM education. The sample size of the present research was determined by the concept of saturation, it refers to a point at which the collected data becomes repetitive, no more new insights are found, and no further emergence of new themes. The researcher had collected sufficient information to fully understand the phenomena under studied.

#### **4.6.2 Interviewee Profile**

Providing interviewee profiles will help to illustrate how participants' backgrounds, roles, and experiences are directly connected to the research questions, and the sampling method was purposefully and methodologically sound. Knowing interviewees' roles will give context to their responses, helping readers to interpret quotes and themes with a richer understanding of the respondent's perspective. Transparency will strengthen the credibility of the research findings, and readers may be able to judge whether the findings can be transferred or generalized to similar contexts.

The interviewees included three school supervisors, seven principals, one vice principal, one assistant to principal as STEAM head teacher, five STEAM head teachers, six STEAM teachers, and two educators from universities. The term PI in brackets indicates that these participants are pilot interviewees. The meanings of the interviewee codes are explained in the job titles. The interviewee profiles were displayed in Table 4.1, with the school codes, interviewee codes, interviewees' working titles, and the type of schools which they work at.

*Table 4.1 Profiles of Interviewees*

Interviewee #	School #	Interviewee code	Job Titles of Interviewees	School type
1	1	ED1 (PI)	Primary and secondary school supervisor	Grant school
2	2	S2	Secondary school supervisor	Aided school
3	2	SP2	Secondary school principal	Aided school
4	3	S3	Primary school supervisor	DSS school
5	3	PP3	Primary school principal	Aided school
6	3	PT3	Primary school STEAM head teacher	Aided school
7	4	SVP4	Secondary school vice principal	Aided school
8	5	SP5	Secondary school principal	Grant school
9	6	SP6	Secondary school principal	DSS school
10	7	PP7	Primary school principal	Aided school
11	8	PP8	Primary school principal	Aided school
12	9	PP9	Primary school principal	Aided school
13	10	SAP10	Secondary school assistant to principal (STEAM head)	Aided school
14	11	ST11 (PI)	Secondary technical school STEAM head teacher	Aided school
15	12	ST12	Secondary school STEAM teacher and librarian	Aided school
16	13	ST13	Secondary school STEAM head teacher	Aided school
17	14	ST14	Secondary school STEAM head teacher	Aided school
18	15	PT15	Primary and secondary SEN school STEAM teacher	Aided school
19	16	ST16	Secondary school STEAM teacher	Grant school
20	17	ST17	Secondary school STEAM teacher	Aided school
21	18	PST18	Primary and secondary SEN school teacher	Aided school
22	19	ST19	Secondary school STEAM teacher	Aided school
23	20	ST20	Secondary school STEAM head teacher	Aided school
24	21	ED2 (Triangulator)	Lecturer of education policy and administrative management	University
25	22	ED3 (Triangulator)	Teaching consultant of human resources strategy and development	University

#### **4.6.3 Types and Bandings of Schools**

The interviewees belonged to four types of schools, aided schools, grant schools, aided SEN schools, and DSS schools; except that the educators who served as triangulators were from universities. These four types of schools are eligible to receive The EDB’s recurrent Life-wide Learning Grant to support their persistent implementation of STEAM education. The interviewees work at schools ranging from band one to band three. These variations offer comprehensive perspectives of the STEAM program being implemented in different educational contexts, contribute thorough understanding of the challenges and achievements encountered by different types of schools.

#### **4.6.4 Time, Location, and Duration of Interviews**

Most interviews were done after school, except that some principals were able to arrange their meetings in the morning. All the interviews with supervisors and principals were held on school premises, either in conference rooms or in the principals’ offices. Interviews with STEAM head teachers were mostly taken place in STEAM rooms or workshops, except one interview was

done in the library with the librarian STEAM teacher. For other STEAM teachers, their interviews were done in coffee shops. They felt more at ease during the interviews, as there was no obligation to inform school principals, or to secure formal approval; as a result, they became more open and engaged. Interviews with supervisors and principals were strictly adhered to their planned time schedules, which was within one and a half hour; except in cases where principals provided guided tours of the school facilities, visited the STEAM rooms, showcased students' STEAM competition awards, introduced the STEAM teachers, and presented both past and current STEAM projects, such kinds of interviews lasted longer. The interview time with the second pilot tester lasted the longest of more than three and a half hours, as the interviewer was eager to share what he had experienced. Most interviews with STEAM head teachers lasted longer than those with STEAM teachers, due to their institutional authority and comprehensive knowledge of STEAM initiatives. STEAM head teachers tended to have more to share, and were proud with their effort and endeavor in leading their schools to achieve well in STEAM education. STEAM teachers' meeting time were generally normal, long enough for them to share, complain, and comment the program.

#### **4.6.5 Pilot Studies and Interview Guides**

Two pilot studies were conducted with interviewees from diverse educational contexts. Two sets of interview guides were used, one for supervisors and principals and one for teachers; detailing all the topics and inquiries that the researcher planned to cover with interviewees in sequence, they were used for organizing discussions and guiding directions. However, the pilot interviews and subsequent interviews revealed that the initially constructed interview guides were too standardized for use in semi-structured interviews. Most interviewees were natural conversation starters, especially for those who are experts and are experiential in the field of STEAM education, they were eager to share in their own ways. As a result, the researcher allowed the interviews to stay flexible and deviates from the original interview guides. The researcher discovered in the pilot and later interviews that STEAM education was not implemented by all schools in full strength as expected by the EDB. The original interview guides were restricted and limited by the existing framework established in literature, they tended not to cover the realities of the real world. Therefore, it is important for the researcher to create a conversational space that encourages natural dialogue, allowing respondents to freely express their STEAM-related experiences and insights in an open and unstructured manner. By adopting this open approach, a broader range of factual data was revealed, some

aspects had not yet been explored by previous researchers. The researcher regarded this as an eye-opening approach to exploring complex issues through the perspectives of the interviewees, rather than being constrained by traditional or historical viewpoints.

For the first pilot test, the researcher conducted it with a school supervisor overseeing two band one public schools, who is a scholar with doctoral degree in educational psychology. The supervisor provided invaluable feedback on how the questions should be asked, suggested to avoid the expressions of difficult concepts and theoretical terms, but rather use simple and understandable terminologies to induce in-depth discussions. The second pilot tester was a STEAM head teacher from a band three technical secondary school. The interview guide had already been refined and the interviewing process was more affluent than the first time. The teacher was extremely helpful to share his experiences and knowledge about STEAM for more than three hours. The interviewee provided unexpected in-depth insights of how STEAM education was implemented in Hong Kong, how stakeholders and parents thought about the program, and most importantly, he revealed some unknown facts about STEAM implementation. The interview brought the researcher immediate understanding of the complexities of the Hong Kong education system, and why STEAM education is not running effectively in Hong Kong. The information revealed by the second pilot tester challenged the previously held assumptions of the researcher about Hong Kong's educational system and STEAM education, which have been perceived as linear and superficial. As a result, some questions were added to the interview guides after pilot testing for enhancing the depth of data collection, and some unnecessary ones were eliminated. The revised interview guides for supervisors and principals, as well as for teachers, were included in appendices.

Drawing on practical experience gained from the pilot tests, the researcher conducted subsequent interviews with greater confidence, fostering relaxed and candid conversations that encouraged interviewees to openly share their real-life experiences. The pilot tests affirmed the effectiveness of the in-depth interview approach, providing the researcher with facts, insightful perceptions, meaningful perspectives, and inspirations, making the research path concise and clear. It coincides with the viewpoint of Kvale in Legard, Keegan and Ward (2003) that interviewer and interviewees are viewed as travelers under the "traveler metaphor". Kvale emphasized that, 'the traveler poses questions that compel the subjects to share their individual experiential stories of their living world', bringing new insights into light; by means of collaboration among the researcher and interviewees, knowledge is not only transmitted, but also constructed (Legard, Keegan & Ward, 2003).

#### 4.6.6 In-depth Interviews

Before interviews commenced, interviewees were asked to sign an informed consent form to acknowledge their voluntary participation and provide formal approval for involvement in the study. The form is included in the appendix. Most of the time, the forms were signed before interviews began, unless the researcher was brought to visit the STEAM rooms and facilities before settling down.

The interviews were initially designed to be on one-on-one basis, so they would enable comprehensive, thorough, and concentrated discussions. However, two schools' participants insisted to be interviewed in pairs and groups. The supervisor of school #2 requested to be interviewed jointly with the principal, and school #3's supervisor insisted to be interviewed in a group with the principal and the STEAM head teacher. At the outset, the researcher opted not to distribute the interview guides to participants in advance, except when specifically requested, in order to minimize the risk of rehearsed or socially desirable responses, and to encourage more spontaneous and authentic conversations. The supervisor, principal, and STEAM head teacher of school #3 asked for a preview of the interview guidelines, they even informed the researcher at the interview that they had held a meeting in advance to discuss how the questions should be answered in order to create the best result for the research. Consequently, they provided general and standardized answers. On the other hand, school #2 did not ask for a preview of the guidelines, so their responses were tended to be closer to reality. The principal was facilitated by the researcher to frankly share his STEAM experiences, and social-desirable responses were not given. The principal was honest to disclose that he was not engaged in organizing the STEAM program, but rather asserted trust in his STEAM head teacher's capability to form and lead the STEAM team independently. He granted the head teacher autonomy to bring transformation to the school.

The outcomes of these two interviews confirmed the researcher's preliminary assumptions that unprepared answers appeared to reveal more empirical evidence. The researcher found intriguing to discover that while school supervisors were sitting around, principals behaved reticently, they were reserved and refrained from speaking freely and openly. Same attitude was found as well in the STEAM head teacher's behavior, he appeared to be calm and reserved during the interview, speak only when directly invited by the principal. This differed from the patterns observed in later interviews, which revealed significant diversity in the social attitudes and personality traits of principals and teachers, highlighting the varied forms of participant

engagement throughout the study. Principals tended to be more socio-emotionally stable with higher self-regulation in expressing their feelings towards STEAM implementation at their schools, their displayed attitudes aligned appropriately with their social roles, whether they were active proponents of STEAM education, or simply adherents to government directives. On the other hand, teachers were more opened to criticize the system, made complaints, and showed their frustrations and worries towards the STEAM program, especially when the interviews were not held on school premises. Teachers did not refrain from voicing criticisms of their principals and candidly shared the challenges and dissatisfaction they encountered during the implementation of STEAM programs.

Through the use of in-depth interviews, data were collected from participants to explore the underlying factors that contribute to answering the following research questions:

1. What are Hong Kong educators' perspectives and purposes for implementing STEAM education?
2. What are the key challenges of implementing STEAM education in Hong Kong schools?
3. What are the key domains for effectively implementing STEAM education in Hong Kong schools?
4. How can a holistic framework be developed for effectively promoting, managing, and implementing STEAM education in Hong Kong schools?

#### **4.6.7 Thematic Analysis Approach**

Thematic analysis is an appropriate analyzing method for in-depth interviews when the research questions are aimed to investigate the experiences, perspectives, knowledge and understandings of participants, in order to uncover subjective realities and gain experiential insights into multifaceted issues. The qualitative thematic analysis method identifies themes and patterns systematically, and brings understanding and interpretations to the meaning and contexts of in-depth interviews.

Forman and Damschroder (2008) suggested a useful approach to split the analysis into three stages, which are immersion, reduction, and interpretation. The researcher followed these three stages to generate new knowledge from raw and unordered data.

### *Stage 1: Immersion*

This is the initial stage where the researcher becomes deeply engaged with the raw data to develop familiarity and initial insights. This begins immediately after data collection, where the researcher documents first impressions, comments, and potential themes. Transcriptions are completed with careful reference to audio recordings to ensure accuracy. Through repeated reviews of each transcript, recurring themes were identified and significant findings were extracted, forming the basis for initial analytical interpretations. Memoing is a critical component of this stage, involving the documentation of spontaneous thoughts, interpretive reflections, and emerging analytical insights are recorded during both transcription and data review. These memos on notepads function as a repository for emerging ideas and reflections, capturing nuanced observations and concepts that may subsequently guide thematic development and in-depth analysis.

### *Stage 2: Reduction*

This phase focuses on structuring and filtering the raw data to emphasize elements most pertinent to the research questions, and irrelevant information is excluded and reduced. Transcripts and memos are segmented into manageable categorized and units, and data are thematized according to their relevance with the research questions. A codebook is developed during this phase to formalize the coding process. Codes are created to represent themes and concepts, and the codebook provides a structured framework for organizing data.

### *Stage 3: Interpretation*

This is the analytical stage where meaning is constructed from the organized data. The research analyzes the coded segments and memo notes to identify patterns, relationships, and significant findings. Using the codebook and conceptual maps, the researcher is able to formulate both descriptive and interpretive summaries. This stage centers on synthesizing analytical insights, drawing out key themes, and validating conclusions to ensure that they are firmly grounded in the data. The purpose is to transform raw findings into meaningful and advanced knowledge, and to study how they relate to the research questions.

#### **4.6.8 Transcription, Coding, Categorization, and Theming of Empirical Data**

The interviews were recorded using audio devices, and interpreted in interviewees' own words, enabling the resulting phenomena to be documented in their original forms. The interviewees

are all local Hong Kong Chinese, so the interviews were conducted in Cantonese. The original sound bites were then being translated into English, and the transcripts were kept as written records for analyzing purposes, and for reliability and validity verification. Interviewees' body movements or sounds of commotion, such as giggles or sighs, were also being transcribed, since these motions were being viewed as signals of resonance aroused in discussions, and they were behavior recognizers. For this research, the researcher had spent months of time to manually transcribe the verbal content of over twenty interviews, gaining a comprehensive understanding of the data and was able to discern its underlying themes and implications. The thematic analysis went beyond the idea of just showing patterns on the surface of semantic content, but was advanced to the latent level to look for underlying ideas, fundamental concepts, presumptions, and conceptual frameworks. As a result, the development of themes entails interpretive work, and the generated analysis is already theoretical instead of merely descriptive.

The thematic analysis method systematically identifies recurring themes and patterns, offering insights and deeper understanding of the meanings embedded within in-depth interview data. This research adopted a blended coding strategy of deductive coding and inductive coding to disassemble the data by developing them into meaningful categorization of codes. As Bihu (2024) explained, the deductive coding approach involves the development of analytical themes based on the research topic, research questions, and underlying assumptions; they are being used for testing or supporting the hypotheses. On the other hand, the primary aim of the inductive coding approach is to facilitate the discovery of research outcomes through the identification of recurring and meaningful patterns in raw data (Thomas, 2003). Inductive codes are used for exploring new dimensions, or for challenging assumptions. The blended coding approach, also referred to as abductive coding, is a hybrid coding process providing balanced insight and flexibility for researchers to validate existing frameworks while staying open to unexpected insights (Fereday & Muir-Cochrane, 2006; Thompson, 2022). Before interviews commenced, the researcher pre-defined an initial set of codes deriving from existing theories, literature, and research questions, and the codes were being organized in the codebook. After the interviews commenced, inductive coding was employed without any preconceived concepts, new themes started to emerge from the raw contextual data, and these emerging codes were also recorded in the code book. The researcher then reviewed both sets of codes, consolidated redundant codes and clarified ambiguous ones, and then grounded the coding in both theoretical and empirical contexts. Throughout the coding process, the researcher remained impartial, employing systematic and standardized coding techniques to ensure

unbiased interpretation of the content. The data were rigorously examined through systematic reading and coding of transcripts; as a result, major themes with recurring semantic patterns emerged consistently. When the recurring patterns of themes were recognized from coding, the codes were served as the foundation of analyses and raw data were converted into comprehensible and manageable units. Quotations reflecting diverse viewpoints aligned with the research objectives were coded using designated colors to capture the data's central ideas and themes.

The process of developing themes from codes were intricate and time-consuming. Initial themes were merged, split, or eliminated, and the themes had to be reviewed from time to time during transcription. When themes were identified, they were being analyzed, and then informative names were given, providing focus and direction for the study. The researcher applied interpretative reasoning to read through the developed themes and then have them placed under individual categories. They were subsequently recorded in the codebook, keeping apart from the interview transcripts. Meanwhile, all emerged ideas and concepts that were perceived by the researcher as important during transcription were kept aside in a memo notebook and to be integrated into the discussion section afterwards. The categorized themes were displayed in Table 4.2.

*Table 4.2 Categorization of Themes*

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Category 1 Perspectives

- Hong Kong educators' general perspectives towards STEAM education.
- Perspectives of schools with low enrollment rate.
- Perspectives of special educational needs schools.
- Perspectives towards the trendiness of STEAM education.
- Perspectives towards STEAM education's sustainability in Hong Kong.

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Category 2 Purposes

- Purposes of educators for implementing STEAM.
- Purposes of students for participating in STEAM competitions.

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Category 3 STEAM Implementation

- Long-term development and curriculum plannings.

- Implementational methods of STEAM.
- Assessment and evaluation of STEAM.

#### Category 4 Challenges

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- Exam-oriented educational culture.
- Attitudes of Hong Kong parents.
- Shortage of teachers.
- Inadequate trainings for STEAM teachers.
- Language barriers of science students.
- Silos in education.

#### Category 5 Leadership

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- Principal leadership.
- Teachers' distributed leadership and teacher collaboration.
- Student leadership.

#### Category 6 Involvement and Supports

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- Involvement and supports from internal stakeholders are crucial for launching and implementing STEAM effectively at Hong Kong schools.
- The EDB utilizes different methods for promoting effective implementation of STEAM in Hong Kong schools.
- STEAM is supported by industry partners, academic institutions, and non-governmental organizations through providing funds, skills, knowledge, learning platforms, and advices.

#### Category 7 Suggestions and Recommendations

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- Feedbacks and suggestions to the Education Bureau and the Hong Kong government.

## **4.7 Chapter Summary**

Chapter 4 provides a comprehensive overview of the theoretical and methodological underpinnings of the research. The theoretical foundations and interpretive frameworks are first explored, encompassing both ontological and epistemological perceptions. The selected research paradigm and the qualitative approach to inquiry are discussed, providing the framework for the research design. The study is designed to include a comprehensive review of literature, the design and development of interview instruments, and the research ethics is particularly emphasized. The sampling design, conduction of pilot studies, interview techniques, and the triangulation of data are all explained. The thematic analysis process is outlined, and continuing through systematic coding, categorization, and theming of the data. The validity, reliability, and generalization of the data are also addressed, ensuring the credibility of the research findings. At the end of the chapter, the empirical data collection procedures employed in the study are interpreted, detailing the methods, instruments, and the steps taken to ensure data integrity.

## **Ch. 5 Interpretation and Analysis of Findings**

Qualitative research fosters deeper understanding by uncovering previously hidden insights through a reciprocal exchange of information between interviewer and interviewees. It enhances knowledge by analyzing informative data through systematic, methodical, and rule-based techniques (Graneheim, Lindgren & Lundman, 2017; Forman & Damschroder, 2008; Bengtsson, 2016). The present research utilized qualitative interviews to explore the personal experiences of individuals engaged in STEAM education in Hong Kong. Prior to analyzing the findings, the practical procedures are first thoroughly explained.

### **5.1 Analysis and Thematic Interpretation**

The researcher conducted a thorough analysis of the interview data during transcription, identifying recurring themes, concepts, ideas, and semantic patterns. To investigate the diversities of schools in STEAM's implementational methods are the researcher's main focus for 'finding common ground while allowing room for differences' to identify the most feasible method to implement STEAM education in Hong Kong. Sampled school selection was guided by a key criterion that they are all managed and, either fully or partially, subsidized by the EDB. All empirical evidence shared by the interviewees was interpreted and presented by the researcher without selective filtering for thesis writing, the integrity and authenticity of collected data are ensured. The practice is considered by the researcher as being responsible and loyal to the research, maintaining its originality, ethics, and accuracies.

#### **5.1.1 Perspectives of Educators**

The varied perspectives of Hong Kong educators on STEAM education provide valuable insights into the program's acceptance, its design and implementation, and the level of engagement among students and teachers. Within thirteen interviewees (68%)<sup>7</sup> who provided opinions, four were principals, and nine were STEAM head teachers and STEAM teachers. Their diverse roles offered a broad perspective on the implementation and reception of STEAM education in Hong Kong.

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<sup>7</sup> The calculation of percentage ratio is based upon nineteen primary and secondary schools as denominator, excluding two universities.

### 5.1.1.1 Hong Kong Educators' General Perspectives towards STEAM Education

The secondary school principal SP2 stated that STEAM was treated as an extra-curriculum activity at their school, in the form of an afterschool club, they would not put it on the school curriculum.

*“Physics, chemistry, and biology are good enough for students’ scientific trainings, I am not able to see how the EDB can add one more course of STEAM into the curriculum and have it to be examined in the DSE. I consider STEAM as only an attitude or an approach of teaching.” (SP2).*

The primary school principal PP7 perceived the program from another angle.

*“Hong Kong secondary schools used to adopt the approach of ‘specialist education’, teachers should hold the degrees of the subjects that they were teaching. However, the EDB is currently promoting ‘blended learning’, that means the five elements of STEAM are blended together in the program, making teachers difficult to manage.” (PP7)*

Primary principal PP8 commented on the EDB’s unsystematic promotional approach of STEAM, complaining that the EDB had just provided schools with STEAM topics, but without standardized guidance.

*“Schools are currently operating in a state of flux, they are afraid that their STEAM implementation do not meet with the EDB’s standard.” (PP8)*

SP2, PP7, and PP8 all held adverse and critical viewpoints. SAP10 and ST14 showed their distinctive perspectives and personal understandings towards STEAM.

*“STEAM is not a standalone curricular subject, it is only a cross-disciplinary learning approach. My understanding for STEAM is, S is for science, T is for DT<sup>8</sup> and computer science, M is for mathematics, and A is for art; but for E, I have no idea of what it should be. STEAM is a hands-on activity, but the concept of STEAM is difficult to be implemented.*

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<sup>8</sup> DT stands for design and technology

*STEAM is like liberal studies<sup>9</sup>, the government has the ambition to train students to be all-rounded.” (SAP10)*

*“The STEAM education of Hong Kong can be described as ‘hundred flowers blossoming freely’. Every school has its unique way to run the program, so their differences in STEAM achievements are obviously seen. Band one schools never need to worry about recruiting students, so they focused in boosting academic performances rather than spending efforts in promoting STEAM.” (ST14)*

The pilot interviewee ST11 was a secondary technical school’s STEAM head teacher, his sharing boggled the mind of the interviewer.

*“Broad-mindedness is essential for promoting STEAM education, this is what the Odessey of the Mind promotes. Students are encouraged to develop problem-solving skills in STEAM learning. I always emphasize the importance of the STEAM learning process and students must learn how to appreciate different kinds of knowledge. However, I was criticized by language teachers that I spent too much time with students on weekends to build models and to do STEAM-related boardgame design, this is ‘sapping students’ studying will by putting too much attention on playing with things,” (ST11)*

ST11 further commented on the distortion of STEAM implementation at some schools.

*“Those schools have to show the EDB where they had put the government subsidies in, so they used the money to buy existing programs, to join competitions, and then filed the EDB annual reports to make the government thought that all subsidies went to the right places. However, many Hong Kong schools are not yet ready to teach STEAM and they are still confused with the interdisciplinary teaching approach. They just did what they were asked to do, as public schools are abided by the EDB’s instructions and guidelines.” (ST11)*

Although ST11 has provided negative comments about STEAM, the program did bring positive encouragement to Hong Kong students, especially those of lower banding schools.

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<sup>9</sup> Liberal studies used to be a subject designed for increasing students’ social awareness by having them study a variety of topics to expand their knowledge base.

*“Although our school is a band three school, we have a mission that if other schools can implement STEAM well, why can’t we. We already had machines and devices available on premise. STREAM<sup>10</sup> is considered by us as a form of career planning for students. There are situations in our school that S.4 students might not be able to complete their secondary education till S.6. Even if they completed S.6, their grades might not be high enough for admitting into universities. STREAM widened our students’ scope of visions about alternative career paths, so they might be able to apply their STREAM knowledge and experiences gained to obtain professional certificates in the future” (ST11)*

On the other hand, PP9 was a proponent who gave positive comments to support STEAM education.

*“The development of A.I. had already reached a point that we all have to learn how to make use of it and apply, otherwise we will be falling behind. Many innovations are now about unmanned-operations, humans have to apply their intelligence to explore and develop. We have to improve the machines to provide us better lives, this is what STEAM is about.”*  
(PP9)

From educators’ perspectives, the interconnected relationship among the 3H attributes of heart, head, and hands is embedded within the structure of Hong Kong’s web-based educational system. Guided by forward-looking educational visions, the EDB takes progressive steps to launch and promote STEAM education in Hong Kong, and these initiatives are supported by enthusiastic and genuine proponents of the STEAM program. For other schools without a crystal-clear vision to align their efforts with the government, the EDB can provide them with clearer and more comprehensive guidelines for navigating STEAM implementation, with the aim to facilitate broader adoption across Hong Kong.

#### **5.1.1.2 Perspectives of Schools with Low Enrolment Rate**

Hong Kong schools face the risks of mandatory closure if they are not able to enroll sufficient students to maintain more than two P.1 classes or two S.1 classes over two successive academic years. If schools fail to meet the enrollment target, the EDB will discontinue their subsidies after a three-year period. A newspaper report with the heading ‘Waiting to die’ was released in

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<sup>10</sup> School #11 added religion into the STEAM program to make it STREAM.

2023, school principals warned the EDB that if it continues to enforce strict policies, nineteen Hong Kong secondary schools are going to face closure in the upcoming academic year (myNews, 2023) Several underlying reasons have led to the emergence of this phenomenon. Yiu (2021) reported that ‘dozens of Hong Kong schools were hit by declining enrollment because of the population shrinks, 40,000 families had left the city for emigration’. Moreover, declining birth rate is another factor causing low enrollment rate. School closure is a complicated issue, but for schools at risk of closure, they would make every effort to ensure their continued survival. Recruiting students from the Greater Bay Area is one strategy, while some schools seek to enhance their institutional quality and attractiveness through successful implementation of STEAM education.

Among the respondents who shared their views on the implementation of STEAM education in schools with low enrollment rate, 80% of them are from band three schools. Their sharing showed the cruel reality of the Hong Kong education system, revealing that only the competence can survive under the strict policies of the government.

SP5 was a principal from a band one secondary school, he was straightforward to express his opinion without agenda.

*“Why those schools which are facing mandatory closure are so keen to implement STEAM? Simply because they have nothing more to lose, STEAM becomes their life-saving straw.”*  
(SP5)

PP9 revealed parents’ school selection criterion, academic performances of schools are always perceived by parents as the key considering factor.

*“If a school’s Internal Assessment result is poor, parents will be reluctant to send their children to study in this school; eventually the school would be forced close by the government if enrollment rate is continuously low. Is STEAM a way out for preventing school closures? Yes, definitely. If STEAM was implemented in a band three school with distinguishable features and achievements, it would definitely increase the school’s enrollment rate.”* (PP9)

ST13 was proud to share his school’s successful experience of STEAM implementation, how they can stand out from the crowd to be a leading school of STEAM education.

*“School closure is definitely not the case of our school. Our school has the privilege to implement STEAM well, we have no mandatory-closure problem; but instead, I am proud to announce that we have to add extra classes next year. Teachers of the discontinued schools in the area now come to work for us. We are only a band three school without academic excellencies, but we had done our best to implement STEAM very well” (ST13)*

PT15 elaborated the basic characteristics and mentalities of general STEAM students in band three schools.

*“I had taught before in band three schools, their students were very bold and brave. They were not interested in regular academic courses, but they showed great interest in creativity and innovation, and they dared to try new things out.” (PT15)*

ST19 clearly defined their school’s standpoint in STEAM education, and showed no embarrassment to disclose the school’s agenda.

*“Helping primary schools in the district to start up their STEAM programs can help to boost our school’s reputation and enrollment rate. After the students graduate from their primary schools, they might consider entering our secondary school to continue their education. A few years ago, we did have the under-enrollment problem.” (ST19)*

Schools which are renowned for offering robust STEAM programs are having the opportunity to establish an image of excellence in science, increasing student enrollment to mitigate the risk of mandatory closure due to persistently low intake. While STEAM education holds significant potential as a solution, its effectiveness is not assured. For school sustainability and improvement, STEAM has to be incorporated into a comprehensive strategy with other factors involved. The threat of school closure can have a detrimental impact on students’ academic outcomes, and their self-esteem is deemed to be comparatively lower than students of other schools in the district (Chiu, Joh & Khoo, 2016).

### **5.1.1.3 Perspectives of Special Educational Needs Schools**

The special educational needs schools are abbreviated as SEN schools. As of 2024, there are 62 SEN schools in Hong Kong, all aided by the government. In pursuit of equitable education, SEN students must be provided with learning experiences comparable to those of their peers, the curriculum of SEN schools was designed by the EDB to align with the integrated education as

objective. As informed by PT15, who was a primary school SEN teacher, STEAM education is integrated into their school curriculum. Four educators PP9, ST14, PT15, and ST17 shared their insights regarding SEN schools, and disclosed how SEN schools implemented STEAM. PP9, PT15, and ST17 explained how schools with SEN students functioned. PP9 and PT15 were found using similar biological approaches to address STEAM education at their schools, and their approaches were supported by ST14. The researcher met ST14 and PT15 at a workshop organized by the Hong Kong Federation of Educational Workers (HKFEW). ST14 was a coding trainer, while the researcher and PT15, who is a STEAM teacher, participated in the workshop as attendees<sup>11</sup>.

The sharing of PP9 brought unexpected boggling to the researcher's mind.

*"I know of some schools which are not differentiated by bandings. They do not admit top-performing students, but they have found ways to endure the challenges posed by class reductions and potential closures. What they do is to admit students with special educational needs whom other schools resisted to take in. They arranged for them special activities catering to their requirements." (PP9)*

ST17 added extra information on how the EDB managed SEN students in regular Hong Kong schools.

*"There are SEN students enrolled in every government aided or grant school. The EDB requested every public school to open a SEN director post to handle the affairs of special needs students." (ST17)*

PT15 is a primary SEN school teacher, her sharing was comprehensive, provided the researcher with a deep understanding of how SEN schools in Hong Kong operate, and how their STEAM program is structured, but inevitably facing various challenges. The respondent reminded the researcher more than twice not to disclose any information about her and the name of the school, as SEN schools in Hong Kong tend to maintain a low profile. The researcher met PT15 at a reptile-rearing workshop organized by HKFEW, PT15 had the intention to introduce the program to her school, a project which she thought could be manipulated by students with special needs.

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<sup>11</sup> For the purpose of the research, the researcher had attended seven workshops coordinated by HKFEW.

*“Our school is mainly divided into two streams, a main stream for normal or next to normal students, and another stream of ‘adapted applied learning’ for students who are having mild or moderate mental retardation with physical disabilities. In terms of STEAM implementation at a SEN school, we have no intention to compete with other schools, we don’t have to think about winning or losing in STEAM competitions, we don’t have to advertise our school, we only need to implement STEAM sincerely with our hearts, solely for the benefits of our students. However, our parents are difficult to deal with, since they have unreasonable expectations and requests, making our teachers demotivated and reluctant to carry out changes in the school curriculum, they considered ‘doing less is better’ for SEN students. I have the passion to implement STEAM in our school, but I hardly change my colleagues’ attitudes. In order to start up the school’s STEAM program, I need to first find a like-minded colleague to work together with me and I had already identified one. I am the type of teacher who likes to explore, to investigate different kinds of teaching methods to improve my teaching skills for benefiting our students.” (PT15)*

To implement STEAM in SEN schools poses considerable challenges; nevertheless, dedicated and aspirational teachers can make meaningful progress. ST14 is a STEAM head teacher and was one of the Top Ten STEAM Excellent Teacher winning in the Greater Bay Area STEAM Excellence Award, he agreed with the approach of PT15 to bring the reptile-rearing project into SEN school.

*“Reptile-rearing is practically good for STEAM learning at schools with SEN students, it involves biology and closed-circuit learning of sensors. These areas were once considered purely theoretical, but now students can learn via the ‘Internet of Things’ to detect the sensing of organisms, this is another approach for learning STEAM.” (ST14)*

It can be advantageous to incorporate STEAM into schools with SEN students, it may facilitate their motor skills development and observational skills via hands-on learning. However, to enhance students’ scientific cognition within the STEAM framework, there is a growing demand for teaching professionals with essential skills and inclusive pedagogical approaches. These teachers must understand the distinct needs of students with disabilities and apply tailored instructional strategies to accommodate different types of impairments (Conde et al., 2023). For the case of PT15, there are formidable challenges that needed to be tackled and handled with cautiousness. Hindrances from colleagues and parents are normal when talking

about the novel and uncharted territories of STEAM. The first step is to enhance principals and teachers' enthusiasm to demonstrate the benefits of STEAM education, and showing how students' learning and development abilities can be improved; and involving parents in the hands-on activities of STEAM is the second step.

#### **5.1.1.4 Perspectives towards the Trendiness of STEAM Education**

Is STEAM an educational trend which will last long or it's only a short-term fad? Thirty-two percent of respondents, composed of four principals and two STEAM teachers, responded to the question. SP2 did not hesitate to say that 'our school implements STEAM mainly because it's a trend that has been talked about by pedagogists around the world, it becomes the world's focus in academia'. ST17 shared similar opinion by saying that, 'our principal decided to implement STEAM in our school due to his belief that STEAM education is going to be the world trend, and most importantly, we were directed by the EDB to do so'. Primary school principals PP3, PP8, and PP9 all shared similar perspectives that STEAM will become a global development trend, it is essential for Hong Kong to align with this movement.

The response of STEAM head teacher ST11 clearly highlighted the importance of STEAM education for band three schools:

*"Our school is a technical school of band three, parents are aware that their sons may not be academically inclined to attain the high grades needed for university admission. Parents are in hope that their children might discover alternative routes via STREAM education to develop their future career paths. Therefore, STEAM will not be a short-term fad, it will last long in our school." (ST11)*

The sharing of ST11 revealed the reality of the Hong Kong educational system, and why they viewed STEAM education as important. ST11 emphasized the sense of helplessness among Hong Kong students who struggle to make educational choices when they fall short of academic standards. For students in the lowest-banded schools, STEAM education appears to serve as a vital lifeline to help them navigate through the uncertainty of their future. This phenomenon has not been previously examined within the context of Hong Kong, making it a compelling area for further research.

### 5.1.1.5 Perspectives towards STEAM Education's Sustainability in Hong Kong

Will the STEAM trend be sustainable? Fourteen educators (74%) responded to the question. Respondents provided in-depth answers that worth pondering. Eleven respondents gave positive answers to agree that STEAM education will sustain for long; whereas ST11, ST17, and PST18 provided negative comments. Prior to analyzing the negative responses, it's worth exploring first the positive feedback that emerged.

*“STEAM will become a sustainable program, for there is a social need. The society needs it, Hong Kong needs it, and the world needs it.” (SVP4)*

*“The STEAM program is in our school's long-term development-plan, it will sustain in Hong Kong. For a program which is executing well, it won't stop at all of a sudden.” (SP6)*

*“When more talents migrate to Hong Kong under the “Admission Schemes for Talent, Professionals and Entrepreneurs”, I feel positive that STEAM will be implemented successfully and sustained in Hong Kong, as long as educators hold fast to the belief.” (PP7)*

*“The EDB must put STEAM on the right track by putting it into Hong Kong's school curriculum, so the program will be able to sustain in the long-run.” (PP8)*

*“The STEAM program would definitely become a long-lasting one, but Hong Kong students need entrepreneurial trainings as well. The government had only provided little support by building the science parks.” (ST13)*

*“Whether STEAM will become sustainable or not, it has to rely on our country's big direction. As long as STEAM is supported by our nation, it will sustain; but how it is going to be developed in Hong Kong, and to what extent, it's hard to say. Without a complete plan, STEAM will not be able to implement well in Hong Kong. STEAM education is good to be sustainable, as it increases students' future competitiveness.” (ST16)*

*“STEAM is already incorporated into our daily classes; however, the EDB's curriculum design for secondary school does not contain too much STEAM elements, so we have to*

*squeeze extra time for implementing STEAM. If STEAM could formally become a part of the Hong Kong school curriculum, it would be idealistic.” (ST20)*

Positive commenters apparently showed the fact that STEAM education is generally not resisted by Hong Kong educators. Some school leaders recognized the benefits of STEAM education, so the program was incorporated into their schools’ long-term development plans and daily classes. However, ST16 believed that the development of STEAM education in Hong Kong was more or less influenced by the direction of the China government. This is indeed the case acknowledged by the Education Bureau (2022a) in the Chief Executive’s 2022 Policy Address, the China government emphasized the value of STEAM education in helping students to build a strong foundation to align with Hong Kong’s strategic direction of advancing technology and innovation. The EDB will increase fundings for instituting a series of initiatives to strengthen primary and secondary schools’ STEAM education, in order to conform with the national policies and broader goals of the Chinese government.

On the other hand, negative comments revealed some true facts about the reality of STEAM implementation in Hong Kong. One of the comments was from ST11, who is a STEAM head teacher of a school implemented STEAM successfully.

*“STEAM was frequently mentioned around the world in recent years, but I feel that the craze of STEAM education had already subsided. Many schools felt that too much funding had been put into STEAM, whereas other subjects were being ignored. I think STEAM had already reached a bottleneck stage, since there were no more emergence of new materials, novel technologies, and new programs. Breakthroughs are needed for STEAM to sustain.” (ST11)*

ST17 previously serves as the STEAM head teacher at his former school, but he resigned due to excessive workload pressures, and transitioned to his current role as a STEAM teacher at another school. The opinion of ST17 was thought-provoking.

*“I don’t think STEAM would sustain in any schools if it was not being respected. It is a program not easy to be executed, teachers have to work tirelessly, but very often, they did not receive gratitude and appreciation from school leaders. The only way to make STEAM sustain is to put it on Hong Kong’s school curriculum and have students to be assessed, so teachers are no longer allowed to make choices for teaching or not teaching.” (ST17)*

PST18 is responsible to teach in both the primary and secondary sections of a SEN school, and also responsible for the school's curriculum planning. Started in the school year of 2024-25, all public schools, including SEN schools, which are funded by the government are required to coordinate quality STEAM activities every year in which students can participate (news.gov.hk, 2022). The comment of PST18 was quite demotivated.

*“To be honest, the forceful drive of Humanities and STEM in primary schools had already made teachers feel overwhelmed, I wonder if STEM would become sustainable under such atmosphere.” (PST18)*

The interdisciplinary approach of STEAM is being highly praised for its capability to stimulate creativity and critical thinking, and there are requests to government for placing it into Hong Kong's school curriculum. However, the program also faces criticism and challenges, and STEAM's sustainability was called into question by educators. McComas and Burgin (2020) even called it 'a passing fad' in their critique.

### **5.1.2. Implementation Purposes**

The EDB's main purpose for promoting STEAM education in Hong Kong is to enhance students' STEAM literacy and the 21<sup>st</sup> century skills, so they might be able to compete and survive in this rapidly changing world. By cultivating students' positive attitudes and competencies in science and technology, we can nurture future innovators and technical talents who will contribute to drive Hong Kong's economic growth. However, STEAM education has not yet been put on Hong Kong's school curriculum by the government, it is not taught as a standalone subject. As a result, STEAM education is implemented differently across schools in ways that reflect their individual approaches and priorities. Interview result shows that for those schools who are vigorously implementing STEAM, respondents have their unique reasons and purposes for implementing the program, and their objectives deserves more in-depth analyses.

#### **5.1.2.1 Purposes of Educators in STEAM Implementation**

Six principals and three STEAM teachers (47%) answered the question concerning their reasons and motivations for integrating STEAM into their school programs.

The responses of PP3 and SAP10 are the purest among all which aligns with the motives of the government.

*“Our objective for teaching STEAM is for cultivating students’ abilities in exploration, problem-solving, and development of creativity. We consider STEAM as an effective instrument for helping students to develop their scientific and technological skills, to have them well-equipped for the future trend”. (PP3)*

*“Personally, I don’t have the intention to implement STEAM at my school with any hidden agenda such as for preventing mandatory school closure, I am simply interested in doing robotics with my students.” (SAP10)*

In fact, the school that SAP10 works in is one of the best schools for STEAM implementation, renowned for frequently winning in robotics competitions, and the schools’ STEAM program and achievements were frequently advertised to the public.

The response of SVP4 reflected the reality of the ethical reciprocity of ‘give and take’.

*“STEAM teachers who are willing to take on additional workload to implement STEAM often do so out of their ambition to advance to higher positions within their schools. The positions of senior graduate masters or senior administrative masters are scarce, so teachers have to compete for these posts. Some STEAM teachers who put effort into running STEAM are for securing their jobs, they wish to shift from contractual-based to become permanent-based teachers.” (SVP4)*

SP5 stated explicitly why schools want students to win in STEAM competitions, and he perceived these practices as a deviation from the core principles upon which STEAM education was originally built.

*“Many schools want to win in STEAM competitions are for fulfilling the purposes of increasing their schools’ reputation and enrollment rate to prevent school closure. In Hong Kong, the most common pathway for students to enter university is through their performance in the DSE examination. Now STEAM creates an additional path for talented STEAM students who are weak in academics to have the chances to get into universities.*

*However, if the purpose for joining STEAM competitions is for gaining credits to prevent school closure, then the original intention of STEAM education is distorted.” (SP5)*

SP6 pointed out the necessity to put STEAM education on curriculum, and PP8 disagreed that STEAM was strategically used as a tool to serve as a means of fulfilling school-specific agendas. The opinions of both SP6 and PP8 coincided with the comment of ST17 that STEAM education deserves recognition and respect.

*“In order to launch STEAM at our school, we need to first look at our school’s calendar. Each school operates within its own context, and their motivations are not uniform; they have their own reasons to determine whether they should implement STEAM in full strength or not. Frankly speaking, STEAM education is needed, it shouldn’t be treated as an extra-curricular interest course; but rather it should be put into the curriculum as a standalone subject for preventing it to be used as a strategic instrument.” (SP6)*

*“There is nothing wrong with schools exploring ways to remain viable and sustainable, but survival should not come at the expense of integrity. It’s a problem with value education. What these schools should do is to put in real effort to improve their students’ academic performance, rather than using a meaningful program to increase a school’s reputation. Motivations for implementing STEAM education should be genuine and aligned with its authentic educational values.” (PP8)*

ST11 is a STEAM head teacher who had tremendous experiences in bringing students to compete in international STEAM competitions. His school has over fifteen teachers in the STEAM team, and each is responsible to lead at least one competition team annually. He disclosed that some schools place excessive emphasis on winning competitions, prioritize competition victories above all else, teachers were pressured by principals to secure achievements.

*“We do have talented students, but they are not up to the level or standard to win in first-class science competitions. Among insiders, it is widely understood that competition outcomes reflect the performance of teachers more than that of students. When teachers failed to win competitions, many principals requested thorough explanations for the outcome, without offering any words of emotional support. This contributed to the growing*

*work-related pressure and stress faced by STEAM teachers. Winning competitions and enhancing school reputation has become a higher priority than any other educational goals” (ST11)*

ST11 further elaborated on the underlying purpose behind schools that frequently sent students to competitions, and revealed the hidden facts concerning the entry products submitted for STEAM or science competitions.

*“Hong Kong schools are inconceivable in a way that, despite of limited resources, they still participate in lots of competitions, in hope to win their schools reputation. In fact, a lot of competing innovations are redesigned products of former creations, and there is a hidden secret that some competition entries were actually inventions of teachers. These entries were too profound and complicated to be designed and produced by secondary school students, they were of university standard.” (ST11)*

*“Understandably, schools in certain districts with consistent under-enrollment problems, are fear of being forcibly closed. These schools are eager and desperate to enhance their public image and social visibility; therefore, they joined many STEAM competitions and their winning results and achievements were frequently shared on social media to gain public recognition. Their aim was to validate their presences by introducing programs that elevated their schools’ visibility and distinctiveness.” (ST11)*

ST11 further responded to the researchers’ question regarding the increasing number of schools posting their STEAM award-winning videos on social media.

*“There are increasing numbers of schools doing this now. Today’s school teaching is not authentic teaching; teachers are not only responsible for daily school operations, but they are expected to engage in marketing and school promotional efforts to help prevent school closure. Our STREAM program, with the religious component, has become our school’s key opportunity and strategic focus for development.” (ST11)*

Both ST17 and ST19 also took into account the motives of their peers, they elaborated on the viewpoints held by certain STEAM teachers.

*“Not only schools need to stay alive, teachers also need to subsist in their teaching lives. Many STEAM teachers are not able to teach in English, so they must stay in a school that uses Chinese as the medium of instruction. It is justifiable that teachers have to calculate as well in order to sustain in their careers.” (ST17)*

*“Some teachers work hard on STEAM is for the purpose to fulfill their personal agendas, I think this is justifiable. However, in the long run, STEAM cannot be implemented well in schools with teachers of these perspectives.” (ST19)*

A school should be a space for nurturing students’ academic, intellectual, and social growth, in response to the evolving demands of the world. Yet, it also reflects a competitive reality, echoing the law of the jungle, only the strongest and most adaptable ones can survive and stay success. Moreover, schools are living in an era of parental choice (Garnett, 2014); school environment, academic quality, extracurricular activities, and special programs are all factors that Hong Kong parents will consider. If a school consistently excelled in STEAM competitions, no matter it wants to ensure the school’s continued operation, or the principal is a science enthusiast, parents would support the program (Cheung & Tsang, 2023). Nevertheless, it is also understandable that the original intent of STEAM education for equipping students with technical and creative skills for navigating the future world, is often overshadowed by schools’ survival-driven agendas. Arguments about this issue deserves more discussions in future studies.

#### **5.1.2.2 Purposes of Students for Participating in STEAM Competitions**

The Hong Kong educational system is exam-oriented, and the tradition is ingrained in the culture. Specific focuses were put on public examinations, such as the Hong Kong Diploma of Secondary Education (HKDSE). Studying in a society which emphasizes ‘learning is all about getting good grades’ implies that students have to learn in an environment filled with competitive challenges. Joining competitions can give students the opportunities to demonstrate their abilities in the real world, although it is stressful. Obtaining success in STEAM competitions can strengthen students’ academic record and improve their chances to get admitted into universities. In addition to conventional examinations, competition offers an alternative way to evaluate success. Two principals, and four STEAM teachers (31.6%) commented on students’ purposes for engaging in STEAM competitions.

*“Our parents all knew that if students won in STEAM or science competitions, the certificate of commendation could be of great value for applying band one secondary schools, and even for applying universities.” (PP3)*

*“There are many humanoid robot sports games held around the world every year. Winning in these competitions is important for serving many purposes. Looking on the bright side, students can learn from other capable participants around the world through joining these competitions.” (SAP10)*

ST11 has extensive experience in guiding students through STEAM competitions, and under his leadership, they participate in numerous events per year.

*“Some alumni of ours were awardees of the Intel International Science and Engineering Fair. Our students had also won before in the Odessey of the Mind, defeating students of band one schools. Winning these competitions meant very much to our students, as the results proved that, despite of their poor school grades, they could also be creative and productive. Our students joined also the Geneva International Exhibition of Inventions, but they were not able to win any awards. Joining competitions is easy, but to win is difficult.” (ST11)*

ST13 took a contrary stance on the notion that STEAM education serves merely as a pathway for university admission.

*“I don’t think STEAM education significantly improves students’ chances of gaining university admission, it depends on individual students. STEAM cannot be perceived as a stepping stone for university entry, but some outstanding students might have the chance to get admitted into universities out of the line. For those students who frequently won in STEAM competitions, their future job opportunities are guaranteed though. Before I joined this school, I heard from other colleagues that, the principal allowed some brilliant and talented science students who frequently won in competitions to stay out of regular classes, so they could concentrate in their research. The principal would nominate them for university admissions under SNDAS.” (ST13)*

Furthermore, ST14 provided a clear and detailed explanation of how the Principal Nomination Scheme operates in Hong Kong, especially for students who demonstrate exceptional talent in STEAM.

*“The School Nominations Direct Admission Scheme, SNDAS, allows the principal to nominate two students who are not able to be evaluated by the DSE for university entrance. These two nominations are not only for STEAM students, but can also go to students who are good in social services, sports, music, or visual arts. Last school year, we had eight students qualified to apply for these two nominations, eventually these two places were given to students who achieved success in STEAM competitions under my leadership. The principals and involved teachers unanimously recognized the exceptional talent of these two students, especially their winning awards were superbly good and highly recognizable in academia. These competitions have to be territory-wide, in which students will compete against students from schools across all three bandings. Another level up, they will participate in national competitions. These two students of ours had won in these contests, and their exhibits had been shown on social medias, so they were selected.” (ST14)*

ST14 further explained how STEAM competitions can increase a school’s reputation and how they benefit students.

*“Our students had defeated many competitors of band one schools. I was advised to make a STEAM competition winning list and had it put on social media, so the public will be aware of our school’s achievements. There are many competitions of smaller scales held in Hong Kong each year, we attend those all the time. Participating in competitions offers us valuable learning experience, as it boosts the confidence of both students and parents in the value of STEAM education.” (ST14)*

PST18 spoke on behalf of STEAM teachers, articulating their concerns about the difficulties involved in leading students to participate in STEAM competitions.

*“STEAM teachers are having pressures too. When a principal request a teacher to lead students in a competition, it is natural that the teacher will aim to win. However, both school and student qualifications are not up to the winning standard of big games. To band one schools, winning or losing does not bring them influences, as they are already reputable, welcomed by parents and student. But to band three schools, students have to win in order to earn their schools the fame for recruiting more students to prevent mandatory closure of the school. Utilitarianism is not good, but school survival is also an urgent matter that needed to be addressed. The government only allows under-enrolment schools three years’*

*time to improve, so students are expected to accomplish something significant within this limited timeframe” (PST18)*

A school’s decisions are judged by their outcomes., though balancing moral and ethical responsibilities with the collective interests of the school remains a challenge. However, there is a need for the government to establish a more holistic and balanced approach to cultivate an innovative and student-centered educational environment, instead of implementing stringent policies to abandon schools for covering up the government’s visionary mistakes of building excessive schools in earlier years.

### **5.1.3 Models of STEAM Integration: Institutional and Extracurricular Approaches**

This topic attracted the greatest attention from all respondents, all interviewees shared their experiences and what their schools have been doing, except school #3. School #3 indeed had a STEAM team led by a STEAM head teacher, but during the interview, they did not mention too much about what they had done for STEAM, but instead claiming that most of their students are from the grassroots level without parental support in academics, so they are not too eager to implement STEAM education.

#### **5.1.3.1 Long-Term Development and Strategic Curriculum Planning**

Nine among twenty (47%) interviewed schools, their principals and STEAM teachers stated that their STEAM programs are not on their schools’ curriculum.

*“When STEAM launched in Hong Kong years ago, we did not implement STEAM at all, we didn’t take STEAM too seriously. Until one day, the EDB asserted driving force to place a document with schools to force setting up STEAM teams at schools, we then did it. The principal’s decision for not implementing STEAM was stemmed from the view that, in absence of formal assessment or examination, its integration into the curriculum may not yield tangible academic benefits, and there are no standardized implementational guidelines and specified contents for the program. Therefore, even today, STEAM is not on our long-term development plan, we seldom talked about it in our school meetings.” (SVP4)*

PP8 also expressed an unfavorable view towards the implementation of STEAM.

*“Students advancing to secondary schools are not specifically prepared for STEAM-related subjects, since it is not a substantive course. If STEAM is to be put on the curriculum, the program would then be carefully planned. STEAM implementation is not standardized, it’s hard for us to consider and speculate how far we should go with STEAM in primary schools, and we have no clue of what secondary schools are doing with STEAM.” (PP8)*

ST11 was from a school renowned for its excellence in STEAM, however his reply was unexpected.

*“Our STREAM program is not officially on our school’s curriculum, it’s an extra-curriculum transdisciplinary activity held after school.” (ST11)*

School #19 adopted similar implementational method as school #11.

*“Our STEAM program is not on curriculum, but it is implemented in form of extra-curriculum society, we collaborate with external partners to run the program.” (ST19)*

ST20 disclosed their school’s difficulties in STEAM implementation, they even not able to execute after school.

*“We understand that the STEAM program has correlations with regular courses, but we need to first finish teaching all fundamental school subjects before we can do STEAM projects, we have a lot of limitations. Students have tutorial sessions to go, and the time is not fixed; some students may complete their tasks ahead of time, while others may require more time to finish. Even teachers are very busy, they also have administrative work to do after classes; therefore, it’s difficult for us to implement STEAM after school.” (ST20)*

The opinions of SP2, ST14, and ST17 were also note-worthy.

*“Schools in Hong Kong are not officially requested by the EDB to put STEAM on the schools’ curriculum. Although STEAM is perceived as a global trend, its teaching methods are very fragmentary at both primary and secondary levels, only touching a tiny bit of each STEAM element.” (SP2)*

*“No matter what is promoted, STEAM, A.I., or whatsoever, general education should remain the top priority. For enrichment courses like STEAM, schools should first identify*

*their potential top-notch students who are interested in science, and then have them selected for special STEAM developmental trainings.” (ST14)*

*“If STEAM is not an academic course on curriculum, and there is no STEAM head teacher help organizing the program, only having a name called STEAM is useless, as it doesn’t have the structure of a formal learning course.” (ST17)*

School #12 is a secondary school of the third banding, but the school’s passion in STEAM implementation is perceptible. The school is having two streams of STEAM program, and their STEAM teams’ spirit is strong. For a school which is situated in the heart of the city, it has plenty of spaces, and its STEAM rooms are spacious and well-equipped.

*“The library’s STEAM program is an afterschool-activity, it is not on the school curriculum. Our school’s official STEAM program is an independent course, and it has already been incorporated into our long-term development plan and is included in the curriculum.” (ST12)*

Forty-five percent of the interviewed schools had already included STEAM education into their schools’ long-term development plan, and was supported by the incorporated management committees (IMC) of their schools, comprising of school supervisors, principals, sponsoring body managers, teacher managers, parent managers, and alumni managers. When the STEAM program is supported by the IMC, it will receive accreditation, and its educational standards are to be ensured. Teachers and administrators will be given opportunities to participate in relevant professional development trainings, and resources for running the program will become easily accessible; moreover, mentorship and networking are also attainable.

School #5 had also incorporated the STEAM program into their long-term development plan. The school integrated STEAM into their S.2 computer science curriculum, so STEAM is to be assessed together with the computer science subject, and assessment results will be formally recorded and included in students’ report cards.

School #6 is similar to school #12 by segregating STEAM into two programs.

*“Our school adopted two approaches: ‘STEM for all’, which is on formal curriculum, and ‘STEM for elite’, which is an extra-curriculum activity holding on weekends. We have students who are very addicted to STEM. Our ‘STEM for all’ is on curriculum, it is implemented in the form of experiments, and grades will be assigned.” (SP6)*

School #9 is a committed advocate of STEAM education, with the program maintained at their school for several years. Even before official launching in Hong Kong, STEAM had already been on their long-term development plan for three years.

*“Once we integrate STEAM into our three-year development plan, we have to implement it in full strength, to assure that it is to be executed effectively.” (PP9)*

School #10 is a former technical school, which is a faithful supporter of STEAM education, holding up to the beliefs and values delivered by the EDB.

*“Learning hours are limited, but learning is unlimited. Our goal is to encourage students to create products of origin. Our curriculum incorporates the components of ‘hands-on activities’ and ‘maker culture’ emphasized by the EDB. Students learn in our workshops about product design, product manufacturing, and machine-operation safety. Our school has to deliver the message to public that we are strong in robotics, and our students are good in it. Our robotic course is on the curriculum” (SAP10)*

School #12’s STEAM program is supported by its IMC with distinctive values and guiding principles integrated into the program.

*“STEAM is on our school curriculum and students are to be assessed. The initiative is supported by the IMC, which develops a strategic plan for its growth every three years. Our program had added in the principles of morality and values. As requested by the government, all Hong Kong schools have to add in these two principles.” (ST12)*

School #16 implements STEAM during regular class hours, and the program aligns with one of their sustainable development goals. School #18 also includes STEAM into the school’s curriculum and the program is taught as an independent course. Relative to others, ST20’s statement is encouraging and motivating.

*“STEAM is in our long-term development plan; although we don’t have sufficient manpower, we will still do our best to implement it step by step.” (ST20)*

### 5.1.3.2 STEAM Implementation Strategies

This section presents insightful discussions on the diverse approaches schools take to implement STEAM education. Seven out of ten interviewed principals shared their experiences, and all ten STEAM teachers interpreted how STEAM is taught at their schools.

#### *Schools with Effective STEAM Implementation*

School #2 used STEAM educational excursions to show students the directions of their future career path.

*“We show students future directions by providing them STEAM education and eye-opening field trips, we let them find out on their own of what they really want to do in the future.”*  
(S2)

School #5 employed extra-curricular activities to identify the real science and STEAM lovers, so the school can focus on cultivating their science interests and talents.

*“Our school has an Innovation and Technology Club for doing extra-curricular STEAM activities. Students are free to join without force. We provide them basic STEAM trainings, and from there, we are able to identify who has real interest in STEAM, we then invite them to join science competitions; and through the preparations for competitions, we are able to sharpen their skills.”* (SP5).

School #6 is an outstanding school performed STEAM exceptionally well.

*“Our school adopts two approaches: ‘STEM for all’, which is on curriculum, and ‘STEM for elite’, which is an extra-curricular activity holding on weekends. We frequently joined competitions held in the Big Bay Area, and we had traveled as far as the United States.”*  
(SP6)

School #7 has designed a program to incorporate the concept of ‘caring the elderlies and communities’ into their STEAM activities, addressing the needs of seniors.

*“In our school schedule, there is an activity by the name ‘Super Fun Learning Task’, it is not an afterschool activity, but a program that all students have to attend in the afternoon, in which they learn how to care for the elderlies. They will first interview the seniors to ask*

*about their needs, and then they will go on to create something that will potentially enhance their daily lives. Numerous publishers in the market offer STEAM education textbooks, each presenting diverse methodologies for STEAM implementation, but we did not use those 'think inside-the-box' materials, we engage in brainstorming and developing ideas that extend beyond the scope of traditional textbooks.” (PP7)*

School #8 applied the concept of ‘give and take’ to make room for the implementation of STEAM. When something important needs to be added, something of lesser importance has to be taken away.

*“Our computer science class is limited to having only 35 minutes for teaching. If we want to teach coding, we must decline some topics in exchange, such as Microsoft Word and Excel. Our solution is to prepare supplementary notes for the omitted topics, enabling students to learn on their own. With the time saved, we are able to teach students something new about STEAM.” (PP8)*

School #9 adopted a ‘Whole School Approach’, and used 3Ps to steer the school’s STEAM implementational directions. The school’s STEAM programs are multifaceted, covering broad arrays of topics.

*“We treated STEAM as an informal curricular course, started first in P. 1, and then spreading out to the whole school level by level, we adopt an approach called ‘Whole School Approach’. The STEAM program had already been put into our long-term development plan, if we only implement it at certain levels but not across the entire school, the program would not work. We use 3Ps to steer our directions. The first P is project-based learning, the program is executed in project format without assignments. The second P is problem-based learning, students have to solve emerging problems while doing projects. The third P stands for proactive-learning, students have to collaborate and work together in groups. At the junior level, we begin with a robotics kit developed in West Germany. Next, we introduce the Japanese ‘Artech Blocks’ kit. For senior students, we utilize the services of ‘Cool Think’. Our STEAM room is called the Star Lab, we also have a greenhouse called Smart Garden, and later we will build a reptile habitat.” (PP9)*

School #10 is formerly a technical school and its STEAM program focused on designing and building humanoid robots. It is a pioneering school that implemented STEM education well

before the Hong Kong government officially introduced the program in local schools. The school is also a participant of the government's QEF Thematic Network.

*“Our school was formerly a design and technology school, we started doing STEM since 2005, long before STEAM was officially introduced to Hong Kong. It was previously a prevocational school, so you can find machines, instruments, and tools here. From day one, we began working on humanoid robotics. Our students have participated in numerous STEM-related competitions, including opportunities to compete internationally. Later on, when technology advanced, we started to teach students how to operate the 3D printers and laser cutters, we insisted to teach students how to cut the parts and drill holes by themselves, rather than buying existing parts in the market. We had infused a lot of engineering and technology components into our STEAM program. Students are able to apply the coding skills they acquired in computer science class to robotics projects. Humanoid robots are more complicated than doing simple robotic cars, as their actions are more sophisticated. Students are very interested in doing this, even girls. Our robotics learning framework follows a polyhedral structure, requiring students to master foundational knowledge before progressing to more advanced level.” (SAP10)*

School #11 is similar to school #10, which was formerly a technical school, they closely resembled each other in the adoption of STEAM implementing approaches. Since ST11 was the pilot interviewee, his interview was more detailed and richer in information, interviewing time was double longer than those of other respondents.

*“Our STREAM team consists of approximately 12 to 13 members, including vice principals, school directors, and teachers from various disciplines, with design teachers playing a leading role. Each teacher on the team has to lead at least one competition per year, with some taking on two.” (ST11)*

*“With the \$200,000 subsidy provided by the EDB, we used it for buying LEGO Technics, a series of toys with STEAM elements integrated. Following that, we introduced students to Micro:bit programming, and then Arduino, a microcontroller platform that we utilized in our STEAM-related competitions. Subsequently, we introduced students to operating the laser cutter, as it is the most accessible machine for them to handle. Our students participated in numerous competitions, including the Odessey of the Mind and the Geneva International Exhibition of Inventions. The latter one is a first-class global competition,*

*topmost in Hong Kong. Winners from the Hong Kong region are invited to Geneva to compete in the final round, where their innovations are showcased. One of the renowned winning products invented by Hong Kong students was the self-sanitizing door handle, which was granted the James Dyson Award. For STEAM or science competitions, it is very challenging to invent something from scratch, solely based on imagination; therefore, we redesigned existing finished products created by others. We explored areas for improvement, such as enhancing functionality or selecting better materials. At times, we combined two or three existing products to create entirely new ones. In practice, teachers often provided the initial concepts, and students took the lead in preparing and presenting the final outcomes. Although students are often credited with producing remarkable innovations, the reality is that teachers play a significant role behind the scenes. This is a widely adopted practice across educational settings.” (ST11)*

*“Only band one schools were invited by sponsors to send teachers overseas for specific STEAM trainings, unless the trainings were supported by the EDB. Ours is a band three school, we do not send teachers overseas for training; even if they were trained at M.I.T, would that alone enable them to inspire creativity in students? I don’t think so.” (ST11)*

*“Even within academia itself, numerous STEAM competitions take place each year. We aspire to become an organizing school to gain visibility and reputation.” (ST11)*

*“All students voluntarily nominated themselves to participate in STEAM competitions. Those who went with me to overseas competitions were not necessarily top academic performers. Every student is given equal opportunity to explore and excel at our school.” (ST11)*

ST12 served as the head librarian, and taught computer science and Chinese history. Upon receiving consent from the principal, they launched a parallel STEM education stream within the school. The library had its own set of scanner, printer, and laser cutter to do STEM projects based on history. ST12 stated that all forms of knowledge, whether scientific or arts-based, they originate from the library. ST12 applied for funding through the Quality Education Fund to support the idea of establishing a second stream of STEM, and eventually a smaller STEM function room was built next to the library by using the 1.6 million dollars subsidized by the government. ST12 had done an outstanding job, but she granted her principal all the credits for supporting her ideas.

*“Five to six years ago, the STEM room did not offer the same open access as the library, where students can come and go freely. I began envisioning a STEM room fully integrated into the library, a public area that serves students and allows them to enter and exit at will. As long as I am in the room, students are welcome to come in at any time to work on mini-projects that they have keen desire to create, such as 3D printing objects of their personal interest. My Chinese history class has to do a project each year, so I initiated the idea to have Chinese history incorporated into STEM education. Education needs collaboration, a subject teacher alone cannot bring the best to students.” (ST12)*

*“Our STEM team is sizable and well-established, having about five to six teachers involved. They did a lot of robotics, and students frequently won in competitions. The library, on the other hand, provided other kinds of services, catered to those students who are not too interested in science, engineering, and technology, but having interest in artistic design and 3D printing. We provide them with alternative opportunities to recognize their potential. We have been using a two-pronged approach in STEAM implementation.” (ST12)*

*“Our principal agreed that the library should take part in promoting STEM. We used to call the library ‘information center, but now it becomes a place for communicating knowledge among different stakeholders. Students can share their learning experiences with others despite of result, telling what they had gone through, why they failed, and how they can improve, these are what we expected them to do.” (ST12)*

*“I wanted to introduce an initiative that would foster cross-disciplinary collaboration among teachers, something already practiced elsewhere, yet still unexplored within our school; therefore, I introduced boardgame production into our STEM program. Over the past few years, I had been working closely with the principal and our Language Learning Support Team to do something innovative but had not yet been done in our school. I hope to let my colleagues know that, besides formal teaching, there are many different ways to impart knowledge to our students” (ST12)*

*“The principles of morality and values were added into our STEM program, the basic idea is to let students know that they have to be responsible for what they are doing, and as well there are environmental issues that they have to consider while doing innovations.” (ST12)*

The interview with ST12 was informative and fruitful, her sharing was fascinating. Inspired by ST12’s passion, the researcher found renewed hope in the future of STEAM education in Hong

Kong. ST12 also shared with the researcher that Hong Kong STEAM teachers maintain a strong culture of mutual support. ST13, a committed and passionate advocate of the program, served as the mentor of ST12 and was instrumental in teaching her effective STEAM teaching methods. ST12 referred ST13 to the researcher as interviewee, and regarded the visit to ST13's school and STEAM room as a truly eye-opening experience.

ST13 is the STEAM head teacher of a band three secondary school, which is one of the cradles for three young scientists who had won in the Intel International Science and Engineering Fair (Intel ISEF), and were having asteroids named after them. ST13 is a highly recognized figure in the music community of Hong Kong. He is well-known for his competency in making computer-controlled organs in addition to other musical instruments such as customized guitars, ukuleles, and home-made 3D-printed musical instruments. With a background in engineering, ST13's projects often applied innovative techniques in constructing musical instruments, making him a contributor to both music and technology, and his works were often shared on social media. Besides making musical instruments, school #13 is also renowned for its effort to connect with the community.

*“Today, there are numerous elements that can be incorporated into STEAM education. I teach students and elderlies playing ukuleles, this represents the Arts in STEAM. Students even went visiting elderlies at their homes to help doing maintenance, this is also a part of the STEAM program, involving technology and engineering. The gentleman who teaches our students doing maintenance job is a retiree, he is grateful that he is still able to make contributions to the community. Our aim is to promote the reciprocal caring concept among all ages through STEAM, they can all serve the community and benefit from it.” (ST13)*

Before the interview with ST13 formally started, the researcher had the opportunity to interview the social worker at School #13, who oversaw operations at the community center, which was situated right next to the school's STEAM room.

*“Many schools came over to learn from us our experience in organizing elderly STEAM programs. We start to become an expert after three phases of STEAM implementation. The ‘ICT Programmes for the Elderly’ teaches elderlies how to use smartphones and smart technologies. We recruited the elderlies via the Elderlies Academy, and then by using the snow-ball and word-of-mouth methods, more elderlies came. Our students played the roles as instructors to teach the elderlies novel technical skills. Interestingly, the teaching and*

*learning processes were reciprocal. Students first learnt from their STEAM teachers, and then they imparted their knowledge and skills to the elderlies; by return, the seniors taught the students their life experiences and wisdom.” (Social Worker)*

School #13 is a spacious school with ample space for running the STEAM program. Besides the major STEAM room and community center, several rooms adjacent to the STEAM room are for displaying the customized hand-made musical instruments, and there is even a recording studio for music production.

*“I am the chief coordinator of the STEAM team, and we have another five teachers in the team. Two teachers are of the humanity side, responsible for the ‘A’ of STEAM. Other STEAM teachers are in charge of the S, T, E, and M of STEAM. STEAM education promotes collaboration among teachers of different disciplines, but we won’t involve every teacher in STEAM meetings to respect their time, I will invite them to join when they are in need.” (ST13)*

*“Our school adheres to the philosophical principle of universalism in student cultivation. We believe that students should be taught according to their aptitude without distinction; however, this philosophy cannot be applied to STEAM education. STEAM education emphasizes collaboration, therefore only students of alike can be put together to achieve collective goals.” (ST13)*

*“Our school has a C. Y. H. Foundation Fund<sup>12</sup>. If our students won in external STEAM competitions, the foundation would grant them awards. This is an effective approach for encouraging students to join the STEAM program, recognition through awards serves as powerful motivators.” (ST13)*

ST14 is a reputable STEAM head teacher of a band three secondary school, who had won the Top 10 STEAM Excellent Teacher award. The researcher met him at the Hong Kong Federation of Education Workers (HKFEW), participating in his coding workshop designed for educators’ STEAM development training. Moreover, ST14 was also invited by universities to be the trainer of STEAM teachers, this is part of the EDB’s plan to provide STEAM developmental

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<sup>12</sup> The full name of the fund was not disclosed, for the purpose to protect the school’s privacy.

trainings to teachers through the Training Calendar System. The training fulfilled one of the CPD<sup>13</sup> requirements for the Professional Ladder for Teachers.

*“I don’t view coding as a core component of STEAM; this is only a computer science topic. The EDB had set the ‘Guidelines for the field of science’, the teaching of STEAM or science is to let students using their knowledge, values, skills, and attitudes to create innovative products. I teach students coding, so they can animate digital figures; students do learn something, but this is not an invention. Students should create products which can be used for solving community problems and are beneficial to the community. Currently, our students create games with historical scenes, elderlies love to play these games.” (ST14)*

ST14 further commented that school #14 had missed certain categories in its STEAM program.

*“I always told my principal that our school was not implementing STEAM, we were only doing science and technology, we were not outstanding in other STEAM categories. I feel that mathematics and engineering were being ignored and omitted.” (ST14)*

ST15 is a passionate teacher from a SEN primary school, the researcher met ST15 at three HKFEW STEAM workshops. ST15 was looking for an appropriate STEAM program which she can implement at the SEN school. The interviewee was frank to openly share her experiences and challenges when dealing with parents and other teachers at SEN school. The SEN school is permeated with low-spirits and a demotivated atmosphere.

*“I teach practical life skills to SEN students. I begin by teaching them how to follow rules, then guide them to developing communication skills and building social connections, aiming to raise their intelligence quotient. Bringing the reptile-rearing program to SEN school is not impossible, but I have to first think about the emotional reactions of parents, students, and colleagues. In fact, our students are simple, they like engaging in activities they find amusing. SEN students are not able to judge, so we have to judge for them. To run a STEAM program at our school, we have to first overcome the barriers related to parents’ points of view, and other teachers’ viewpoints of ‘doing less is better’.” (PT15)*

*“Our school’s current STEAM program is ineffective and not implemented well, it doesn’t have a spindle. The program is loose without strategic plannings, since we have no chief coordinator, so no one has a full picture of what’s going on in the program. Our principal*

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<sup>13</sup> CPD stands for ‘Continuing Professional Development’.

*should appoint a STEAM head teacher to plan the events, and form a team for implementation. Without a leader, we have a lot of pressure to fumbling blindly.” (PT15)*

School #16 is a reputable boys’ secondary school, highly favored by parents and students. The interviewee is a STEAM teacher. The school has seven classes in one level, more than those of regular schools which have only four. Due to its grant school nature, the school is able to recruit more talented science teachers; therefore, the STEAM program has been implemented effectively at their school.

*“We use regular class time to implement STEAM, and train students to apply STEAM knowledge into daily problem-solving. External program providers come in to give lessons, since we rent from them the STEAM project kits, so they have to provide instructional support. The provider will teach our students the basic knowledge of the program, and our STEAM teachers will do the follow-up teaching afterwards. The project kits are not permanently sold to us, once we finish using them, we have to return them to the provider. This is a simple way of doing STEAM, a model that involves minimal manpower, since teaching responsibilities are shared. When outstanding STEAM students are identified, the STEAM teachers will concentrate in cultivating them for joining competitions.” (ST16)*

*“Our STEAM program is designed for S.2 students only. The implementing modus follows the ‘sustainable development goals’ of the government. Higher level students are not able to spare too much time on STEAM projects, and teachers have tight schedules as well. Fortunately, our students rely very little on teachers’ lecturing. In case teachers teach too fast, they will have ways to catch up with the progress. To us, teaching fast is never a problem, our students demonstrate a strong ability to absorb new knowledge, this is how our time is saved for implementing STEAM. We regard the instruction of a topic as complete once all students show clear understanding. We are highly flexible, and the practice is agreed by all stakeholders. We are lucky to have enough science classes, so STEAM can be incorporated into our daily schedule. No negative comments had been made by our teachers regarding our school’s STEAM program, we only need to teach fast. Not every school can do what we are doing, if the government wants to promote the ‘one size fits all’ approach for STEAM, it is nearly impossible.” (ST16)*

ST17 is a computer science teacher of a renowned band-one-A<sup>14</sup> coeducational aided school. The school adopted an alternative approach to implementing STEAM, departing differently from typical educational practices. The interviewee disclosed some overlooked perspectives that worth noted.

*“Students of this school are duty-bound to get into universities, as this is a band-one-A school. Our students are nurtured to look beyond future earnings and potential financial gain; but instead, they learn how and what they can contribute to the world. In this school, a student who likes very much physics, teachers will not encourage him to become a physics teacher, but rather will tell him to work hard to become a scientist of physics.” (ST17)*

*“The trainings for our students have already gone beyond the 4Cs of STEAM education, we help them to create a vision for the goodness of the world, so they can bring this mission along with them to universities and future careers. At the present stage, what they choose to study highly determines what they are going to do for their future; even if they choose among the elements of STEAM, they can still look forward to bright futures.” (ST17)*

PST18 serves as a teacher of both the primary and secondary sections of a SEN school, and also acts as the school’s curriculum planner. PST18 did not talk too much about her present school, as she said they are inconspicuous.

*“In the primary section of my current school, we incorporate STEAM into general studies; but in the secondary school, STEM is treated as an independent course, without integrating with other subjects.” (PST18)*

*“My current school’s STEM program is straightforward for teachers to implement and aligns with practices commonly adopted by most Hong Kong schools. We bought the STEM material kits from textbook publishers, they prepared all the necessities, we just need to follow the executing methods which are direct and clear.” (PST18)*

School #19 is another school implementing STEAM without the lead of a STEAM head teacher. The school mainly joins the RoboMaster program and attended their competitions.

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<sup>14</sup> Even among band one schools, there are three levels of differentiation: A, B, and C, with A representing the highest tier in educational performance.

*“We don’t have a STEAM head teacher, so when there is competition coming up, the STEAM teachers will sit together to determine who will be the leader of the competing team. The principal is only acting as a messenger to pass us the competition news.” (ST19)*

### ***Divergent Paths of STEAM Implementation***

The principal of School #20 met the researcher at school office; however, due to her tight schedule, she was unavailable for an interview. She emphasized more than once that their school does not do too much in STEAM, since their students’ academic results in DSE had shown significant improvement during recent years; therefore, the school prioritizes academic achievement over the development of STEAM education. The interview with ST20 left the researcher with a strong impression of the STEAM head teacher’s sense of helplessness in managing a program that is not fully supported by the school, yet remains obligatory under the EDB’s policy.

*“We schedule weekly STEAM meetings to keep students informed about the developments in the field, and sharing with them environmental topics such as environment protection, microplastic, and marine plastic. On the other hand, students share their reflections and present videos that they created about STEAM. The meeting will conclude with a group performance of a song about environmental protection, which we regard as a meaningful artistic expression representing the ‘A’ in STEAM. Our students had joined the Robofest competition, and an external instructor was hired to train them. However, we currently lack teaching staff to supervise students during after-school or weekend STEAM training lessons. All teachers are occupied with their regular duties, I feel uncomfortable asking them to sacrifice their personal time to take on additional responsibilities.” (ST20)*

### ***Small-step Approach***

Thirty-seven percent of interviewed schools admitted that they use a ‘small-step approach’ to implement STEAM. By breaking down the complicated tasks of STEAM implementation into smaller, and more manageable parts, STEAM teachers feel less unpalatable to accept the transformational changes brought by the program. The small-step approach helps to avoid overburden, procrastination, burnout, and big mistakes (Allen, 2003; Duhigg, 2015).

*“When STEAM launched at our school, there were complaints from teachers. We have to use the small-step approach’ to make them feel comfortable in teaching STEAM.” (PP3)*

*“Within limited capabilities, everything cannot be changed at once, STEAM has to be implemented step by step. The EDB has to use strategies and more considerate approaches to promote STEAM.” (S2)*

*“We do not engage in STEAM merely to fulfill the EDB’s requirements, we rather take a thoughtful step-by-step approach to ensure meaningful integration.” (SP5)*

*“We implement STEAM on a trial-and-error basis, moving a little step at a time. We aim to let students learn about the STEAM concepts first. Besides students, we also have to train our teachers. ‘Cool Think’ is difficult to manipulate, we must train our teachers step by step” (PP9)*

*“Our school is fully committed to implementing STEAM in accordance with the EDB’s directives, but we have to do it slowly in small steps; therefore, the timeline for the official launch of the program at our school has yet to be determined.” (PT15)*

*“The EDB advised us to implement STEAM as a standalone course, so we gradually have it merged with the new humanities course by adopting the ‘small-step approach’. Hong Kong was once slow in advancing STEAM education, but schools have accelerated their efforts following the arrival of the new government.” (PST18)*

*“Our school adopts the small-step approach to integrate STEAM into daily classes.” (ST20).*

### ***Hong Kong Government’s assertive approach to advancing STEAM education***

An analysis of educator perspectives reveals recurring criticisms of the EDB’s forceful and top-down approach in advancing STEAM education. According to the Information Note of the Legislative Council Research Office (2023), ‘95.7% of schools had arranged extra-curricular activities in the form of competitions, workshops, and exhibitions; and 29% had put STEAM in their curriculum’. According to SP5, the EDB requires all schools to submit year-end reports outlining their STEAM-related efforts. However, the reporting process is highly superficial, consists of checkbox responses, offering limited opportunity for meaningful reflection or evaluation. ST16 remarked that the EDB is attempting to adopt a ‘one-size-fits-all’ approach to launching STEAM across all Hong Kong schools, without adequately considering their

distinct characteristics of differing school cultures, unique backgrounds, and varied banding levels. From interviewees' responses, it is evident that all Hong Kong schools have followed the EDB's directive to implement STEAM education, though each has done so at its own pace, in its own way, and on varying scales. Based on respondents' feedback, Hong Kong is not falling behind other countries or regions in STEAM implementation. However, despite the progress made, further efforts are needed to make the program more systematic, structured, and consistent across schools.

### **5.1.3.3 Evaluation of Student Performance in STEAM Disciplines**

Educators expressed differing views on whether students' performance in STEAM should be formally assessed or evaluated. Eight schools (42%) responded to the question, six of them have their own STEAM evaluation system, whereas two refuse to have students assessed. School #5 set up assessment criteria for STEAM projects include the quality of group collaboration and the extent of each student's individual contribution. Schools in the area visited them to seek advice on setting up evaluation systems for STEAM. School #10 described its STEAM assessment model as similar to a driving test, requiring students to complete both a written test and a hands-on practical task. The school adopts a 'scientific inquiry approach', encouraging students to make independent decisions, such as selecting materials for building their robots. These choices directly influence the outcomes, and a single misstep can lead to unexpected results, reinforcing the importance of critical thinking and experimentation. Material selection is their first assessment. The second assessment is in form of written tests, and the third evaluation is called 'internship assessment'. Students have to apply what they had learnt in the past to practically make a product. School #11 evaluates their students' abilities to apply computer science knowledge within STEAM projects, and the scores are counted as partial grade towards their computer science course. School #12 also assesses students' STEAM performance as part of the computer science course, with the resulting grades reflected on their report cards. School #16 divides a project into multiple smaller procedures, each of which is individually assessed, with the corresponding marks recorded on students' report cards. The school views assessment as a means to inspire students to strive for excellence and encourage them to reach their full potential. ST18's former school also assesses students on their STEAM performance. Contrarily, School #6 and School #9 held opposite perspectives towards assessing students on STEAM. School #6 acknowledged the assessment rubrics proposed by

the EDB but opted not to adopt them. Similarly, School #9 declined to evaluate students on STEAM, citing the program's immaturity and the wide disparities in students' operational skills. They emphasized the need for a centralized standard to be established by the EDB before meaningful assessment can take place. ST9 further commented that if STEAM was formally integrated into the Hong Kong school curriculum as a standalone subject, then assessment would become feasible.

Although responses were not comprehensive, it is noticeable that most respondents have their schools' STEAM education related to the subject of computer science, so students' marks for their STEAM projects are incorporated into their overall subject grades. This phenomenon may have emerged due to the EDB's strong promotion of coding in schools, along with the influence of the CoolThink@JC initiative, which was promoted as 'Computational Thinking Education' (Education Bureau, 2024c). Nonetheless, ST14 argued that he does not consider coding as part of STEAM, since it does not involve making a product which can be used for benefitting the society.

From the above points of view, Hong Kong educators offered a comprehensive interpretation of how they perceive STEAM education, and how the program is implemented and assessed. The educators generally agreed to implement the program as advocated by the government, although educators held differing views regarding the value of STEAM, they still chose to participate. Whether schools implement it on a large scale or take a more incremental approach, the initiative continues to be embraced. With or without a dedicated STEAM team, schools are actively finding ways to engage with the initiative. Hong Kong's STEAM implementational methods are diverse without general consensus on its best achievable ways. Schools are implementing the program in their own ways, but have encountered varying challenges. While some challenges are universally encountered, others are shaped by the distinctive characteristics and context of Hong Kong, such as high-stakes testing, a rigid curriculum, and limited time for creative exploration.

#### **5.1.4 Challenges of Hong Kong STEAM Education**

Challenges of STEAM education commonly stem from unclear guidelines, insufficient teacher training, limited resources, time constraints, and resistance to change among stakeholders. These issues have been consistently highlighted by previous research. The current research

introduces new perspectives and fresh insights on challenges that are distinctive to Hong Kong, highlighting aspects that have remained underexamined in previous research.

#### **5.1.4.1 Exam-Oriented Educational Culture**

Hong Kong's educational system is highly demanding with a deeply-rooted exam-oriented culture, where standardized answers and examination techniques dominate the learning and teaching process. This culture fosters rote learning, impeding students' capacity for innovation and their enthusiasm to engage in exploratory learning. Teachers are under pressure to keep up with coursework and preparing students for tests and examinations, leaving insufficient time for incorporating STEAM activities into a tightly packed curriculum. Students may find it difficult to engage deeply in STEAM activities, and the exam pressure overrides the pleasure and inquisitiveness that STEAM education intends to foster. Teachers often struggle to strike a balance between covering core curriculum requirements and implementing STEAM effectively. Nearly half of the interviewees (47%) shared their views on the exam-oriented nature of Hong Kong's education system and how it influences the implementation of STEAM.

*“We have to always bear in mind that preparing students for DSE is the top priority. It is widely recognized that most competition entries are originated from teachers' ideas. Given this practice, what is the true value of implementing STEAM education in our school?” (S2)*

*“Hong Kong's education system is heavily skewed towards exam performance that hinders holistic development. Students tend to focus primarily on core subjects assessed in the DSE, with only university entrance as their objective, but neglecting inquiry-driven learning in non-examined areas. Recently, even prestigious band one schools have begun implementing STEAM education more aggressively, prompted by the success of lower-banding schools. Motivated by the desire to maintain their reputation on the STEAM honor roll. STEAM achievements are currently recognized by universities as one of the admission criteria” (PP3)*

*“In STEAM education, we emphasize the vision about ‘rejuvenating the country through science and education’. To sustain this spirit, students must gradually cultivate their scientific curiosity and exploratory drive. Our traditional education system is exam-oriented, we must develop strategies that promote a thoughtful balance between fostering innovation and preserving the tradition of exam-driven education.” (PP8)*

From PP8's point of view, it is evident that educators recognize the importance of STEAM education in preparing students for the future and contribution to national rejuvenation. However, the deeply entrenched tradition of exam-focused learning continues to shape their mindsets.

PP9 raised two thought-provoking issues regarding Hong Kong's university admission criteria and students' mental health, both requiring pedagogists and policy makers to address to.

*"The prerequisite standards for university admission may hinder outstanding STEAM talents from gaining university entry, primarily due to their lower language proficiencies, which fall short of the stringent standards of the Hong Kong DSE. The current examination format may suppress the talents of many gifted science students. Moreover, it is regrettable to concede that Hong Kong students are mentally unhealthy, due to their inability to cope with the pressure, some have taken their own lives. The education system is highly demanding, and many students struggle to cope with the stress it imposes." (PP9)*

ST11 shared the facts about the STEAM implementing behavior of Hong Kong schools.

*"Some schools do not care about STEAM at all, especially those cultural secondary schools which only focus in boosting academic achievements. For band three schools which are facing threats of school closure, they are simply trying to take action to ensure their schools' survival. They choose to implement STEAM effectively poses no harm." (ST11)*

ST13 observed the attitude-change in senior secondary school students towards STEAM.

*"Under the exam-oriented educational system, both teachers and students are not encouraged to think outside the box. I don't have these shackles, as I teach lower-level students. Besides STEAM knowledge, I can equip them with essential life skills, and even introduce them to the fundamentals of entrepreneurship. Beyond the S.3 level, the learning atmosphere becomes increasingly exam-driven. Although a few senior students still visit the STEAM room to ask questions or engage with activities they enjoy, they no longer take the program seriously. Therefore, at lower secondary, I will arrange more activities or competitions for them to experience." (ST13)*

ST16 respected students' individual preferences, whether they were in favor of STEAM or not.

*“It’s hard to justify whether our STEAM program is effective or not. Honestly speaking, whether it’s schools, parents, or students, academic achievement remains their top priority. When STEAM launched at our school last year, students’ performance was not formally assessed. However, starting this year, their work will be graded. Hong Kong students are constantly busy; and for many, academic scores are the only real motivator to engage them with STEAM. While STEAM can be intellectually enjoyable, it does not appeal to everyone. Some students prefer traditional test-based assessments, which they perceive as quicker and more straightforward. Such mindsets are commonly understandable within the current educational culture. Primary school students work hard to get promoted to secondary schools, and secondary school students work hard for getting into universities, this is Hong Kong’s exam-dominated education system.” (ST16)*

ST17 described Hong Kong students as ‘examination machines’, which is pessimistic but true. PST18 interpreted how Hong Kong people perceive and respond to the structure of their education system.

*“Hong Kong’s education system is assessment-ingrained, ‘studying is for achieving high exam scores’ and ‘one test determines the rest of one’s life’ is the innate belief of Hong Kong people, which can hardly be changed. I agreed that separating the subjects into different testing streams, and assigning them different standards for university admission is reasonable.” (PST18)*

The exam-oriented culture of Hong Kong has both advantages and drawbacks. Optimistically, it pushes students to face with high academic requirements, but they are prepared and equipped with the abilities to embrace future challenges and global competitions. On the other hand, students have to face immense pressure, which might constrain their abilities to create and critically think. From the opinions of the interviewed educators, some argued that the exam-driven system might foster students’ self-discipline in learning and build strong work ethics, while others worried about excessive focus on rote learning and exam preparation might take away students’ opportunities to receive well-rounded education. The introduction of STEAM into Hong Kong’s education system revealed the government’s effort in striking a balance to maintain the ingrained exam-oriented culture, and in the meantime, to execute an all-encompassing teaching approach.

#### 5.1.4.2 Attitudes of Hong Kong Parents

To comment objectively, Hong Kong's high-stakes examination culture makes parents highly cautious about any changes to the education system that will impact their children's academic performance. As a result, most tend to favor traditional teaching methods. However, Hong Kong parents also recognize the importance of equipping their children with essential 21<sup>st</sup>-century skills such as critical thinking, problem-solving, and creativity. Parents believed that STEAM education is able to prepare their children for the future workforce, technologically and innovatively. (Su et al., 2024). Twelve interviewees (63%) shared their experiences on how the parents of their schools think about STEAM education, and its subsequent impact on school policies and decision-making.

*“At our school, one of the major barriers in STEAM implementation is from parents, when their involvement in school increase, they hold higher expectations and possess greater influence in shaping the school's decision-making through their discourse power.” (S2)*

*“This issue concerning parents requires careful attention, as it is closely tied to our school culture. Whenever teaching materials were removed to make room for STEAM, parents expressed deep concern, especially if those omitted materials were to be assessed. However, if the content was not to be evaluated, parents found the changes more acceptable. Nonetheless, parental engagement with our STEAM program remained strong, largely due to the fact that their children are to be formally assessed in the program.” (ST16)*

Meanwhile, PP3 described the obstacles encountered by their school in achieving full-scale implementation of STEAM education.

*“Some of our students are from grassroot families, lacking parental support in academics. We do not intend to avoid implementing STEAM in full strength, but to compare with other schools with parental support, we are in a less favorable position. Looking on the bright side, STEAM has helped some parents from band three schools to uncover their children's alternative strengths and talents. As a result, these parents strongly support the STEAM program, and they insert greater influence on their children's interest development.” (PP3)*

SP6 used the term 'a game of matching' to explain why parents have to choose the right school for their children, school bandings should not be their prioritized consideration.

*“At our S.1 admission briefing, I explained to parents that the classification of school bandings has become increasingly ambiguous. Choosing a right secondary school for their children no longer depends on school bandings, but rather it is a game of matching. Our school is strong in STEAM, if their children like this program, we then make a perfect match. We have to give our students the opportunities to glow and shine in an area that they are interested in.” (SP6)*

To many primary school parents, the mindset of ‘studying is for achieving high examination scores’ is still deeply ingrained, as they believe that to study is for entering a good secondary school of high banding.

*“Parents are very concerned over the marking scheme of the new science and humanities course in primary schools, as they care very much about how marks are to be given for the written paper, and how the group work is to be assessed. Parents raised concerns about fairness when their children are grouped or paired with less capable peers, highlighting the need for teachers’ careful consideration in balancing student abilities in group projects. I need to discuss more with teachers for reaching consensus in dealing with parents’ concerns.” (PP7)*

The STEAM program of School #9 places no pressure on students or parents, so the school is able to implement STEAM effectively.

*“Hong Kong parents’ biased mindsets about education are built upon the admission mechanisms of schools at all levels, it’s difficult to change their way of thinking. Our parents like our STEAM program, due to the absence of formal assessments. Students genuinely enjoy engaging with STEAM activities every Friday.” (PP9)*

Compliments are always appreciated, but complaints are an unavoidable reality. Fortunately, schools have established ways to address concerns and accusations effectively.

*“Some parents complained that their children were staying too long after school to build robots, so I had to call them personally to explain the situation. When our students won in competitions, their achievements were featured in newspapers. I would encourage them to show the articles to their parents, helping them recognize the value and acknowledgment their children were gaining through STEAM.” (SAP10)*

Based on the following incident disclosed by ST11, it is clear that parents' attitudes can significantly influence a school's decision.

*"We used to include R and A<sup>15</sup> in our STEM program to make it STREAM, but eventually we took away these two elements. Do you know why? On Parents Day and Open Day, we found difficulties in explaining to parents why R and A are included in STEM education. We wanted to simplify the term for easier explanation, so we must change it back to STEM. In fact, the R and A are still in the program." (ST11)*

For school #11, the R stands for religion, and the A stands for arts.

Most hindrances from parents regarding STEAM education were found in SEN schools, so their STEAM teachers' effort in trying to run the program is praise-worthy.

*"Our school's STEAM education primarily focuses on biology. For STEAM implementation at a SEN school, one of our major challenges stems from parental concerns, as many of our students face physical vulnerabilities and heightened sensitivity to bodily functions. Beyond physical disabilities, some students also live with internal health conditions, such as heart disease, kidney complications, or a history of cancer. Understandably, this places parents in a constant of worry. They often feel anxious about anything unfamiliar or unpredictable, especially when it involves their children's well-being. As a result, they preferred not to allow their children approaching any unknowns. Some of our teachers argued that it is not necessary to inform parents of what the school intends to do, but I do not agree with this perspective. If parents can build up confidence and trust in us through sincere explanation, much can be achieved, including STEAM education." (PT15)*

School #11 has its inherent advantages in implementing STEAM, and parents have their reasons for supporting it.

*"Our STEAM program is welcomed by parents, since we were originally a technical school. Our school is not of high banding, and most students do not perform well in academics. Parents know that their children have little chances to get into universities. However, they found hope in STEAM education when their children were recognized for their unique*

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<sup>15</sup> R stands for religion, or reading and writing; and A stands for arts.

*strengths in science, this suggests they may have access to alternative career pathways. When we had boys winning in the Odessey of the Mind, parents were overwhelmed with joy. Once we had a boy stepping on stage to receive the award, a parent could not control her emotions by yelling out: ‘this is my boy, this is my boy’.*” (ST11)

ST13 further elaborated on how some high-banding schools approach STEAM education.

*“Band one schools tend not to allocate substantial resources to STEAM education, since their students were identified as having exceptional scientific abilities, the schools relied on parents to provide additional training through external organizations. Our school is a band three school, parents become enlightened as they gained a clearer understanding of their children’s future paths, so they give their children freedom to develop their own interests. STEAM education indeed provides alternative opportunities.”* (ST13)

ST14 shared similar experiences as ST11 and ST13, these similarities are seemed to be common in band three schools.

*“Once I told a parent that her daughter received a STEAM competition award, she first asked if the competition is a formal one, or it’s just for fun. Our parents all aware that their children are attending a third-band school, they do not expect their children to have outstanding academic achievements. Until later, we officially sent this parent a letter to inform her of her child’s achievement by outperforming many competing teams, especially some are band one reputable schools, this parent started to recognize her daughter’s hidden abilities.”* (ST14)

ST17 had exceptional experiences with parents regarding STEAM, an unusual stance for a top-ranked school.

*“Many students here are from well-off families, their parents do not need them to make a lot of money, but they want their children to learn how to create a better world. Our parents have different expectations here.”* (ST17)

From the above interpretations, we might realize that the concept of school banding differentiation plays a key role in determining parents’ attitudes towards STEAM education. The original purpose for developing the bandings system in Hong Kong is to rank secondary

schools in accordance with school quality, so parents and students are able to make informed decisions about selection of schools. However, the perceived prestige of higher-ranked schools significantly creates strong competitions among students, and band one schools are also having higher stress and pressure to push themselves continuously for excelling in academics. Consequently, excessive focus is put on examination results, instead of promoting education holistically. On the other hand, students of band three schools are affected by their low academic self-concept. Chung (2016) indicated that the ability-grouping concept behind the bandings system influences the self-efficacy, self-concept, and motivation of band three students. However, based on the above interpretations, it is evident that both students' self-concept and parents' perceptions are affected. The low ranking of their children's school often discourages parents, making it harder for them to recognize and appreciate their children's alternative strengths and abilities. Self-concept is vital, since it has a direct influence on students' behaviors, self-perception, future targets, and life accomplishments. A school which is good in executing STEAM might have the chance to alter the misperception of the biased concept about band three schools and the abilities of students. STEAM education might initiate the possibility to narrow the gaps in ability groupings.

#### **5.1.4.3 Insufficient Teachers**

Twelve respondents (63%) agreed that Hong Kong is running short of educators, including principals, teachers, and teaching assistants, thus causing difficulties for schools to carry out educational reforms. The interviewees provided comprehensive reasons to explain about the phenomenon.

*“Recently, Hong Kong is having the teachers’ emigration problem, it reinforced the shortages of teachers. Our school already had difficulties in recruiting enough teachers, all work-loads had to be shared among existing ones. Nowadays, teachers are required to teach ‘Moral, Civic and National Education’, this renewed education system led to tremendous resignation of teachers.” (ST11)*

*“We don’t have enough teachers studying science in universities. Human resources are important for STEAM’s implementation success, some schools are performing well as they have a whole team of knowledgeable science teachers working closely together to execute the program.” (PP3)*

*“It is true that recruiting teachers in recent years is difficult, especially for teaching STEAM. Loss of teachers in academia is getting serious. DSS schools finds even harder to recruit, since we are dissimilar to government schools or grant schools which offer permanent teaching posts, teachers of DSS schools are on contract-base. Permanent teachers will never be fired, so their jobs are secured. Even as a principal, my contract has to be reviewed annually.” (SP6)*

*“We use the fundings from the QEF to hire a teaching assistant for easing out the responsibilities of our STEAM head teacher, since he still has regular classes to teach. However, we are not able to keep this assistant for long, as fundings are not sufficient for us to do so.” (PP9)*

*“Universities had already established STEAM teacher training courses, but they don’t have competent lecturers to teach. When I studied my master’s degree in STEAM education, I was disappointed that the lecturer was lacked of practical STEAM experience to teach the subject, I ended up learning nothing. As a frontliner of STEAM education, I knew more than the lecturer.” (ST13)*

*“The biggest shortage of teachers is in the departments of English and computer science. STEAM education is now in a state of ambiguity, less than fifty percent of Hong Kong schools have STEAM head teachers. Furthermore, the STEAM program and the ‘bring your own device’ program required a lot of computer science teachers to look after. Secondary schools of Hong Kong tend to appoint computer science teachers to sit in the positions of director for their I.T. teams. We are now heavily in lack of computer science specialists in academia.” (ST17)*

ST14 and ST17 stated the problems of STEAM head teachers, the job nature has made these coordinators mentally or psychologically burnt out.

*“Colleagues of mine talked about the matter of fairness when they were asked to look after the STEAM team. They expressed frustration about working not only after school, but also on weekends and holidays. The school even don’t have enough teachers to take turns. Do you think I really want to work on Sundays? Of course not. It is not surprising that Hong Kong is not implementing STEAM effectively. The teachers who leave at 4:15 receive the same salary as I do. Who would willingly take on additional responsibilities that demand perpetual overtime without any form of recognition or reward?” (ST14)*

*“At my previous school, I had to teach computer science and to be the STEAM head teacher at the same time. Very often, I had to lead students to STEAM competitions on weekends, that cause my family to complain. I felt very strenuous and overloaded, so I resigned and joined this school as a regular STEAM and computer science teacher.” (ST17)*

Schools had tried different ways to solve the teacher-shortage problems.

*“Due to the popularization of smart phones, students’ practical knowledge of technological devices has been enriched, so we don’t have to teach them operational skills any more. As a result, we can take this part out of the computer science course and replace it by STEAM learning. Replacing outdated knowledge with coding and ChatGPT operational skills can save teachers’ time and energy in finding extra time to teach regular classes, and will not constitute extra workload for them.” (PP8)*

*“We don’t have the posts of vice principals at our school, below the principal are the masters and mistresses of education affairs. The government subsidies are only sufficient to hire a limited number of teaching staff. In order to save money for recruiting more teachers, our principal has to congeal the hiring of vice principals. The salaries of vice principals are good enough to hire several frontline teachers.” (PT15)*

The practice of School #20 is seemed to be passive in STEAM implementation.

*“I am the only one in the STEAM team. Our teachers are helpful, they don’t mind helping me with the STEAM implementation; however, in fact, they are so occupied by their daily work, I do not want to add them extra workload by asking them to help in STEAM activities.” (ST20)*

Hong Kong is indeed having a significant teacher shortage problem in recent years. High turnover rates, teacher migration, low job satisfaction, lack of qualified teaching candidates, absence of specialized teachers to fill up the vacancies of specific subjects, and unbearable administrative workloads are all influential factors. In particular, STEAM teachers are showing a lower level of dedication. PS2 and ST11 shared the same opinions that teachers’ devotion to the school or to STEAM education largely depends on the nature of their teaching posts. If teachers are on contract, for certain they will be less dedicated than those teachers with jobs

permanently secured. However, teacher shortage is a world problem, according to the UNESCO's projected report (UNESCO, 2024), by 2030, there will be a shortfall of 44 million primary school and secondary school teachers worldwide. It is an urgent matter that international governments need to address to, much efforts are required for training, recruiting, and showing supports to teachers.

#### **5.1.4.4 Inadequate STEAM Teacher Training**

The problem of inadequate STEAM training for teachers is not exclusive to Hong Kong, it is a global challenge. Without sufficient STEAM-focused professional development, teachers often lack the confidence and competence needed to effectively deliver STEAM content. This gap in training makes it difficult for teachers to grasp the fundamental components of STEAM and apply its interdisciplinary teaching methods in the classroom (Herro & Quigley, 2016); and cannot gain the necessary skills without a solid understanding of the conceptional and foundational ideas of science-inquiry across multiple disciplines (Shernoff et al., 2017).

Five interviewees (26%) stated that Hong Kong teachers were not well-trained for STEAM.

*“My colleagues were required by the school to attend external professional development courses to learn how to teach STEAM. However, they still felt that the training they received was insufficient.” (PP9)*

*“I had been invited by the EDB to be the instructor for STEAM teacher training programs, and I was also invited by The University of Hong Kong to teach courses related to STEAM education. The EDB's STEAM developmental trainings for teachers are definitely not enough.” (ST13)*

*“The EDB never forces teachers to attend STEAM education's development trainings. Teachers are required to attend 150 hours of trainings within three years' period, but they may choose other subjects, not necessary to be STEAM.” (ST14)*

*“It will be beneficial to introduce a curriculum at the junior secondary level that mirrors the integrated approach of Humanities and STEAM taught in primary schools. Hong Kong does not have enough well-trained teachers for STEAM teaching”. (PT15)*

The varying responses from principals and teachers may suggest that their schools have adopted different approaches in STEAM implementation, so they generated indifferent points of view. ST13's response was particularly significant, as ST13 is on the secondment scheme of the EDB's Seconded Teachers Strategy, his understandings about Hong Kong's STEAM education are substantially different from other respondents. The purpose of secondment is to enable seconded teachers to share their valuable frontline experience with other educational professionals, representing the EDB in the process. This strategic program strengthens the rapport between the EDB and schools, in addition to offer beneficial chances for the seconded teacher to gain insightful exposure to new areas of work (Education Bureau, 2019)

*“Most teachers in Hong Kong are not well-trained for teaching STEAM, they are not well-equipped with the necessary skills to teach technologies.” (ST13)*

The government recognized the problem, so it attempted to improve teachers' abilities in STEAM teaching by strengthening the professional development programs for teachers provided by the EDB, in order to assure that all teachers are adequately prepared to deliver STEAM education effectively. To address the need for more comprehensive and structured training programs, the EDB collaborated with external partners to organize pedagogy workshops, such as the Jockey Club STEAM Education Resources Sharing Scheme, to provide teacher training activities that support educators in implementing STEAM education (STEAM 教育, 2022).

#### **5.1.4.5 Language Challenges for Science Students**

Prior to analyzing this topic, the researcher must clarify that there is no specific data indicating that science students in Hong Kong possess weaker language proficiency when compared to their peers in other academic disciplines. The emergence of this topic stems from the requirement that students must take four core subjects for the DSE, without the option to select subjects aligned with their individual strengths or interests. A thought-provoking question was raised by the Young Post (2024), ‘if students choose to study literature or history in universities, is it necessary that they have to achieve the minimum competency level in mathematics?’. To revamp this question, the researcher asked, ‘if students choose to study one of the STEAM subjects in universities, is it necessary that they have to reach the minimal standards in Chinese and English?’.

Fourteen interviewees (74%) participated in the discussion on whether students' limited language proficiency will hinder their academic performance and future development in science and STEAM education, or reduce their chances of university entrance due to unmet prerequisite standards. Respondents' perspectives on this issue were threefold. Three of them just gave opinions in a neutral manner without showing stances, six respondents supported the importance of languages in all kinds of learning; whereas four respondents, including the teacher receiving the best STEAM teacher award, criticized how languages hinder outstanding science students from entering universities.

SP2 agreed that information literacy and linguistics are both important, languages are for communicating scientific ideas, and should complement STEAM in learning.

Both PP3 and ST20 suggested to make use of technologies to assist students in learning and manipulating languages.

*“If ChatGPT or other language apps are allowed to be used at schools for assisting students in solving language problems, that would be helpful for learning English and Chinese.” (ST20)*

Six educators emphasized the importance of languages in learning.

*“In primary school, the ‘strong in science, but weak in linguistic competencies’ phenomenon is not that obvious, students are more balanced in all subjects. Language is a tool for thinking, if students are deficient in languages, their reasoning abilities are also ineffectual. Even if a student is good in science, he still needs to acquire science knowledge by means of reading.” (PP8)*

*“I agree that there should be a university of applied science where young scientists can fully realize their potential. However, we cannot wipe out the importance of Chinese and English. At my early age of robot-building, I would search on web for more open-source information, it was unavoidable that I had to read articles in English.” (SAP10)*

*“I encouraged my students to demonstrate their creations clearly and confidently through language, as doing so would truly elevate their work. Presentation includes script-writing and speaking, this was the idea that I put into my QEF proposal to build a smaller STEAM*

*room next to the library, so I might be able to collaborate with language teachers to bring STEAM learning to another level.” (ST12)*

*“I consider language skills to be very important, as they serve as the medium for learning; especially English, which is the language of instruction at universities. Setting prerequisite blockades for university entrance is normal, but I don’t see why the standard of Chinese is set similarly high. Conversely, if a student is going to study Chinese literature at university, why he has to be stuck in the DSE English? The admission scores of languages should be adjusted by universities in accordance with the faculties that students want to enroll in. Science and arts programs should be treated with flexibilities. There were many cases that students nearly failed in Chinese language at English as MOI schools. A student might like to learn both languages, but to assess them for determining their future is another matter” (ST16)*

*“For successful implementation of STEAM, outstanding science students have to be identified; however, if they were weak in languages, they were not able to enter universities. The two principal nomination places are not guaranteed, universities grant only conditional offers, minimal standards of Chinese and English are still needed to be met.” (PST18)*

*“I designed a project-based activity about water filtration for students to join STEAM competition. During the process, students learnt how to overcome the psychological barriers and difficulties to deliver their project through both written and spoken English.” (ST19)*

Contrarily, four teachers opposed to the stringent requirements of languages that students have to meet for university admission.

*“In the future, science students might gain privilege in languages by adopting technology. There is a possibility that the language threshold for university admission can be lowered. Universities should teach students on the proper use of ChatGPT, avoiding plagiarism while integrating their own original ideas.” (PP7)*

*“Science students’ language skills are weaker. The HKDSE language examinations pose a significant barrier for many capable science students to enter universities, that’s why there is a School Nominations Direct Admission Scheme.” (ST14)*

*“The requirement to meet language standards in the DSE reduces many science students’ opportunities to enter universities.” (PT15)*

*“Before I left my previous school, both school principal nomination places were taken by two exceptional STEAM students whom I nominated. They were those who were not able to meet the minimal standard of both English and Chinese, but they are now studying at the Hong Kong University of Science and Technology.” (ST17)*

ST11 shared a case of his student who had overcome the barriers in English learning, which was motivative for promoting STEAM education.

*“We once had a student who was a frequent repeater, spending a total of nine years in secondary school. He hated English, so he refused to put effort into learning it. Until one year, he came to my afterschool STEAM activity class, he fell in love with boardgame design. In order to understand more about the game’s background, he went to the library, borrowed a whole series of English history books which were related to the background of the game, and he read them all. I asked him how he managed to read in English, he told me that he put a dictionary right beside him, so the problem was solved. In an instant, his brain was enlightened, he rejected English no more. As a teacher, I am pleased to have discovered the key to unlock students’ language learning abilities.” (ST11)*

It is noteworthy that when a student genuinely passionate about engaging in STEAM projects aligned with his interests, language barriers often cease to be a significant obstacle. The student becomes motivated to seek solutions for overcoming challenges.

#### **5.1.4.6 Intra-School Silos**

Silos in education refers to a segregated and compartmentalized approach to teaching, where subjects are separately taught rather than through interdisciplinary integration. Educators frequently work in their own disciplines, concentrating only on their assigned subjects without cooperating with other teachers across disciplines (Johnson, 2024). Abolishing these silos can

motivate interdisciplinary teaching, in which teachers can build up connections among subjects to create more integrated and comprehensive learning experiences for students. Sixteen respondents (84%) shared their experiences with respect to this topic, six provided negative feedback, while ten responded positively.

The emergence of silos in School #11 is particularly pronounced, as subject teachers actively compete for student participation in their respective afterschool activities.

*“Our STREAM program faced resistance from teachers of other disciplines, particularly language departments. They expressed strong opposition to the STREAM program, as it gained popularity among our boys. The STREAM association recruited ten times more participants than the language clubs, even the principal felt fascinated; however, this led to dissatisfaction and complaints from language teachers. A language teacher came to me and said directly: ‘Excessive focus on playthings erodes the boys’ drive and determination’, they had already lost their interest in learning languages. The language teacher’s dissatisfaction had reached an indescribable level”. (ST11)*

*“When a teacher places excessive emphasis on implementing STEAM, others may perceive him as overly laid-back, as his focus tends to center solely on project design and guiding students through competitions.” (PP3)*

*“Silo problems are very common in many schools. It’s reasonable that all subject teachers want to have students supporting their courses. My STEAM students are very understandable, they do not want to bring me troubles, so they work hard in other subjects. They always completed their homework before coming to the STEAM room.” (SAP10)*

*“The silo issues in our school largely stemmed from the misunderstandings among teachers of other subjects regarding the source of subsidizing funds, leading to perceptions of inequitable resource distribution by the principal. Literally, our subsidies were from the Inno Lab Fund and Quality Education Fund, amounting to several million dollars. Other teachers felt frustrated and resentful when their funding proposal of \$300,000 was turned down.” (ST17)*

*“The silo effect is evident at traditional schools when resources are not evenly distributed, this is very common.” (PST18)*

Academic silos appear to stem from a pervasive shortage of institutional resources. Fortunately, PS2 and SP5 stated that their school have no silo problems at all, their teachers are getting along very well in STEAM implementation. S3 and SP6 emphasized the importance of collaboration among teachers.

*“All teachers should work holistically as a team, why can’t all faculties cooperate? It’s the school management’s duty to modify the executing strategies of STEAM education. When STEM becomes STEAM, and STEAM becomes STREAM, each alphabet added indicates that the equilibrium among teachers is developing.” (S3)*

*“For reducing the effect of silos, my approach is to involve the whole school in STEAM implementation, not just inclined to teachers of science subjects. You saw the 3D-printed weapons in our STEAM room, our history teachers who involved were genuinely excited in doing this.” (SP6)*

School #12 also shows no sign of organizational silos, ST12 gave the compliments to their principal for putting in tremendous effort to ensure STEAM’s smooth implementation. School #13 was direct and transparent in articulating its stance within the STEAM educational framework; therefore, every teacher knows about the school’s mission and vision in the program. School #14 is successful in elucidating STEAM education’s genuine meaning to stakeholders.

*“Our school has no silo problems among departments. STEAM education is being perceived by us as an applied-learning method, and students’ achievements were being recognized; some of them even got admitted into universities through SNDAS. Our school’s STEAM program is highly respected by stakeholders.” (ST14)*

School #5, #16, and #20 adopt the easiest methods to implement STEAM, therefore no silo problems emerged.

*“The school is not requiring every subject department to participate in implementing STEAM, therefore no teacher’s classes are being taken away.” (SP5)*

*“As long as no subject’s lesson time is disturbed, there will not be any conflicts.” (ST20)*

*“Our STEAM program is incorporated into the daily class schedule and is on curriculum, no teachers would complain.” (ST16)*

ST16 and several other interviewees inadvertently revealed insights during their interviews regarding the optimal implementation of STEAM education in Hong Kong: ‘If the program was officially included in the Hong Kong school curriculum, objections would likely decrease’.

### **5.1.5 Leadership**

For effective implementation of STEAM at schools, leadership plays an important role to tackle the challenges. The role of leadership is recognized as indispensable, leaders are responsible for guiding individuals and steering them toward the right direction, ensuring alignment with shared goals and values (Kapur, 2021). Effectual leaders in STEAM education are visionary, strategic, pedagogical, and transformational in nature, possessed with emotional intelligence, and able to decentralize power (Geesa, Stith & Rose, 2020). Within the scope of STEAM education, power is needed to be dispersed by principals to teachers, who will act as distributed leaders to guide and lead students to explore and create (Ma & Sun, 2022). Teachers are empowered by principals to assume the leadership and decision-making responsibilities to promote collaboration and team work, in order to navigate transformational changes (Verma, 2024). Student leadership is equally important in the STEAM learning process, it gives students the opportunities to make valuable and meaningful contributions to their schools and communities through employing their social empowerment skills (Allina, 2017). Sixteen interviewees (84%) stated their viewpoints when the researcher asked the question about the roles and styles of leaders in STEAM education. From the sharing of principals, various leadership styles were uncovered.

#### **5.1.5.1 Principal Leadership**

An effective leader should have the discerning eyes to recognize the right persons to do the right jobs.

*“Both the principal and I are able to identify talented science teachers. In cultivating a strong STEAM environment, it’s essential to first identify those who genuinely love and enjoy teaching STEAM. Once identified, we aim to give these teachers the freedom and support to fully showcase their abilities.” (S2)*

Some leaders understand the transformative power of encouragement. They recognize that rewards and recognition can significantly enhance motivation, morale, and overall efficiency among their followers. Offering verbal praise alongside tangible rewards provides a well-rounded approach to delivering prompt and authentic recognition to teachers' contributions. This is what school #2 does for motivating their STEAM teachers.

*“For good STEAM teachers, we will reward them with intrinsic motivation of verbal praises, and extrinsic motivation will be presented once a year in form of cash bonuses.”*  
(SP2)

In SP2's interpretation, the heart and head domains of the 3H framework clearly emerged. Through an empathetic view, the principal is able to identify the right teachers who have the hearts to implement STEAM with passion, and by engaging their intellect collectively, they can set the directions of their school's STEAM program effectively.

School #5 demonstrated foresight by initiating cross-disciplinary, project-based teaching and learning well before the government formally introduced STEM education in Hong Kong. The school is currently led by an empowering leader, who delegates duties, grants autonomy, and trusts his team's abilities. As a result, a collaborative and cohesive team is established.

*“Our school's STEM program has been established for quite some time, it launched in the school year of 2005-2006. I am not well-acquainted with music and technology in STEAM education, so I have to trust my teachers. Our school adheres to the principle of liberty, but is contingent upon teachers' self-discipline and self-responsibilities. Teachers are given the autonomy to implement STEAM projects of their ideas, and I will not stand behind them to monitor their work.”* (SP5)

SP6 is having the characteristics of a servant and charismatic leader, with a follower-first mindset, and always be there to offer followers assistance for achieving success, creating a positive morale for them to work under a strenuous environment.

*“Teachers are already fully engaged with their daily teaching responsibilities, I do not want to burden them with extra STEAM duties. If resources allowed, I would recruit assistants to help with STEAM implementation. The successful implementation of STEAM in a school is influenced by the principal's leadership and strategic vision. Principals who genuinely*

*value STEAM will naturally take initiative to restructure schedules and reallocate resources to embed STEAM effectively within the curriculum.” (SP6)*

The principal’s compassionate ‘heart’ drives his dedication to caring for his followers and embrace the STEAM program at the same time, she uses her head to discover methods for executing STEAM smoothly.

PP7 is a transformational leader who embodies the qualities of situational and charismatic leadership, effective in building positive morale within the school, and able to inspire and motivate teachers through rewarding methods to achieve expected outcomes.

*“Our teachers had walked an enormous step in STEAM teaching by leaving their comfort zone. I have to praise and appreciate my teachers for their hard work, their connections with the school spirit, and their courage to head towards the goals of our school. For keeping good STEAM teachers, I offer them permanent positions. I nurture them, help them solving problems by providing mentorship advices, and care about their professional development and career advancements. I am not good in teaching STEAM, but I know how to motivate teachers to do so.” (PP7)*

PP8 is a leader who will provide strategic trade-offs for avoiding conflicts. The principal is not only a strategic leader, but also illustrates the characteristics of servant and visionary leader.

*“We can always cancel a competition if time doesn’t allow, or it is not a good one. We must let go of outdated practices to make space for new ideas. We look for quality instead of quantity, only trade-offs can make STEAM education work. As long as teachers work happily with satisfaction, and build up the sense of belonging, that’s acceptable to me. A principal should never pressure teachers into doing something they’re unwilling to do. How STEAM is to be implemented relies on how far a principal looks into the future. I look far, so I know what I should give to my students and what to expect from my teachers.” (PP8)*

As a leader, PP8 run the STEAM program with ‘heart and head’ by putting teachers’ job satisfaction as priority, and tactically applying the ‘trade-offs’ strategy to make the STEAM program effectively implemented.

PP9 is an empowering leader, granting followers autonomy, trust, and flexibilities to implement the STEAM program; and alongside, all information is openly shared to other stakeholders.

*“At June every year, our school holds a ‘STEAM Gallery’ for half a day, at where our students’ productions are presented, and visitors can participate in STEAM activities. The purpose for organizing the gallery is not solely for students, but also for other teachers to learn of what the STEAM team is doing. I give colleagues high degree of autonomy to implement the STEAM projects, I offer minimal suggestions, but ensuring that they have all the necessary resources.” (PP9)*

PP9 implemented STEAM at her school with heart, entrusting her teachers to execute the program with autonomy, and through the application of ‘head and hands’, all stakeholders were informed of what the STEAM team is doing.

The positive interpretations of school supervisors and principals brought the researcher glimmers of hope for the effective implementation of STEAM education at Hong Kong schools. The question about leadership also stimulated the thinking of interviewed teachers, all ten of them, which is hundred percent, shared their opinions in lengthy talks. However, not all teachers are in favor of their school leaders’ attitude and behavior towards STEAM education.

*“With retirement approaching, our principal has become increasingly cautious about introducing new initiatives, such as the STEAM program. He is hesitant to take on anything new like STEAM. As a result, most teachers do not show much interest either.” (SVP4)*

ST11 has been teaching STEM, STEAM, and STREAM for fifteen years, and joined countless competitions along the way. To win or to lose in competitions gives him sobering insights into how different principals react.

*“Over the past fifteen years, I have worked with four principals, but only two demonstrated complete trust in their teachers, empowering them to make key decisions regarding STEAM implementation. The remaining two consistently monitored our progress, closely tracking all activities. At times, they asked students inappropriate questions in the presence of teachers, created considerable pressure for us. Several STEAM head teachers shared that when their schools lost in competitions, their principals would confront them directly and bluntly asked about the reasons for failure, without comforting and encouraging words. In one case, a lead teacher invited the principal to attend a competition to boost student*

*morale; however, upon learning that the team had lost, the principal left immediately without staying for a group photo or acknowledging the students' efforts. In fact, some principals only show up in the photo-shooting sessions, as they want to appear on social media. My current principal makes no effort to address staff members who are opposed to the STREAM initiative. As a result, I have to manage the resulting pressure alone, with limited means to revert my colleagues' entrenched views.” (ST11)*

PT15 recognized the challenges faced by a principal at a SEN school who struggles to navigate complex issues. This type of leader can be described as ‘well-intentioned but ineffective.’ To overcome such difficulties, it is essential for the principal to build a capable team, engaging them in professional development, and mentorship from higher-level authorities can be sought.

*“Our principal has only been at the school for three years, but he hasn't demonstrated any focused effort on motivating his staff in STEAM. He wants to push STEAM forward, but there are still a lot of obstacles he hasn't tackled. The principal himself is of I.T. background, strong in science, but he has no idea of how to motivate teachers to work together with him to implement STEAM effectively. Teachers here are not ambitious to get promotions, no one wants to promote to higher management level and assumes extra responsibilities. All teachers collaborate harmoniously well without divisional silos, we are united by a shared frustration towards our principal, who has assigned them additional responsibilities. This has led to a sense of resentment among staff. Frankly speaking, I appreciated my principal for letting me leave two classes earlier so I could attend the HKFEW's STEAM workshops, he gave me the opportunity to advance.” (PT15)*

The comment of ST17 towards his principal is full of contempt. From ST17's short description, his leader can be considered as an absentee leader who disengages from the STEAM program, fails to provide necessary support, guidance, and directions.

*“My principal is just like a distributor, only distributing circulars of competition to relevant teachers, that's all.” (ST17)*

Although there were criticisms, there were also expressions of appreciation from teachers to principals, acknowledging their leaders' effective leadership in inspiration, support, empowerment, and visions, teachers were able to initiate a positive and impactful

implementation of STEAM. Key traits of charismatic leadership can be found in the following comments.

*“Our principal remains informed about all ongoing STEAM activities and provides essential support without direct intervention. I always express deep appreciation to my principal, without his support, the library STEAM program would not have been possible. Recently, he encourages me to explore the board game project and supports another application tot the Quality Education Fund. I must thank my principal for his support and endorsement. Because of his understanding and reassurance, our school’s teacher resignation rate is low.” (ST12)*

*“Our principal is not of science background, and she knows very little about STEAM education, but she acknowledges our efforts and always give us encouragement”. (ST13)*

*“Our principal is very supportive and provides us with ample freedom to run the STEAM program, I am free to carry out my work without interference.” (ST14)*

*“We have limited space to implement STEAM at our school, so our principal practices utilitarianism to overcome the challenge. Departments that have shown outstanding performance and contribute more to the school will be given priority in accessing the shared spaces. Our principal never pressured us into doing anything; instead, we take the initiative to look after the STEAM society after school on our own.” (ST19)*

*“Last year, I led a group of ten S.5 students to a six-days-five-nights’ Youth College Science Camp. The principal arranged for them make-up classes in advance, so they did not have to worry missing any school work. The principal is doing her best to support.” (ST20)*

ST13 was an awardee of the “Chief Executive’s Award for Teaching Excellence’ in music. He successfully integrated music into his school’s STEAM education, he was the pioneer to integrate music, design, and technology into one program. His commentary on STEAM leadership was both evocative and intellectually stimulating.

*“While principals play a vital role in providing overarching support, it is the leadership of teachers that truly drives the successful implementation of STEAM. In this context, the credit belongs to the teachers who bring the STEAM vision to life. The STEAM implementation system is bottom-up, STEAM teachers serve as the frontline drivers of project success.” (ST13)*

### **5.1.5.2 Teacher Leadership**

Teacher leaders are proactive individuals in schools who undertake extra responsibilities to help bringing changes to the school system, they influence their counterparts through coaching and mentoring, and assist principals in curriculum planning, strategies formulating, and classroom managing. They are pioneers and innovators who guide and inspire fellow teachers and students to establish a cooperative and innovative environment in schools (Danielson, 2006). The challenges of STEAM education present the need for principals to distribute power to teachers, since distributed leadership and instructional quality are strongly associated with teacher autonomy and teacher innovativeness (Hsieh, Song & Li, 2024).

Teacher leadership is not planned to be a topic for discussion in the interview guide; however, the phenomenon emerged as interviews progress. Respondents, no matter they are STEAM head teachers, or just regular STEAM teachers led by teacher leaders, openly shared their opinions on how teacher leadership is accountable for their schools’ STEAM implementational success. Eight interviewees (42%), had deliberately or unintentionally provided an account of teacher leadership.

SAP10 had just recently stepped down from the post of STEAM head teacher when he was interviewed, his reason was inspiring. SAP10 had undertaken the role of a teacher leader to connect, communicate, and motivate fellow teachers and students in the process of STEAM implementation. His deed of stepping down is a motive from the ‘heart’ to take the school’s overall situation and benefit into consideration, creating meaningful opportunities for the next generation of teachers.

*“My principle of teaching is to do my best for students. This year, I step down from my long-held role as STEAM head teacher to create opportunities for the younger generation of teachers, allowing them to lead and infuse new perspectives into our school’s STEAM program. As long as my decision benefit the school and its students, my principal offers his*

*full support. I don't think I need to humble myself about my accomplishments, I was the chief motivator to drive the implementation success of STEAM in our school.” (SAP10)*

ST11 is also a respectful teacher who always take the schools' overall benefit into consideration.

*“My student teammates in the STEAM competition collaborated effectively and treated me with great respect throughout the process. I do not allow clashes or disagreements to escalate into discord. Leading teams in competition really tests teachers' leadership skills. In boy school, if the boys feel that their teachers are knowledgeable and being fair to them, they will admire and respect their teachers. Do principals play important roles in facilitating STEAM success? I admit that frontline teachers are more important in pursuing STEAM success, not the principal. If a school have a very outstanding science teacher leading the STEAM team, and acting as a role model for students, the chance of getting success would be high. I am willing to work with the boys on weekends without pay. I even spent my own money to buy boardgames from overseas to use as teaching materials. I also work in the Special Support Task Group to take care of the students who are having learning disabilities. My workload is heavy, but the principal is able to see my selfless contributions.” (ST11)*

The experience of ST12 also reflected the adaptability, commitment, and curriculum planning roles of a teacher leader, who as well demonstrated the courage and willingness to take risks.

*“My principal assigned me the post to lead the VR project which other colleagues refused to apprehend. I took up the project, but in fact I had no idea of what I should do. I had to seek advices from the teachers who refused to take up the leading post, and I had to ask the history teacher to cooperate with me, so we could integrate VR into the history project. We need to take the initiative to achieve something feasible for students' well-being. The principal appreciates our effort and supports us in every aspect. Our principal should also be credited for establishing good relationships among teachers.” (ST12)*

It was the 'heart' of the principal that motivated the 'head and hands' of ST12 to step out from her comfort zone to undertake new challenges of STEAM teaching, echoed to the emphasis of Pestalozzi that 'teaching should be a unity of the heart, head, and hands' (Gazibara, 2013).

Inside the school, ST13 assumed the roles of a leader and a mentor to drive positive outcomes of the school's STEAM program, establishing a cooperative and encouraging educational environment. Externally, ST13 leads a professional association to support the promotion of STEAM education in Hong Kong. ST13 was the only interviewee who stressed that he himself, his school, and the association that he affiliated with, could have their names disclosed in the present study. Nonetheless, in accordance with the voluntary participation informed consent form, the researcher will withhold participants' names. However, limited additional information about ST13 can be disclosed. ST13 is an educational and pedagogical leader who does not only work in academic institutions, but also works in the EDB as a seconded administrative leader to guide other schools in attaining positive outcomes of STEAM education. All the three domains of heart, head, and hands manifested in the work of ST13, he does not only bring a comprehensive and balanced development strategy to his school's STEAM program, but also support the promotion of STEAM education in Hong Kong.

*“It's my leadership that successfully guide students through the imitational learning process of STEAM. It is very difficult for students of this age to start from scratch to create something completely innovative, but by using semi-finished products, learning becomes easy and possible. A colleague of mine is interested in guns and cars, so he collaborates with me to integrate his interest into our STEAM program. In return, I teach him how to make guitar. We combine our interdisciplinary knowledge to benefit our students. During the years that I work as a secondment staff, I have organized an 'Enhance Team' for the EDB to support the effective implementation of STEAM education in Hong Kong, where we provide guidance to schools on project design. After work, I am the president of the Hong Kong Teaching Excellence Alliance, we have the aim to promote the STEAM Expert Program, so the talented teachers can be introduced to the EDB to assist in developing STEAM programs.” (ST13)*

ST14 leverages his personal resources, professional connections, and social networks to further advance the school's STEAM program. Teacher leaders are able to unite individuals and the society to work collectively towards the same goal. The heart and hands domains work in powerful synergy when integrated into the work of ST14. The integration fosters a compassionate and practical approach to the school's STEAM education.

*“Through a personal connection, our school was invited by a financial institution to exhibit students' innovations at their premise. I knew someone in the Social Welfare Department,*

*students were able to seek assistance from the department in developing a metaverse environment for the elderly project. Although our principal has limited knowledge of STEAM, leadership of the program has clearly been assumed by teachers.” (ST14)*

Establishing an effective STEAM program in a SEN school that serves students with physical or cognitive disabilities involves navigating a range of complex challenges. To successfully initiate the program, PT15 must apply the leadership skills of emotional intelligence, strategic thinking, and practical action. To motivate stakeholders, including the IMC, principals, teachers, parents, and students, requires extraordinary courage, adaptability, and resilience to take risks.

“I aim to introduce STEAM education to students with intellectual disabilities in our school’s Adapted Applied Learning Department. However, my principal has a strong aversion to reptiles, I must put additional effort to first persuade him before moving forward with the program.” (PT15)

ST17 showed what real school life is like and how STEAM education has made a big difference for students. He also explained what makes a good STEAM head teacher and described the main duties of the role.

*“Schools frequently achieve success in STEAM competitions largely due to the strong leadership of STEAM teachers. Students’ participation and achievement are significantly influenced by the school’s commitment to promote STEAM education, and how they are deeply inspired and motivated by their STEAM teachers. Attending school might seem boring, but when a dedicated and enthusiastic STEAM teacher is committed to delivering the STEAM program effectively, students’ enjoyment and engagement can greatly enhance, particularly during competitions. When I left my previous school, I handed over a comprehensive STEAM implementation guide that I personally developed. Inside are project ideas for different levels, project execution methods, recommendations for suitable competitions tailored to our students’ strengths and needs, along with clear instructions on how to apply for the recommended competitions. Effective implementation of STEAM greatly relates to the STEAM head teacher’s personal experiences, exposure, and passions.” (ST17)*

ST17 demonstrated how a STEAM program can thrive within a school when led by a head teacher who embraces a collaborative approach, and manages with heart, head, and hands.

Teacher leaders are driven by a deep commitment to education, teacher leaders cultivate dynamic and inclusive learning environments that empower students and inspire growth. Through mentoring new teachers, organizing learning opportunities for colleagues, and advocating policy reform, teacher leaders shape the future of education through their vision and influence.

### **5.1.5.3 Student Leadership**

In recent years, student leadership has increasingly played a pivotal role in educational process. By engaging in project implementation, students are empowered to grow as individuals and make contributions to both their academic and social communities. The call for student leadership has recently risen in momentum and schools have to shoulder the responsibilities in preparing students to lead (Adams, Semaaddeh & Tan, 2018). Six interviewees (32%) shared their experiences on student leadership. These six schools are all strong in STEAM implementation.

*“Our school founder had established a Foundation Fund. This year, the fund collaborates with a university to form a student learning platform. We recruited ten top students from P.5 to attend Saturday classes at the university to learn A.I. After completion, they will act as little STEAM teachers to instruct students of lower levels. They are the top-notch students who are going to play the role as leaders.” (PP9)*

*“In recent years, while my direct involvement in teaching STEAM has decreased, senior students have taken on mentoring roles, passing their knowledge to younger peers. This approach has become a lasting tradition in our school.” (SAP10)*

*“Our STEAM program has leadership trainings for senior capable students; therefore, they must first learn STEAM well.” (ST11)*

*“We always encourage students to be leaders. They have the responsibilities to first manage well their own learnings, and then convey their experiences and knowledge to younger students. They have to take the initiatives to explore and gain experience, not only to shape their own paths, but also to guide their junior peers.” (ST12)*

*“This plane was made by a S. 1 student for joining competition, his instructor is a S. 5 student. The S.5 students heartily want to teach, and the juniors are keen to learn from them. This is the culture that we implanted in our school. Peer-to-peer teaching is beneficial to their growth.” (ST13)*

*“Student leadership is a key component of STEAM education promoted by the Hong Kong government. Students applied STEAM in social services, not only making the lead to share their knowledge to the public, but also using their STEAM inventions to benefit the communities.” (ST14)*

Visionary principals articulate clear visions for STEAM. SP5 entrusts teachers with the responsibility to lead interdisciplinary projects and foster a culture of innovation and professional autonomy. This culture of trust extends to students, empowering to take initiative, lead projects, and mentor their peers with confidence and purpose, these practices are evident in the peer-to-peer teaching models implemented in schools #12 and #13. SP5 strategically delegate responsibilities to teachers, and in turn, teachers entrust leadership roles to students. Recognition and motivation enhance the morale, confidence, and performance of both teachers and students, as clearly demonstrated in the cases of SP2 and ST14.

Applying the 3H framework in student leadership fosters the development of effective, compassionate, and well-rounded student leaders who are well-equipped to excel in STEAM education. Students have the opportunities to grow with heartfelt compassion, developing a genuine care for elderlies and striving to improve their lives through inventions. For junior students, senior students inspire and motivate them with their own learnings. With their heads, student leaders are able to develop into analytical thinkers and problem-solvers, enabling them to address problems more efficiently and with greater insight. With practical skills of hands, students become action-oriented leaders, and are able to convert ideas into practical actions that foster transformative change.

The 3H framework illustrates the dynamic triangular relationship and interactions among principal leaders, teacher leaders, and student leaders. It integrates the hearts and heads of principals, the heads and hands of STEAM teachers, and the hearts and hands of students to work in synergy for implementing effective STEAM programs in schools that ultimately benefit the society.

### **5.1.6 Other Stakeholders' Engagement and Support**

In Hong Kong, STEAM education is supported by individuals from diverse sectors and backgrounds, many of whom are deeply engaged in its practical application and development. Key supporters include policy makers, the Education Bureau, universities, industrial partners, non-governmental organizations, communities, school sponsoring bodies, the school incorporated management committees, school supervisors, principals, STEAM teachers, school staff, students, and to some schools, even parents. Supporters of STEAM education may engage with the 3H framework in diverse ways, contributing through heart, head, and hands, aligned with their specific roles and professional expertise. By heart, supporters advocate a well-rounded, inclusive, and caring learning environment to motivate the compassion of students, and to satisfy their curiosity. By head, supporters stress the value of critical thinking and intellectual growth through adopting innovative teaching methods, or by collaborating with field experts to expand students' learning horizon. By hands, supporters contribute financial and practical resources, mentorship guidance, and platforms for students to experience varied STEAM learnings, enabling students to translate STEAM ideas into real-world applications.

#### **5.1.6.1 Stakeholder Support and Engagement in Schools**

Eight interviewees (42%) shared insights on how internal stakeholders within their schools actively support the implementation of STEAM. Most comments were positive, except School #4, her remarks towards her principal were pessimistic.

*“Our school participated in very few STEAM competitions, largely due to a lack of motivation, as we believed that our students had minimal chances of winning. While forming our STEAM team had already marked a significant achievement, its implementation was sustained entirely through the joint efforts of STEAM teachers and students, in the absence of principal support. At times, we had to seek guidance and approval directly from the school supervisor.” (SVP4)*

On the other hand, SP6 is a motivational leader who supported the STEAM program heartily.

*“I always encourage my students to put in full effort. When students excelled in STEAM competitions, their motivation surged, leading to noticeable improvements in their academic performance. I consistently bring them to university information days, believing*

*that such exposure broadens their aspirations and strengthens their commitment to long-term educational goals.” (SP6)*

School #9 is greatly supported by its school’s sponsoring body for STEAM implementation.

*“Years ago, our school’s sponsoring body had already reserved for us a portion of the ‘School Sponsoring Body Supporting Fund’ for executing STEAM education. With this internal subsidy and the QE Fund, we have adequate funding for implementing the program.” (PP9)*

Supports can take many forms. SAP10 was fully supported by his principal to strive for the best deal to purchase STEAM material kits from overseas.

*“My principal was very supportive to back me up in doing robotics. In order to buy robot kits at better prices, I flew directly to Akihabara, in hope to purchase the materials at cheaper prices without going through distributing agents.” (SAP10)*

STEAM teachers’ commitment to the program was rooted in their sense of job security, career contentment, and love of science. ST13 felt genuinely encouraged and valued under the guidance of a supportive principal.

*“My current principal and previous principal are both very supportive to STEAM education. In fact, my current school has had only three principals since its founding, reflecting a legacy of stable leadership and a positive school culture. Whenever I built a rapport with a principal who supported me, I felt genuinely valued and emotionally fulfilled. I am truly content in my present school.” (ST13)*

A principal’s strong support for STEAM education is valuable, but it may inadvertently lead to dissatisfaction among teachers from other disciplines.

*“To allow time for preparing STEAM competitions, the principal reduced my teaching load, which is a normal practice. However, teachers of other disciplines were dissatisfied, as they felt that the principal was being unfair. Regardless of what others said, I viewed the principal’s support as appropriate and sensible.” (ST14)*

ST16 and ST17 both agreed that the atmosphere of the learning environment plays a crucial role in determining students' level of engagement in the STEAM program. Both schools highly value science-inquiry learnings, so their students have strong determination, passion, and ambition towards STEAM education. ST17 further commented on the importance of a positive teacher-and-student relationship in STEAM implementation, which is fundamental for the program's success.

*“Students of band one schools are more eager to learn and to make progress, so STEAM can be easily implemented. However, STEAM implementation in band three schools heavily relies on the positive relationship between teachers and students. If the STEAM teachers were supportive and welcomed by students, the program could be easily implemented.”*  
(ST17)

#### **5.1.6.2 Government Engagement and Support**

The Hong Kong government has played an active role in promoting STEAM education through various initiatives and policies. The EDB submitted the LC Paper No. CB (4)71/2023(03), which is a proposal to be discussed with the Hong Kong Legislative Panel on Education about the ‘Promotion of STEAM Education in Primary and Secondary Schools’. On page 3 of the paper, the EDB clearly stated that it is going to ‘establish regional STEAM resources centers and organize a team of experts to offer on-site support for schools’ (Education Bureau, 2023a). SP6, SAP10, ST13 and ST14 were those experts or professionals being invited by the EDB to participate in this program. Thirteen interviewees (68%) responded proactively to discuss about the support of the EDB.

School #6 was invited by the EDB to assist in running the workshops of STEAM Education Resource Hub within the QEF Thematic Network (QTN).

*“The EDB acknowledged our school's exceptional performance in STEAM education at the on-campus level, they subsequently encouraged us to share our implementation strategies with the broader educational community, targeted those ‘Quality Education Fund Network Supported Schools’. We are one of the schools in the New Territories West that is invited by the government to help training primary school students in the area. The EDB funded us an extra two million dollars for running our STEAM program. We had been cooperating*

*with the EDB for two years, and had already received four million dollars in government funding.” (SP6)*

School #10 was also invited by the EDB to participate in the QTN.

*“The government had sponsored us two million dollars of ‘special appropriation’, we then used them for building our STEAM room. I am helping the EDB to run a program in the QTN. Our school was appointed to lead robotics instruction for primary school students across the network. We provided all essential materials and custom-designed components, along with comprehensive guidance throughout the learning process.” (SAP10)*

ST13 is a seconded teacher working for the Education Bureau as a professional expert of STEAM education, providing the EDB invaluable insights and hands-on experience.

*“Financial challenge is never a problem to Hong Kong’s STEAM implementation; with good proposals, schools can always apply for government fundings. Over the years, subsidies granted to my STEAM team have accumulated to over ten million dollars. I also played a key role in assisting the EDB in forming a task force by the name ‘Enhance Team’ to promote STEAM education across Hong Kong. I supported schools in planning and designing STEAM projects, and also helped identify STEAM education experts to join the Enhance Team. This work was carried out under the EDB’s secondment program.” (ST13)*

ST14’s sharing provided deeper insight into the EDB’s support for STEAM education, and highlighted how professional STEAM teachers have contributed to promote the program throughout Hong Kong.

*“Our school had applied twice for the EDB’s I.T. Innovation Lab Fund, and up to two million dollars were granted. The second one million dollar was used for building our I.T. Innovation Lab. This fund is readily available to all schools, it is up to them to take the initiative. The EDB collaborates with universities to form a program called ‘Training Calendar System’, I am currently employed by a university to train primary and secondary school teachers in the skills and strategies essential for effective STEAM instruction. The EDB has made substantial efforts to support the rollout of STEAM education across Hong Kong schools.” (ST14)*

SP6 mentioned about the ‘School-Based Support Services’ provided by the EDB years ago. Officials from the EDB visited the school to assist in designing its STEM program, providing guidance on lesson planning, as well as conducting school-wide observations and evaluations to support the school’s instructional quality and strategic development.

Other interviewees, including PP3, SP5, PP8, ST12, and ST17, highlighted the diverse funding sources they had secured to support the implementation of STEAM education, including the Quality Education Fund, the I.T. Innovation Lab Fund, and the Life-wide Learning Grant. ST13 was granted a scholarship of \$80,000 by the EDB to pursue a master’s degree in STEM education.

ST7 expressed gratitude on behalf of his school for the support provided by the EDB.

*“Our school supervisor is a retired senior official of the EDB, often shared how the EDB actively advocated for resources from legislators. These efforts enable us to implement STEAM education smoothly without financial hardship.” (PP7)*

### **5.1.6.3 External Sponsor and Entrepreneur Participation and Support**

STEAM education is supported by a diverse network of stakeholders and benefactors, including entrepreneurial corporations, industry partners, educational institutions, non-profit organizations, and community groups. Their involvement takes many forms, such as funding, teacher training workshops, student competitions, collaborative projects between universities and secondary schools, and expert guidance on innovative approaches to STEAM teaching and learning. Fourteen interviewees (74%) described how their schools received support from external STEAM education patrons, and how educational institutions selected partner schools for collaboration.

*“I am so deeply impressed by M.I.T.<sup>16</sup>’s collaboration with CoolThink to deliver STEAM training for teachers in Hong Kong. Some schools demonstrated outstanding academic performance, so universities would proactively reach out to those schools to initiate collaborative partnerships.” (PP3)*

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<sup>16</sup> M.I.T. stands for Massachusetts Institute of Technology.

*“Dating back to 2006, we joined the M.I.T. training program called ‘Leading through Engineering, Arts and Design’. Today, we joined another M.I.T. program by the name ‘Catalyst Education Lab’, the coordinator was very generous to offer our STEAM teachers and school leaders free STEAM trainings at the United States.” (SP5)*

*“The Jockey Club Charities Trust Fund’ had organized a program by the name ‘How Memory Sticks 2.0’, students were taught to use I-pad for doing Chinese landscape painting’. (PP7)*

To support robotics learning, School #10 built an additional room specifically for project work and experimentation. The room was funded by the QE Fund and an entrepreneur whom the school met on its fund-raising day.

*“With support from this company beginning in 2014, and additional funding from the QE Fund, we successfully built a dedicated robotics room. Students are also provided with opportunities to compete in international STEAM competitions, as their airfares were sponsored by these funds.” (SAP10)*

School #17 was also fortunate to receive sponsorship that offered financial support for the implementation of its STEAM program.

*“Last year, our students developed an aquaculture plantation field as a STEAM competition project, aiming to address the issue of limited land availability. Their project earned them both the championship title and the third runner-up award. With the support from a generous sponsor, they were able to compete in the final round held in Geneva.” (ST17)*

However, the sponsorship of School #11 is not long-term, requiring school leaders to do annual negotiations.

ST12, ST13, ST16, and ST19 all expressed that through collaboration with external STEAM education organizers and sponsors, their students gained opportunities to participate in STEAM exhibitions and projects.

Visionary schools are well-positioned to attract strategic partners. For instance, SP5's school exhibited proactive stance and long-term dedication to STEAM education, indicating both credibility and readiness for collaboration. From the EDB's perspective, schools that exhibit strong leadership in STEAM are frequently chosen to participate in pilot programs, highlighting how leadership quality directly influences access to sponsorship and partnership opportunities.

External supporters and sponsors provided financial assistance to schools by funding resources, hardware, and programs. Crucially, this support also covers students' travel expenses to participate in overseas STEAM competitions. External organizations and academic institutions provided schools with expert knowledge, trainings, professional guidance, and networking opportunities to help teachers stay updated on the latest STEAM progress and teaching methods. However, external funding for STEAM education is often short-term, sporadic, and unevenly distributed, so is the case of School #11. The funded programs are susceptible to corporate restructuring, economic fluctuations, and a lack of strategic alignment.

PP6, PP8, PP9, ST16, PST18, and ST19 had all proposed a strategy to facilitate the successful implementation of STEAM education, which will be discussed in Chapter 6.

## **5.2 Chapter Summary**

Chapter 5 presents a comprehensive thematic analysis of the data collected, offering deep insights into the evolving ecosystem of STEAM education in Hong Kong.

This chapter begins by analyzing the diverse viewpoints of interviewees regarding STEAM education in Hong Kong, highlighting their enthusiasm, expectations, and the challenges they encountered. A significant number of respondents recognized the value of STEAM education in promoting innovative thinking, enhancing creativity, and cultivating students' problem-solving abilities, which they consider as important capabilities for embracing the need of future world, so the program is likely to be sustained. STEAM education is generally well-received by Hong Kong educators; however, the underlying motivations for its implementation vary across schools. One of the most thought-provoking cases emerged from band three schools, some of which faced the risk of being shut down as a result of persistent low student enrolment. Students participated in STEAM education with diverse personal goals. Those with a clear and strong passion received dedicated support from STEAM teachers and principals to pursue their

aspirations of university admission. Special education needs school are also required to implement STEAM, but their confronted difficulties were more pronounced than those of regular schools. Teachers from schools with effective STEAM implementation consistently emphasized their pivotal role as frontline practitioners in driving the program's success. While some schools have incorporated STEAM into their long-term development plans and formal curricula, others have treated it merely as an extracurricular activity. Interviewees offered detailed interpretations of various STEAM implementation methods, presenting a comprehensive overview of programs adopted across Hong Kong. While some programs utilized ready-made kits provided by commercial suppliers, others were collaboratively developed by teachers and students through joint efforts. To different extents, schools implemented STEAM programs according to their individual approaches, to their own timelines, and financial capacities, in response to government directives. It was apparent that if STEAM education were formally assessed and integrated into the grading system, both students and parents would likely show greater interest and engagement.

Given the distinctive nature of Hong Kong's educational system, interviewees offered specific and unique insights into the challenges they encountered. Notably, many of these challenges constitute emerging areas of inquiry and new domains of knowledge that remain largely unexamined in existing academic literature. Hong Kong is having an educational system driven by examinations, the traditional educational culture of 'learning is subordinated to test results' firmly embedded in its people's thinking. Parents play a role in influencing the direction of school transformation, particularly in decisions related to the implementation of STEAM implementation. The shortage of teachers poses a significant challenge to the effective implementation of STEAM. Many teachers feel unprepared to teach STEAM, pointing to inadequate professional training. The Hong Kong government has offered professional training opportunities for STEAM teachers; however, participation in these programs remains optional rather than mandated by policy. The language proficiency challenges faced by Hong Kong science students have given rise to a relatively unexplored area of research. These difficulties have not only impacted students' engagement with STEAM education but also revealed a divergence in perspectives between language and STEAM teachers, resulting in fragmented collaboration and the formation of silos within schools.

Leadership of principals, teachers, and students received interviewees' great responses. Various leadership styles were identified in principals during the STEAM implementation process, and distributed leadership were disbursed from principals to teachers for leveraging their expertise

in leading the transformational changes of STEAM education. While at the same time, some schools take initiative to encourage students to participate actively in community services and STEAM education crossover programs, acting as mentors to support elderlies in acquiring digital literacy and technological competencies. Within schools, student leaders actively support and mentor their junior peers in the executive of STEAM projects.

Beyond primary and secondary schools, STEAM education in Hong Kong is actively supported by a range of external stakeholders who contribute to its promotion and implementation. Their support encompasses funding, professional skills, knowledge sharing, strategic guidance, and inter-organizational collaboration. The governmental support is vast and in-depth, besides offering significant financial support for infrastructure and technological upgrades in schools, the present government has enhanced previous initiatives and is actively implementing STEAM policies through strategic and vigorous efforts. In conclusion, Chapter 5 provides a full and explicit picture of how STEAM education is implemented in Hong Kong.

## **Ch.6 Discussion and Implications Addressing the Research Questions**

The study had achieved its goal in gaining a detailed and in-depth understanding of how STEAM education is promoted, managed, and implemented in Hong Kong, with challenges and the key domains for effective implementation identified. The 3H framework of heart, head, and hands for leadership was proven to be applicable and useful for developing a holistic management approach for STEAM. The STEAM program is vigorously promoted by the Hong Kong government at primary and secondary school levels. School leaders, including principals and teachers, are the focus of this study for exploring from them the challenges that they had encountered and how they solved the problems. They do not only play critical roles in developing the best learning environments for students to access quality STEAM education, but they are the ones who have to make determined decisions to address with the problems and difficulties of STEAM implementation. Fostering supportive school culture, developing strategic leadership, establishing collaboration among teachers, and reinforcing the principal-teacher and teacher-student relationships by encouragement and motivations are all means for achieving a unified goal. However, Hong Kong's education system is having its own uniqueness and peculiarity, shaped by the deeply entrenched educational culture and an ever-evolving educational framework. Hong Kong's education system is having its own distinctiveness and eccentricity which is dissimilar to other educational systems of the world. At the beginning of this research, the researcher aimed to uncover emerging domains of knowledge within STEAM education that have not been previously explored in existing literature. The approach of conducting in-depth interviews was proven to be effective, and the truth and certainty of the findings are backed up by the triangulation of findings.

### **6.1 Evidence Validation**

Prior to composing the chapters on discussion and conclusions, the thematic analysis was brought to independent pedagogists for cross-verifying the findings. They looked at the problems from different angles with unbiased perspectives, and to confirm the findings through diverse forms of evidence, so the researcher was able to get a more comprehensive understanding of STEAM education in Hong Kong. Through comparative data synthesis, same research questions and problematic issues were examined by external triangulators. The triangulators, ED2 and ED3, contributed diverse personal and professional insights,

experiences, opinions, attitudes, beliefs, feelings, emotions, and contextual understanding of the STEAM program, shaped by their professional engagement in the field of education. As a result, their experiential perspectives strengthen the validity and credibility of the findings. The evaluators' comments were similar, providing sufficient evidence to support the conclusions on good grounds, so the results can be considered as credible.

## 6.2 Discussions

The research was designed to explore how STEAM education can be successfully implemented in Hong Kong's primary and secondary schools, and how it can be effectively promoted and managed by different level of school leaders, including the EDB, school principals, and STEAM teachers. Numerous past literatures were reviewed for gaining contextual understanding of the background of the research. Various contextual gaps were identified, indicating that no research had been conducted towards developing a framework for effectively promoting, managing, and implementing STEAM education in Hong Kong schools. As interviews went on, empirical gaps emerged due to the distinctiveness of Hong Kong's educational culture and system, these areas had never been explored. Several identified empirical factors exhibited intercorrelations, with some demonstrating causative relationships that influenced one another. Table 4 illustrates the summary of the key findings.

*Table 6.1 Summary of Key Findings*

Research Questions	Themes	Key Findings	% of Responses
1 What are Hong Kong educators' perspectives and purposes for implementing STEAM education?	General Perspectives	STEAM is not resisted by general educators, and they understand what STEAM education is.	68%
	Perspectives of schools with low enrolment rate	A school with low enrolment rate faces the forced-closure threat. To implement STEAM well with frequent winnings in STEAM competitions will earn the school reputation to increase enrollment rate.	26% (80% of respondents are from band 3 schools)
	Perspectives of special educational needs schools.	STEAM education is incorporated into the curriculum of SEN schools, teachers have to look for ways to launch the program.	21%

Research Questions	Themes	Key Findings	% of Responses
	Perceived trendiness	STEAM education is a world trend, and so is for Hong Kong.	32%
	Perceived sustainability	Most respondents believed that STEAM would sustain in Hong Kong, except 22% felt that the program would not last long due to teachers' overwhelmed workload.	74%
	Educators' purposes for implementing STEAM	Among the respondents, two showed authentic interest in doing STEAM. One revealed teachers' promotion desire for accepting STEAM duties. Four expressed the purpose for preventing school closure. Three opposed to the hidden agendas.	47%
2 What are the key challenges of implementing STEAM in Hong Kong schools?	Exam-oriented educational culture	The DSE examination format and university admission criteria were respondents' major concerns. The 'studying is for scoring' mindset deeply ingrained in all stakeholders.	47%
	Attitude of Hong Kong parents.	Students' academic performances are Hong Kong parents' primary concern. Their influential power would create barriers for STEAM implementation. The school bandings system gives parents and students pressure.	63%
	Shortage of teachers	Social movements causing uprise of migration rate, inadequate science students graduated from universities, the EDB's teacher contract policy, insufficient qualified teaching candidates, low job satisfaction, and high turnover rate are all reasons.	63%

Research Questions	Themes	Key Findings	% of Responses
	<p>Inadequate STEAM trainings for teachers</p> <p>Language barriers of science students</p> <p>Silos in education</p>	<p>Both STEAM teachers and STEAM teacher trainers think that their trainings are insufficient. The EDB had never exercised authoritative power to enforce STEAM's developmental trainings.</p> <p>43% of respondents indicates that language is important for all aspects of learning; while 29% felt that the stringent requiring standard for languages will bar brilliant science students from entering universities. Three other respondents suggested allowing students to use AI-powered tools to assist in writing presentation texts.</p> <p>Silo effect appears in schools which focus intensely in the implementation of STEAM, the phenomenon closely tied to the leadership of school leaders. Effective leaders encourage open communication and interdisciplinary collaboration. Two schools reported having silos, whereas some schools concentrated less on STEAM, so fewer mistakes were made.</p>	<p>26%</p> <p>74%</p> <p>84%</p>
<p>3 What are the key domains for effectively implementing STEAM education in Hong Kong schools?</p>	<p>Principal leadership</p>	<p>Various leadership styles were identified, as leaders tried to promote STEAM under situational variances. The STEAM implementational system is bottom-up, the decision-making process is from lower levels of teachers and students to principals.</p>	<p>84%</p>

Research Questions	Themes	Key Findings	% of Responses
	Teacher leadership	The leadership of teachers was found to be above the leadership of principals in effectual STEAM implementational system. Leadership responsibilities were distributed and shared among principals and teachers.	42% (Respondents are all teachers)
	Student leadership	All six respondents were from schools which were strong in STEAM education. Their outstanding STEAM students were given the chances to contribute their knowledge to the academic and social communities by performing as STEAM teaching leaders.	32%
	Governmental involvement and support	The EDB's support came in forms of fundings, teaching and learning resources, professional development, organisations of events and activities, supporting services, such as guidance on course design and teaching methodologies.	68%
	Patronage involvement and support	Supports and involvement came in forms of fundings, teacher trainings, student competitions, collaborative projects, and providing innovative approaches for teaching and learning. Supports from patrons are not limited to Hong Kong, but worldwide.	74%
4 How can a holistic approach be developed for effectively promoting, managing, and implementing STEAM education in Hong Kong schools?	Pivotal crux	Put STEAM officially in the Hong Kong school curriculum as an independent course, so principals and STEAM head teachers no longer have to inadvertently inviting other teachers to participate in the STEAM program.	95%

Research Questions	Themes	Key Findings	% of Responses
	Synergistic alliance	The EDB could consider university-primary partnership to cooperate in doing STEAM projects. Collaborate with more governmental departments could give students wider exposure.	Individual respondent
	The EDB as initiative driver	Make changes to the exam culture of memory-recitation. Lower the language requirement standard for university entrance. Adjust the DSE subject selection system, allow students to choose more than two subjects of their interest. Add extra SNDAS places. Establish a university solely for applied science. Science students with dyslexia should be allowed to use language aiding tools. STEAM education should be started in kindergartens. More STEAM teacher trainers are needed to be trained in universities. Re-instate the 'design and technology' course in universities. Adjust the academia employment system, the STEAM report filing system, and the funding application system. Line up business partners and universities for schools. Reduce the brain drain and outflow of Hong Kong scientists.	Individual respondent

### 6.2.1 Addressing Research Question #1

The first question asked about educators' perceptions towards the STEAM education of Hong Kong. These perspectives were instrumental in clarifying the extent of educators' support for the program, whether in terms of acceptance or resistance. Thirteen interviewees (68%) expressed opinions. Six of them (46%) provided critical and adverse comments, stating that without standardized guidelines, teachers can hardly manage STEAM teaching, so making the

program difficult to be implemented. Some schools only execute the program in accordance with the EDB's directives, driven more by compliance than genuine commitment. In more severe case, STEAM was criticized by core subject teachers as 'wasting time on playing something that damages students' willpower in proper learning'. Chen and Lo (2019) perceived STEAM education as essential for addressing the demands of the 21<sup>st</sup> century, this perspective was echoed by 68% of the present study's interviewees; however, some researchers considered the reform as a big task (Geng, Jong & Chai, 2019). Sánchez and Cortés (2019) perceived STEAM education as a 'pure utopia' within the constraints of the current education system; it is regarded as an idealistic vision, a buzzword leveraged primarily to attract funding and serving marketing purposes. Mejias et al. (2021) pointed out that STEAM is not well theorized and is not visualized in an ambivalent manner, it emphasizes varied modes of knowledge with innovative perspectives, but it is always used in theories, pedagogies, and practices in ways which are unclear and problematic (Mejias et al., 2021). Lev Vygotsky's Sociocultural Theory on education and his conceptualization of play offer a robust theoretical foundation that challenges the perceptions of the core subject teachers at School #11, who regarded STEAM education as nothing more than recreational activity. Vygotsky interpreted that 'playing is triggered by situations that could be pertinent to students' lives, and they transform these situations into games' (Heinze et al., 2022). Playing is an essential part of child development and creativity establishment (Bodrova, Germeroth & Leong, 2013), and Vygotsky's theory is closely aligned with STEAM education (Yasser & Hamza, 2019), particularly through its emphasis on play as a catalyst for cognitive and social development. Supportive interviewees of STEAM education assert that it broadens students' perspectives on future career pathways by equipping them with necessary skills; and artificial intelligence had already advanced to a point where humanity must learn to coexist with it for enhancing the quality of life. Their perspectives align with those of Dell'Erba (2019), who emphasizes that at the core of STEAM education lies cognitive development, encouraging students to engage with novel experiences, embrace diverse perspectives, and cultivate understanding through divergent thinking and creative exploration. STEAM education fosters AI literacy and cognitive skills by promoting human-centric reasoning as a foundation for knowledge development (How & Hung, 2019). Supportive interviewees echoed this view, emphasizing the importance of equipping students with future-ready competencies, including the ability to navigate emerging technologies through critical and ethical reasoning. Furthermore, STEAM's interdisciplinary and transdisciplinary nature opens doors to diverse career pathways (Bertrand and Namukasa, 2020), a point strongly reinforced by respondents who highlighted the value of exposing

learners to multiple perspectives, empowering them to apply integrated skill sets across varied contexts, having them prepared for the rapidly changing work environments.

The perspectives of under-enrolment schools and special educational needs schools warrant particular attention, as the challenges they face in implementing STEAM education are significantly greater than those encountered by mainstream schools. A report on the Young Post (2023) stated that ‘nineteen secondary schools in Hong Kong are at heightened risk of closure due to tightened government enrolment thresholds amid declining student population’. Hong Kong’s primary schools are facing similar challenges, ‘in the current academic year, five schools will no longer receive government grants due to their inability to enroll at least sixteen students per grade’ (Wai, 2023). One of the five schools planned to raise fund for saving the school, but was prohibited by the EDB. DSS schools are also affected by the rising emigration rate of Hong Kong citizens, which has led to significant declines in student enrolment (Young Post, 2022). Interview findings revealed that some schools facing similar challenges had proactively addressed the issue years earlier. Among the educators who responded to questions concerning under-enrolment, 80% were from band three schools. These educators commonly described band three students as bold and courageous, noting their strengths in creativity and innovation. Educators viewed STEAM education as a strategic remedial approach that may mitigate the risk of school closure, provided that the program is implemented well with school reputation elevated. In addition to striving for excellence in STEAM programs and competitions, secondary school educators actively support primary schools in launching their STEAM programs, positioning themselves as compelling options for parents to choose when they consider secondary school placement for their children. A single set of instructional practices is insufficient for schools to capture students and their parents’ interests, principals have to strategically promote their schools by presenting their capacity to deliver high-quality education (Chan, 2019). It is the responsibility of school leaders to implement significant reforms in response to declining enrolment and the corresponding reduction in resources (Roberson, 2014).

SEN schools offer inclusive education for students with diverse disabilities and learning challenges, requiring educators to exercise heightened care and apply extra attention in designing targeted instructional strategies and customizing educational programs to support their learning needs. Various respondents shared their experiences of how STEAM education is implemented in SEN schools. Insights shared by the SEN school teachers highlighted the

significant hardships and challenges encountered in implementing STEAM education. Previous research has explored strategies for incorporating STEAM into SEN schools, identifying a range of barriers that hinder effective adoption. The barriers identified by Klimaitis and Mullen (2021) align with the experiences shared by PT15 from the SEN school where she teaches. Key challenges include insufficient knowledge and skills among principals and teachers to effectively support SEN students; a tendency for teachers to work in isolation rather than collaboratively; reluctance to adopt innovative teaching methods tailored to SEN learners; limited access to professional development focused on STEAM learning; and the persistence of low academic expectations for SEN students. Elsayed et al. (2022) used the term ‘diversability’ to describe SEN students as individuals with diverse neurological, cognitive, developmental, and physical differences. Regardless of whether they are classified as abled or disabled, every student with special educational needs has their own strengths and can learn well when they get the right support that fits their needs. Therefore, ‘all students should have fair and equal chances to learn science, and take part in activities of science and engineering’. This viewpoint aligns with the incorporation of STEAM education into the curricula of Hong Kong SEN schools. In light of this, educators are expected to identify effective strategies for implementing and sustaining STEAM learning for students with diverse needs.

In relation to the sustainability of STEAM education in Hong Kong, three interviewees expressed negative views. Critics argued that the sustainability of STEAM education was at risk if the program lacks genuine respect and institutional support. The program was aggressively promoted, but teachers’ tireless efforts were not recognized, leaving many teachers feeling overwhelmed and undervalued. Moreover, concerns were raised about disproportionate funding allocations towards STEAM programs, and resources are diverted away from other essential subjects. However, a report released by the Lingnam University (2022) indicated that, although the Hong Kong government ‘had invested more than 130 billion Hong Kong dollars to develop science and technology in the past four years, the invested amount only account for no more than 1% of the local GDP’. To the contrary, STEAM education was perceived by six respondents as a world trend that will last long without fading, and eleven respondents believed that the program will sustain in Hong Kong’s education system, and STEAM education had already been included in their long-term development plans. Educators perceived STEAM education as a developing direction of the People’s Republic of China, as the country positions the program as a strategic component of its broader national strategy. China has placed strong emphasis on advancing STEM education across the cities of

the Greater Bay Area; therefore, in 2016, the ‘STEM Education Alliance of Guangdong-Hong Kong-Macao Greater Bay Area was founded by the China Education Information Industry Innovation Platform’ (Zhong et al., 2022).

Interviewees showed diverse view points towards STEAM education of Hong Kong, reflecting enthusiasm, anticipation, and challenges. Many respondents supported STEAM education’s promotion of innovativeness, creativity and nurturing of students’ problem-solving skills, which they considered as important capabilities for embracing the future world, so the program is likely to be sustained. STEAM education is generally not resisted by educators of Hong Kong, it is apparent that most interviewed educators of band three schools attempted earnestly to implement STEAM education. However, some interviewed band one and band two schools emphasized their focus on academics, and their school’s STEAM education were comparatively not executing in full strength. Furthermore, some hidden agendas were disclosed by interviewees declaring that STEAM head teachers have their desires to get promoted after taking up the post, and some schools aim only to prevent school closure by implementing STEAM well. Although there were proponents or opponents among respondents for or against STEAM education being implemented in Hong Kong, this novel education system is generally not resisted by them. Resistances often appeared in educators’ perspectives of not being supported and appreciated, thus making them feel overwhelmed. Nevertheless, these complaints can be overcome by applying appropriate leadership skills, which includes providing support through tailored training to help teachers build competence and overcome psychological barriers; facilitating curriculum integration through strategic leadership that aligns teaching practices with STEAM objectives; encouraging students’ active participation by fostering an inclusive and motivating learning environment through effective leadership; ensuring equitable access to infrastructure and resources by creating fair and balanced policies, and making thoughtful decisions that reflect the real needs of students and schools; and strengthening community and external partnerships by building collaborative networks and engaging stakeholders through visionary leadership. Overall, respondents expressed confidence in the long-term sustainability of Hong Kong’s STEAM education. It is indeed fortunate to have a strong community of committed educators like PP6, PP7, SAP10, ST11, ST12, ST13, ST14, and ST15, who bring genuine enthusiasm, engaging both heart and hands to cultivate a holistic, humanistic, and harmonious learning environment that supports the development of well-rounded and balanced students.

### **6.2.2 Addressing Research Question #2**

Research question #2 explores the key challenges in implementing STEAM education across Hong Kong schools. Despite the enthusiasm among principals and teachers, the obstacles and complexities involved in STEAM integration remain significant and cannot be overlooked. STEAM education is not formally embedded in the Hong Kong School Curriculum by the EDB; consequently, different schools adopted diverse approaches. Some schools treated the STEAM program as an extracurricular activity, whereas some integrate it into existing subjects. How STEAM is taught is significantly influenced by teachers' perceptions, own experiences, and their level of confidence. Hong Kong teachers require more organized trainings, and specific teaching techniques are needed for integrating STEAM education into their daily teaching practices. On top of these challenges, there comes more complex hardships. The 'learning is for achieving high grades' mindset is a deep-rooted belief embedded in Hong Kong's educational culture, and it is not easy to be eliminated. In the minds of educational stakeholders, including school leaders, teachers, parents, and students, examinations have taken precedence over other valuable learning opportunities.

Challenges of STEAM education are frequently documented in existing literature, especially in areas such as resource allocation, professional development for teachers, curriculum integration, facilitation of student engagement, and promotion of interdisciplinary collaboration. Herro, Quigley, and Cian (2019) recognized various challenges of STEAM implementation in their study, issues included pacing and time constraint, students' understanding of the STEAM content or process, planning and discipline connection problems, insufficient class time, and assessment difficulties. Lee, Chai, and Hong (2019) further identified challenges within the pedagogical design of STEAM education, disciplinary coverage was unevenly balanced, mathematics and engineering had been under-represented in particular; the design of STEAM programs has an inclination towards moral teaching, with insufficient technology-supported instructions. Scholars also criticized that the integration of STEAM into instructional design remains largely undefined (McComas & Burgin, 2020). The usefulness of STEAM education was questioned by educators and school administrators. Criticisms range from limited program access and insufficient curricular integration to enduring instructional difficulties. Moreover, ongoing debates have emerged over the appropriate inclusion and positioning of the arts within STEM education (Herro, Quigley & Cian, 2019; Mejias et al., 2021), requiring school leaders and teachers to recognize how these elements interconnected and seamlessly integrated into one another (Herranen, Fooladi &

Milner-Bolotin, 2021). The researcher suggested scholars to look at the art issue from an alternative angle, rather than simply weaving art into STEAM, educations can consider braiding STEAM education into art. In-depth interviews with Hong Kong school leaders and educators uncovered challenges from novel perspectives that have rarely been explored in previous research. Inadequate trainings and shortage of teachers are universal challenges faced by education systems around the world. When STEAM education promotes teacher cooperation in interdisciplinary teaching, many teachers feel demotivated due to insufficient training in navigating the complexities of the STEAM program, especially in the transition from STEM to STEAM, where teaching resources and subject knowledge remained limited (Dorofeeva, Budarina & Parakhina, 2020); and preservice teachers' trainings are subject-based instead of cross-disciplinary-based (Li et al., 2022). The teacher shortage problem is world-wide, due to high turnover rates, low pays, and challenging working conditions (Buchholz, 2024).

The teacher shortage in Hong Kong is severe, as a significant number of educators have chosen to relocate abroad. The most acute shortages are found in the fields of English and computer science. Many computer science teachers transit to the business sector, where significantly higher salaries are offered. Teacher shortage caused many complaints about work overload, and schools are not able to recruit extra manpower to implement STEAM education. STEAM teachers who agreed to participate in STEAM education expressed grievances about unfair treatment, complaining about increased workloads without adjustments to their regular teaching schedules, and compensation remains unchanged when compared to colleagues who opted out of the program. With respect to insufficient STEAM trainings, the percentage of response rate from interviewees was low at twenty-six percent. It is widely recognized among educators that STEAM teacher training in Hong Kong has been strongly supported by the EDB, primarily through workshops and external visits for teachers and principals. In addition, various external organizations and industry partners have offered programs aimed at enhancing teachers' STEAM competencies. However, the implementation of STEAM education remains largely dependent on individual schools and principals, who determine the extent to which it is promoted and resourced. Since STEAM training is not mandatory, the level of commitment varies significantly across schools.

Further challenges in the Hong Kong's STEAM implementation, including the underlying motivations of teachers and students for participation, were viewed by the researcher as revelatory, shedding light on previously overlooked or hidden concerns. Half of the interviewed

respondents expressed their opinions towards how STEAM education was affected by Hong Kong people's deep-rooted mindsets of 'one examination determines all' and 'learning is for achieving high scores'. Hong Kong is an exam-oriented city with tests and examinations being placed top on students and parents prioritized list. Parents hold significant authority over students, shaping their thinking, attitudes, and behaviors towards learning something which they perceived as unnecessary, such as STEAM education. Interviewees agreed that Hong Kong's education system is distorted. When exams approach, all other learnings unrelated to core subjects must be set aside; except for some band three students, STEAM education serves alternative purposes beyond its intended academic objectives. STEAM talents of band three schools are having the opportunities to enter universities under the system of SNDAS<sup>17</sup>, and the schools they attend have also gained recognition for their strong delivery of STEAM education. This distinctive feature has enabled some schools to mitigate issues of under-enrolment. However, for general students of all bandings, examinations always come first, and STEAM is only perceived as an afterschool activity. Given these prevailing attitudes, STEAM is facing significant challenges in being effectively implemented in Hong Kong schools.

Language barrier is another challenge affecting many science students. Although there are no evidences shown in past literatures to support the correlation between language and science, interviewees stated that low proficiency of language could be a barrier restricting science students' access to universities. Cantonese and English are both Hong Kong's official languages, implying that students are required to put in double effort to manage bilingual proficiency. Seventy-nine percent of participants responded to the question of whether science students' scientific achievements, university entrance rates, and future developments are affected by their low-proficiency of languages. With three respondents being neutral, nearly half of interviewees agreed that languages are important in all kinds of studies, whereas the other half believed that the high threshold of language requirement for university entrance will impede talented STEAM students to develop into outstanding scientists. In fact, Hong Kong is having a 'trilingual and biliterate' language education policy (Li, 2022), with Putonghua added to English and Cantonese as medium of instruction, and both English and Chinese are written languages for used in the DSE, and there is no mixing of languages allowed in writing. Li (2022) interpreted a case in his study that 'a Cantonese-dominant student was having difficulty

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<sup>17</sup> SNDAS stands for School Nominations Direct Admission Scheme.

demonstrating her comprehension of a science concept in an EMI<sup>18</sup> “pulled-out” science class. The teacher accepted the student’s answers in partial Cantonese and partial English during class discussion, and the teacher guided the class to get familiar with the corresponding meanings in the science discourse, instead of insisting the student to communicate fully in English’. However, this mixture of English and Chinese is not accepted in any testing paper of the DSE. From this case, it is discernible that language incapability is indeed a barrier for understanding the difficult concepts of science, and Li (2022) described the EDB’s trilingual and biliterate language target as a ‘tall order’. A longitudinal study conducted by Yip, Tsang, and Cheung (2003) had also made the same discovery. The study explored the variations in scientific proficiency between two groups of Chinese students, one group learned science in English, while the other group learned science in Cantonese. Results showed that despite of having a higher starting ability, English-medium students performed significantly worse than their Chinese-medium peers on a science achievement test consisting of multiple-choice and free-response questions. EMI students performed particularly poor on tasks to assess their comprehension on abstract ideas, they were weak in distinguishing scientific terms, and their capabilities to apply scientific knowledge in practical contexts were also inferior. The research findings indicated that low English proficiency among EMI students hindered their abilities to learn science effectively. Students were not well-prepared for full English immersion programs in secondary schools, as English is taught merely as a language subject at the primary level. Pun, Thomas, and Bowen (2022) also indicated that science students face double challenges in an EMI science learning classroom, and the negative effect is significantly shown in academic results. On the other hand, a study by Tsui and Ngo (2017) indicated that Hong Kong university students perceived Hong Kong as an internationalized cosmopolitan city, therefore a strong command of both English and Chinese is essential for Hong Kong’s knowledge-based economy.

Challenges of departmental silos are frequently found in subject-specific classes, where teachers work only in their own classrooms or subject silos, without understanding what their peers are doing in other fields. This may restrict cross-disciplinary cooperation between teachers of different disciplines, such as language and STEAM. Silos are also found in grade-level isolation, where teachers and students are frequently isolated in their grade level, that means upper secondary teachers typically do not teach junior secondary students, or vice versa.

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<sup>18</sup> EMI stands for English Medium Instruction.

Isolations and independent operations make teachers difficult to work together and limited their chances to exchange best practices of teaching.

Resource segregation tends to emerge when resources are insufficient to be equitably distributed across departments. Sixteen respondents (84%) shared their perceptions, six of them had encountered unpleasant experiences, whereas the other ten has no silo problems at their schools. Schools with silo conflicts are usually having tensions between STEAM teachers and other subject teachers primarily stemmed from competition over student participation in extracurricular activities, misperceptions about the distribution of STEAM-related funding and resources, and limited understanding of STEAM education, which often led to resistance towards collaboration. Recent researchers have suggested that STEAM education can play a vital role in fostering critical thinking and enhancing students' problem-solving skills, STEAM education should move beyond traditional subject silos by adopting interdisciplinary approaches that incorporate core subjects into a coherent curriculum (Hwang et al., 2024) Overcoming subject-specific teaching silos encourages collaboration and coordination among science and art teachers for enriching students' learning experiences; nonetheless, resistance to change is a critical issue that must be overcome (Ashirov and Imankulov, 2024).

Some globally pervasive challenges in STEAM implementation were not found in the Hong Kong context, such as the gender stereotyping challenge. Eleven interviewees (52%) responded to this issue and all of them stated that both genders equally enjoyed the STEAM program, and both genders have similar capabilities in doing STEAM projects, except that some girls are not as strong as boys in cutting materials and weaker in assembling. Nevertheless, in terms of linguistic skills, girls tend to demonstrate stronger abilities in understanding scientific terminology and presenting effectively in competitions; therefore, ensuring gender-equitable task distribution can enable students to perform more effectively that reflect their capabilities. Furthermore, the art element added into STEM had increased girls' interest in doing science projects. Three educators remarked that their female students frequently excelled in STEAM competitions, while others said that both genders performed equally well at competitions.

Some of the challenges observed in Hong Kong are notably distinct from those encountered in other regions. The city's exam-oriented educational culture encourages rote memorization habits among students, undermining the cultivation of critical thinking, creativity, and holistic development. The challenges and barriers facing STEAM implementation in Hong Kong can be addressed through strategic management measures aimed at cultivation an effective and

supportive STEAM environment. However, this requires coordinated efforts among the government, schools, and STEAM education supporters. A well-functioning STEAM ecosystem relies on collaboration among key stakeholders. When the government provide policy support and funding, schools can implement effective teaching strategies, while the talents of STEAM bring innovation and mentorship. Strategic management plays a crucial role in aligning objectives, allocating resources effectively, and ensuring that all components ranging from curriculum design and teacher development to infrastructure and student engagement will all function cohesively. Schools are the core of this ecosystem, depending on leadership and a network of support to adopt STEAM practices. Challenges such as under-enrolment, resource disparity, and teacher resistance can be mitigated through collaborative responsibility and ongoing feedback and reflection. As a result, the ecosystem will become more resilient and be ready to adapt to future challenges.

### **6.2.3 Addressing Research Question #3**

Research question #3 is about identifying the essential domains for successfully launching and implementing STEAM education in Hong Kong schools. The complex challenges of education reform require a managerial competency framework to define the skills, behaviors, and knowledge required by educational leaders to perform their roles effectively (Naguin & Holton, 2006). The holistic-domain model of managerial competencies consists of four core components, including leadership skills, interpersonal skills, intrapersonal skills, and operational skills; it is a comprehensive model that integrates multiple domains of expertise to provide a holistic understanding of the system (Asumeng, 2014).

Hong Kong STEAM education requires the joint leadership of the government and school leaders to set the directions, determine the paths, make strategic decisions, motivate schools and teachers, and overcome obstacles. Without strong leadership, even the most well-crafted strategic plans can falter. The EDB, school leaders, teachers, and students are all responsible for STEAM's implementational success, and each with its own responsibility. The EDB has to be in charge of the leadership and operational domains within the STEAM educational system, and to interlink effectively with schools. Principals and teachers have to balance the intrapersonal, interpersonal, leadership, and operational demands within the school system, and student leaders have to focus in executing their domains of interpersonal and operational skills. All four domains interconnected with the learning system of STEAM education to activate the interdisciplinary approach for solving real world problems, to ensure that every student can

participate and benefit from the inclusive method of learning, and be able to develop their 4Cs of STEAM comprehensively, regardless of their backgrounds and learning needs. Traditional theories of educational management suggest that the performance of students, teachers, and the school as a whole is significantly influenced by principals' leadership behavior and capabilities. Principals were considered as the key players in improving teaching and learning, by applying effective leadership tactics in flexible and practical ways, the school environment will be improved and results are ensured (Liebowitz & Porter, 2019). However, in the context of Hong Kong STEAM education, the prevailing belief that principals are responsible for the successful implementation of STEAM remains largely unexamined and should be critically evaluated. It is essential to critically examine this assumption, since STEAM success requires collective effort, and placing sole responsibility on principals seems to be an unrealistic expectation. Furthermore, teachers' empowerment matters, as they are the ones delivering STEAM content directly; without their buy-in, the best leadership strategies may not achieve intended outcomes. Moreover, systemic and policy-level support, in forms of funding and guidelines, is crucial. A more sustainable model involves shared leadership, where STEAM coordinators, head teachers, and external partners contribute to planning and execution.

The topic of leadership sparked strong reactions among respondents, with sixteen interviewees (84%) sharing their experiences and views. While the school supervisor and seven principals spoke appropriately yet cautiously, the vice principle seize the opportunity to voice out her dissatisfaction with her principal's leadership. Various leadership styles were identified in principals during interviews, including visionary, transformational, transactional, charismatic, laissez-faire, empowering, servant, situational, democratic, learning, strategic, autonomous, and absentee; whereas the distributed and educational leadership styles were identified in teachers. Table 6.2 illustrated the taxonomy of various leadership styles found in interviewees.

*Table 6.2 Taxonomy of Interviewees' Leadership Styles*

Leadership Style	Interviewee
Visionary	SP2, SP5, PP8, ST13
Transformational	SP2, PP7, ST13
Charismatic	PP3, SP6, PP7
Empowering	SP5, ST12
Servant	SP6, PP7, PP8, ST12
Transactional	SP2
Situational	PP7

Leadership Style	Interviewee
Democratic	PP7
Learning	PP7
Autonomous	PP9
Laissez-faire	Principal of VP4
Distributed	SAP10, ST11, ST12, ST13, ST14
Educational	ST13

### 6.2.3.1 Leadership

The majority of principal interviewees exhibited traits aligned with visionary, servant, transformational, charismatic, empowering, and strategic leadership, which were consistently reflected in the literature reviewed in this research. However, instructional and pedagogical leadership styles were not identified among the principals interviewed in this study. This might be attributed to the fact that these leadership approaches are more prevalent in general educational management, but less commonly associated with the specific requirements of STEAM leadership. The following leadership approaches aligns with the practical demands of effective STEAM program implementation.

#### *Governance Leadership of the Education Bureau*

The government exercises governance-in-practice, whether it is ‘instrumental-rational’, aimed at achieving efficiency, accountability, and performance, or ‘agonistic-political’, which sees governance as a place of ongoing contestation and political engagement, at where different values, interests, and ideologies clash, it plays a key and dominative role in educational leadership and school management (Gobby and Wilkins, 2020). Governance involves goal orientation, it engages various stakeholders in decision-making, and the decisions might bring influences and changes to organizational culture and practices. It sets the framework of policies, directions, and processes which organizations have to follow, and they are controlled within the framework. The EDB plays a crucial role in the administration, formulation and regulation of policies pertaining to Hong Kong’s educational system. They take priority to uphold professional standards, assuring accountability, putting educational reforms into action, and setting guidelines that schools are expected to follow. The EDB’s leadership style can be described as directive, authoritative, regulatory, bureaucratic, and transformative in the context of STEAM education. For the promotion of STEAM education, the EDB adopts a progressive

and collaborative leadership style. They carried out curriculum renewal by incorporating STEAM concepts into science, mathematics, and technology for updating and enriching the curricula. The EDB emphasizes teachers' professional development and coaching, striving to enhance their STEAM teaching skills through workshops and mentorship offered by pioneering educators of the STEAM program. They also encourage community partnerships, so students have practical chances to work together with a variety of stakeholders, such as entrepreneurs, universities, and neighborhood communities. The EDB has a secondment program by the name 'Staff Interflow Scheme'. For a set period of time, the program allows the heads and teachers of grant, aided, DSS, and SEN schools to assume professional responsibilities in the EDB, aimed to foster cross-exchange of knowledge and experience for strengthening the collaboration between the EDB and schools (Education Bureau, 2024e). ST13 and ST14 were seconded to the EDB to support the mutual exchange of STEAM-related knowledge and experience.

### ***Principal Leadership***

For developing inclusive and successful schools, principals play crucial roles. Principals' leadership have indirect influences on students through teachers' instructions, but have direct influences on teachers with respect to their performance. Without competent leadership at the school level, education reforms can not be effectively implemented. The principal professional development programs in Hong Kong had been criticized as not adequately preparing principals for educational reforms in real-life school settings, and not able to inspire them for long-term career goals; these programs are short-sighted to train principals only for dealing with short-term job requirements (Walker & Dimmock, 2012; Kwan, 2011 in Wong & Liu, 2018). Hong Kong's educational policies are constantly changing with massive education reforms after its return to the Chinese sovereignty in 1997, principals' leadership styles had been detected of having subtle changes. In contrast to previous viewpoints of teachers that characterized principal' leadership as dictatorial which 'exercises too much management but too little leadership', Yu (2002) indicated that principals had exerted some form of transformational leadership change in order to cope with the education reforms. It is also argued by Wong (2010) that Hong Kong's principalship is undergoing changes in principals' autocracy, teachers and principals held conflicting opinions towards what leadership should be. In Wong's study, school principals place higher value on their professionalism and management abilities, whereas teachers tended to ask for principals' decentralization of power in order to close the gap of mutual distrust. Walker (2004) held an alternative opinion that 'reforms attempted

or partially attempted to change the power structures in Hong Kong schools, and also the relationship between schools and the government; however, the attempts failed, as they conflicted with the structure of Hong Kong school leadership that supported the ‘order and lead’ of schools. This opinion of Walker generates a knowledge gap for future researchers to explore and to gain deeper understanding of the ever-changing leadership structure of Hong Kong, as the structure had been changing significantly over time, and had been influenced by the political, governance, and governmental changes.

School #13 has a stabilized school culture of low principal turnover rate. The school had only undergone the services of three principals since establishment, implying that there is stability and continuity of leadership. Each principal had a profound and long-lasting impact on the school’s development, possibly promoting a unified culture and vision over time. This could be interpreted as an indication of effective management and strong leadership, especially in the process of STEAM education promotion, and cultivation of the ‘Sons of the Asteroids’<sup>19</sup>. High principal turnover has a relationship with teachers’ frequent turnovers at a school, thus increasing the chance of affecting students’ performance in an unstable learning environment, especially in schools which are under-privileged (DeMatthews, Knight & Shin, 2022). A school with affectionate principal-teacher relationship is beneficial to build up positive school climate of openness, trust, and shared visions (Price, 2012). ST12 had cultivated a warm and trusting relationship with her principal through open communication, mutual understanding, respect, support, and recognition, thus creating the conditions for enabling the successful launch of the school’s STEAM library program. Where trust is present, direct interaction and collaboration among teachers are more likely to emerge, helping to break down silos and promote meaningful information sharing (Hallam et al., 2015) Principals can apply the Expectancy Theory to motivate STEAM teachers and enhance their job satisfaction. The theory is formed by basing on three elements, the first is to make teachers believe that they are competent for their position, so they are inspired to put in extra effort. The second element is based on the rewards or incentives that teachers will receive after successfully completing their tasks; and thirdly, it based on how teachers perceive and feel about the rewards (Estes & Polnick, 2012). However, it is hard to put the expectancy theory into practice, since principals might find difficult to offer a variety of rewards to meet with teachers’ expectations (Sholihah, 2017), and some argued

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<sup>19</sup> The MIT Lincoln Laboratory named asteroids after students who excelled in science competitions like the Intel International Science and Engineering Fair. These students are sometimes being affectionately called sons or daughters of the asteroids, which are tributes to their brilliance, and their names become immortalized in space.

that success is impacted by the overall school environment, not only by reward motivations (Min et al., 2020). Most of the interviewed principals of this research is having the qualities of mixed leadership styles, which are necessary for addressing to the specific demands and challenges of STEAM implementation. The mixed leadership approach is a flexible strategy for principals to leverage the advantages of different leadership styles to develop a holistic leadership plan to adapt to the needs of STEAM teachers, to respond to the changes in curriculum, and to embrace with external challenges from the environment. A leader who is having mixed leadership qualities, like PP7, is able to lead the school with adaptability and flexibility to embrace with the changes of STEAM education, she is able to act fast to adjust strategies to adapt to emergent STEAM problems, and to establish adaptable and customized solutions to meet with the requirements of diverse members of the STEAM team. Leaders with mixed leadership qualities are able to encourage collaboration, and delegate authority to STEAM teachers with trust; but when problems arise, they will address them proactively, and they will continuously improve the STEAM program from the feedbacks of stakeholders. Through the implementation of strategic management approaches, a mixed leadership model empowers leaders to transcend barriers and cultivate a dynamic, inclusive, and forward-thinking environment for the STEAM team, anchored in strategic optimism.

### ***Teacher Leadership and Distributed Leadership***

Research on leadership competencies had extended to explore how teachers can be more effectively engaged in leadership roles (Szeto, Lee & Hallinger, 2015). Teacher leadership was described by Harris (2003) as a new leadership idea emerged in Europe at the beginning of the 21<sup>st</sup> century; however, in fact, this ‘new’ leadership theory has long existed in North America, which was renowned and being accepted. There were various definitions for teacher leadership in literatures, the researcher agreed most on the definition of Katzenmeyer and Moller (2001), saying that ‘teacher leaders are those who lead within and beyond ordinary classrooms, identified by peers to make contributions to the community for improving practices of education’. This definition tallies with the deeds of SAP10, ST11, ST12, ST13, and ST14 on how they led their colleagues to enhance their knowledge and skills in STEAM teaching, and how they made contributions to the learning community. In reality, these middle-level leaders shared the heavy load and responsibilities of principals to monitor and manage the surge of new policy initiatives that were imposed on schools during the period of reformation (Szeto, 2022). The distributed leadership approach tackles leadership in conjunction with groups and

teams, in which the leaders and their followers interact (Goksoy, 2016). Opponents of distributed leadership argued that ‘transformational changes should have the direction and guidance of specific leaders, and leadership is not to be shared’ (Hoy & Miskel, 2012 in Goksoy, 2016). Nevertheless, proponents counter-argued that since a school is too complex for one individual to handle alone as a heroic leader, distributed leadership is essential (Gronn, 2008). This situation is particularly conspicuous in the implementation of STEAM programs in Hong Kong schools, where principals without a science background often delegate instructional responsibilities to STEAM head teachers, these are the cases of school #4 and school #13. Shared leadership is closely related to ‘distributed leadership’, but with distinctive functions. In shared leadership, responsibilities shared are not limited to be just across multiple teachers, but can be between principal and team head teachers. Principals and head teachers contribute distinctively to their schools by sharing their instructional responsibilities. Teachers, using their preferred methods, demonstrate instructional leadership when they engage in productive interactions with peer teachers in educational reforms. Teacher leaders share their knowledge with peers, collaborating with them to enhance their professionalism, and peer teachers are anticipated to align with the same practice. Principals, in their capacity as instructional leaders, provide teachers with necessary resources and support while upholding the coherence and standardization of the reforming educational system (Printy & Marks, 2006). Shared leadership entails the collective contribution of knowledge and skills among teacher leaders to achieve a unified goal, rather than relying solely on the principal’s expertise. Principals can adopt participative perspectives to observe how individuals engage with various situations, while fostering a sense of collective responsibility for achieving the intended goals. In addition to serving as distributed or shared leaders, teachers can also be recognized as instructional leaders, team leaders, mentor leaders, curriculum leaders, policy leaders, professional development leaders, and technology leaders in the context of STEAM education. School effectiveness is determined by multiple factors, such as students’ academic achievements, teachers’ satisfaction, teachers’ level of engagement, and parents’ socio-economic status (Javornik & Mirazchiyski, 2023). Teacher effectiveness is considered as most important since their willingness to engage in shared decision-making contributes to a positive school climate (Schmid, 2018; Baydar, 2022). Teachers’ perceptions of school leaders’ efforts in decentralizing authority contributes positively to their professional engagement and sense of job satisfaction (Gülbahar, 2020). Although many scholars had argued that distributed and shared leadership might not be as effective as it appears superficially, as there would be biases existed in the granting process of leadership, and the assigned leader might not have same shared vision (Holm and Fairhurst,

2018; Zhang, Waldman & Wang, 2012), these phenomena appeared sporadically in Hong Kong schools; since the beginning, principals had already encountered challenges in encouraging teachers to take on the role of STEAM head teacher. Furthermore, distributed leadership in this context may be more accurately described as bounded distributed leadership, as it lacks full autonomy and is shaped by school culture, administrative support, and policy constraints (Bolden, 2011). While enthusiasm can spark innovation, bounded conditions may hinder its long-term viability, reflecting a key characteristic of bounded distributed leadership.

### ***Student Leadership***

Encouraging students to take leadership roles in schools and communities is an effective strategy for cultivating students' leadership skills. Student leadership promotes the development of responsibilities, skills for collaborative teamwork, and abilities for decision-making (Dempster & Lizzio, 2007). Student leadership develops within the theoretical frameworks of authentic and servant leadership. Kiersch & Peters (2017) explained that authentic leadership emphasized personal responsibility and the making of unbiased decisions grounded in core values rather than short-term outcomes; and servant leadership stresses followers' development and empowerment, fosters a sense of community custodianship. Students of two interviewed schools, one primary and one secondary, had participated in the schools' student-leader program of STEAM education. Outstanding primary school students were selected for mentorship development trainings, and they became student leaders to take part in peer mentoring. By sharing their experiences and knowledge, senior students are able to help junior students to better understand the STEAM concepts, and they also serve as relatable role models for junior students. The program benefits both age groups. Secondary school students are involved in the cross-generation STEAM teaching program. They are the mentors for junior peers, and also serve as coaches to support elderlies in learning and using technology applications within the community. Student leaders are needed to be empowered and cultivated by good teacher leaders who offer them opportunities to take up new challenges for establishing new skills. For the student leadership program to be successful, teacher leaders should act as role models and mentors whom students can rely on and turn to for support, and they should always be present to acknowledge and recognize students' efforts and achievements. Same as the bounded distributive leadership of teachers, students' leadership is also bounded within defined boundaries, students are empowered to take on leadership roles;

however, their leadership is situational, as they are under the guidance of teachers and institutional frameworks.

In the context of STEAM education, understanding the distributed and bounded nature of both teachers' and students' leadership can help researchers and educators identify obstacles to leadership development. This insight is essential for striking a balance between autonomy and accountability within the teaching and learning environment, thereby facilitating the development of supportive frameworks that strengthen leadership capacity.

### **6.2.3.2 Complementary Educational Theories**

The following section explores seven complementary educational theories that constitute the theoretical framework for understanding the education, organizational change, curriculum redesign, and STEAM learning in Hong Kong. Complementary theories are distinct but compatible frameworks, when thoughtfully combined, they offer a richer and more multidimensional understanding of complex phenomena. Each of them offers a unique perspective, and together, they will create a coherent, robust foundation for new theories that are both theoretically sound and practically impactful. They work together to support, enrich, and enhance one another, ultimately contributing to a more comprehensive and nuanced understanding of Hong Kong STEAM education. This review of literatures will help the research to anchor the new theory in established knowledge, identify gaps, and look for relationships between concepts.

#### ***Sociocultural Theory***

Lev Vygotsky's Sociocultural Theory, which is also known as Social Development Theory, serves as a core principle underlying the constructivist approach to education (Scott & Palincsar, 2013). STEAM education thrives on inquiry-based exploration, creative problem-solving, and collaborative learning, all of which resonate strongly with Vygotsky's sociocultural theory. STEAM teachers may make use of Vygotsky's concept of 'Zone of Proximal Development' and scaffolding to design projects with difficulty level slightly beyond students' capabilities, which they can still accomplish on their own, but with little directions and limited support from teachers. Vygotsky stressed the importance of social interaction in collaborative learning, and by use of cultural tools such as languages and artistic media, students are able to shape their learning experiences through cognitive development. The theory emphasizes that cognitive

development is deeply rooted in social and cultural interactions. Children do not learn as isolated entities, but learn through dynamic interactions with others, and thrive in environments rich with social and cultural exchange. These exchanges include verbal communications, shared experiences, and recreational play. STEAM education is far more than mere child's play, it is a purposeful and thought-provoking approach that mobilize creativity, inquiry, and interdisciplinary thinking, and Vygotsky perceived language as fundamental to the development of thought (Jaramillo, 1996). Play-based learning aligns with the core objectives of STEAM education by fostering experimentation and risk-taking, developing problem-solving abilities, sharpening critical thinking skills, igniting curiosity and intrinsic motivation, and promoting collaboration and communication. Shabani, Khatib and Ebadi, (2010) indicated that learning occurs most effectively within the 'Zone of Proximal Development', it refers to what a learner can accomplish independently, and what they can achieve with guidance from a 'More Knowledgeable Other', this other can be a teacher or peer, who has greater expertise to guide the learner; however, this scaffolding support can be temporary. Vygotsky's sociocultural theory offers a valuable framework for informing and enhancing STEAM education within the Hong Kong context. The theory is highly relevant to student-centered and inquiry-based learning, as it supports integration through collaborative projects, scaffolded exploration, cross-disciplinary exchange, and innovation labs. The theory is able to form a base for the development of a localized STEAM education model tailored to Hong Kong's unique context, an area which has never been thoroughly explored by previous educators and researchers in the region.

### ***Constructivist Learning Theory***

The Constructivist Learning Theory posits that learners actively construct their own understanding and knowledge of the world through experiences and reflection. Instead of receiving information passively, learners actively build new knowledge by connecting it with their existing cognitive concepts (Devi, 2019). Two influential theories of the Constructivist Learning Theory are Piaget's Constructivist Theory of Learning and Vygotsky's Sociocultural Theory. The core principles of Piaget's concept emphasized individual cognitive growth through interacting with the environment via the four stages of sensorimotor, preoperational, concrete operational, and formal operational; and by means of schemas, individuals construct mental frameworks that facilitate understanding. Eventually, through assimilation and accommodation, knowledge is continuously reshaped to accommodate new experiences

(Waite-Stupiansky, 2022). Vygotsky's concept fits into the Constructivist Learning Theory by viewing learners as the active constructor of knowledge, and the constructivist principle emphasizes building understanding through experience. With respect to the role of social interaction, Vygotsky believed that learners are the central to learning, and constructivist think that learning is shaped by collaboration. Vygotsky thought that culture influences learners' cognitive development, which is coincide with Piaget's concept, while constructivist considered context is a matter in knowledge construction. Regarding teaching approach, Vygotsky presumed that learning is guided within the Zone of Proximal Development, and constructivist assumed that learners are facilitated over direct instruction. Piaget's point of views can be related to Hong Kong STEAM education by means of stage-based learning. Primary school students can participate in hands-on experiments, such as robot kits, and secondary school students who are in the formal operational stage can involve in coding, AI, and scientific reasoning projects. Both group of students are encouraged to explore and experiment, aligning with Piaget's emphasis of active learning. On the other hand, Vygotsky's theory encourages pairing students with more experienced peers to scaffold learning and stretch their zone of proximal development.

### ***Social Exchange Theory***

In the process of learning and teaching, the teacher-student relationship is built upon open communication, interaction, and trust. The social exchange theory can be used to explore the ways of how teacher-student relationship is established, it can be used as a base for understanding the positive dynamics of teacher-student interactions in the reciprocity of perceived advantages, in the balanced exchange of effort and rewards, and in the equity of fairness from teachers to students (Sun & Sun, 2024). In the reciprocal relationship between teachers and students, students respond with engagement, effort, and respect to teachers' instruction, guidance, and encouragement. Both parties balance the costs of time, effort, and emotional energy for the benefits of scoring high grades and learning successfully. When students believe that their teachers are fair, and their efforts are recognized and awarded, they will be motivated and become more engaged. The relationship is likely to succeed if the perceived advantages outweigh the drawbacks.

Various interviewed STEAM teachers emphasized that they had established strong and affectionate relationships with students in the afterschool STEAM workshops, at where

STEAM teachers and students shared common interest to achieve the same goal and to solve complex problems collaboratively. The relationship of SAP10, ST12 and ST13 with their students are successful examples of positive teacher-student relationship. Students worked fast on their homework to exchange for play time at STEAM workshops, since they did not want to place their respected teachers in silo troubles. On the other hand, STEAM teachers worked vibrantly with students on weekends and holidays to exchange for students' achievements in competitions, and more importantly to gain admissions to universities. A caring teacher who is aware of students' positive or negative emotions will always show students support, so their interest and engagement in science are encouraged (Braxton, 2023). However, Robinson (2022) considered cultivating a positive teacher-student relationship is regarded as a challenging endeavor, it is essential to first understand teachers' motivations, in order to explore 'how teachers' motivated relationship-building behaviors with students are shaped by their underlying motivational beliefs'. Opposing views on the social exchange theory indicates that teachers often feel pressured by principals to prioritize improving students' academic performance and raising test scores. Consequently, they may view investing extensively in teacher-student relationships as impractical (Valli & Buese, 2007).

### ***Resource Dependence Theory***

An essential domain for schools to effectively manage and implement STEAM education in Hong Kong is the provision of financial and resource support from the government and industry sponsors. Through their joint efforts, a resilient STEAM education ecosystem is cultivated in Hong Kong, equipping students to meet future challenges with competence and confidence. The responsibilities of the government, nonprofit organizations, and corporate partnerships are all accounted for education reform success, and through their shared visions, new learning goals can be developed (Howard et al., 2019). The Resource Dependence Theory (RDT) provides a framework for understanding how Hong Kong schools collaborate with external stakeholders to manage their dependence on essential resources for implementing STEAM education. Pfeffer (2003) suggested that through resource dependence, organizations can accrue benefits such as expert advice and access to additional resources from their engagement with external stakeholders. The RDT explains how an organization, such as a school, can pursue success through reliance on government assistance, support from external sponsors, and collaborative network exchanges. Preserving these resources is essential for the organization to survive, expand, and develop with stability (Fiorini et al., 2018). However, the RDT has

multiple drawbacks. Researchers argued that an organization which relies too much on external resources will become vulnerable when access is restricted or withdrawn, especially when the economy is under unpredictable turmoil (Liang & Yang, 2024). Moreover, the organization might lose its autonomy when it over-relies on external assistance, losing its independence and be forced to comply with the requirements of the resource suppliers (Davis & Cobb, 2010). School administration is becoming increasingly complex, since extra strategic management effort is required for cultivating and securing the interdependence relationship with external organizations, and the supplementary resources have to be managed and allocated effectively (Hillman, Withers & Collins, 2009). In Hong Kong, schools are required to submit reports to the EDB detailing how grants and funding are utilized in their schools' STEAM program, as these resources are administered and regulated by the government.

The Hong Kong government sets ambitious goals for STEAM education, the responsibility for implementation is delegated to individual schools, hence creating a power imbalance. Schools are expected to meet government expectations but without guaranteed access to the necessary resources. The resource dependence theory shows that if schools have to rely on outside resources to carry out government policies, the schools have to focus on meeting funding criteria rather than designing programs to meet with students' actual learning needs, it will reduce the schools' autonomy to make decisions and hold back their ability to create and try out new ideas. As a result, the quality and accessibility of STEAM education in Hong Kong are likely to vary significantly across schools, with some offering high-caliber programs while others lag behind. This deepens educational inequality, as resource-rich schools are able to thrive, while under-resourced schools face significant challenges in keeping up. The RDT indicates that surface-level commitment can conceal deeper structural issues within the education system, and institutions are to be constrained by their reliance on limited funding sources (Bennett & Law, 2021)

Drawing on the social exchange theory and resource dependence theory, the establishment of a tripartite framework, comprising school leaders, the Hong Kong government, and external sponsors, can be interpreted as a strategic alliance grounded in mutual support and resource negotiation. The framework demonstrates a cooperative and interconnected supporting structure to strategically incorporate the key domains of leadership and resource provisions into STEAM's implementational system, in order to ensure the program's long-term viable success.

### *Change Theory*

For educational reform, Micheal Fullan's Change Theory is especially influential, Fullan's work is tailored to schools, teachers, and educational systems. His model about initiation, implementation and institutionalization covers every stage of the change process within the educational context, it provides a roadmap for change management in educational settings, from initial adoption to long-term integration and implementation, then to sustainability (Fullan, 2006; Ahtiainen, 2017). The theory fits with the STEAM education reform in Hong Kong, involving a systemic change that requires coherence across schools, districts, and government bodies. It encompasses curriculum redesign, teacher training, infrastructure improvement, and fostering collaboration across disciplines, all of which require cohesive leadership and strategic system-wide coordination. STEAM reform requires educators to embrace innovative pedagogies, leverage technology, cultivate inquiry-driven learning environments, and fostering a culture of collaboration. Fullan emphasizes that meaningful change must be anchored in moral purpose that enhance student outcomes and promote equity. The implementation of STEAM education in Hong Kong reflects this initiative by equipping students to meet future challenges and bridging the gap between traditional education with the evolving needs of modern industries. This aligns with Fullan's vision in prioritizing students' benefits and driving social impact. Hong Kong's education system is hierarchical, but Fullan's concept encourages distributed leadership, empowering principals and teacher leaders to drive change. Fullan's theory navigates complexity rather than avoiding it, as Fullan perceives resistance, diversity and conflict as essential forces for progress. Hong Kong's STEAM reform faces challenges like curriculum overload, uneven teacher readiness, and unequal access to resources, Fullan offers valuable lens to address these issues. At the initiation stage, pilot programs were assigned to selected schools with adequate government funding, and public awareness campaigns were conducted. At the stage of implementation, teacher development training, curriculum integration and resource allocation were executed. At the final stage of institutionalization, STEAM will be embedded into long-term policy, assessment frameworks, and educational culture. The Change Theory is important for understanding the landscape of Hong Kong STEAM education, then evidence-based strategies can be developed.

### *Theory of Change*

In the changing environment of education reform, leaders' roles are 'no longer about persuading followers to follow them into the future, but instead, inviting followers to co-create

the future' (Hill, Canniford & Eckhardt, 2022). The change theory provides a framework for comprehending how changes happen, and how leaders can manage it effectively through Lewin's 'unfreezing, changing, and refreezing' stages (Cummins, Bridgman & Brown, 2016). School leaders, including both principals and teachers, have to get ready for embracing the STEAM educational change in the unfreezing stage, leading followers through the transformational changing stage, and stabilizing the changes that have been accomplished in the refreezing stage. The Theory of Change is frequently adopted in new program planning, evaluation, and strategic planning. Practically, with the help of this theory, a program's beneficial impacts can be more clearly interpreted with evidence, logic, and structure, bringing credibility to the eyes of the IMC, funders, and other stakeholders; it also helps to 'enable communication for changes in the system, and create a ground for the development of a grand strategy' (Jurevicius, 2024). The change theory customizes strategies to align with the unique context of Hong Kong education system, including its exam-oriented culture, diverse student needs, and the government-driven innovation objectives; to engage stakeholders, such as principals, teachers, students, and industry partners; and to achieve the aim of nurturing interdisciplinary thinking, fostering creativity through hands-on learning to prepare students for their future career.

### ***Ecological Systems Theory***

Urie Bronfenbrenner's Ecological Systems Theory posits that a person's development and socialization are influenced by different environments, interconnected within a multilayered and complex web of environmental systems. Individuals are situated in the core and then webbed from inside out by microsystem, mesosystem, exosystem, macrosystem, and chronosystem (Guy-Evans, 2020). As Darling (2007) and Guy-Evans (2020) explained, the microsystem relates to immediate surroundings, such as family, school, neighbors, peers, extracurricular activities, and healthcare providers. The mesosystem corresponds with the interactions between microsystems, such as student-teacher interactions, family-peer group connections, principal-teacher relationship, school-neighborhood interrelationships, and parent-teacher communications. The exosystem is linked to indirect environments, like local government policies, school board decisions, parents' workplace and policies, local community organization, mass media, social media, and extended family networks. The macrosystem resonates with educational policies and standards, cultural values, socioeconomic conditions, technological advancements, and gender roles and expectations. The chronosystem aligns with

time-based changes, such as life transitions and historical events. The ecological systems theory relates to Hong Kong STEAM education in the following ways:

*Microsystem: School and Classroom*

Students' engagement with STEAM is deeply influenced by their direct interactions with teachers, peers, and the learning environment. When educators cultivate supportive relationships with students, and provide them with hands-on learning experiences, students' curiosity, creativity, and confidence to explore and innovate will be ignited.

*Mesosystem: School-Community Collaboration*

Collaborations between schools and local industries enrich students' learning by connecting classroom concepts to real-world applications. Hong Kong's emphasis on interdisciplinary teaching and school-industry partnerships strengthens this approach, integrating pedagogical practice with technological advancement and career readiness.

*Exosystem: Policy and Infrastructure*

Investments in STEAM labs and professional STEAM trainings for teachers are government's policies that influence school resources and capacity, playing an indirect yet crucial role in shaping students' learning experiences. However, the lack of centralized support and clarity in curricular guidelines has posed significant challenges to the consistent and effective implementation of Hong Kong STEAM education.

*Macrosystem: Cultural Attitudes*

Hong Kong's highly competitive academic environment and strong focus on examination performance can influence how STEAM is perceived and executed, either as a valuable creative platform or a potential distraction from core subjects. The integration of A and R, representing disciplines of arts, religion, or reading and writing, into STEM education enriches the learning experience by fostering creativity, moral and ethical inquiry, and textual engagement.

*Chronosystem: Education Reform Over Time*

The transition from STEM to STEAM reflects a profound transformation in educational philosophy, emphasizing creativity alongside technical skills. The emergence of AI and digital

art signals historical changes, and reshapes what STEAM education actually looks like in practice. The chronosystem signifies time-based changes.

The effective implementation of STEAM education in Hong Kong schools is shaped by a dynamic interplay of interconnected theoretical domains, requiring alignment across multiple interdependent areas of practice. Vygotsky's sociocultural theory supports the collaborative and play-based learning; Bronfenbrenner's ecological systems theory account for the influence of family, school, and governmental policies; and Fullan's change theory guide systemic transformation and stakeholder engagement within Hong Kong's education system. Together, these domains form a dynamic ecosystem that supports meaningful and sustainable STEAM learning experiences. Ongoing exploration and strategic partnerships will be essential for deepening and refining these theoretical domains, to ensure that they remain responsive and applicable across diverse contexts, so that STEAM education in Hong Kong may continue to thrive.

#### **6.2.4 Addressing Research Question #4**

STEAM education is exceptionally different from other types of learnings inside a regular classroom, it is both student and teacher-centered, both parties are supporting each other through shared responsibilities, and empowered by the distributed leadership decentralized by principals. The EDB promoted the STEAM program, and all aided, grant, and DSS schools have to comply and execute. Functioning under a new structure with ambiguities, principals, teachers, and students would show reluctances or resistances, as their familiar way of learning and teaching are being challenged.

All stakeholders are striving their ways to fit into this interdisciplinary project-based teaching and learning approach, both parties are supporting each other at the same time through shared responsibilities and distributed leadership empowerment. The whole STEAM implementational system is designed and developed by the EDB, all aided, grant, and DSS schools have to emulate to achieve. Functioning under a new structure with ambiguities, principals, teachers, and students would show resistances or reluctances as a result of their existing beliefs and practices being challenged. The strategic management of STEAM education requires a holistic, balanced, and cooperative approach for school leaders at all levels to develop new methods of teaching, and to alter their inherent thoughts about traditional

education. As final words of this section, School #10, #11 and #13 have the intrinsic privilege of being technical schools, all equipment were available, and they are familiar with technical teaching; therefore, their outstanding performances in STEAM implementation and competitions are unparalleled by other schools, and it is unjust to declare them to be better and more effective than other schools in STEAM implementation. One additional factor is that, although the Hong Kong government have abundant fundings for all schools to apply for acquiring facilities, technical schools have innate privileges that their schools are more spacious than regular schools, so they are able to implement projects in different scales. People might argue that it is inherently unjust to highlight technical schools' success in STEAM without acknowledging the systemic inequities that enable such performance. To the researcher's opinion, it is not unjust to reflect the truth, but it is unjust to stop at the truth. If technical schools are outperforming, they should be called to action. Their success should serve not as a boundary, but as a bridge to elevate STEAM education across all schools. To address the disparities in STEAM education and promote cross-school collaboration, the EDB appointed ST13, who is a highly experienced head teacher from a technical school, to act as a seconded administrative leader to provide mentorship and strategic assistance in planning and executing STEAM initiatives across schools, this does not only encourage knowledge-sharing, but also foster capacity-building.

#### **6.2.4.1 Integration of the 3H Framework of Heart, Head, and Hands**

The development of holistic leadership can be viewed through the lens of the 3H framework of the heart, head, and hands, incorporating 'emotional intelligence, stewardship, strategic planning, controlling, coaching, training, and practical application' (Kelly et al., 2004; Yu, 2021). Within Hong Kong's education sector, emotional intelligence and stewardship lie at the heart of the EDB, school principals, and teachers, driving the authentic connections with their communities. Through the cultivation of empathy and communication skills, they foster collaboration and establish long-term trust. Emotional intelligence is a psychological concept associated with the decision-making and strategic thinking process of the head, (Kelly et al., 2004; Hess & Bacigalupo, 2011), if it is to be applied effectively with change decision management, it may be used as a predictor for success (Chrusciel, 2006). While the heart and head are in charge of the affective and cognitive domains of learning respectively, hands are responsible for the psychomotor domain of learning (Gazibara, 2013). Nicholls (1994) interpreted that, leaders incorporate their heart's inspirational leadership into their head's strategic and supervisory leadership, and their hands' responsive leadership enables them to

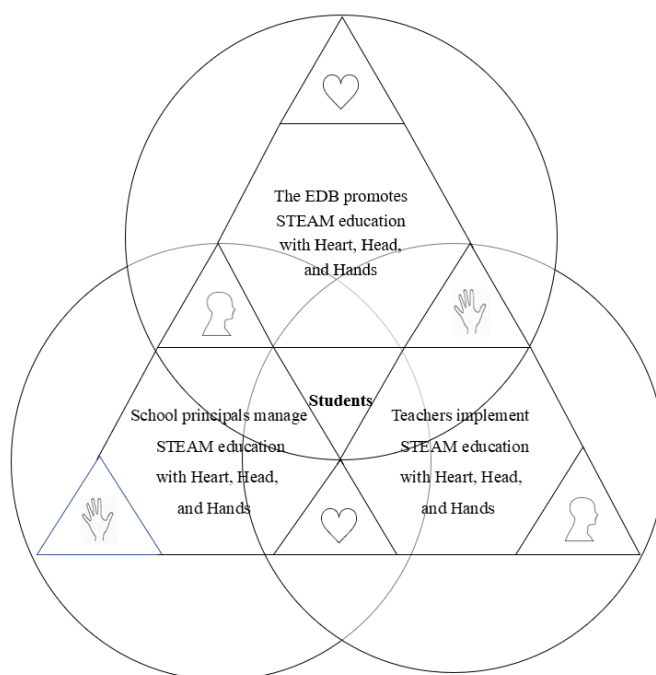
become visionary facilitators. School principals actively engage with teachers, empowering them to perform with autonomy while working towards a shared goal. The current researcher draws a connection between the inspirational leadership of the heart and the strategic leadership of the head as embodied by the EDB and school principals. Teachers in the research play both the roles of educators and learners. They first learn the STEAM skills in the developmental training workshops or from universities where they were educated, and then students learn from them in STEAM classes. On the other hand, students are also both learners and educators, they first learned from their STEAM teachers, and then they shared their knowledge to the elderlies in communities and to their juniors at schools. All members of the STEAM learning community experience personal and professional growth to ‘move from leader competences to the practices of leadership’ (Fisher, 2015). The psychomotor hand skills emphasize experiential learning and knowledge application, both of which are vital in STEAM education. These practical STEAM skills are transferable skills which teachers can bring them along when transferring from one institution to another, students can take these skills with them when promoting to the next grade level, and the general public can bring these skills to their local communities.

While the 3H model is frequently praised for its holistic approach to leadership and education, it has also faced criticism from some scholars. Tan et al. (2021) argued that the model oversimplifies the complexity of human behaviors and interactions, with only three domains being generally categorized, and there are not precise instructions on how these domains are to be balanced and integrated into practice; and moreover, the linear characteristic of the model is not sufficient to address the dynamic and non-linear nature of the real world, as a result, effective implementation can be challenging. Schmidtchen (2024) had raised thought provoking questions about the imbalance of the model: ‘What if a leader only leads with heart, or just leads with hands while the other two domains are missing? Or, the head is not the key player, the leader leads with only basic impulse and personal desire?’. These are the questions that researchers need to rethink of.

In spite of what the arguments are, the current researcher would like to introduce a 3H framework that illustrates the interconnected and collaborative relationship established among the EDB, school principals, and teachers, to demonstrate how STEAM education can be driven by the ‘head’ to promote critical thinking and teacher training, and to redesign the curriculum; guided by the ‘heart’ for empathetic collaboration, arts integration, and building connections with students and the communities; and operationalized through the ‘hands’ to implement project-based teaching and learning, showcase outcomes in exhibitions and join competitions,

and create real-world impact. Effective implementation of STEAM education in Hong Kong schools requires the collective engagement of the heart, head, and hands across the EDB, school principals, and teachers. No single effort is sufficient on its own, success is achieved through the synergy of collective efforts. External sponsors are important for STEAM’s implementation success, but they are not included in this interconnected framework, since there are variances in their supporting purposes and behaviors, and their supports might not be consistent. The Interconnected 3H Collaborative Triple Leadership Framework of the EDB, school principals, and STEAM teachers is shown in Figure 5.1.

*Figure 6.1 The Interconnected 3H Collaborative Triple Leadership Framework*



Both the EDB and individual schools can leverage the 3H framework to foster collaboration and strengthen leadership within Hong Kong’s STEAM education landscape. The EDB use their ‘head and hands’ to create a challenging and inspiring STEAM learning environment for students to strengthen their abilities in preparing for the future. Implementing STEAM effectively in Hong Kong requires supportive educational policies and sufficient fundings, the government needs to have the ‘heart’ to commit in fostering the development of innovation and technology by providing financial support. By using the ‘head’, the EDB plays the leading role in the program’s overall strategic planning, and providing schools with guidance to ensure the feasibility and reliability of the STEAM policies. By means of hands, the EDB takes concrete actions to turn policies into practices, and act decisively to help schools in solving STEAM

implementation problems and to assure the effectiveness of the program. On the other hand, principals use their ‘heart and hands’ to cooperate with the EDB to translate policies into practice by providing students with opportunities to engage in hands-on and project-based experiences. Chances are not confined to schools alone, but also extend into the wider community through externships and mentorship programs. Furthermore, principals use their ‘hearts and heads’ to motivate teachers and students to positively engage in STEAM activities as a team. Teachers use their ‘heart, head, and hands’ to translate STEAM education from theory into practice, turning educational ideals into tangible realities. Above all, students who are positioned at the core of the interconnected 3H framework, are not merely passive beneficiaries within the tripartite leadership structure of the EDB, principals, and teachers; but they are deeply connected to the heart and head domains of these leaders, reflecting shared values, aspirations, and intellectual growth, they play the vital role in driving change. Student-centered advancement serves both as the driving force behind the framework and as the ultimate measure of the STEAM program’s success.

#### **6.2.4.2 From Practice to Theoretical Framework: Mapping the STEAM Ecosystem**

To effectively promote, manage, and implement STEAM education in Hong Kong schools, a holistic approach must not only address leadership for driving success. Besides integrating the emotional, cognitive, and practical dimensions of the Interconnected 3H Collaborative Triple Leadership Framework into the STEAM ecosystem, key influences should also include teacher training, redesigned curriculum, student engagement, supportive infrastructure, multifaceted resources, industry and community partnerships, student enrichment opportunities, and the buy-in of teachers and communities. Leadership can facilitate change, but it is not the primary determinant of success, STEAM education can only thrive through coordinated support and diverse initiatives, not solely under the leadership of empowered principals and teachers. The key influences of STEAM education can serve as a foundation for developing a theoretical framework, which may be conceptualized as an ecosystem model. Identifying the core phenomenon is essential, as each of the aforementioned influential factors can be transformed into conceptual variables within the proposed theoretical model. Following a comprehensive review of existing literature, the researcher developed a robust theoretical framework titled the ‘STEAM Ecosystem Theory’, a novel perspective that has not been examined in prior research. This new theory is inspired by the Ecological Systems Theory of Bronfenbrenner, and weaved with the aforementioned complementary theories of education to form a layered and

interconnected system, wherein students are shaped by the microsystem of their immediate environments.

#### **6.2.4.3 Development of the Emerging Theoretical Framework**

As explained by Kerlinger (1973), a theory is “a set of interconnected constructs, definitions, and propositions that collectively offer a structured understanding of phenomena”. For this research, the theoretical framework is developed through synthesis of related literature, existing educational theories, data collection, conceptual analysis, logical reasoning, and critical reflection, it is evidence-based, testable, systematic, predictive, and with broad applicability. In order to develop a theoretical framework, the core phenomenon has to be first identified, literatures have to be reviewed, key concepts are to be defined, and the relationships among conceptual variables have to be established. A theory should offer a foundational explanation for why phenomena occur and how various elements are interrelated. This is the ‘how’ and ‘why’ behind the observable ‘what’ (Dankasa, 2015; Borsboom, van der Maas & Haig, 2021). The researcher aimed to develop a new theoretical framework in response to an emerging phenomenon within the STEAM education ecosystems that existing theories fail to adequately explain, revealing a conceptual gap in the current literature. The development of a new theory aims to consolidate disparate findings within a unified and coherent framework. To construct a theoretical framework, the researcher needed to start with clear and measurable predictions about how something works, and to uncover the rationale underlying the phenomenon.

#### ***Identification of the Core Phenomenon***

The researcher identified the core phenomenon of the new theoretical framework as follow:

‘The STEAM education ecosystem is shaped by a constellation of interconnected factors, including a shift toward learner-centered pedagogies, the integration of interdisciplinary curriculum design, evolving teacher roles amidst limited training support, strategic industry and community partnerships, ongoing efforts to promote equity and inclusion, alignment with systemic education policies, and the pursuit of sustained student engagement within a culture deeply rooted in high-stakes examinations’.

This phenomenon encompasses how various stakeholders of schools, principals, teachers, students, policymakers, and industry and community partners collaborate to create environments conducive to interdisciplinary, inquiry-based, and future-focused learning.

### *Literature Review on Ecosystem Thinking*

Although interest in STEAM educational research continues to rise, existing literatures remain fragmented across academic disciplines and institutional contexts. Emerging research envisions STEAM as a thriving and interconnected ecosystems of interdisciplinary learning, rather than merely a curriculum model. Scholars have increasingly argued that STEAM should be conceptualized as a dynamic ecosystem, not merely as a curriculum model. This perspective is informed by the ecological systems theory of Bronfenbrenner (1979), which situates learning within nested layers of influence, from individual experiences to broader societal structures. The innovation ecosystem theory further contributes by highlighting the interdependence, adaptability, and co-creation dynamics among diverse stakeholders and institutions (Adner, 2006). Arts education literature further contributes insights into cultural ecosystems. The study of Peppler and Wohlwend (2017) enriches this view by highlighting how culture, personal background, and creative idea expression play a key role in influencing how students understand and integrate arts into STEAM learning experiences. The study of Repko and Szostak (2020) offers a structured methodology for synthesizing insights across disciplines, aligning closely with the foundational aims of a STEAM ecosystem theory. His emphasis on epistemological awareness, complex problem-solving, and systemic thinking provides a valuable scaffold for understanding how the diverse knowledge domains of STEAM can interact within educational settings. In the context of Hong Kong's dynamic STEAM environment, Repko's framework<sup>20</sup> supports the development of cohesive, theory-driven models that move beyond fragmented initiatives toward sustainable, interdisciplinary learning environments.

Despite the widespread of STEAM initiatives across Hong Kong's primary and secondary schools, a significant gap persists in the development of a cohesive theoretical framework. A STEAM Ecosystem Theory tailored to Hong Kong helps to unify fragmented efforts of educators, students, and the governance framework by bridging disparate efforts to promote long-term cross-disciplinary educational reform.

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<sup>20</sup> Repko's framework consists of ten steps for conducting interdisciplinary research, which is outlined in his work 'Interdisciplinary Research: Process and Theory' under The Integrated Model of the Interdisciplinary Research Process.

### *Definition of Key Concepts*

Key concepts play the role as building blocks of the theoretical framework. These concepts grounded in empirical qualitative in-depth interviews, and will be defined to ensure clarity and consistency. The following are the key concepts of the study:

#### *STEAM Ecosystem*

The STEAM Ecosystem is an evolving network composed of stakeholders, resources, and approaches that fosters STEAM learning across both formal classrooms and informal environments.

#### *Facilitating Factors*

It's the structural, cultural, and policy-related factors that facilitate the development of Hong Kong STEAM education.

#### *Interdisciplinary Learning*

Interdisciplinary learning integrates the STEAM elements of science, technology, engineering, arts, and mathematics to solve complex problems.

#### *Capacity and Autonomy of Students*

Students actively take initiative in their educational learning, looking for opportunities, and assuming responsibilities for their growth. They make decisions and reflections on what they learn, how they engage, and why the content is important to them. Their actions are intentional and purpose-driven.

#### *Teacher Proficiency*

Teacher proficiency refers to educators' expertise, pedagogical knowledge, and professional dispositions that enable them to effectively design and facilitate STEAM learning experiences.

#### *Policy Alignment*

Policy alignment refers to the deliberation of coordination and harmonization of policies, strategies, and practices across sectors and governance levels to ensure the consistency, coherence, and collective progress of the Hong Kong STEAM educational system towards achieving common goals.

### *Cross-sector Collaboration*

Cross-sector collaborations are structured collaborations between government entities and private-sector organizations designed to deliver services or infrastructure. These partnerships combine the private sector's creativity, flexibility, and resources with the public sector's regulatory commitment to achieve equitable, socially driven education. They work side by side to bring together their strengths for delivering impactful solutions. Private sector includes educational institutions, industry entrepreneurs, financial institutions, charities, and non-profit organizations. Public sectors include government departments and ministries, public educational institutions, and regulatory bodies.

### *STEAM Education's Sustainability*

It is the ability of the ecosystem to endure and evolve over time, adapting to the changing educational environment and societal needs.

### *Establishment of Relationships among Conceptual Variables*

Relationship establishment theorizes how the key concepts interact for producing and sustaining the core phenomenon.

### *Facilitating factors contribute to the formation of the STEAM ecosystem formation*

With structural and cultural supports like leadership mindset, funding, curriculum reform, and community engagement, laid the foundation for a thriving ecosystem.

### *Teacher proficiency, along with students' capacity and autonomy, contributes to the quality of interdisciplinary learning*

Skilled teachers and empowered students collaborate to shape impactful STEAM experiences.

### *Policy alignment facilitates cross-sector collaboration*

Well-aligned policies attract and foster enduring external partnerships, these cross-sector collaborations contribute to ongoing policy refinement.

### *Interdisciplinary learning plays a crucial role in sustaining STEAM education*

A thriving ecosystem emerges from sustainable practices and drives ongoing innovation.

### ***Construction of the Theoretical Framework***

By interweaving the complementary theories previously discussed with the STEAM Ecosystem Theory, a more holistic and multidimensional understanding of interdisciplinary learning emerges. The theoretical framework is pedagogically grounded in constructivist and sociocultural paradigms, relationally dynamic through the theories of Social Exchange and Resource Dependence, strategically grounded in the principles of the Theory of Change and Change Theory, and structurally coherent through the application of the Ecological Systems Theory. This integrated framework conceptualizes STEAM education not as a discrete approach, but as a dynamic ecosystem, which is responsive to learners, shaped by relational networks, supported by the continuous sharing of resources, and progressively evolving through systemic change.

The emergence of the STEAM ecosystem theory represents a transformative advancement in redefining education as a dynamic and interconnected framework that cultivates creativity, communication, critical thinking, and interdisciplinary collaboration. By conceptualizing STEAM as a holistic ecosystem, integrating schools, educators, students, industry partners, the broader community, and policy makers, the theory moves beyond a traditional curriculum model, but offers a resilient foundation for enduring and impactful educational reform.

#### **6.2.4.4 Theoretical Convergence of the Interconnected 3H Collaborative Triple Leadership Framework and the STEAM Ecosystem Theory**

The Interconnected 3H Collaborative Triple Leadership Framework does not merely reflect the interconnectedness and contributions of the EDB, principles, and STEAM teachers, but it is also characterized by distributed leadership, relational leadership, and participatory leadership of diverse collaborative participants. The framework emphasizes shared visions, purposes, collaborative will, and responsive decision-making. Meanwhile, the STEAM ecosystem fosters a dynamic interdisciplinary learning environment that thrives on creativity, collaboration, and practical application, driven by innovation, inclusivity, and real-world relevance. The integration of the framework and the theory has the potential to generate a learning ecosystem which is transformative, the following table highlight the relationship between the framework and theory and reveal how they theoretically converge and align in practice to create impacts.

*Table 6.3 Theoretical Convergence of the Interconnected 3H Collaborative Triple Leadership Framework and the STEAM Ecosystem Theory, and their Synergistic Impacts*

<b>Interconnected 3H Collaborative Triple Leadership Framework</b>	<b>STEAM Ecosystem Theory</b>	<b>Synergistic Impact</b>
Distributed leadership empowers multiple stakeholders	Foster interdisciplinary collaboration across STEAM fields	Encourages collaborative creation and decentralized innovation
Relational leadership builds trust and shared values	Establish community-driven learning and partnerships	Strengthens stakeholders' engagement and equity
Participatory leadership encourages inclusive decision-making	Encourages student-centered inquiry and experiential learning	Empowers participants to take initiatives to shape their learning environments

The theoretical convergence of the Interconnected 3H Collaborative Triple Leadership Framework with the STEAM Ecosystem Theory has the potential to generate a novel transformative learning ecosystem, leading to the emergence of various interconnected phenomena as follows:

***Ecosystemic co-leadership***

Initiatives are led through the collaborative efforts of diverse participants, dissolving traditional hierarchies and fostering shared ownership.

***Evolving regulatory systems***

Governance networks emerge across schools and communities, forming adaptive structures that guide innovation with agility and inclusivity.

***Balancing innovation with structure***

Balancing innovative inquiry with disciplined implementation enables educational systems to remain forward-thinking and driven by measurable outcomes.

***Collaborative problem-solving across distributed ecosystems***

Collaborative problem-solving across distributed ecosystems is driven by stakeholders' engagement and shared leadership. This context-responsive approach supports the educational ecosystems by responding to local needs, and delivering practical and meaningful solutions.

### ***Activating student participation for transformative education***

Encouraging students to co-construct their own education can help them develop confidence and engage more deeply in solving problems creatively and shaping positive transformation.

### ***STEAM education redefines the learning ecosystem beyond grades and examinations through tripartite collaboration***

Through shared leadership and collective decision-making, the triple leaders can reshape educational culture by promoting learning that values creativity, curiosity, and real-world relevance over students' exam performance.

As the world becomes increasingly complex and fast-changing, the integration of collaborative leadership into the STEAM ecosystems can help Hong Kong to reshape its approach to education, innovation and governance development. By synergizing the Interconnected 3H Collaborative Triple Leadership Framework with the STEAM Ecosystem Theory, the EDB and Hong Kong educators can establish a strategic foundation for building educational systems that are resilient, inclusive and future-ready.

## **6.2.5 Chapter Summary**

Chapter 6 synthesizes the study's findings by validating the evidence and systematically addressing each of the four research questions.

By addressing research question #1, interviewees' perspectives on STEAM education in Hong Kong is explored. Supportive respondents broadly affirmed the value of STEAM in fostering future-ready competencies. Many emphasized its potential to prepare students for the rapidly evolving career environments. SEN and under-enrolment schools highlighted significant challenges in STEAM implementation, requiring tailored strategies and greater support. Perspectives on the sustainability of STEAM education were mixed. While some interviewees expressed concern over inadequate institutional support, lack of recognition for teachers, and imbalanced resource allocation, others perceived STEAM as a lasting global trend which they had already embedded in their long-term school development plans. Some respondents disclosed hidden agendas behind STEAM leadership appointments, such as teachers' career advancement, or the strategic implementation is for survival of under-enrolled schools facing mandatory closure.

Research question #2 explores the key challenges in implementing STEAM education across Hong Kong schools. The chapter outlines the multifaceted challenges facing STEAM education in Hong Kong, key challenges identified include the lack of organized teacher training, insufficient teaching techniques for STEAM integration, deep-rooted mindset of “learning is for high grades”, severe teacher shortage due to emigration, limited interdisciplinary collaboration among teachers, demotivation from navigating complex STEAM programs without support, hidden or unclear motivations for participation in STEAM, language barriers, departmental silos, resource segregation across departments, under-enrolment pressures, and lack of coordinated support from government and stakeholders. Addressing these barriers requires strategic coordination among government, schools and STEAM supporters to build a sustainable and inclusive ecosystem.

Research #3 pinpoint the key domains necessary for the effective launch and implementation of STEAM education in Hong Kong schools which are vital for securing its success and sustainability. Effective implementation of STEAM hinges on strong and coordinated leadership across the EDB, school principals, teachers, and students. The Education Bureau (EDB) must guide strategic direction and operational alignment, while principals and teachers manage complex interpersonal and instructional demands. Student leaders also play a role in fostering collaboration and execution. Leadership approaches are essential to activating STEAM’s interdisciplinary learning model and ensuring inclusive participation. The complementary educational theories provide a multidimensional foundation for STEAM. Their integration supports a coherent framework that aligns theory with practice, enabling schools to address real-world challenges and support students to developing the 4Cs of STEAM.

Research question #4 addresses the strategic and holistic measures that must be developed for effectively promote, manage, and implement STEAM education across Hong Kong schools, ensuring alignment among policy, leadership, pedagogy, and resource allocation. This section introduces the Interconnected 3H Collaborative Triple Leadership Framework as a model for collaborative leadership in STEAM education. It illustrates how the EDB, school principals, and teachers can work together to drive curriculum reform and teacher training by head, foster empathetic collaboration and community engagement by heart, and implement hands-on project-based learning. Building on this practical foundation, a theoretical STEAM Ecosystem Theory is developed. Key influential elements are reinterpreted as conceptual variables within the emerging framework through a structures process by identifying core phenomena,

reviewing ecosystem literature, defining key concepts, and establishing a theoretical convergence of the Interconnected 3H Collaborative Triple Leadership Framework and the STEAM Ecosystem Theory. This convergence offers a transformative lens for understanding STEAM education, revealing interconnected dynamics and guiding future implementation across diverse educational contexts.

## **Ch. 7 Conclusions**

The concluding chapter synthesizes the theoretical contributions, emergent understandings, and strategic directions that have emerged and developed throughout the study. At its core, the research explores how education is evolving in response to a world that is becoming more complex, fast-paced, and globally connected, emphasizing the importance of interdisciplinary thinking, innovation, and collaboration. By situating educational practices within a broader societal and institutional context, the study highlights the need for approaches that are not only inclusive and adaptive, but also capable to foster meaningful connections across diverse sectors and communities. The conclusion does not merely serve as a space for consolidating understandings and perspectives, but also for reflecting on the implications for shaping the future of education.

### **7.1 Contributions of the Study**

Effective leadership in STEAM education extends beyond routine administrative tasks, it requires a multidimensional strategy grounded in educational theory and made receptive to the unique cultural and institutional context of Hong Kong. The aforementioned complementary theories are able to guide school leaders, educators, and policymakers in designing and maintaining impactful STEAM initiatives. By reviewing existing literature, the educational leadership of STEAM education preponderantly focuses on visionary and collaborative approaches that support innovation and interdisciplinary teaching and learning. Findings of the current research revealed that the Hong Kong STEAM educational system entails three crucial roles regarding the EDB, principals and teachers that work collaboratively together to form a triple leadership framework to balance the implementational aspects of the program. The triple leadership framework remains largely unexplored, particularly within the distinctive socio-cultural context of Hong Kong schools. This approach blends traditional leadership skills with innovative strategies, offering flexible and collaborative pathways to address complex challenges, and moving beyond the notion that leadership of one single entity is sufficient for solving current educational problems. The collaborative triple leadership framework has not been identified in existing research on STEAM education or organizational management, particularly within the context of Hong Kong. Therefore, the current research yields valuable contributions of introducing new insights to pioneering knowledge and had laid the groundwork and foundation for future studies of collaborative leadership.

The 3H framework of heart, head, and hands were expanded to form an interconnected framework to link the EDB with Hong Kong principals and teachers. The interconnected 3H framework illustrated the contextual insights of how a change in one part of the framework may impact the other parts. It clearly demonstrates the shared and distinctive characteristics of this relationship. In an education system with diverse culture and schools of different background, there is not a single pedagogical model appropriate to be adopted for providing students with solid STEAM learning experiences. Only the 3H mindsets of heart, head, and hands can inspire the EDB, principals, and teachers to build strong and collaborative relationships by adopting a holistic approach to share their efforts in promoting, managing, and implementing STEAM education.

This research introduces the STEAM Ecosystem Theory, a holistic framework for implementing and sustaining STEAM education in schools, which is an original theoretical framework developed by the researcher. It treats STEAM integration as a dynamic, multi-layered system, and emphasizes the interdependence of leadership, teacher competence, curriculum design, infrastructure improvement, stakeholder engagement, community-partnership, and student-centered learning. The framework positions student engagement at the core, supported by nested environmental systems that reflects ecological and systemic influences. By aligning educational reform with the sociocultural theory, the STEAM Ecosystem Theory offers a robust foundation for transformative practice and policy. The model provides actionable guidance for educators, school leaders, community partners, sponsoring entrepreneurs, and policymakers to explore collaborative strategies for driving meaningful and sustainable educational reform. The framework is proposed as a new lens for understanding the systemic and ecological dimensions of sustainable STEAM implementation in educational settings.

This research provides valuable insights for Hong Kong policymakers to strengthen STEAM education by proactively addressing the current challenges and formally integrating the program into the school curriculum, as advocated by the educators interviewed. Research findings suggested that more specifically-targeted professional development programs are needed for teachers to navigate the transformational changes of STEAM education; but of greater importance, school leaders may not inherently possess strong leadership qualities, especially in STEAM education, so they may also require targeted developmental trainings to cultivate essential leadership competencies to move the STEAM program towards more integrated and cross-disciplinary teaching practices, unbound by traditional silos. These

trainings do not only empower school leaders to make informed and evidence-based decisions regarding STEAM management and implementation, but also enable teachers to respond more swiftly to the rapid and continuous evolution of technology, guided and supported by trusted leaders. The research highlights effective teaching methods and strategies shared by interviewees, offering valuable insights to educators not only in Hong Kong but also worldwide. Currently, the EDB's approach to STEAM education embodies a permissive stance that emphasizes school-level flexibility at the expense of systemic accountability. While such openness may encourage innovation, it also risks deepening inequalities in access, consistency, and STEAM's educational quality. Research discussions suggested the necessity to establish a strategic approach for educators to implement STEAM as a core discipline, instead of treating it as an optional enrichment. The researcher will propose a three-phased strategy in the later Suggestions and Recommendations section for STEAM to integrate more effectively in Hong Kong.

## **7.2 Limitations**

The current research is primarily based on in-depth interviews with a specific group of pedagogical interviewees, which yielded valuable insights. To be precise, the study could be extended to obtain a more comprehensive understanding about STEAM education from a wider population of stakeholders, such as students, parents, and the EDB staff. This expansive interview approach is able to assure that diverse standpoints and holistic perspectives are to be explored, leading to the uncovering of more robust and nuanced findings. The current research is limited to interviewing only twenty-five informants, the small sample size could limit the generalizability of research findings to wider educational ecosystems. The findings might have the chance to be derived from subjective viewpoints and experiences of interviewees, which might not be representative of the general population in academic context. Furthermore, interviewer bias and response bias did occur, the interviewer's unconscious movements might influence respondents' answers. Moreover, participants were found providing socially desirable answers and withholding to share information which they deemed sensitive. Withholding responses were commonly found in principals, especially when came across sensitive topics related to academia, they would choose to skip the discussion and direct autonomously to other areas.

### **7.3 Implications for Future Research**

The progressive development of STEAM education is advancing faster than anticipated, so exploratory studies have to catch up with the rapid evolvement of STEAM knowledge. The following suggestions and directions arising from research findings and gaps will point future researchers to address areas that remain underexplored or insufficiently understood:

#### ***The Interconnected 3H Collaborative Triple Leadership Framework and STEAM Ecosystem Theory***

The unexplored domains of the Interconnected 3H Collaborative Triple Leadership Framework and the STEAM Ecosystem Theory are empirical gaps that future researchers can delve deeper for further study; not restricted to the Hong Kong academic context, but to education systems worldwide. The collaborative triple leadership framework initiates investigations not only within the context of STEAM education in Hong Kong schools, but can be extended to diverse organizations. Furthermore, the triple leadership model is not limited to three individuals, it may extend beyond three, depending on the organizational structure and collaborative needs. Future studies can yield deeper understanding on how the triple leadership concept can triplicate the power and efforts of the group to achieve decided objectives. The outcomes of further studies will be able to confirm the results of the current research, and able to validate the framework's applicability in other contexts.

#### ***The Hong Kong school leadership structure***

The structure of school leadership in Hong Kong has undergone significant transformation over time, as it is influenced by historical progressions and continued evolution of political structures and governance models. Future research is needed to address this knowledge gap.

#### ***Exploring systemic interactions and constraints in Hong Kong's STEAM education ecosystem***

The STEAM ecosystem theory perceives education as not only classroom instructions, but as a complex and adaptive system that involves schools and educators, government and policy makers, industry partners, communities, students, and parents. This theory can be employed for further exploration in systemic interactions, such as the interaction between government policies and school-level implementation of STEAM, and how external partners shape STEAM

opportunities. In cultural and structural constraints, future explorer can exam how the Hong Kong's exam-centric culture affects the ecosystem's capability to promote creativity, and interdisciplinary teaching and learning. In resource distribution and equity, whether all schools are equally equipped to participate in the STEAM ecosystem can be studied. And for the adaptation problem, the ecosystem's response to challenges such as teacher overload, lack of interdisciplinary support, or unclear guidelines and definitions for the 'Arts' in STEAM in Hong Kong can be studied. In view of this, the researcher will propose a research question for future study,

'How do the interdependent components of the STEAM ecosystem interact and adapt to the structural and cultural constraints of the Hong Kong education system?'

### ***A longitudinal study of STEAM-talented students***

A longitudinal study can also be conducted on a sample of outstanding Hong Kong STEAM students who frequently excel in competitions, in order to gain deeper understanding of how these students evolve over time in terms of knowledge, skills, and attitudes towards STEAM subjects and careers. The research will offer valuable insights about the efficacy and long-term effectiveness of Hong Kong STEAM education, consequently will enhance teaching strategies, and facilitate essential modifications to the Hong Kong school curriculum and the educational system.

### ***Exploring STEAM education's role in revealing underrated students' potential***

The perception of STEAM education as a crucial lifeline for guiding underrated students to recognize their potentials and interests in science deserves further exploration, this is an area that was uninvestigated by previous researchers.

### ***Language barriers in dual-language STEAM learning environments***

In bilingual STEAM learning settings where Chinese and English are used concurrently, limited language proficiency may hinder students' comprehension of complex concepts, and restrict their abilities to articulate ideas effectively. Future research should investigate how language barriers influence mental workload, classroom engagement, and overall learning outcome. Strategies, such as scaffolded instructions, bilingual learning materials, or language-integrated pedagogical approaches for bridging linguistic gaps and communication barriers could be explored.

### ***Misaligned mission to use STEAM education to prevent school closure***

The skewed representation of STEAM education for being employed as an instrument to prevent school closure may lead to the misunderstanding of the original objectives of STEAM education, more research should be done on this issue to unveil if there are any effects followed by the misapprehension.

### ***Integration of STEAM education in exam-oriented contexts***

Balancing STEAM education with an exam-oriented curriculum presents a viable, though complex, educational endeavor; however, this endeavor seems to be feasible, since the curriculum integration is already underway as discussed earlier. The EDB has already introduced STEAM-based teaching into primary and junior secondary curricula, making the integration of STEAM education feasible. The government is also pursuing both mass STEAM education and elite STEAM student cultivation. However, there are still challenges to address, including teachers' empowerment in bridging the gaps between exam preparation and interdisciplinary teaching, reformation of the rigid assessment systems, and reframe parental expectations about academic scores. As a result, the researcher would like to propose another research question for future study:

'In what ways does Hong Kong's STEAM education ecosystem navigate the challenges posed by an exam-oriented academic culture?'

### ***Balancing developmental and academic demands between play-based learning and score-oriented parental expectations: A sociocultural perspective***

Vygotsky's sociocultural theory emphasizes the role of play as a crucial tool for fostering cognitive and social growth, especially through guided interaction within a child's zone of proximal development. However, Hong Kong parents prioritize academic achievement, structured learning and academic excellence over exploratory play. A future study to explore how educational practices grounded in Vygotsky's theoretical principles can be reconciled with parents' score-oriented expectations will help to bridge theory and practice. The study will offer valuable insights of how play-based learning can coexist with Hong Kong parents' strong desire to achieve their children's academic excellence. As a result, more balanced educational practices can be introduced to foster holistic child development while cultural expectations are being respected. The study will also help to shape curriculum development, strengthen school-

parent collaboration, and add valuable insights to global discussions on how developmental theory can be applied within education systems that are academically-focused.

#### **7.4 Suggestions and Recommendations**

Over the past years, the EDB had integrated science and technology education separately into the Key Learning Area (KLA) Curriculum of primary schools, placed under the subject of General Studies; and for junior secondary, the EDB placed ‘Information and Communication Technology, System and Control, Technology and Living, Materials and Structures, and Operations and Manufacturing’ under the Technology Education KLA Curriculum, and every secondary school has to allocate 10 to 14 hours per teaching cycle to carry out AI learning (Education Bureau, 2024d). For senior secondary, technology education is elective. Hong Kong’s Technology Education (TE) Curriculum emphasizes four stages: ‘Awareness’, ‘Exploration’, ‘Exploration, Experiencing and Familiarisation’, and ‘Exploring Orientation for Life-long Learning and Specialisation’ (Education Bureau, 2021), which does not align with the core principles of the interdisciplinary and project-based STEAM education that promotes critical thinking, creativity, collaboration, and communication. Essentially, STEAM education covers a broader range of disciplines and skills, whereas the technology education, which is on the Hong Kong school curriculum, is only a component of the wider STEAM educational framework. Therefore, at the in-depth interviews, PP6, PP8, PP9, ST16, PST18, and ST19 proposed strategic directives for promoting the effective execution of STEAM initiatives. According to the educators, the STEAM program should not be treated as an after-school activity or interest class, whereas it should be put into the Hong Kong school curriculum for all primary and secondary schools to implement mandatorily. As a result, principals are able to recruit STEAM head teachers effortlessly to lead the STEAM teams, since the gains of becoming head teachers overshadow the negatives of doing extra work; and furthermore, STEAM head teachers will find much easier to engage teachers in the program without the need to convince and persuade them, since STEAM implementation has become part of their daily duties. Imposing the incorporation of STEAM education into the curriculum not only significantly enhance the learning experience of students, but to assure parents that their children are being well-prepared for future careers. Regardless of the initial period of adjustments, the long-term benefits of formally integrating STEAM education into the educational framework can lead to the academic, societal, and economical advancement of Hong Kong. Moreover, the researcher suggests a ‘fusion of power’ among the EDB, school

principals and STEAM head teachers to create a strong and unified force to enhance STEAM education's effectiveness. The three parties should hold meetings regularly to share information, visions, ideas, updates, and feedbacks from stakeholders regarding STEAM education, not only to ensure that their goals are in sync, but any challenges can be instantly addressed to and possible solutions can be brainstormed.

#### **7.4.1 Recommendations from Educators**

The following recommendations were from 95% of interviewees (eighteen out of nineteen), they recommended ideas for improving the promotion, management and implementation of STEAM education. In general, respondents' recommendations are constructive and noteworthy, and these recommendations can be grouped into three categories.

##### **7.4.1.1. Pedagogical Approaches**

The following approaches are methods and strategies suggested for facilitating learning and teaching:

###### ***Reducing memory-recitation of standard answers***

S2 urged the government to reduce memory-recitation of standard answers in tests and exams of science, and suggested to ask more open-ended questions.

###### ***STEAM education should begin as early as kindergarten***

Both PP3 and PP8 suggested that STEAM education should be started early at kindergartens. PP9 identified a gap in the qualifications of STEAM educators, these trainers themselves were not well-equipped with STEAM knowledge, so the government should enhance professional development trainings for educators.

###### ***Avoid overcomplicating STEM education with non-essential elements***

SAP10 argued that STEM is already good enough, it is not necessary for the EDB to add extra elements to make the term too complicated. STEM education should remain focused and not be overloaded with superficial additions.

### ***Outdated teaching materials should be eliminated***

ST16 recommended that the government should remove outdated teaching materials to facilitate the effective integration of STEAM education into the curriculum. In order to solve the time constraint problem, school #16 has to record some teaching lessons for students' self-study at home, in order to create time for STEAM activities, this practice is strongly opposed by parents.

#### **7.4.1.2 Recommending Actions to the EDB**

The following is a set of actionable recommendations from interviewees to education policy makers:

##### ***Collaboration between higher education institutions and primary schools***

PP3 recommended the government to consider university and primary school partnership to cooperate in executing STEAM projects, partners not only limited to secondary schools.

##### ***Streamline STEAM-related reporting requirements for schools to the EDB***

SP5 and ST14 both asked if the EDB can reduce report filing on schools' progress in STEAM education; it is not only time-consuming, but schools are structurally bound within the EDB's STEAM reporting system. Schools are constrained by a rigid, checkbox-driven framework imposed by the EDB's STEAM specifications, flexibilities and authentic reflections are limited, but instead schools are boxed into compliance-driven documentation. Administrative work should be streamlined.

##### ***Refine the School Nomination Direct Admission Scheme for science-talented students***

PP6 concerned about science-talented students being held back due not to meet the minimum language requirements in the DSE, so they are not able to enter universities. The principal suggested the government to refine the 'School Nominations Direct Admission Scheme' to take in more students who are brilliant in science and STEAM education. ST14 also proposed the government to add extra SNDAS places.

### ***Establish a dedicated university specializing in applied science***

PP8 suggested the government to found a university specializing in applied science, so the entrance criteria can be slightly modified, especially for language requirements. ST11 shared similar view as PP8, as he felt that capable scientists might not be able to master both English and Chinese well, especially boys.

### ***Hong Kong government's interdepartmental STEAM engagement***

PP7 appreciated the current government for providing schools with more resources, so teachers and students are having more learning opportunities; and the principal is in hope to have the opportunity to work with other government departments, such as the Leisure and Cultural Department, so students might acquire experience in botanical studies.

### ***Supportive language tool access for special-needs students***

ST12 suggested the EDB to allow brilliant science students with serious dyslexia using language tools to help communicating ideas, in order not to squander the talents.

### ***Reinstatement of the design and technology course***

ST13 looked forward for the reinstatement of the 'design and technology' course in universities, so more students can be developed into capable STEAM teachers, and universities need to open more STEAM educational courses. ST14 disclosed the fact that many teachers who resisted STEAM education were near retirement age, so they neglected to strengthen their teaching competencies, and they even displayed indifference towards the forced closure of their schools.

### ***Workforce support, equity, and resource allocation***

PT15, the SEN school teacher, advocated on behalf of her schools' janitors and colleagues for a salary increase, highlighting the difficulty in attracting sufficient manpower due to the low wages currently offered. As a result, the responsibility of caring SEN students mostly falls on teachers, limiting their capacity to plan and implement the STEAM program.

### ***Sustaining resources for STEAM program staffing***

ST20 strongly proposes the EDB to allocate dedicated subsidies for schools to recruit STEAM program assistants, enabling STEAM teachers to focus fully on instructional delivery and curriculum development.

### ***Strengthening school-industry links in STEAM education***

Both ST16 and ST19 suggested the government to take the initiative to line up business partners for schools, as they felt that launching STEAM education in Hong Kong was entirely feasible, but to implement effectively, the government must take additional action.

### ***Revamping the educational funding application process***

ST17 suggested the EDB to renew the funding application form, as when they apply for subsidies, the officials assessed costs using outdated records, without accounting for inflation.

### ***Mitigating the outflow of STEAM talents***

ST17 felt that the government was falling short in addressing the loss of scientific talents due to increasing emigration; even if they were graduated from Hong Kong universities, they would still be recruited by foreign companies to work overseas.

## **7.4.1.3 Education Policy and Reform Recommendation**

Educators recommend refining existing education policies and advocate for broader reforms.

### ***STEAM education remains a low priority in certain schools***

PST18 commented that band one schools have shown limited engagement with STEAM education, resulting the program becoming a distinctive feature more commonly associated with band three schools.

### ***Refining the DSE assessment framework***

PST18 suggested that the assessment methodology of the DSE requires adjustment, as students should be evaluated based on subjects aligned with their interests and future study plans, rather than applying a fixed standard across all subjects, some of which may be unrelated to students' future pursuits. ST19 shared similar opinion that students are only permitted to choose two elective courses which they are interested in, students should have more flexibility to choose subjects that align with their personal interests.

### ***Sustaining effective government policies for long-term impact***

PST18 commented that Hong Kong's government policies have long been marked by discontinuity, many well-intentioned policies introduced by the current government will be discarded by its predecessor, a pattern that undermines long-term planning and public trust.

In response to the shortage of qualified staff, the EDB launched a pilot scheme permitting schools to hire STEAM teachers who lack specific training in primary-level STEAM education<sup>21</sup>. A policy report revealed that Hong Kong teachers often lack interdisciplinary training, but are expected to independently design STEAM programs. This growing workload has led to diminished enthusiasm and reduced participation among teaching staff. Many schools face challenges in accessing STEAM-special resources and lesson plans, forcing teachers to invest additional time in preparing interdisciplinary content. This reflects issues of budget constraints or misallocation, where available funding may not be effectively directed towards frontline educational needs (Hong Kong STEM Education Alliance & Hong Kong Federation of Education Workers, 2023).

The current researcher will propose a three-phased strategy for Hong Kong STEAM's integration, if the approach is proven feasible, this could serve as a balanced and pragmatic recommendation for the EDB.

#### **7.4.2 Proposal of Three-Phased Strategy for STEAM Integration**

The three-phased strategic approach provides a clear developmental pathway for schools, moving from foundational readiness to advanced implementation. Each phase is built on the previous one.

##### ***Phase 1: Establish foundational support***

Provide clear guidelines, funding, and professional development to encourage STEAM integration.

##### ***Phase 2: Monitor and scale strategically***

Evaluate outcomes systematically and identify best practices. Basing on these facts and insights, STEAM can be progressively integrated into the core curriculum, starting with pilot schools, and later across broader range of schools.

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<sup>21</sup> Could refer to the EDB paper 'EDB(SLPD)/PL/PEF/1

### ***Phase 3: Institutionalize STEAM education***

STEAM should be made compulsory once adequate infrastructure, sufficient teacher capacity, and curricular alignment are firmly established. STEAM can then be formalized as a compulsory component of Hong Kong's education system, so equitable access and long-term sustainability can be ensured.

If this strategic framework is to be deployed, the EDB is able to motivate all stakeholders of STEAM education to adopt a whole-hearted, whole-headed, and whole-handed approach to implementing STEAM in Hong Kong.

### **7.5 Conclusion**

Throughout the research, respondents' perspectives on STEAM education, along with the complex challenges of STEAM associated with the management and implementation in Hong Kong schools were explored. The key domains leading to successful implementation of STEAM education were investigated, and the study provides crucial insights of how STEAM education could be effectively promoted, managed, and implemented in Hong Kong through the establishment of the interconnected 3H collaborative triple leadership framework; and the building of a resilient STEAM ecosystem that requires more than just infrastructure and policy, but by synergistic relationship among educators, resource availability, and a shared interdisciplinary vision, where innovation thrives through collaboration. The EDB sets overarching policies and strategic directions for STEAM to be efficiently executed in Hong Kong, and it ensures that there are adequate resources, supports, and developmental opportunities to well-equip schools and teachers for STEAM education's effective implementation. School principals play vital roles in converting the EDB's policies into feasible plans by managing resources, coordinating teachers, and fostering the atmosphere and environment for promoting the STEAM initiatives. As natural leaders, they create the culture that values creativity, innovation, and interdisciplinary teaching and learning, they motivate teachers and students to embrace and engage in STEAM activities. Facilitative and delegative leaders who lack familiarity with STEAM education often empower capable STEAM teachers to take the lead in driving implementation, entrust them with autonomy in guiding the process and making key decisions. Front-line STEAM teachers play a pivotal role in directly engaging students, not only by imparting valuable skills and knowledge, but also by patiently guiding them through hands-on project participation. Their efforts reflect the human-centered

foundation of the STEAM ecosystem, emphasizing learning through collaboration, creativity, and guided support. The interconnected 3H collaborative triple leadership framework further reinforces the ecosystem by demonstrating the interdependent relationship among the EDB, school principals, and teachers. Through mutual support and well-balanced dynamic, these stakeholders cultivate an environment in which effective STEAM implementation can thrive.

While artificial intelligence and smart technology persistently dominating the world and the future work force, educators have to stay committed to the belief that, ‘at the heart of education is the education of the heart’ (Ng, 2022). Starting by cultivating the emotional intelligence of the heart, students will be inspired to engage intellectually with their heads to creatively and critically think, and through STEAM education, they will be equipped with practical hands-on skills to connect their learning with real-world applications. The interconnected 3H collaborative leadership approach fosters students’ holistic development, equipping them confidently to embrace emerging challenges and capitalize on evolving opportunities. The STEAM ecosystem reveals a dynamic but bounded framework in which stakeholders operate within a multifaceted and often challenging educational environment. Despite the strategic effort made by the government to promote STEAM education, Hong Kong’s education system is still influenced by exam-centric values, resource disparities, and limited interdisciplinary support. STEAM integration across schools remains uneven, with the program limited to extracurricular activities rather than embedded with core curricula. Viewing Hong Kong’s STEAM education through the lens of the STEAM Ecosystem Theory, there is a need for more coherent policy alignment, equitable access to resources, and cultural transformation that prioritizes creativity and holistic learning. Future research and reform should aim to strengthen the interconnections among key ecosystem stakeholders that enable STEAM education to thrive, not only to integrate STEAM education effectively within the formal curriculum, but also establishing it as a driving force for transformative changes across all educational ecosystems.

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## **Appendices**

### **Appendix A**

## **Voluntary Participation Informed Consent Form**

### **Date of Interview:**

### **Researcher:**

Lee, Tak Man Anna Lisa – DBA candidate of University of Wales Trinity Saint David

### **Contact Information of Researcher:**

Phone number – (852) 93175646

E-mail address: [takie.mandie@gmail.com](mailto:takie.mandie@gmail.com)

### **Research Title:**

Towards Developing a Holistic Management Framework for Effectively Launching STEAM Education in Hong Kong Schools: Challenges and Prospects

### **Purpose of Research:**

STEAM education teaches students substantially more than science, technology, engineering, arts and mathematics, it is an experiential learning pedagogy engaged students in hands-on learning and real-world applications to develop their life-long skills of creativity, critical thinking, communication techniques, collaboration and problem-solving skills. It also benefits teachers in reinforcing their professional development and capacity on interdisciplinary planning and instruction. The Hong Kong Government is keen to promote STEAM education in Hong Kong schools, however recent researches indicated that only a small amount of surveyed Hong Kong teachers regarded themselves as well-prepared for teaching STEAM. Findings even showed that Hong Kong students are degrading in performance of science and mathematics, falling behind other major Asian countries. Hong Kong is facing with three orders of STEAM implementation barriers - first in time, resources, and support, second in educators' beliefs in their readiness for change, and third in curriculum redesign. Many Hong Kong schools are obviously in short of competent STEAM teachers, resources and facilities for carrying out STEAM activities successfully. STEAM education in Hong Kong is mandatory, for successful execution, the education system requires transformation of the original belief and learning culture by promoting collaboration among different stakeholders to enrich the

learning-teaching process. Through the content analyses of survey data obtained from in-depth interviews with supervisors, principals, teachers, STEAM-related pedagogists, and external STEAM program sponsors, the researcher will be able to identify the implementation challenges and the key successful and failure factors. The researcher looks forward to provide more informative and useful data to Hong Kong educational policy makers for addressing the actual needs of STEAM education stakeholders, so as to develop more practical and motivational strategies for promoting this novel education system more effectively.

**Voluntary Participation and Withdrawal from the Study:**

Your participation in the study is completely voluntary and are having the freedom to stop and withdraw from the study at any time according to your own will. You may also choose not to answer certain questions, the researcher respects your autonomy.

**Confidentiality:**

Your name, work place and position held will all be kept as confidential and will not be disclosed in any report or publication of the research. Your identity will only be denoted by a code number. All confidential information and collected data will be kept safely at a secured facility and will be destroyed within a period of time after the thesis is being submitted.

**Signature of Consent:**

**Date:**

\_\_\_\_\_

\_\_\_\_\_

**Participant:**

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自願參與知情同意書

**訪談日期：**

**研究員：**

李德敏 – University of Wales Trinity Saint David DBA 研究生

**研究員聯繫方式：**

電話號碼 –

電郵地址 –

**研究題目：**

建立全人管理架構為香港學校有效地推行 STEAM 教育：挑戰與展望

**研究目的：**

STEAM 教育授與學生的不僅僅是科學、技術、工程、藝術和數學，而是一種體驗式的學習和教學方法，讓學生動手參與學習，然後應用於現實世界中，以發展他們的終身創造力、批判性思維、溝通技巧、協作和解決問題的能力。STEAM 教育還有利於教師的專業發展，加強他們對跨學科的規劃及教學能力。香港政府熱衷於香港學校推行 STEAM 教育，但最近有研究表明，只有少數受訪的香港教師認為自己已為教授 STEAM 而做了充分的準備。調查結果甚至顯示，香港學生的科學和數學成績正在下降，落後於其他主要亞洲國家。香港正面臨三個 STEAM 的實施障礙——首先是時間、資源和支援，第二是教育工作者對準備變革的信念，第三是課程需重新設計。許多香港學校顯然缺乏稱職的 STEAM 教師、資源和設施，而無法成功開展 STEAM 活動。香港的 STEAM 教育是強制性的，要成功執行，教育系統需要通過促進不同利益相關者之間的合作來豐富學與教的過程，從而改變原有的信念和學習文化。通過與校監、校長、教師、STEAM 教育家及 STEAM 課程的校外贊助商進行深入訪談後，獲得的調查數據會經過內容分析，研究員將會瞭解更多 STEAM 在實施上之挑戰，以及識別出執行上的成功與失敗關鍵因素。研究員期望為香港的教育政策制定者提供更多資訊和有用的

數據，制定更實用和激勵的策略，以解決 STEAM 教育持份者的實際需求，好讓此新教學模式得以透有效地推廣。

**自願參與和退出研究：**

您參與研究完全是自願的，您可以根據自己的意願隨時停止和退出研究。您也可以選擇不回答某些問題，研究人員尊重您的自主權。

**保密性：**

您的姓名、工作地點和職位都將會被保密，不會於任何研究報告或出版物中披露。您的身份將僅由代碼表示。所有機密資訊和收集的數據將會安全地保存在受保護的設施中，並將在論文提交後的一段時間內銷毀。

**同意書簽署:**

**日期:**

\_\_\_\_\_

\_\_\_\_\_

**參與者:**

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## **Appendix B**

### **Interview Guide for Supervisors and Principals**

#### **校監及校長訪談大綱**

##### 1. Interviewee Profile and other Demographic Factors 受訪者簡歷

Please provide a short introduction on the position that you are in, the subjects that you had been teaching, year of service in this school, and your current role in your school's STEAM program.

請簡短介紹閣下在校擔當的職位、曾任教的科目、服務年期及在校內 STEAM 課程中所擔當的任務等。

##### 2. STEAM is a mandatory program promoted by the Hong Kong Education Bureau (EDB), what are your perspectives about STEAM launching in Hong Kong?

STEAM 是香港教育局 ( EDB ) 推廣的必修方案，你對 STEAM 在香港推出有何看法？

3. Please introduce how your school's STEAM program work. Is it included in your school's long term development plan? Is it viewed as important to your school?

請您介紹一下貴校的 STEAM 計劃是如何實施的。它是否包含在您學校的長期發展計劃中？它有否被學校視為重要？

4. How did your principal promote the STEAM program to teaching staff and related stakeholders? How does your principal show support to STEAM implementation?

貴校長如何向教學人員和相關利益者推廣 STEAM 計劃？他 / 她如何支援學校的 STEAM 的執行措施？

5. Who is responsible to set the STEAM implementation policy for your school? Who are involved in the STEAM steering and implementation team?

貴校的 STEAM 課程執行政策由誰來制定？哪些人參與了 STEAM 的指導和執行團隊？

6. When STEAM is compulsorily launched at your school, what are the responses of teachers, students and parents? Who is responsible to inform the stakeholders the importance of STEAM to the future society?

當 STEAM 在貴校強制推行時，老師、學生及家長有何反應？誰負責向所有持份者講解 STEAM 對未來社會的重要性？

7. What kind of responsibilities have you taken in the STEAM program? What do you think about these extra workloads? At the beginning, did you have the sense of rejection, or you take things as they come since it is part of your job? Please elaborate.

閣下在 STEAM 計劃中需要承擔哪些責任？您如何看待這些額外的工作負擔？開始時，您有拒絕感，還是因為這是你工作的一部分而順其自然？請詳細說明。

8. Please elaborate how your school's STEAM program work. Is it included in your school's long term development plan? Is it being viewed as important to your school? How does your school develop the STEAM culture at school?

請您闡述一下貴校的 STEAM 計劃是如何執行的。它是否包含在您學校的長期發展計劃中？它有否被學校視為重要？貴校如何在校內建立 STEAM 文化？

9. How do you feel about the inter-disciplinary approach of STEAM teaching? What kinds of implementing strategies and plans are set?

您如何看待 STEAM 的跨學科教學模式？貴校制定了怎樣的實施策略和計劃？

10. What kind of difficulties had you confronted with when the STEAM program launched? Did your principal or the steering team help you to solve the problems, or you have to deal with the challenges yourself? How did they help you?

您如何看待 STEAM 的跨學科教學模式？在 STEAM 計劃啟動時，您遇到過甚麼困難？貴校長或指導團隊有否協助您解決問題，或您必須自行處理挑戰？他們如何協助您？

11. Besides the STEAM trainings provided by EDB for teachers, what other internal or external trainings had your school provided for teachers? What kinds of trainings are they? Are these trainings effective? Please elaborate.

除了教育局為教師提供的 STEAM 培訓之外，貴校有否為教師提供其他的內部或外部培訓？請問是甚麼培訓計劃？這些培訓是否有效？請詳細說明。

12. How do you perceive the collaborative structure of STEAM learning and teaching? Do you have difficulties collaborating with teachers of other disciplines? And what about students? Please elaborate.

您如何看待 STEAM 的學習和教學相互合作之結構模式？您與其他學科的老師合作時遇到過困難嗎？學生又如何？請詳細說明。

13. What is your opinion about collaborating with students to accomplish STEAM projects? Are you opened to accept suggestions or even instructions from students? Please explain your point of view.

老師與學生一起合作去完成 STEAM 項目，您有何看法？您是否願意接受學生的建議，甚至是指導？請解釋您的看法。

14. What kinds of challenging threats had your school encountered in STEAM implementation that will hinder STEAM's successful execution?

貴校在 STEAM 的實施過程中遇到過哪些具有挑戰性的威脅，這些威脅足以阻礙 STEAM 的成功執行？

15. ‘Principals hold key responsibilities in facilitating STEAM success’ – What is your opinion about this statement? Is your school principal like this? Is he/she keen to promote STEAM education at school? Please elaborate.

“校長在促進 STEAM 的成功方面發揮著關鍵作用” - 您對這種說法有何看法？貴校長是這樣的嗎？他 / 她是否積極去推動學校的 STEAM 教育？請詳細說明。

16. What would your principal do to facilitate STEAM success? How does your principal motivate teachers to meet STEAM goals? Or, he/she has great confidence in teachers’ capabilities that they can work independently to achieve the goal, so he/she adopts the hands-off leadership approach? Please elaborate.

貴校長會如何促進 STEAM 的成功？他 / 她會如何激勵老師去實現 STEAM 目標？又或者，校長對老師擁有高度信任，他 / 她會採用不干涉不過問的領導方法，放手讓老師獨自去完成任務？請詳細說明。

17. In STEAM curriculum reformation and transformation, what kind of principal leadership approach do you think is more effective, and why? If STEAM is successfully executed at your school, how would your principal react and act?

在 STEAM 的課程改革及轉型中，您認為校長採用哪種領導方法會較為有效，何解？如果貴校的 STEAM 執行成功，校長會有何反應及行動？

18. How does your school evaluate whether the STEAM implementation goals are met, and how are they measured? Are students encouraged to join competitions, so the accomplished goals can be measured by the amounts of awards received? Or, are the students evaluated by tests? Please explain.

貴校如何評估 STEAM 的執行目標是否已達，以及這些目標如何被量度？貴校會否鼓勵學生參加比賽，由獲獎數量來衡量目標已達？又或者貴校會採用考核方式去評估學生？還是貴校會採用其他方法？請解釋一下。

19. In case goals are not met, what would your principal do?

如果目標沒有實現，貴校長會怎樣做？

20. Does your school have sufficient resources and appropriate facilities for implementing STEAM successfully? What kind of resources are lacked and are mostly needed by your school? What would your principal do to obtain such insufficient resources?

貴校有否足夠資源及適當的設施去成功執行 STEAM？貴校最缺乏及最需要的資源是甚麼？貴校長會如何去尋求這些匱乏資源？

21. Due to the school's limited resources, how does your principal reduce the impact of silo effect occurred from STEAM implementation?

(Prior to STEAM curriculum reformation, each subject was separated and had its own allocated resources. Due to the advent of STEAM, it is inevitable that partial resources of various subjects will be transferred to the STEAM program, hence causing dissatisfaction among other subject subordinates and they might even feel that the principal is unfair)

由於學校資源有限，貴校長會如何減低 STEAM 執行上的筒倉效應影響？

(在 STEAM 課程改革之前，各學科一向各自為政，亦各自擁有被分配的資源。由於 STEAM 的出現，各學科的資源難免會被抽調至 STEAM 課程，因而引起其他學科同僚的不滿，甚至會覺得校長不公平。)

22. How does your principal foster interdisciplinary team collaboration among different subjects in STEAM implementation? How do you maintain a good cooperative relationship with teachers of other disciplines?

貴校長會如何促進不同學科的教師在 STEAM 的執行上合作無間？閣下如何與不同科目的老師維持良好的合作關係？

23. Among the leaderships and management of principals, school supervisors, school incorporated management committee (IMC), and the Education Bureau (EDB), which style(s) of leadership and management approach(es) you would consider to be most impactful to the successful implementation of STEAM, and why?

請問在校長、校監、法團校董會及教育局的不同領導和管理當中，您認為哪些領導風格及管理方式會對 STEAM 的執行成功影響最大？為甚麼？

24. How do you feel about your school's STEAM implementation? Do you consider the STEAM program of your school successful? Please explain. What are the success and failure factors? If you are the team leader, what would you do to improve the program outcome?

閣下對貴校的 STEAM 課程執行有何觀感？您認為貴校的 STEAM 課程成功嗎？請解釋一下。請問有哪些成功及失敗的因素？如果您是團隊負責人，您會如何改善計劃？

25. What kind of suggestions regarding STEAM would you like to make to your principal and EDB?

您會向貴校長和教育局提出哪些關於 STEAM 的建議？

26. Do you think STEAM is a trend or it is a worthy and sustainable program? Why?

閣下認為 STEAM 只是一種短暫的時尚，還是一個具價值及可持續的課程？何解？

27. Do you identify other important particulars about STEAM that we had neglected in our discussion? Please replenish.

在有關 STEAM 的討論中，是否還有被我們忽略了的重要細節？請補充一下。

End of interview. Thank you very much for your participation!

訪問結束。非常感謝您的參與！

## Appendix C

### Interview Guide for Teachers 老師訪談大綱

#### 1. Interviewee Profile and other Demographic Factors 受訪者簡歷

Please provide a short introduction on the position that you are in, the subjects that you are teaching, year of service in this school, and your current role in your school's STEAM program.

請簡短介紹閣下正在任教的科目、在校擔當的職位、服務年期及在校內 STEAM 課程中所擔當的任務等。

#### 2. How important is the STEAM program to your school? Is it highly advocated by the principal, school supervisor and incorporated management committee?

貴校的 STEAM 課程是否被視為重要？是否被校長、校監或法團校董會大力提倡？

3. Who is responsible to set the STEAM implementation policy for your school?

貴校的 STEAM 課程執行政策由誰來制定？

a) Incorporated management committee?

法團校董會？

b) School supervisor?

校監？

c) School Principal?

校長？

d) Teaching staff?

教學人員？

e) Others? Please specify.

其他人士？請具體說明。

4. Were you well in-formed by the principal about the STEAM program before it launched at your school?

在貴校的 STEAM 課程實施前，閣下是否已被校長充分告知實況？

5. Does your school develop a conducive STEAM culture, which engages principals, teaching staff, students and other key stakeholders such as parents and external sponsoring bodies, aligning them all to achieve the program goals? If yes, who promoted this STEAM culture at school?

貴校有否建立有助益的 STEAM 文化，好讓校長、教職員、學生及其他  
關鍵利益者如家長及外部贊助團體等共同參與，一起實現課程目標？  
若有的話，由校內何人推動此 STEAM 文化？

6. How do you feel about the STEAM program implementation at your school?

閣下對貴校的 STEAM 課程執行有何觀感？

7. Does your school develop an effective program structure by setting clear strategies, development policies and action plans for the STEAM program, with clearly written policy statements, mission for all, and measurable goals?

貴校有否制定有效的 STEAM 課程結構綱領，設定清晰的策略、發展方針及行動計劃，包括明確寫下政策聲明、各人之任務及可衡量的目標等？

8. How does your school set strategies and implementation plans for STEAM so it can be scheduled and well-translated into actionable projects? Does your school form a designated steering committee for STEAM implementation? How does it work?

貴校如何為 STEAM 制定策略和實施方案，有計畫地將構思轉化成教學行動？貴校有否成立一個由指定人員組成的指導委員會？它是如何運作？

9. Do you have a clear vision and sense of purpose towards STEAM? What are your roles and responsibilities in the STEAM program?

閣下對 STEAM 有否清晰的願景和目標感？在 STEAM 課程內，閣下肩負哪些任務及責任？

10. What kind of relevant skills are you equipped with to act in concert with the school to go through the process of STEAM launching and curriculum transformation?

閣下具備何種相關的技能來配合學校去推動 STEAM 及進行課程轉型？

11. What kind of professional development trainings had you received in order to implement STEAM program effectively? Were they provided internally or externally? Are you mandated to attend such activities or on a voluntary basis?

為了有效地實施 STEAM 課程，閣下接受了哪些專業發展培訓？是校內的，還是校外的？是強制規定要參加，還是屬於自願性質？

12. Does your school adopt the inter-disciplinary approach, multi-disciplinary approach, or trans-disciplinary approach for integrating STEAM into learnings? Has your school's traditional subject-siloed mode been dismantled by the cross-disciplinary collaboration of STEAM implementation? How does your school design the STEAM program?

貴校是採用跨學科方式、多學科圍繞同一主題方式，還是超學科方式去進行 STEAM 課程的整合？貴校的傳統筒倉學科模式是否被這種 STEAM 的跨學科合作形式所打破？貴校如何設計 STEAM 課程？

13. Does your principal or school supervisor actively involve in the design of STEAM program, such as soliciting new ideas or proposing new

implementation methods? If yes, please specify what your principal or school supervisor had done.

貴校校長或校監是否積極參與 STEAM 的課程設計，例如徵求新思維或建議新的執行方法？若是的話，請具體說明貴校校長或校監曾參與的工作。

14. Would your principal or school supervisor pay attention to teaching staff's individual concerns, such as your deficiency of teaching efficacy in STEAM implementation due to insufficient cognition of this new model of education? If yes, what kind of support and inspirational motivation would your principal or school supervisor provide?

貴校校長或校監會否關注教學人員的個人擔憂，譬如大家對 STEAM 這種新型教育模式認識不足，因而導致教學效能匱乏？如果會，貴校校長或校監會如何給與支持及鼓勵？

15. Does your school have sufficient resources and appropriate facilities for implementing STEAM successfully? What kind of resources are mostly needed by your school?

貴校有否足夠資源及適當設施去成功執行 STEAM 課程？貴校最需要的資源是甚麼？

16. What kinds of effective control measures does your school apply to ensure the successful implementation of STEAM program? For instance, your principal would regularly monitor the program progress by meeting with the vice principals and teaching staff to collect performance data for comparing with targets. Please further explain.

貴校對 STEAM 教學設置了何種有效的監察及管控機制? 例如校長會定期與副校長及教學人員會面、監測課程進展及收集工作數據來與預定目標作比較。請進一步闡述。

17. Does your principal manage the school's STEAM program by exception to focus on identifying implementation mistakes and standard deviations, so problematic issues can be detected rapidly? Please provide examples.

貴校校長是否會運用例外管理，專注於識別 STEAM 課程的執行錯誤和標準偏差，以便能快速地發現問題的癥結？請舉例子。

18. Does your principal or school supervisor manage the school's STEAM program by adopting a hands-off approach and allow teaching staff to make STEAM implementation decisions? If yes, is the approach effective? Please further elaborate.

貴校校長或校監會否採取不干預的方式來管理學校，並允許副校長及教學人員去為 STEAM 的執行方式來做自行決定？如果會，校長或校監的不干預管理方法是否有效？請進一步詳細說明。

19. Would there be contingent rewards or special recognition given to teaching staff if STEAM's performance goals are achieved? How would it be fulfilled?

如 STEAM 的執行表現達標的話，學校會否給與教學人員後效獎勵或嘉許認可？若會的話，請問會以何種方式履行？

20. What kind of challenges had you encountered during STEAM implementation that might affect the effectiveness of the program? Please give some examples.

閣下曾否碰上 STEAM 的執行上困難，以致影響課程的成效？請列舉例子。

21. Does your principal involve in solving the STEAM implementation problems, or he/she trusts the capability of teaching staff as they can handle the difficulties independently? Please further elaborate.

貴校校長會否參與解決 STEAM 的執行上問題，還是他/她會相信教學人員有足夠能力去獨立處理困難？如果校長會參與解決問題，他/她會採用哪些有效的策略？

22. How does your principal foster interdisciplinary team collaboration among vice principals and teaching staff for STEAM implementation? How do you maintain a good cooperative relationship with teaching staff of other disciplines?

貴校校長如何促進副校長及不同科的教學人員在 STEAM 的執行上合作無間？閣下如何與不同科目的教學人員維持良好的合作關係？

23. Among the leaderships of principals, school supervisors, school incorporated management committee (IMC), and Hong Kong Education Bureau (EDB), which leadership(s) is/are most impactful to the successful implementation of STEAM? Why?

請問在校長、校監、法團校董會及香港教育局的不同領導中，哪些或哪種領導方式對 STEAM 的成功實施影響最大？為甚麼？

24. Do your principal and school supervisor play active roles in providing your school directions and implementing plans for STEAM? Do they make suggestions to EEB for improvement? If yes, what kinds of plans and suggestions had they made?

貴校校長及校監是否積極為 STEAM 提供計劃方向和執行指導？他們有否向香港教育局提出改善建議？若有的話，他們曾提出何種計劃及建議？

25. Overall speaking, do you consider the STEAM program at your school successful? What are the success and failure factors? If you are the team leader, what would you do to improve the program outcome?

整體來說，你認為貴校的 STEAM 課程成功嗎？成功和失敗的因素是甚麼？如果您是團隊負責人，您會如何改善計劃？

26. Do you think STEAM is a fad or it's a worthy and sustainable project? Why?

閣下認為 STEAM 只是一種短暫的時尚，還是一個具價值及可持續的課程？何解？

27. To recap, three important dimensions about strategies, execution and leadership had been discussed in the interview, they are considered as the key determinants of STEAM program's success and failure. Do you identify other determining factors that we had ignored? Please replenish.

回顧一下，採訪中討論了三個重要方面 - 戰略，執行和領導力，它們被認為是STEAM計劃的成功與失敗決定因素。除此之外，是否還有其他被忽略了的因素？請補充。

End of interview. Thank you very much for your participation!

訪問結束。非常感謝您的參與！

**Towards Developing an Interconnected 3H Collaboration Triple Leadership Framework and the STEAM Ecosystem Theory for Effectively Promoting, Managing, and Implementing STEAM Education in Hong Kong Schools**

**Correction List**

<b>External Examiner Prof. Robin Snell's Remarks</b>		<b>Corrections</b>
	Chapter 1	
1	There are a few ungrammatical passages to clear up.	Done. Ungrammatical passages had been cleared up throughout Chapter 1.
2	It would be useful to have a glossary of ST(R)EAM-related terms of what each initial stands for.	Done. Each initial of STEAM and STREAM is explained in the List of Acronyms on p. xii.
	Chapter 3	
3	What are the ontological and epistemological assumptions of the study?	The previous Ch.3 is now Ch.4. The ontological assumptions of the study was added into 4.1.1 on p.49. The epistemological assumption of the was added into 4.1.2 under Epistemological Underpinnings on p.50
4	How is it possible to be objective when the researcher is an active participant?	This question is answered in the last paragraph of 4.3.2.1 Research Ethics on p.54.
5	On page 49, it wasn't clear if there were prior studies of STEAM in Hong Kong.	P. 49 is now P. 52. The phrase 'scarcely studied' was changed to 'deliberately studied'.
6	Two sets of interview guides - how was the sample divided?	The answer to this question is on p.53. The researcher explained that one set is for 'supervisors and principals', and the other set is for 'teachers'.
7	How do you distinguish between purposive and representative sampling?	The answer to this question was on p.56 and p.57, under Selection of Sampling Strategies, near the end of p.56, and the first few lines of p.57.
8	What is your position in relation to manipulative dialogue? (see page 55)	Page 55, is now p.59. My position in relation to manipulative dialogue is elaborated near the end of 4.3.5 Interview Method.
9	How did you combine inductive and deductive coding?	The method of combining inductive and deductive coding was explained on p.61, in the middle section of 4.4.1, under Transcription, Coding, Theming, and Categorization.
10	Is your sample too narrow for contextual analysis?	The research adopted the method of thematic analysis, the sample size is good enough for reaching thematic saturation.

	Chapter 4	The previous Ch. 4 is now Ch. 5.
11	On pages 61 to 62, it's not clear how many were interviewed.	25 educators were interviewed. Table 4.1 Profiles of Interviewees on p. 66 was reconstructed with interviewee number added. The list of schools is anonymous without school names, but were characterized by individual school number assigned by the researcher.
12	How they were interviewed, in solo, in a pair, or in trio?	How respondents were interviewed was clarified on p.69, in 4.6.6 In-depth Interviews.
13	Should the RQs on p.66 be numbered 1-4 rather than 5-8?	The research questions are now on p.70, and should be numbered 1-4.
14	On page 67, the research stages are unclear and ambiguously defined.	P.67 is now p.71. The three stages are clearly segmented, and each is having a definition for better clarification.
15	On page 85, the comments about parents' views of STEAM teaching are not based on direct data.	Yes, the data is from the peer-reviewed literature of Gamet (2014), and Cheung and Tsang (2023). Parents were not invited to participate in the interviews of this research, thus leaving room for future studies.
16	Regarding pages 91-103, It might be better to organize the material into themes rather than just have the stories presented one by one.	The pages are now from 98 - 110. All the stories are now organized into themes, presenting individually under specific titles.
17	What is meant by 'Hong Kong's unique characteristics and traits'? (on p.105)	The meaning of this phrase is now on p.111, in the last paragraph just above the 5.1.4 section about Challenges of Hong Kong STEAM Education. The original phrase had been taken away, and was replaced by examples, such as high-stakes testing and rigid curriculum.
18	Page 107. Is it possible to strike a balance between STEAM and the conventional curriculum in the face of such overwhelming pressure from exam culture?	P. 107 now becomes p.114. This question lays the groundwork for future research; but by the mean time, this issue will be discussed further in later chapters.
19	Page 110. What is R and what is A?	The interpretation regarding the R and A is now on p.117. R in school #11 stands for religion, and the A stands for arts.
20	Page 116. First quote: please clarify, is this ST11 or ST13 being quoted?	This quote is now on p.123, and was corrected to being cited by ST13.
21	Page 121: 'if the program was in the Hong Kong school curriculum, no teachers would <u>likely</u> complain. I suspect some people complain nonetheless.	The sentence is now on p.129. It had been changed to: 'if the program was officially included in the Hong Kong curriculum, objections would likely decrease'.
22	Page 121-127 on Principal Leadership, recap some references at the top of page 122.	Principal Leadership is now on p.129. Four references were recaped in the paragraph above 5.1.5.1 Principal Leadership.
23	Page 124, 5th paragraph, it should be empowering leader rather than autonomous leader.	The paragraph is now on p.132. Correction had been made to change from 'autonomous' to 'empowering'.

24	Pages 135-137. It seems that abundant government funding for facilities is there for people who have sufficient know-how to obtain it. [In which case, why carp later about the 'unfair' advantage of the technical schools?"]	This phenomenon was explained later in 6.2.4 Addressing Research Question #4 on p. 182.
25	It seems that what is not sufficiently funded may be teaching staff levels. Or is this a problem of poor resource allocation within some schools?	This is not solely a poor resource allocation problem, whereas teacher shortage due to relocating abroad is also a problem (explained on p.161). Overall speaking, Hong Kong does not have enough teachers.
26	Pages 138-140. The recommendations by the interviewees are presented one-by-one. Is there any way of categorizing or clustering them?	The recommendations section was moved to 7.4.1 Recommendations from Educators on p. 202. These recommendations were categorized into three clusters: 7.4.1.1 Pedagogical Approaches, 7.4.1.2 Recommending Actions to the EDB, and 7.4.1.3 Education Policy and Reform.
27	Page 139. What is meant by the interviewee's comment that "schools are deadly framed within the EDB's STEAM specification".	This phrase on p.139 had been manipulated and was moved to p.203, being put under 7.4.1.2 Recommending Actions to the EDB - Streamline STEAM-related requirements for schools to the EDB.
	Chapter 5	
28	Page 144. "...may even have causal relationships..."	Page 144 is now p. 151. The sentence was changed to "Several identified empirical factors exhibited intercorrelations, with some demonstrating causative relationships that influenced one another.
29	In <i>perspectives of schools</i> row: "80% of these respondents"	The word "these" was taken away. (p.151)
30	On page 149, you mention several concepts derived from Vygotsky. There seems to be no theory of STEAM, but these ideas seem to be a very good basis for one. Do Hong Kong educators know about them?	P.149 now becomes p.156. Vygotsky's concepts was one of the complementary theories that contributed to the development of the STEAM Ecosystem Theory. The current researcher had reviewed literature during August 2025. Hong Kong educators who studied about STEAM seemed not to realize Vygotsky's concepts.
31	Page 149, last two lines, what is meant by "STEAM education is able to draw out the AI thinking skills"?	P.149 now becomes p.156, the researcher had taken away this sentence, since How and Hung (2019) did not explain either; therefore, the researcher did not want to make a wild guess.
32	The text on pages 148-152 could be made to align more explicitly to the points made in Table 5.1.	Pages 148-152 has now become pages 155-159, and Table 5.1 is now Table 6.1. The texts had been modified to align more explicitly to the points made in the table.
33	Page 153, just below middle. This is the second mention of an apparent embargo on recruiting newly graduated students from the PGDE programme. A bit shocking! Can one trust EDB to make reasonable and fair policies?	P. 153 now becomes PP.160-161. The researcher had deliberately taken away this sentence. As discussed with Prof. Snell during viva, if the researcher is not able to have triangulators verifying this point, it is better to be eliminated.
34	Page 157. What are the 4Cs of STEAM?	P.157 is now p.166. 4Cs is on the first line. It represents critical thinking, communication, collaboration, and creativity. 4C is now placed in the List of Acronyms.

35	Page 160 top: Please explain 'instrumental-rational' and 'agonistic-political'.	P. 160 is now p.167. The terms are found in the first two lines under the title 'Governance Leadership of the Education Bureau'. The researcher had refined the sentence to provide meaning for 'instrumental-rational' and 'agonistic-political'.
36	Page 160, on Governance Leadership of the Education Bureau. The provision of their programme is all very well (done) within the circumscribed patch of STEAM, but it appears that the broad educational system remains largely unchanged. The fish is being released into a non-benign pond environment.	P.160 now becomes pp. 167-168. Suggestions for addressing this issue is found in Ch. 7, under 7.4.1.2 'Recommending Actions to the EDB'.
37	Page 161. It seems that the principals are more often than not perceived as a positive force, but they are facing a very challenging context unless EDB gets away from the "education for points" mentality?	P. 161 now becomes pp.168-169, under Principal Leadership. This mentality is hard to be taken away within a short timeframe. The EDB has to adopt the small-step approach, since the 'education for points' is part of Hong Kong's societal culture, which is deeply rooted in the beliefs of parents and students.
38	Page 161. What are the "Sons of the Asteroids"?	P.161 is now p.169. The meaning of the "Sons of the Asteroids" is explained in footnote #19 at the bottom of p.169.
39	Page 162. Your characterization of the principals as "mixed leaders" is an "optimistic take" - but is it just a "coping" strategy?	P.162 now becomes pp.169-170. Mixed leadership is a coping strategy, which is well-explained in the last paragraph of Principal Leadership on p.170.
40	Pages 162-164. There are a number of examples of enthusiastic teachers leading their own STEAM programmes, albeit at some risk of burnout. Could this be a phenomenon of bounded distributive leadership?	PP.162-164 have now become pp.170-172. Risk of burnout for teachers could be a phenomenon of bounded distributive leadership, provided that they do not have adequate support from principals, with insufficient training, without genuine collaboration, their core teaching load is not adjusted, and autonomy is limited as they are bounded. The distribution is hence required to be thoughtfully designed and considered by the principal.
41	Pages 164-165. This material on student leadership might also be related to "bounded distributive leadership", where enthusiastic teacher leaders foster student leadership among some students.	Student leadership is now on pp.172-173. The researcher had explicated that student leadership is situational since they are still under the guidance of teachers and institutional frameworks. As explained in the last paragraph of student leadership, striking a balance between autonomy and accountability within the teaching and learning environment is essential. This line applies to both the bounded distributive leadership of teachers and students.
42	Page 166. Could you consider providing a more critical assessment of Resource Dependency in relation to the HKSAR government? If the government has some basic requirements or expectations for STEAM, shouldn't it by itself provide sufficient funding to meet these standards?	The Resource Dependence Theory is now on p.176. The critical assessment of Resource Dependency in relation to the HKSAR government is on p.177. Providing sufficient funding to meet the EDB's expectations for STEAM is complicated, since not all legislators who approved or going to approve the funding requests are advocates of STEAM.

43	Page 167. Why is it unjust to reflect what might be presented as "the truth" about technical schools' superior STEAM performance? Wouldn't it be better to provide other schools with sufficient facilities and frameworks to improve and level up their STEAM education?	P.167 is now pp.181-182. The answers to the questions are well-articulated in the paragraph on p.182, above the title of 6.2.4.
44	Page 168. Why, in the text on page 168, are the heart and head domains not also associated with the teachers and students? Indeed their role in HHH is actually shown in Fig. 5.1!	P.168 is now p.185, and Figure 5.1 has become Figure 6.1. In the top paragraph of p.185, near the end, it says: "students who are positioned at the core of the interconnected 3H framework, are not merely passive beneficiaries within the tripartite leadership structure of the EDB, principals, and teachers: but they are deeply connected to the heart and head domains of these leaders". That means students' heart and head domains are associated with the EDB, school leaders, and teachers in driving STEAM changes, not just with teachers alone.
<b>Internal Examiner Prof. Peter Fong's Remarks</b>		<b>Corrections</b>
	Abstract	
1	The abstract lacks a clear structure and should be organized into - background, aims, objectives, methodology, findings, and conclusion.	The abstract had been rewritten according to Prof Fong's advices.
	Chapter 1 Introduction	
2	The research problems, aims, objectives, research questions should be linked in a logical sequence in one section. They might be shown in a figure or chart format indicating their relationships.	The research problem, research aims, research objectives, and research questions were linked in a logical sequence by having them shown in a table. The Table 1.1 is on p.12.
	Chapter 2 and Chapter 3	
3	It's too lengthy and should be divided into two chapters 2 & 3.	The researcher followed Prof. Peter Fong's instructions to divide five chapters into seven chapters. Please see the revised Table of Content on pp.vii - ix.
	References:	
4	Ensure consistent font size and style throughout the thesis.	Consistent font size and style are ensured throughout the thesis.
5	Ensure all in-text citations have corresponding entries in the reference list.	All the in-text citations were thoroughly checked to ensure their correspondence with the reference list.
6	Check missing publication years or other information in the references.	The references were carefully checked.
	Language and style:	
	a. Structure and logical sequence:	
7	Ensure that each section logically follows from the previous one.	Yes. This is ensured.
8	The introduction jumps directly into STEAM education without providing a broader context. May be better to add a brief overview of the current educational landscape in Hong Kong.	In the Introduction chapter, the researcher had written the overviews in the following order: 1.1 Background of STEAM Education 1.2 Hong Kong STEAM Education 1.3 The Hong Kong Education System and Inherent Educational Culture

9	Use more active voice throughout the document to improve clarity and directness. Reduce the use of long and complex sentences.	These areas had been addressed to in accordance with Prof. Fong's advices. The complex sentences are broken down into simpler ones for clarity.
	Punctuation:	
10	Ensure consistent use of punctuation marks, especially commas and periods.	The proper use of punctuation marks were ensured.
	Redundancy:	
11	Remove redundant phrases and sentences to improve readability.	Redundant phrases and sentences were eliminated or revised throughout the document for readability.
12	Examples of errors and suggested corrections.	Had proceeded with the suggested revisions to address errors throughout the document.