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Visual Arts Teachers' perception on STE(A)M education to enhance students' creativity

Submitted by

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Declaration

I, **Tse Chit Yi**, declare that this research report (*Teachers' perception on integrating Visual Arts into STEM education to enhance students' creativity*) represents my own work under the supervision of **Dr. Wong So Lan** and that it has not been submitted previously for examination to any tertiary institution.

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11 April 2021

Abstract

The Hong Kong Education Bureau has only introduced STEM education, yet many schools incorporate Arts into STEM and implement STE(A)M education. Therefore, this research aims to explore visual arts teachers' perceptions on implementing STE(A)M education and how they implement it. Qualitative research is the main methodology of this research and a semi-structured interview was held with two visual arts teachers that have participated in the implementation of STE(A)M education and their teaching strategies, opinions and students' products were collected. The research found out that the implementation of STE(A)M giving a positive result on students' creativity, but the implementation process insists a lot of obstacles. Teachers need more professionals training which schools and the Hong Kong educational bureau to strengthen teachers' understanding of STE(A)M and increase the opportunity of STE(A)M education by offering more professional workshops and courses.

TABLE OF CONTENTS

Chapter 3: Methodology

Chapter 4: Findings and Analysis

Chapter 5: Conclusion and implementation

List of Table

List of Figure

Chapter 1: Introduction

1.1 Background

In the 21st century, students are grown up in an information and technology world which brings great influence on their lives, for example on how they work and communicate. In order to tackle the challenges provoked by information and technology development, we need to improve our education curriculum to cultivating more talented students. Therefore, most countries have implemented STEM education, allowing students to engage in science, technology, engineering, and mathematics, in a bid to improve their achievements (Scott, 2012). Most of the educators call for using an integrated approach to STEM education which is more applicable to the real world (Honey, Pearson, & Schweingruber, 2014). Therefore, the Hong Kong Education Bureau (2016) has introduced STEM education which aims to enhance students' interest in science, technology, engineering, and mathematics and equip students with necessary knowledge for their future.

However, as mentioned above, from 21st Century Minds (21CM) Accelerator Program, the ability to think smart and creatively, solve problems, persist, take risks, have strong digital skills and know how to collaborate effectively' are the aims for children to prepare for their future jobs (PricewaterhouseCoopers, 2016), the visionary science educators have recognized the limitations of STEM in developing students'

higher-order abilities, they team up with their colleagues in the arts learning areas to design innovative interdisciplinary STEAM curricula and teaching approaches (Root-Bernstein, 2008; Sousa & Pilecki, 2013) to raise students' creativity. The combination of science and art as STEAM Education can create a creative and scientifically literate workforce for the 21st Century (Boy, 2013).

Under the context of educational policy, the STEAM conversation has spread across the United States and some other countries (Eger, 2015). Looking into the learning environment in Hong Kong, a few schools try to take STE(A)M education which involve arts as extra curriculum activities. As Hong Kong's educational system only introduce STEM education for a few years, the curriculum resources for Visual Arts teachers to handle STE(A)M education with Arts is limited. Besides, following the worldwide trend, Visual Arts teachers in Hong Kong are expected to take part in STE(A)M education as STEAM might be a new emphasis on education to foster creativity. Therefore, this dissertation will focus on Visual Arts teachers' perceptions on implementing STE(A)M education and the necessity of implementing STE(A)M education in Hong Kong when the EDB only introduce STEM education. Besides, the research will investigate the methods for Visual Arts teachers to implement STE(A)M education to enhance students' creativity.

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1.2 Research Objectives

This research will explore the views of implementing STE(A)M education from the perspective of Visual Arts teacher and their teaching strategies to enhance students' creativity. Furthermore, it will analyze the possible challenges that might be faced during the implementation by Visual Arts teachers. The aim of this research is not only to provide a reference for other Visual Arts teachers or pre-service Visual Arts teachers, who may become one of the responsible teachers to handover the STE(A)M project, to enhance their understandings on how to handle STE(A)M education in schools, but also to explore how teachers can help students to be more creative after integrating Arts into STEM education.

1.3 Research Questions

1. How do Visual Arts teachers perceive STE(A)M education?
2. How can Visual Arts teachers implement STE(A)M education to enhance students' creativity?

Chapter 2: Literature Review

In order to understand Visual Arts teachers' perceptions on integrating Arts into STEM education to enhance students' creativity, the literature review will discuss the opportunities and obstacles of implementing STE(A)M education. Besides, the 4P creativity model will be used to understand the strategies of curriculum implementation to enhance students' creativity.

2.1 STE(A)M education

STE(A)M education means integrating Arts into STEM education in the way to improve student's achievements. Numerous researches have proved that arts and STEM subjects show a positive result in improving student engagement, creativity, innovation, problem-solving skills, and other cognitive benefits (Hetland & Winner, 2004; Liao, 2016; NAEA, 2016; Root-Bernstein, 2015). Therefore, integrating Arts is an effective pedagogy to boost STEM education in school. The research mainly focuses on, as a Visual Arts teacher, promoting STE(A)M education in primary school will still face some difficulties during implementation.

2.1.1 Understanding curriculum integration

Integrating Arts into STEM education, STEAM education needs schoolteachers to design the curriculum to provide the most benefits to students and an integrated curriculum is an effective way to explore STEAM education (Drake, 2018). Drake (2018) suggested four types of integration methods such as fusion, multidisciplinary, interdisciplinary, and transdisciplinary (see Figure 2.1). Interdisciplinary means to break the boundaries of disciplines and replace them with learning areas that are combined according to the nature of knowledge (游家政, 2000). Breaking the original subject concepts and designing courses based on the research methods and perspectives of various subjects with common themes, events, problems, or experiences. For the transdisciplinary curriculum, it refers to transcending the related disciplines; the organizing center revolves around a pressing question, issue, or problem. “Subjects lose their boundaries when they are holistically blended around the question.” (Drake, 2018, p35)

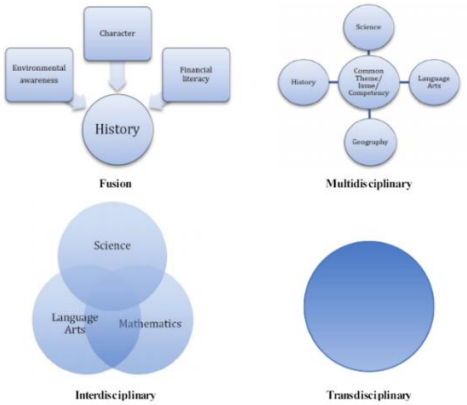

Figure 2.1.1 The types of curriculum integration

Looking into some of the studies about the integration of STE(A)M education, most of them used interdisciplinary to organize the STE(A)M activities while a few researchers tried to use transdisciplinary integration (Liao, 2016; Zheng, 2016; Henriksen, 2017; Xu, 2019) (see Table 2.1.1). Zheng (2016) researched on the curriculum design of 3D printing in interdisciplinary model and Xu (2019) conducted a paper-cutting light for STEAM course to enhance students' creativity. Henriksen (2017) also designed a project about water usage in interdisciplinary integration while Liao (2016) tried both models and suggested that incorporating 3D electronic storybooks in learning through both interdisciplinary and transdisciplinary ways can help students to make their work relevant to real situations.

Table 2.1.1 Integrated method of the studies

Scholar / Model	Liao (2016)	Zheng (2016)	Henriksen (2017)	Xu (2019)
Interdisciplinary	✓	✓	✓	✓
Transdisciplinary	✓			

(Liao, 2016; Zheng, 2016; Henriksen, 2017; Xu, 2019)

Overviewing the studies, interdisciplinary is the common integrated curriculum method which maybe more suitable for implementing STE(A)M education into current situation. In fact, teachers have paid efforts to merge the content and methods of different disciplines to achieve the same goals of creativity enhancement through interdisciplinary way (Holley, 2009).

2.1.2 Defining Arts in STE(A)M

Besides understanding the curriculum integration in schools, we should also emphasize on the different strategies to add Arts into STEM. Arts has different formats that can integrate into STEM such as focusing on the curriculum design of STEAM activities (Liao, 2016; Zheng, 2016; Henriksen, 2017; Xu, 2019) (see Table 2.1.2). Liao (2016) integrated children's literature, beautify, aesthetics and design thinking into the 3D electronic storybook making. Henriksen's (2017) water usage project focused on the design thinking aspect of arts which students needed to design a poster for promoting water usage. For the 3D printing curriculum design from Zheng (2016), aesthetic and the outcome decoration were also included in STEAM activities while Xu (2019) applied an art technique of paper cutting to combine with a micro bit in the STEAM curriculum.

Table 2.1.2 The role of Arts in STE(A)M

Scholar / "Art"	Liao (2016)	Zheng (2016)	Henriksen (2017)	Xu (2019)
Decoration	✓	✓		✓
Aesthetics	✓			
Design thinking	✓	✓	✓	✓

(Liao, 2016; Zheng, 2016; Henriksen, 2017; Xu, 2019)

Design thinking is the most useful and common method for arts to occupy a place in STE(A)M education while decoration purpose is an essential method which simply

beautifies the outlook of the products (Liao, 2016; Zheng, 2016; Henriksen, 2017; Xu, 2019). Steve Jobs repeatedly linked technology with creative thinking and artistic design was a key factor in his stunning accomplishments (as cited in Toni Wynn & Juliette Harris, 2012). As mentioned by John Maeda (2012,2013), design education which was the same as STE(A)M Education could cultivate students' creativity and foster their innovation through design thinking skills (as cited in Liao, 2016).

2.2 STE(A)M education in 4P creativity model

Understanding the current progress of STE(A)M education development through interdisciplinary approach, the main purpose of implementing STE(A)M education is to enhance students' creativity.

In order to focus on the development of children's creativity in education context, teachers and schools are the optimal tools to cultivate children's creativity development (Kupers, 2019). Teachers in school can emphasize on specific means for students to develop their creative thinking and characteristics (Starko, 2000) such as providing a suitable classroom environment for teaching (Wang, 2002) and using planned teaching activities and strategies during the teaching process. Many researchers concluded that creativity can be trained or taught through school context (Starko,2000; Wang, 2002; Chen& Wang, 2004). For the assessment of creativity in creativity teaching, after

analyzing more than forty definitions of creativity, Rhodes (1961) summarized these definitions into four P (Product, Process, Person, Press/Place). Mooney (1963) once again proposed 4P work at a conference on scientific creativity held in Utah and he generated a conceptual model for exploring creative talents. In Taiwan, Wu, Chen, and Lin (2000) also used 4P framework to analyze local teaching revisions or developments.

2.2.1 Person-related Approach

Teachers are the main person who get access to students and possess great influence affecting students' creativity. Person, one of the P in the 4P creativity framework can be explained as person or personality that support or affect certain individuals' creative thinking and behavior (Runco & Kim, 2017).

There are some common creative characteristics stated out (Chen, 2009; Zheng, 2011; Runco& Kim, 2017; Gao, 2018) (see Table 2.2.1). Most of the scholars agreed that flexibility is a common characteristic that a creative person owned while independent and challenging are also other creative traits for the measurement of a creative person. Chen (2009) has mentioned that highly creative people have different characteristics, such as breaking through regulations, surpassing habits, and having an adventurous spirit of seeking innovations and changes. Highly creative people often exhibit behaviors such as adventurous, challenging, curiosity, imagination, etc. Gao

(2018) conducted a questionnaire about creativity characteristic in primary school which the result showed that independent and challenging are characteristics that most creative teachers have. Zheng (2011) mentioned a creative person need to have independent ability to face challenges, active and capable, flexible originality, curiosity for seeking knowledge, agility of imagination while Runco& Kim (2017) stated that the creative person characteristics are openness to experience, wide interests, autonomy, flexibility, nonconformity, and intrinsic motivation.

Table 2.2.1 Creative characteristics

	Chen (2009)	Zheng (2011)	Runco & Kim (2017)	Gao (2018)
Curiosity		✓		✓
Imaginative	✓	✓		
Independent		✓	✓	✓
Challenging	✓	✓		✓
Risky	✓			
Flexible	✓	✓	✓	✓
Wide interests			✓	✓

(Chen, 2009; Zheng, 2011; Runco& Kim, 2017; Gao, 2018)

As the creative personalities may affect the activity design of integrating Arts into STEM education, therefore, this research aims to find out would flexible, challenging, and independent personalities affect teachers on the process of integration of Arts into the STEM curriculum.

2.2.2 Press-related Approach

Besides people, press is another factor affecting students' creative process. The press-related approach of the creativity framework is defined as the environment of the teaching process which can push students' "potential" (Runco & Kim, 2017).

Most of scholars agreed that freedom and independent environment are important to the development of students' creativity while trust and open environment are also quite useful for cultivating students' creativity development (Fleith, 2000; Kampylis et al., 2009; Davies, 2012; Runco et al., 2017) (see Table 2.2.2). Some studies (Cole, Sugioka, & Yamagata-Lynch, 1999; Fleith, 2000) found out that a relaxed classroom environment with freedom which did not have strict rules may boost willingness of children to express freely, as they are under a comfortable environment. In this flexible classroom atmosphere, children's creativity might be fostered successfully. The atmosphere stimulated them to have independent space in thinking and taking risk (Kampylis et al., 2009). Davies et al. (2012) reported that students' creativity can be stimulated by providing a balanced and structured learning environment with the freedom that students were supported, thus they were willing to take risk for a creative expression. Moreover, an open environment could dedicate high internal motivation so school providing more independence and an autonomic environment could help students' creativity development. (Runco et al., 2017; Torrance, 1977).

Table 2.2.2 Characteristics of creative environment

Scholars	Denise de Souza Fleith (2000)	Kampylis et al. (2009)	Davies (2012)	Runco et al. (2017)
Challenging	✓	✓		
Freedom/ Independent	✓	✓	✓	✓
Idea support			✓	
Trust/ openness		✓	✓	✓

(Fleith, 2000; Kampylis et al., 2009; Davies, 2012; Runco et al., 2017)

Not only teachers need an independent and open environment for implementing STE(A)M education, but also students need such an environment for learning STE(A)M. Therefore, how schools and teachers provide a beneficial environment for students is one of the important aims of this research.

2.2.3 Process-related Approach

Positive environment helps in creative process. In addition, problem-solving skills is also important for creative process. No matter different ideas, patents, inventions and designs, creative products depend on a process. In education, the process during the working period is led by teachers so teachers' strategies become essential in making the process creative.

Many studies reviewed that during the teaching process, most teachers use

brainstorming activities and induce cooperative learning to raise student's creativity (see Table 2.2.3). Cropley (2001) suggested that during the teaching process, teachers can adopt cooperative and socially integrated teaching to motivate students to be proficient in factual knowledge, to establish a solid foundation for diffuse thinking and to encourage flexible thinking and independent learning. Zhang (2011) encouraged teachers to brainstorm and applied independent learning that could help students to have self-evaluation. Denise de Souza Fleith (2000) stated that teachers could give students choices and boost students' self-confidence, accepting students' ideas but not imposing things on students and providing students opportunities to become aware of their creativity through activities of cooperative groups, brainstorming, open-ended and hands-on activities.

Table 2.2.3 Teaching activities in process

Scholar / Activities	Denise de Souza Fleith (2000)	Cropley (2001)	Zhang (2011)
Cooperative learning	✓	✓	✓
Free time	✓		
Brainstorming	✓	✓	✓
Open-minded activities	✓		
Encourage independent learning		✓	

(Denise de Souza Fleith, 2000; Cropley, 2001; Zhang, 2011)

One of the most important part that previous researchers focused on would be the kinds of activities teachers designed for the STE(A)M education and how they applied

the strategies during the process of creativity teaching.

2.2.4 Product-related Approach

In school, besides person, environment and teachers' teaching, artworks and final products are also factoring in the measurement of creativity. Product in the creative framework means that creativity is considered as a cognitive ability to produce something novel and useful (Runco & Jaeger, 2012) and the product is used to show the result. There are some studies (Stermberg & Lubart, 1999; Besemer & O'Quin, 2006) (see Table 2.2.4) showed that the creativity of a product can be determined as novelty and resolution. Synthesis and elaboration (Besemer & O'Quin, 2006) were used to measure a proper product on sale in the market. In school, the creativity of a product is somehow according to teachers' requirements on it.

Table 2.2.4 Creativity measurement of product

Scholars / Measurement	Sternberg & Lubart (1999)	O'Quin & Besemer(2006)
Novelty (originality, incentive, transformational effect)	✓	✓
Resolution (appropriateness or feasibility, logic, relevance, usefulness)	✓	✓
Synthesis and elaboration (style characteristics, i.e., elaboration, complexity, organic, well-craftiness, elegance)		✓

(Stermberg & Lubart, 1999; Besemer & O'Quin, 2006)

To summarize, resolving the issue of elusive criteria for creativity relies upon the

integration of several perspectives, including its objective and subjective components. Researcher wants to understand would teacher measure students' creativity through final products and if it is the case how do they measure.

2.3 Conclusion

Studying the above literature review, the methods for integrating Arts into STEM and different STE(A)M activities are designed by teachers and schools while students' creativity may be affected by teachers, classroom environment, the teaching activities and the measurements of products.

To sum up, the chart (see Figure 2.3) concludes the current situation of integrating Arts into STEM education and the strategies and factors affecting the enhancement of students' creativity.

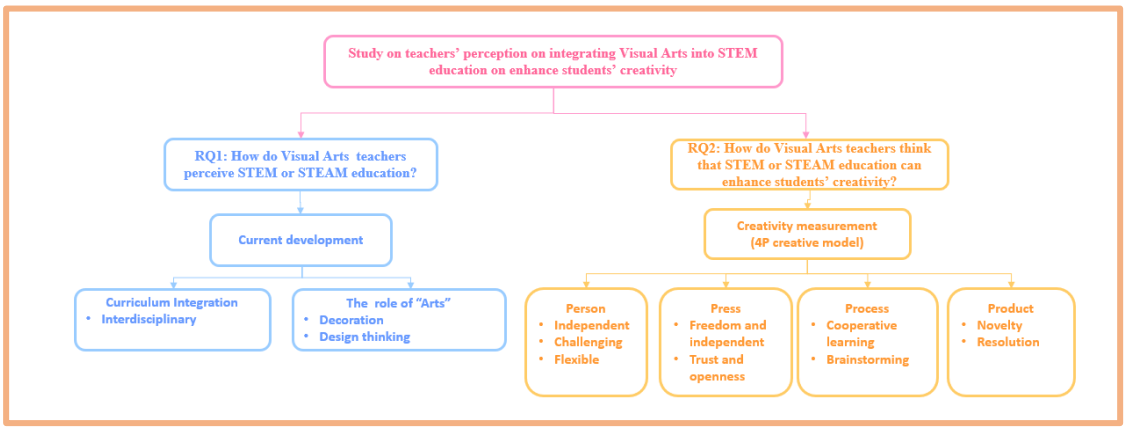

Figure 2.3 Research Framework

Chapter 3: Methodology

This study mainly focused on how teachers implement Arts in STE(A)M education and design STE(A)M activities and how STE(A)M activities affect students' creativity. To conduct the study, the research focuses on schools that promote STE(A)M education. Since the researcher wants to know how teachers promote STE(A)M education and students' creativity, interviews and classroom observation is performed to obtain more in-depth information.

3.1 Research method

In the whole research project, qualitative research is the main research method as it helps researcher to explain phenomena, people's behaviors, and life experiences, as well as given significance (Keegan, S., 2009). During the research, teachers' personal teaching experiences are important. Under qualitative research, the triangulation method (see Figure 2.3) is used which are semi-structured interview, document, and observation. As this method aims to use miscellaneous methods and collects different data to develop understanding of a phenomenon exhaustively (Patton, 1999) which data collected can provide a mutual verification to raise the validity and reliability for the research (Bogdan & Biklen, 2007)

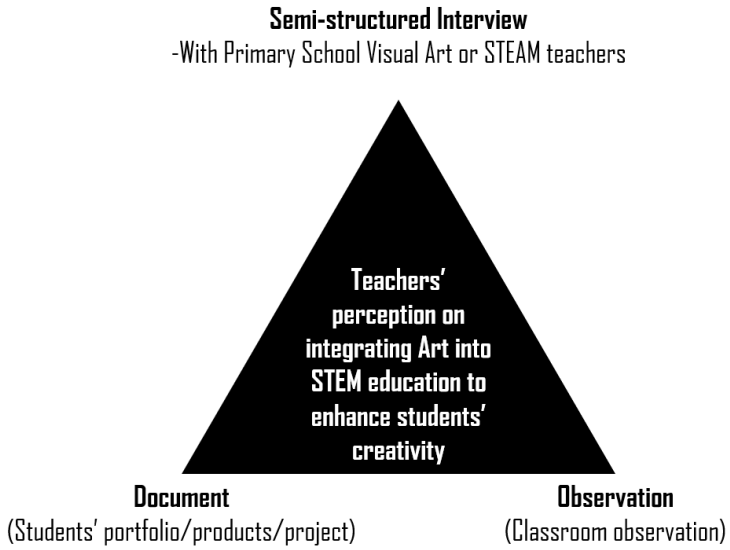

Figure 3.1 Triangulation Method

3.1.1 Interview

Researcher wants to understand how Visual Arts teacher participate in, design their STEAM activities, and what challenges and opportunities for them to promote STE(A)M education in primary schools. As semi-structured interview can help researcher to receive more in-depth responses with a systematic format (Qu & Dumay, 2011), a face-to-face semi-structured interview with teachers is conducted. The interview questions are as follows,

1. I know you are teaching STEAM education. Please share your experience in STEAM education.
2. When did your school start teaching STEAM education? Please share the development and current situation of STEAM education. ((Research Q1)
3. Please share whether adding A to STEM will affect students' learning? In what way does it affect? ((Research Q1)
4. Do you think STEM + A education can more effectively cultivate students' creativity and Why? (Research Q2)
5. How to evaluate the creativity of students? Please share some creative products for illustration. (Research Q2)

In addition, interviewer takes audio recordings and jot notes during interviews. Recording ensures that all content spoken by respondents can be retained for later analysis. The recoding script is reviewed by the respondents.

3.1.2 Document

To increase the credibility and consistency of data, the related teaching documents such as students' final products of the project are collected. The document can be read and reviewed multiple times and provide supplementary research data (Marshall & Rossman, 2016). The products of projects may show the creativity measurement from the teachers' perception. Therefore, documents also can provide information for further discussion and compare with the measurement from literature review.

3.2 Research Target

According to the research topic: "Visual Arts teachers' perspective on STE(A)M education to enhance students' creativity", Visual Arts teachers teaching in Hong Kong primary schools are invited (see Table 3.2) The in-service teachers who have experiences on designing and implementing STE(A)M project in their schools are the criteria for selection. The interviewees are expected to share their personal views, experiences and provide examples that involved students' products and artworks of STE(A)M projects.

Table 3.2 Research target data

Responder	Gender	Title	Year of Teaching	Educational Background	Teaching Subjects	Interview Date
Teacher 1	Female	Visual Arts teacher	4 years	Major: Mathematics Minor: Visual Arts	Visual Arts General Studies	3/3/2020
Teacher 2	Female	Principal	21 years	Major: Visual Arts Minor: Personal and Social Development	Visual Arts Chinese	11/3/2020

3.3 Research Schedule

Table 3.3 Research Schedule

Date	Implementation Matter
31 March 2020	➢ Submission of project proposal
Sept to mid-Oct 2020	➢ Meetings with supervisor for discussion
16 Oct-Nov 2020	➢ Submit the full research proposal and the ethical review application
Nov to Dec 2020	➢ Design research questions
Jan to Feb 2021	➢ Interview with the interviewees
Feb to mid-March 2021	➢ Data analysis
Mid-March to 2nd week of April 2021	➢ Project presentation ➢ Refinement of Project report
Mid-April 2021	➢ Honours project report submission

3.4 Limitation

The opinions and information of the interviewed teachers cannot represent the views of all teachers participating in STE(A)M education in Hong Kong. As well as the sample will be comprised of STE(A)M and Visual Arts teachers with varying backgrounds, teaching skills and strategies which can affect the results of the interviews. Moreover, as the Covin-19 and the suspension of school, the class observation cannot be obtained. Therefore, the results of this research can only be a reference.

Chapter 4: Findings and Analysis

This research compares information provided by two in services primary school Visual Arts teachers to explore the perspectives of Visual Arts teachers in interdisciplinary measures to implement STE(A)M education and the involved strategies to enhance students' creativity. The analysis result showed below is separated into two parts, personal and school aspects according to the research questions 1 and 2.

4.1 The teachers' perception on implementing STE(A)M education

To review the individual interviews of the two visual arts teachers, the research aims to summarize their personal information and their implementation experiences about STE(A)M education.

4.1.1 Teachers' learning background

From the interview, both two Visual Arts teachers mentioned about their learning background in secondary and university schools affects the implementing of STE(A)M education. The information of Visual Arts teachers' education background is shown as below (Table 4.1.1).

Table 4.1.1 Teachers' education background

Teachers / Studies	Teacher A	Teacher B
Science	✘	✓
Technology	✘	✘
Engineering	✘	✘
Arts	✓	✓
Mathematics	✓	✘

The two Visual Arts teachers studied Visual Arts and one related subject about STE(A)M. Both Teacher A and B think that the learning background provides a positive effect on implementing STE(A)M education. They mentioned that:

> Teacher A: *"The study background in university gives me a* ***certain academic Foundation*** *in STEAM. Also, I take minor in Visual Arts, so that it is lucky that I can* ***handle all the elements*** *of STEAM."*
>
> (Interview, Teacher A, A3)

> Teacher B *"I studied* ***science*** *when I was in middle school, so when I Implement STEAM, I have* ***basic mathematical knowledge****, which makes it easier for me to implement it, and I* ***am less afraid of some deeper scientific knowledge and theories****."* (Interview, Teacher B, A1)

Both Visual Arts teachers realize that teachers' learning background provides a basic knowledge of some elements in STE(A)M education, which aids them in implementing STE(A)M education. Moreover, teacher B mentioned in the perspective of Visual Arts that her educational background has made her understand more about Visual Arts and the role of Arts in STE(A)M:

> Teacher B: *"The definition of arts was **quickly dismantled**, because of my educational background, I understand what art is."* (Interview, Teacher 2, A4)

To analyze, Visual Arts teachers who want to engage in STE(A)M education need to have the basic idea of scientific knowledge which no matter study major or minor will be easier to handle implementing STE(A)M education. Moreover, Visual Arts teachers can more professionals on defining the role of Arts in STE(A)M.

4.1.2 Teachers' experiences and position

Comparing the teaching years of the two Visual Arts teachers, teacher A is a newbie teacher with 4 years of teaching experience whereas teacher B is a professional teacher who has 21 years of teaching experience and now is a principal. Based on the

differences in teaching years, teachers have different methods of proficiency training and have different understandings towards STE(A)M education (see Table 4.1.2). Teacher A mentioned that:

> Teacher A: *"Focusing on the school development needs, I will explore STEAM through* ***workshops or visiting other schools*** *to learn from their experience of STEAM implementation and consider how* ***to promote and apply it in our own schools****."*
>
> (Interview, Teacher A, A2)

Teacher A's professional training on STEAM is mainly from common resources such as the workshops provided by the educational bureau or by observing other schools' information and even, she needs to explore different learning materials by herself. However, Teacher B has more experience and has more professional training as she mentioned that:

> Teacher B: *"We will consider how to perform better, and how to use 100,000 Dollars in a better way.* ***Talk to professionals and observe how other schools or overseas places promote it*** *are possible ways."* (Interview, Teacher B, A2)

and "To define Arts, we have ***done research and asked the opinions of scholars and experts****."* (Interview, Teacher B, A4)

Table 4.1.2 The methods teachers understanding STE(A)M

Teachers / Methods	Teacher A	Teacher B
Workshops	✓	✓
Observe other schools	✓	✓
Ask and invite professionals	✘	✓
Do research	✘	✓

To analyze, teachers who have more teaching experiences have more channels and methods to understand STE(A)M education and they can learn more professional skills on implementing STE(A)M education. Moreover, teachers' position will affect their implementation of STE(A)M education while Teacher A needs to find out the useful method after requesting school while Teacher B can directly operate. Two teachers' personal beliefs are important for implementing STE(A)M as they are interested in STE(A)M, they are willing to implementing STE(A)M and to make the whole system mature, especially Teacher B. She emphasizes that Arts is the focus of STE(A)M education in her school.

4.1.3 Schools' atmosphere in implementing STE(A)M

From the interview, both teachers mentioned that schools' environment is important for implementing STE(A)M education. However, their schools' implementing environment are different. As mentioned by Teacher A*:*

> Teacher A: *"Because the school believes that STEAM is* ***a universal education, not an elite activity****. Universal education is for all students in grades one to six, and even the entire* ***atmosphere*** *of the school is very important. The school hopes that all teachers can participate."*
>
> (Interview, Teacher A, A6)

Teacher A's school attempts a whole school approach which all the teachers and students need to participate in STE(A)M. The learning environment and atmosphere is good in school. However, in contrast, Teacher B's school seems being forced to implement STE(A)M education for the subsidies from Education Bureau. Therefore, teacher B's school choose to infiltrate the content of STE(A)M into different subjects slowly and to implement small STE(A)M projects, mentioned as follow:

Teacher B: *"In the past few years, the government has promoted STE(A)M and provided $100,000 subsidies to schools. If there is subsidy, the school must implement it." (Interview, Teacher B, A2)*

and "At the beginning, we all started with ***small steps and small groups, infiltrating each subject****. The* ***course director establishes a panel to think about the idea****, it will be easier to proceed."*

(Interview, Teacher B, A11)

To analyze, Teacher A is a fresh teacher by given positive support from school so that she can implement STE(A)M education in the whole-school approach by herself so that the result of implementation seems good in progress. However, Teacher B's implementation is choosing by the panels and the teachers follow the instructions of panels to implement.

4.1.4 The difficulties and solutions of implementing STE(A)M

Although the implementing method is not the same, both schools are facing similar difficulties (see Table 4.1.4).

Table 4.1.4 The difficulties facing during implementing STE(A)M

Teachers / Difficulties	Teacher A	Teacher B
Lack of human resources	✓	✓
Course Design	✓	✘
Expensive Equipment	✓	✘

Teacher A's school is facing a lot of difficulties such as lack of human resources, course design and choosing equipment. However, Teacher B's school has less difficulties when implementing STE(A)M education.

As mentioned by both Visual Arts teachers in two schools, the educational bureau did not provide updated information for schools. Also, teachers professional training is needed. However, as mentioned by Teacher A:

> Teacher A: *"EDB has promoted STEAM a long time ago, but the documentation course is relatively backward. The curriculum planning is still less clear than other subjects. Therefore, our schoolteachers will* ***participate in different teacher training*** *to gain different experience."* (Interview, Teacher A, A20)

And *"Sometimes, our topics may not be equivalent to the knowledge or ability level of the students. Therefore, we have used two years of time to* ***slowly run in****. What topics are suitable for the students' level, we must continue to* ***try****."* (Interview, Teacher A, A5)

Teacher A wants to join the professional training to understand which teaching material can be used to fulfill students' ability and teachers can choose to have professional training however participating in which courses depending on the teacher's willingness. However, Teacher B's school mainly focuses on teacher's ability to teach STE(A)M education so that schools will choose the courses for teachers to participate which mentioned as follow:

Teacher B: *"We must first solve the problem of* ***professional development of teachers****……I thought my knowledge was OK, but later found out that it was not enough. The model cannot be changed just through* ***a three-hour lecture****……. The second year, our school* ***hired another expert****, and the two experts had a* ***20-hour workshop*** *with the teachers,allowing the teachers to experience the process of design thinking and research in person." (Interview, Teacher B, A3)*

Teacher B's schools put the priority of focus on professional developments of teachers first than concerning students' learning content. Therefore, the teachers involved in STE(A)M education must have professional training. However, which focus will be more suitable for implementing STE(A)M education?

4.2 The influences of STE(A)M on students' creativity

Though the interview of two Visual Arts teachers and their sharing experience, the researcher finds out that the course design and the strategies apply in lessons is important for operating STE(A)M education.

4.2.1 Course design

Teacher A defines and explores different publishers for STE(A)M education for four years and finds out some suitable topics for students for each form (see Table 4.3.1), she mentioned that:

> Teacher A: *"We will re-examine, and at first we will look for resources from different publishers to find the appropriate topics for each level. But sometimes, our topics* ***may not be equivalent to the knowledge or ability level of the students****. Therefore, we have used two years of time to slowly run in. In the end, to find out which* ***topics*** *are suitable for*

students' levels, we must continue to try. Now, we have basically established the learning topics for students at each level."

(Interview, Teacher A, A5)

Table 4.2.1 The STEAM topics of each form in Teacher A's schools

Primary	STEAM Topics
1	大掃除機械人
2	磁浮列車
3	海洋保育號
4	智能電燈
5	/
6	投石器

Teacher A will observe the process of different topics and review students' final products to decide whether the topic is suitable for them or not. Comparing to Teacher B's school, they implement STE(A)M education without an exact topic as they do not want to repeat the same content of science and general studies in previous STEM education, as mentioned below:

Teacher B: *"Our school itself has science classes and general studies classes and the proportion of science is heavy. Thus, in* ***STEAM project****, it is more difficult for students to achieve results. There is a limitation, but STEAM will still be implemented, with other subjects just penetrated in."* (Interview, Teacher B, A11)

4.2.2 Environmental strategies

The main strategies that apply for the STE(A)M course is contextual and inquiry-based learning.

Teacher A has mentioned that: "Our school uses **CRT (contest, role, target)**, which is a model design. C is the situation, R is the role, and T is the purpose. In each level, a life situation will be introduced. In this situation, everyone has a role. In terms of roles, we will give students different tasks." (Interview, Teacher B, A13)

Teacher B has mentioned that: *"The Steam project provide chances for students to* ***visit the community****, take pictures and understand what problems in the community, more than once.*

Therefore, students will know that the elderly are bored and will think what can be done to help them? Our project allows students to get into the community." (Interview, Teacher B, A9)

Both schools use contextual setting to raise students' learning motivation, teacher A's school has a complicated system of CRT (Context, Role and Target) whereas Teacher B's school brings students out of classroom for learning STE(A)M education.

4.2.3 Teaching strategies

During the teaching of STE(A)M education, two Visual Arts teachers consider different strategies to enhance students' creativity (see Table 4.2.3). Here are some strategies that Visual Arts teachers will use in the lesson.

Table 4.2.3 Teaching Strategies

	Teacher A	Teacher B
Choosing materials	✓	✘
Provide independent brainstorming space	✓	✓
Cooperative learning	✓	✓
Presentation	✓	✓

Take the examples which mentioned by Teacher A (see Table 4.2.3.(1))

Table 4.2.3.(1) Teacher A's STE(A)M activity

Years	Topic	S	T	E	A	M
P3	Marine Conservation	Buoyancy and power source of the ship	Take a video for presentation	Assemble a ship with a trash net	Decorate the final product	Calculate the length of the trash net

At the beginning, teacher A brought the STE(A)M material set from Taobao but the result turned out more scientific and less Arts involved, as mentioned below:

> Teacher A: *"In the early stage, students are required to install a boat, they need to consider the buoyancy, materials and power sources of the boat, which is more scientifically involved.* (Interview, Teacher A, A10)

And later, Teacher A starts to explore the new method which only provides electrical motor and battery box, the material and shape will be designed by students, mentioned as follow:

> *"In this process, they can design the garbage or garbage basket, what material, shape, and how to install tools and so on*

to achieve this goal, and when they complete the whole work,

they will report why they designed in this way."

(Interview, Teacher A, A10)

To review the final products provided by teacher A, the products have great changes than the products the students made before (see Figure 4.2.3.(1) and Figure 4.2.3.(2)). The outlook is quite similar, yet the choice of materials and the design of the final products are more novel (see Figure 4.2.3.(3) and Figure 4.2.3.(4)).

Before	
 Figure 4.2.3.(1) Student work (1)	 Figure 4.2.3.(2) Student work (2)
After	
 Figure 4.2.3.(3) Student work (3)	 Figure 4.2.3.(4) Student work (4)

In contrast, Teacher B chose the materials for students, take the example as below (see Table 4.2.3.(2))

Table 4.2.3.(2) Teacher B's STE(A)M activity

Years	Topic	S	T	E	M	A
P4	Light drawing	Phosphorescence scientific theory				Painting

Figure 4.2.3.(5) Student work (1)

Figure 4.2.3.(6) Student work (2)

Teacher B take STEM as the understanding theory and put the exploring the scientific theory of Phosphorescence through drawing. Teacher B's school focus more on artworks than products.

4.3 Conclusion

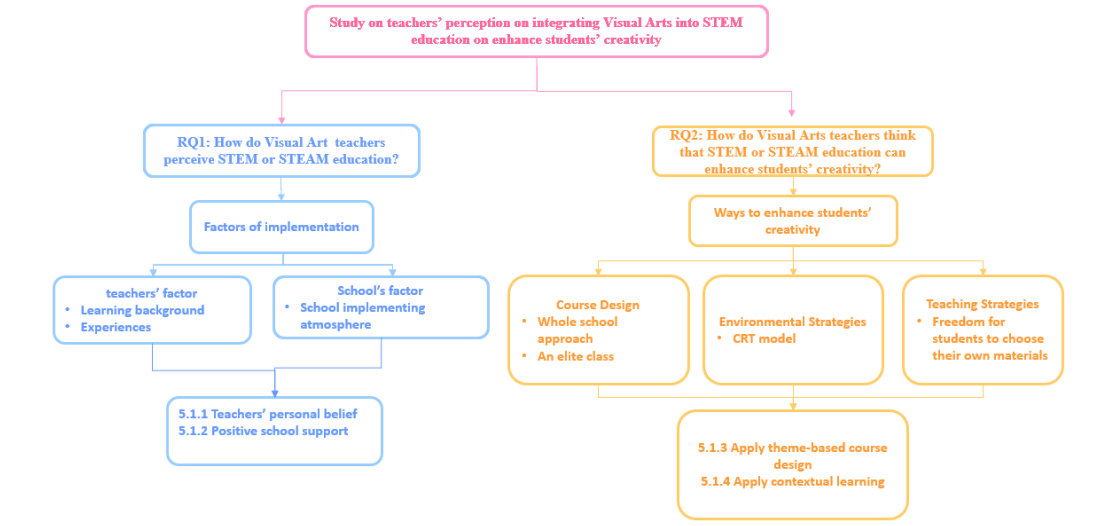

Figure 4.3 Finding and analysis

Chapter 5: Conclusion and Implementation

5.1 Research insights

Conclusion and implementation will be made in this chapter based on the literature review and research results, as well as the researcher's insights, to respond to the two research questions and objectives, which are understanding the Visual Arts' perspectives on STEAM education and exploring strategies to enhance student's creativity. Finally, suggestions will be given to the preservice teachers who want to participate in STEAM education.

5.1.1 Teachers' personal beliefs

According to review findings, teachers' educational background and teaching experiences may affect schools' implementation of STEAM. However, for the younger teacher A, although she only has teaching experience for four years, she has run the STE(A)M education in whole schools' approach successfully step by step. Comparing to the experienced teacher B, although she has taught for 21 years, since her schools are not willing to implement STE(A)M education in a whole-school approach, at last, only the elite class could enjoy STE(A)M education.

To conclude, teachers' learning background can provide them a basic concept of STE(A)M education for implementing STE(A)M, but still not a full understanding of every element. On the other hand, teaching experiences only affects the channels for teachers to understand STE(A)M, but this can be overcome if the teacher has a creative personality such as independence, they will try their best to find the channels to understand and try to implement STE(A)M. The result is the same as the literature review that independent, challenging, and flexible teachers can help to implement STE(A)M more creatively as they have their own beliefs.

5.1.2 Provided positive support by schools

From the findings and analysis in chapter 4, both Visual Arts teachers revealed a positive view on implementing STE(A)M education although they complained that the Hong Kong Educational Bureau does not have enough teaching resources and guidelines on STEAM. Thankfully, they have found different learning channels and methods to start implementing STE(A)M education and the implementation is in progress now. They all agreed that STE(A)M with "A" can help students to develop their whole-personal development. However, implementing STE(A)M education need schools to provide positive school support which teachers can design the course and modified the content freely such as Teacher A. With schools' support, teachers can implement STE(A)M without any pressure and stress. They will become more willing to participate in STE(A)M education.

5.1.3 Apply theme-based course design

From the findings of course design, it starts with a whole school approach or a small STE(A)M project. As we can see from the findings in chapter 4, a whole school approach will face a lot of obstacles such as lack of human resources and difficulty to unite course design and buy new equipment. It seems to start implementing STE(A)M education first with an elite class is better as it can be easily controlled, it can also provide a strong cornerstone for implementing STE(A)M in a whole-school approach. No matter the whole-school approach or STE(A)M project approach, applying theme-based teaching in course design can enhance students' creativity more. As mentioned in UKEssay (2018), teaching in a theme-based manner, the application of knowledge, principles, and values to more than one subject can be taught at the same time through a common topic, text, place, or event. Topics in STE(A)M education can help to level students' ability which can help teachers to modify the content just based on the topics

with different materials, learning knowledge to enhance students' creativity.

5.1.4 Apply contextual learning

To review the findings and analysis from Chapter 4, teachers' strategies during the lesson are important to enhance students' creativity as contextual learning provides a challenging environment for students to change their roles in the project. Johnson (2002) has mentioned that contextual learning allows the brain to search for the meaning of specific relationships with our surroundings (as cited in Daytyan, 2014) Creativity will then appear. Therefore, no matter taking the learning model of CRT (Context, Role, and Target) or bringing students to the exact environment, both benefits in enhancing students' creativity as Davtyan (2014) mentioned that contextual learning can help teachers connect to content that students' learning with real-world situations that usually students experience.

Therefore, the importunateness of Arts cannot be defined. But implementing STE(A)M education needs Visual Arts teachers to be involved as the definition of Arts will be defined as decoration. With the participation of Visual Arts teachers, the Arts' role can change into like design thinking and language art presentation skills which can raise students' creativity more instead of decoration. Moreover, during lessons, it seems teachers A provide chances for students to choose their own materials, this can enhance students' creativity, we can know this by the total change in the outlook of the final products into novelty, this fulfills the requirement of creative products which mentioned in the literature review. In contrast, Teacher B's schools focus more on promote Arts, therefore, most of the content about STEAM education focuses on Visual Arts and less related to scientific knowledge.

5.1 Recommendation

Overview the whole research, teacher is the important role in implementing STE(A)M education. Implementing STE(A)M education in a situation of lacking teaching materials is difficult for teachers. Both schools and teachers play essential roles in the successful implementation of STE(A)M education and they need to cooperate. Moreover, teacher professional training on STE(A)M is important as most teachers who engage in STEAM education are in a miserable situation. It is suggested that the Education Bureau should provide more resources and training for teachers, for example, continuous workshops or courses on the background and methods of application of STE(A)M in schools, to increase the popularity of STE(A)M education in local schools in Hong Kong. Also, schools should encourage teachers to engage in activities about STE(A)M and to apply STE(A)M in lessons. For example, arranging teachers with fewer lessons so they can devote more time to attending workshops and courses about STE(A)M. This could probably increase the number of schools with successful STE(A)M education implementations. When teachers experience STE(A)M education, they will be more confident to implement and willing to participate in STE(A)M implementation.

For enhance students' creativity, teachers provide an independent brainstorming space for students is necessary that students always have a lot of different ideas in their mind. Teachers cannot be afraid that students will have the ideas that out of the course design criteria so suspension students' idea. In addition, in the process of teaching, the teacher's encouragement is very important. For example, if a student's work is well completed, the teacher's encouragement can let other students know that when I want to learn from my classmates and cannot copy directly, the students will work hard to come up with more different ideas. Besides, creativity lies in how much creative space the teacher gives students during the teaching process. The teacher will lead the students

to think together and come up with better solutions. During this period, it is impossible for the teacher to give the answer directly, because STEAM does not have a predetermined teaching content like other subjects. Therefore, giving students space to think and develop creativity depends on how much the teacher gives students in the course design and implementation process.

References

Bogdan, R. C., & Biklen, S. K. (2007). Qualitative data. *Qualitative research for education. An Introduction to theory and methods*, *5*.

Boy, G. A. (2013). From STEM to STEAM: Toward a human-centred education. Paper presented at the European Conference on Cognitive. Retrieved from: http://ntrs. nasa.gov/search.jsp?print=yes&R=20130011666

Cropley, A. J. (2001). *Creativity in education and learning.* Sterling, VA: Stylus.

Davies, D., Jindal-Snape, D., Collier, C., Digby, R., Hay, P., & Howe, A. (2013). Creative learning environments in education—A systematic literature review. *Thinking skills and creativity*, *8*, 80-91.

Davtyan, R. (2014, April). Contextual learning. In *Asee 2014 Zone I Conference* (pp. 3-5). USA: niversity of Bridgeport.

De Souza Fleith, D. (2000). Teacher and student perceptions of creativity in the classroom environment. *Roeper Review*, *22*(3), 148-153.

Drake, S. M., & Reid, J. L. (2018). Integrated curriculum as an effective way to teach 21st century capabilities. *Asia Pacific Journal of Educational Research*, *1*(1), 31-50.

Eger, J. (2015, November 24). The Congressional STEAM Caucus may turn STEM to STEAM in the reauthorization of ESEA. Retrieved from: www.huffingtonpost.com/ john-m-eger/stem-may-becomesteamoffi_b_8634126.html

Hetland, L., & Winner, E. (2004). Cognitive transfer from arts education to nonarts outcomes: Research evidence and policy implications. *Handbook of research and policy in art education*, 135-162.

Henriksen, D. (2017). Creating STEAM with design thinking: Beyond STEM and arts integration. *The STEAM Journal*, *3*(1), 11.

Holley, K. A. (2009). Interdisciplinary strategies as transformative change in higher education. *Innovative Higher Education*, *34*(5), 331-344.

Hong Kong Educational Bureau (2016), *STEM Education Report Executive Summary.* Retrieved from: https://www.edb.gov.hk/attachment/tc/curriculum-development/kla/science-edu/STEM_Education_Report_Executive_Summary_Chi.pdf

Honey, M., Pearson, G., & Schweingruber, H. A. (Eds.). (2014). *STEM integration in K-12 education: Status, prospects, and an agenda for research* (Vol. 500). Washington, DC: National Academies Press.

Kampylis, P., Berki, E., & Saariluoma, P. (2009). In-service and prospective teachers' conceptions of creativity. *Thinking skills and creativity*, *4*(1), 15-29.

Keegan, S. (2009). *Qualitative research: Good decision making through understanding people, cultures and markets*. Kogan Page Publishers.

Liao, C. (2016). From interdisciplinary to transdisciplinary: An arts-integrated approach to STEAM education. *Art Education*, *69*(6), 44-49.

Marshall, C., & Rossman, G. B. (2016). Chapter 4: The "what" of the study: Building the conceptual framework. *Designing qualitative research*, 65-96.

National Advisory Committee on Creative and Cultural Education. (1999). All our futures: Creativity, culture, and education. Retrieved from http://sirkenrobinson .com/pdf/allourfutures.pdf

O'Quin, K., & Besemer, S. P. (2006). Using the creative product semantic scale as a metric for results-oriented business. *Creativity and Innovation Management*, *15*(1), 34-44.

Patton, M. Q. (1999). Enhancing the quality and credibility of qualitative analysis. *Health services research*, *34*(5 Pt 2), 1189.

Perignat, E., & Katz-Buonincontro, J. (2019). STEAM in practice and research: An integrative literature review. *Thinking Skills and Creativity*, *31*, 31-43.

PricewaterhouseCoopers. (2016). 21st century minds: Accelerator program. Retrieved from: http://www.pwc.com.au/stem.html

Qu, S. Q., & Dumay, J. (2011). The qualitative research interview. Qualitative Research in Accounting and Management, 8(3), 238-264.

Rhodes, M. (1961). An analysis of creativity. *The Phi Delta Kappan*, *42*(7), 305-310.

Root-Bernstein (2008). Arts foster scientific success: Avocations of nobel, national academy, royal society, and sigma xi members. *Journal of Psychology of Science and Technology*, *1*(2), 51-63.

Starko, A. J. (2000). *Creativity in the classroom: School in the curious delight.* NJ: LEA

Sousa, D. A., & Pilecki, T. (2013). *From STEM to STEAM: Using brain-compatible strategies to integrate the arts*. Corwin Press.

STEM to STEAM [Webpage]. (2013). Retrieved from: http://stemtosteam.org.

Sternberg, R. J., & Lubart, T. I. (1999). The concept of creativity: Prospects and paradigms. *Handbook of creativity*, *1*, 3-15.

Scott, C. E. (2012). An investigation of science, technology, engineering and mathematics (STEM) focused high schools in the US. *Journal of STEM Education: Innovations and Research*, *13*(5).

Root-Bernstein, R. (2015). Arts and crafts as adjuncts to STEM education to foster creativity in gifted and talented students. *Asia Pacific Education Review*, *16*(2), 203-212.

Runco M.A., Kim D. (2017) Four Ps of Creativity and Recent Updates. In: Carayannis E. (eds) Encyclopedia of Creativity, Invention, Innovation and Entrepreneurship. Springer, New York, NY. https://doi.org/10.1007/978-1-

4614-6616-1_429-2
Thurlings, M., Evers, A. T., & Vermeulen, M. (2015). Toward a model of explaining teachers' innovative behavior: A literature review. Review of Educational Research, 85, 430–471. doi:10.3102/0034654314557949
UKEssays. (November 2018). Advantages of Theme based teaching when teaching children. Retrieved from https://www.ukessays.com/essays/education/theme-based-teaching-when-teaching-children-education-essay.php?vref=1
Wynn, T., & Harris, J. (2012). Toward a STEM+ arts curriculum: Creating the teacher team. *Art Education*, *65*(5), 42-47.

陳龍安（2002）:《創造思考教學的理論與實際》，台北，心裡出版社。
陳霞鄢（2003）:《國小資優班教師創造力教學行為之研究》，臺灣師範大學特殊教育學系學位論文，未出版。
高淑婷（2018）:《高雄市國小教師創造力人格特質與創造力教學之相關研究》，屏東大學社會發展學系碩士論文，未出版。
許家瑜（2019）:《國小高年級 STEAM 課程之創造力研究-以 Micro:bit 剪紙藝術燈為例》，國立臺中教育大學數位內容科技學系碩士論文，未出版。
黃政傑 (1997):《課程改革的理念與實踐》，台北，漢文出版社。
王瑞（2002）: 創造思考教學策略對學生創造力之影響，《台灣教育》，614，頁 24-28。
吳靜吉(2003):《創造力的評量-4P 觀點》.*2008 年,10.*
游家政 (2000): 學校課程的統整及其教學，《課程與教學季刊》，3（1），頁 19-38。
張世彗（2011）: 創造力教學、學習與評量之探究，《教育資料與研究雙月刊》，100，頁 1-22。，
鄭賢（2016）:《基於 STEAM 的小學《3D 打印》課程設計與教學實踐研究》，中國電化教育研究論文，未出版。

Appendixes

1. Interview transcript of Teacher A in Chinese

受訪者：Teacher A 訪問者：謝婕兒 晤談日期：3/3/2021 晤談時間：由 2:30 到 3:30 晤談地點：xxx 小學會客廳 謄寫員：謝婕兒 受訪者：Teacher A 訪問開場白：老師你好！感謝你參與這次的訪問。這次採訪主要是想了解有從事過視覺藝術科目的老師對融入藝術在 STEM 教育中，能否提高學生創造力的看法。		
00:01		
問	我了解到你在學校裡面有擔任一些關於 STEAM 教育的事務，可以分享一下你的教育背景嗎？	Q1
Teacher A	我是香港教育大學畢業生，當時我修讀Major數學和Minor視覺藝術。很幸運，一畢業就在學校任教，我任教的四年裡，我主要任教數學，重心放在常識，前2到3年有參與視覺藝術科，但因為工作的安排，所以就沒有機會再任教視覺藝術科。	A1
01:04		
問	你教育背景有和STEAM相關的內容嗎？	Q2
Teacher A	未至於到STEAM，首先沒有A，有關STEM，在教育大學讀書的時候，和STEM相關的課程或者內容不多，數學里有program的課程，已經是比較和STEM有關係。在工作上，學校發展需要，我再自己透過坊間或者參觀其他學校摸索。在家上這間學校推行的是STEAM，有A的元素存在，自己透過坊間的講座或者參考其他學校的經驗了解STEAM這個概念，和考慮如何推動和在學校運用。	A2
02:06		
問	你覺得是個人的性格影響你參與STEAM嗎	Q3

Teacher A	我本身理科的背景，大學和數學系也有，STEM在學術上有一定的基礎，再加上minor有VA，所以STEAM集齊這麼多元素，再加上學校給機會，背景加興趣和工作也有需要。我也很樂意參與其中。	A3
03:01		
問	你們學校是什麼時候開始進行STEAM教育的，可以分享一下STEAM教育的發展和現況嗎？	Q4
Teacher A	我們學校的開始不是用STEAM這個名稱或活動，但一直都有進行和STEAM有關的活動。學校過去是進行科學探究日，考試之後就有連續的三天全校各級都有科學探究活動。三年前，大約17到18年之後，時間上的規劃和課程重組就安排星期三的下午的導修課，改為特色課，把以前三天的內容改為每週平均每一級包含10或12節STEAM課。（特色課要遷就其他科目的學習需要或課時等等問題）平均每級就有10節STEAM課程。這樣上課的時間橫跨月份有2-3個月，有假期就三四個月，可以讓學校的STEAM氣氛濃厚。	A4
04:50		
問	為了STEAM過程中，都會遇到什麼困難？你會如何去克服這些困難？	Q5
Teacher A	我大致上分三個方面講講我們發展STEAM遇到的困難：首先是人力方面，其實前期像剛剛提到17 18年我們剛剛開始STEAM特色課，我們會想每一班都需要老師進入課室教學，教師的人數足不足夠。過往三天的科學探究日中，基本會集合全級一起上課，那麼每一級的老師人數大概4-5位，但現在特色課安排每班都需兩個老師的時候，一級至少要6位老師。有的在教學活動上要更加細緻或者低年級的學生需要多一點照顧，要請教學助理幫忙,所以要增加很多老師。除了教學外，亦要推動STEAM活動，我們有很多比如課後比如在小息或者午間劇場等等都需要人手，很慶幸學校很致力發展這個活動，所有同事都會參與在STEAM教育中，無論任何科目的老師例如中文科，英文課或者數常等等所有科目的老師都會參與在STEAM特色課中。在老師的編排上，我們會讓一些在STEAM上沒有什麼經驗的老師跟一個比較有經驗的老師在一起合作教學。 到中期的時候，人數足夠的時候，我們就在考慮有些老師的學科背景或者性格方面未必不是很有興趣，或者擔心他	A5

	們的能力上是否能夠做到。因此，我們希望能找一些合適和STEAM有關的同事，如何栽培他們，師資培訓方面，令參與的老師又足夠的相關知識和經驗教學。 而課程方面，我們由過往的科學研究日變成了如今的STEAM特色課，我們在考慮六年學生每一級的教學內容和教學主題，因為我們要把過往三天的教學內容，變成十節課的教學，有些教學內容未必合適。當然，以前是以科學探究的角度去設計。而如今是用STEAM或者STEM的角度去設計，要考慮課程是否達到每一個元素。所以我們會重新檢視，起初會尋找不同的出版社的資源，找一下每一級合適的課題。但是有時候，我們的課題未必可以達到學生該年級的知識或者能力點，因此我們利用了兩年的時間慢慢磨合，到底哪些主題是適合該年級的學生的呢，要不斷地試。現在我們基本上都確立了每一級學生的學習課題。我們現在主要就如何發展六級學生的縱線規劃，比如一年級，我們的重點是可能很簡單地看說明書，構建學生跟指引做事的能力，到三年級，說明書可能會更加複雜，比如一些實驗的步驟。橫向發展，我們會看看除了數學常識之外其他的學科，因為我們覺得STEAM是一個跨學科的課程來的，所以看看中英音樂體育有沒有相關的元素可以融入特色課中。 最後就是器材設備方面，STEAM需要很多不同器材，不止是量上，種類也是很多的。初期教育局給了10萬資金學校發展STEAM教育，用來買STEAM課程的器材。剛開始我們不敢買，出去看別的學校買哪一類比較多，因為怕買錯了或者買了之後和課程沒關係的會很浪費。初期買了Mbot和Micro:bit，然後到這兩種器材能夠順利加入電腦科之後，我們在看坊間其他器材，再添加了3D printer， laser cutting和機械臂等等。 所以從這三個方面，我們也可以看到學校不同角度如何去發展和會遇到的困難。	
10:03		
問	所以貴校的STEAM發展是由全校有興趣的老師去參與？	Q6
Teacher A	一開始沒辦法理會老師對STEAM課程有沒有興趣，因為每一班都需要有老師的時候，學校編排到的話，不能拒絕，一定要參與。只不過，我們盡量一個資深加一個不是很資深	A6

	的老師在一次。因為學校認為STEAM是一個普及化教育，不是一個拔尖活動。普及化教育不止是學生全體，一到六年級所有學生一起上，甚至學校的整個氛圍也很重視。學校會希望所有老師都可以參與其中。	
11:00		
問	STEAM現在算是一個科目，而不是單單只是一個課外活動？	Q7
Teacher A	我們就不是單單一個課外活動，課外活動學校也有，是一個比較拔尖的層次。但是普及程度上，我們會放在特色課裡面有一個STEAM的教學	A7
11:26		
問	因為有很多學校只是推行STEM，而貴校推行的是STEAM，貴校的A是以什麼角色放入STEM的？	Q8
Teacher A	A 的角色，對應是藝術的元素，學校也有思考過這個問題。STEAM 其實很容易理解每個元素，可是 A 相對來說，以我自己接觸一些大專院校或者在不同坊間的機構，a 相對 STEM，a 的定義是有很大出入的。當然，最容易理解當時是藝術。但是我們學校發展來說，最初的時候，很多老師都有參與，但是有些老師沒有相關方面的背景，對於 STEAM 和科學探究等等是會有所擔心的。所以 A 方面，我們也不會要求什麼， A 的剛開始 A 覺得是 visual arts，美學上的裝飾美化。也很容易理解為什麼這些老師又這樣的想法，因為我們學校視覺藝術科，也沒有很專業到專科專教，編入 STEAM 組的視覺藝術老師。這些老師教藝術課都會覺得就是做一份好看的勞作，arts 就是把作品弄得好看，美化裝飾一下作品。因為學生的能力也挺高，初期我們 Art 只是美學上的裝飾，到後期不應該只是裝飾，我們思考如何評定作品，到底什麼可以稱作美，到底是顏色很豐富，有很多視覺藝術就是沒？但是這個是不是那個作品想要做的東西？比如 iphone，我們很多時候不是以顏色去判斷它好不好看，先看他外形是不是流線型設計，是不是由方形的框變成圓潤曲線的框，屏幕的物料，甚至折。裡面就會留意 Apps 或者界面的設計，使用的層面上面。所以說，不是純粹是裝飾上，如果要這樣講，如果想要電話好看，我們買個電話殼，不就已經很漂亮了？所以 A 在後期我們會放在如何優化和做得好一點，會放在作品的功能性上，可以更加 user-friendly。這是我們現在課程設計會做到這個層面。而再深入一點或者高年級我們會讓他們覺得藝術不是只是畫畫和做一份作品，報告自己創作好的作	A8

	品也是一種語言的藝術。因此我們會讓學生創作好作品之後，如何講解給別人聽，或者是口頭匯報的內容，或者用短片介紹輔助。因為廣告 media 也是藝術的其中一類，所以 A 的理解範圍還是比較大的。不過定義 A 的層面難度還是高的，因此始終大家對 A 的看法和定義有出入。亦不是所有老師都會了解清楚了解這一點。還是會有共識把 art 但是會比較放在作品的功能性上，令到作品更加容易達到作品目的。	
16:09		
問	很多學校都是推廣STEM，而貴校推廣的是STEAM，你覺得加入Arts在STEM教學里，對學生的學習有影響大嗎？在哪方面的有影響？	Q9
Teacher A	我會覺得作用是重要的，對學生的影響大的，因為剛剛有提及到學生去到 STEAM 裡面的 a 已經不是單單停留把作品變得漂亮，因為弄一個漂亮作品，視覺藝術科已經是可以達到這個目的的。而是在作品的創作過程中，他們要思考怎樣才能把作品如何設計的更方便別人使用，或者是更加容易達到目的等等各樣，讓別人理解他們的操作。而這個也是他們思考過程中，給到他們很好的引導作用。另外除了在用的方面，在介紹方面和語言方面也希望他們懂得如何去匯報。所以希望他們弄出來的作品呈現得更加全面，完整整體。	A9
17:36		
問	可不可以分享多一些，除了在語言上或者思考上的引導，過程中老師又什麼方法引導學生提高創意？	Q10
Teacher A	在課程中我們有融入和引導他們，我們也未至於說會很明顯地，比如 2、3 年級都曾做了和船有關的課題。前期這個過程是要學生裝一個船，主要是針對在船的浮水性，物料和動力來源，比較科學上的內容。後期想更加 art，以前叫流水動力船，真的是弄一隻動力船就基本達到目標了。可是後期我們的課程設計就想要他們弄一隻海洋保育號，那麼就可以解決海洋上塑膠垃圾的問題。在弄這個船的過程中，他們就會思考如何解決海中的塑料垃圾，如何撈。因為很多塑料垃圾都是浮在水面，那麼保育號怎麼浮在水面撈垃圾，而在這個過程中，他們正正可以做到設計裝垃圾或者撈垃圾的籃子，用什麼物料，形狀，如何安裝工	A10

	具，角度等等來達到這個目標，然後當他們完成整個作品匯報的時候，他們會匯報為什麼這個位置我這樣設計。	
19:47		
問	在教學過程中會不會有些時間是讓學生思考，或者是自由時間讓學生在上課期間能發揮創意？	Q11
Teacher A	初期在經驗和材料上不足時，我們在淘寶上買材料。而 ARTs 的元素着重裝飾上，所以每艘船用相同材料，拼砌完都是長得一模一樣，差異不大，唯一特別的就是顏色塗得好不好看，有的學生會很有心思，想要用塑料罩罩著電池盒，以免入水。就會靠在水池全級一起放船。隨後優化課程之後，以海洋保育號再設計課程。因為 STEAM 不是希望培訓一個只會看說明書拼砌的工人，所以我們只是提供電池盒和摩達這兩個最基本的結合，而其他船身，撈垃圾的籃子各樣都是由學生自己收集物料，學生的發揮和創作空間就大了很多。 四年級的智能電燈，他們會畫設計圖，然後口頭報告。 投石器做了一年，發現不太適合，我們就放棄了。這個是全班一起做的。六年級第一年是做這個，發現投石器不是很合適，放棄了。就改了做全班的摩天輪。所以形式上，個人活動和小組甚至到全班的活動都會有的。	A11
23:25		
問	老師你覺得小組的活動上的好處會不會比個人活動的好？	Q12
Teacher A	我們大多時候安排個人作品就是小作品，比如一年級的機器人。雖然每人一個機器人，但在上課過程中，也會有小組活動的時候的，比如，這種刷子過往只有一種，現在我們有三種，三種刷子分別有不同的材料，分別是鋼絲，豬毛和塑料。他們每人弄一隻，小組里每人有用一種物料。學生會在實驗測試哪一種比較好用，就會用小組的形式。所以未必單單看作品，即使是學生最終創作自己的個人作品，但在課程設計中也會有小組活動的機會。同樣，即使創作小組作品，學生也會有自己個人工作的時候，這個設計上是用彈性的。	A12
24:38		
問	另外就是在實施 STEAM 教育的過程中，老師會不會出一些開放性問題引起學生學生創造思考嗎？還是讓學生自己發	Q13

	現問題？	
Teacher A	如果呢這裡有兩個層面，第一個層面就是課程設計上面我們學校用的是 CRT （contest， role，target）是一種模式設計。C 是情景，R 是角色，T 是目的，每一級中都會有一個生活的情景引入，在這個情景中每個人都有一個角色。而在角色上，我們會給不同的任務學生。比如剛剛講到海洋垃圾這一個方面，我們的生活情景會提供一些時事節目，資訊節目，也會叫他們到海灘看一看，觀察塑料垃圾的情況。而他們的角色就是環保人士，目標就是要清潔海洋上的垃圾。如果再縱線來看，連校中的發展中有 3C 的核心價值，3C 包括 caring，creativity 和 connect。 設計上我們也會嘗試如何回應這 3C。列如 caring 是關愛身邊的人，社會上的時事，creativity 就是發揮學生的創意，connect 就是學科和學科之間的聯繫 或者人和人，人和不同機構之間的聯繫。那麼我們就希望學生（12 年級）（34 年級）(56 年級）推己及人，及環境，及社會三個層次，每個層次兩個年級。一二年級就是家居大掃除的機器人，二年級就是今年最新的微震家居清潔人，從他們自身，家人和校工的角度出發。第二階段，環境就會是三年級的海洋保育號，四年級就是智能電燈（光污染），五年級就是和老人家有關的叫做護脊小精靈，六年級就是做一個 micro beat 智能裝置幫助老人家在不同溫度上吃東西。 有沒有什麼引導性的問題，我們就是利用情景引入，在了解生活情景上，我們會有一些問題在工作冊上讓學生填寫，當然中間肯定有反思的地方，讓學生發現創作過程中有什麼問題，要如何去改善。正正要讓他們知道他們的 STEAM 特色課學習的重點是什麼。然後在每一節課，跟著教學目的，上課中老師也會有一些專業的提問。	A13
29:30		
問	引入情景的過程中，教學環境對於提高學生創意有沒有什麼影響？會提供什麼樣的環境？	Q14
Teacher A	Steam 特色課是個很好的平台給了學生機會去跨學科，將不同的學科的知識運用出來。沒有 STEAM 這個平台，可能數學科就只是算數，其實每一個都會散亂地操作各個科目的內容。可是 STEAM 跨學科，甚至融合了中英，體育的元素在裡面。學生可能只是覺得數學我是用來計算的，可是	A14

	在 STEAM 中他們在計算智能燈泡是用哪一種比較划算，program 上時間秒數怎麼設定，那麼他們會知道在數學科他們要學到什麼技能，再把技能應用出來。而應用不是用紙筆寫出，而是學以致用，把學的東西回歸生活中去。	
31:30		
問	學校提供了怎樣的環境讓學生學習 STEAM 特色課去促進學生的創造力？	Q15
Teacher A	有些地方限制了，一是人手，二是地方（課室夠不夠），3 是活動的設備數量夠不夠，四就要看課時。如何我們能夠兼顧的話，我們是期望每一級都可以有跟課題相關的一些課外參觀，或者校外嘉賓進來和學生做交流。如果不行，我們也只能將任務交給學生比如去海邊看看塑料垃圾的多少。或者會在光污染的話題，我們會在教室講完課，就帶學生到禮堂台上，感受強勁的舞台燈，感受光污染，學生也會有 apps 量度光污染。所以要視乎教學的設計上，比如船的設計就會開個水池在操場。會按照題目上的需要提供空間。但是我們也希望盡量多點室外的空間，不是總是留在課室。我們也還是可以提供多元化的學習環境給學生。我們也用了 3 年時間，把常識室翻新成 STEAM room，主題 Dream Builder。	A15
33:50		
問	在作品上，你會如何評估學生的創造力，可以展示一下學生的作品解釋一下嗎？	Q16
Teacher A	作品上，評估的元素我們是有的，但是是不是發展的很成熟就未必。因為在過去的三年中，我們從研究課程模式，在發展中，我們要逐步逐步來。上一年準備處理好課程之後，本來理想上，今年是會處理評估學生作品的內容，可是疫情關係很多課題我們都開展不了，所以有一點進度停止。但是現在每一集都有小小的評估，一年級可能有短短一兩句感想，tick 或者 x，34 年級根據作品有多一點內容分享，有互評，出來講感受，56 年級會有老師的評估在。如何看到學生達標，我們會根據給他們的 task 任務是什麼。	A16
35:45		
問	所以學校會出個 list 看看學生哪一個 task 做到或者沒做到？	Q17
Teacher	對的，但是那個 list 還沒有優化到每一個年級都可以有，	A17

A	學校發展還需要一點時間。	
36:00		
問	所以整體上覺得 STEAM 對學生的創造力有影響？	Q18
Teacher A	我自己根據這幾年的經驗，我覺得 STEAM 具有創造力在課程和老師在教學的空間給了學生多大的發揮空間，例如流水動力創，我們買了教學材料包回來，然後大家一起拼砌和我只是給最基本的結構摩達和電池盒，你會很明顯看到後者的發展空間多很多，當然也需要學生的能力和老師的輔助多一點，也未必每個老師有信心，因為教材包我自己試了一次就能教學生拼砌。但是現在只有兩個零件，然後學生自己收集物料，我們如何知道學生收集什麼物料回來 ，我又得如何叫他們拼砌。這樣的情況當然增加了老師的挑戰性，但是這樣學生的創造力空間會很大。最搞笑的是有些學生經歷了兩年同一個主題，可是我們可以看到他們二年級和三年級的作品，但是是不是去年比今年沒怎麼創造力，也不是，而是看老師的課程設計上給了學生多少的創造力發揮空間。 另外，Micro:bit 主要是電腦科學，而 STEAM 特色課放在 4 年級的智能電燈和 6 年級那。而校外比賽更可展現學生的創造力，如比賽作品「BB 保母」，利用夾在衣服內層，感受 BB 的溫度，因為小朋友的溫度怕冷，會太熱。所以產品會在太熱是，在 app 上有提示。參加產品設計比賽是從零開始去做，一起上網看 BB 會遇到什麼困難，如何用 microbeat 的功能去做，甚至老師帶著學生去做，一開始會做出什麼作品出來，我們也是不知道的。以往常規的課程，我們會有教案，其他同事進課室教學，都會知道如何帶著學生進行製作，會知道下一步是什麼。如果以拔尖班的課程來講，創造力的空間會更加高。	A18
40:55		
問	有沒有考慮過把 STEM 加入 Art 課	Q19
Teacher A	我看到其他學校可能想割裂 STEM 加入 VA，數學或者常識課。教育局在各學科的課程指引亦有提及，並提供 STEM 活動的範例，不一定是規定這麼做，可能只是想給同事和老師多點資料參考和鼓勵。我留意到比如常識科，都有一些 STEAM 的設計教學套在 EDB 網站。可是還是要看學校的那	A19

	個校程或者學校想要走的方向，而我們是想走跨學科的方向，才有放在特色課。所以我們未必會重回去單科目中。可是是不是完全沒有，也不是，比如常識課裡面做實驗，做塑料瓶大改造，其實也可以發展 STEAM 的課題，是視乎學校想要做到有多深入和多大型。	
42:20		
問	老師還有沒有想要補充的？	Q20
Teacher A	學校的 STEAM 發展和困難 學校不是一個很成熟但還是算穩定的狀態，之後我們在人力方面有哪些同事是有興趣想發展 STEAm，我們也會大力鼓勵他們，始終這些事情需要花老師很多額外的時間去準備，要學習新的技能，新的儀器，新的 program。除了花時間，會令到工作量變多了，就算不夠人手，我們也會邀請其他同事幫幫忙。所以合適的人選不是很多 課程方面剛剛也提到，我們希望六級有個明確一點的規劃。因為不想其他學科，會有很清晰的指示，學的課題。中文其他科也有，但是 STEAM 方面，EDB 很早已經推動 STEAM，但是文件課程比較落後。但是課程規劃比其他學科還是不太明確的。因此我們學校會參加不同的教師培訓去得到不同的經驗。 器材方面 我們學校的設備已經很多，但是始終要有人學習懂得如何用，還要製作課程讓學生可以跟著用，這樣才會有很高的使用量。用的多也會壞，如何去跟進，保修維護，零件材料入貨等等。不止是校內，校外會不會有新的儀器推出。我也很感受到，主流學界現在流行什麼 STEAM。學校一定要和主流的機構學界有很密切的聯繫才能知道自己學校是不是最新的。 這方面對每一個老師來說肯定是辛苦的，即使是一個有興趣的老師，未必有相關方面的經驗和知識。很多時候，我們老師也得一邊學一邊教。	A20
46:00		
問	對於創意上，還有沒有想分享的？	Q21
Teacher A	創意是課程的設計上有沒有充足的空間給學生展現創造力。另外第二樣我覺得學生怎樣可以變一些新的東西出來。雖然小朋友，想像力很天馬行空的，但有時亦要考慮	A21

	技術、成本等限制的。首先，教授學科上的知識，怎樣推動或者把知識變成新的東西，不止是學生覺得難，老師也是會覺得難的。比如老師教我這個機器是猜剪刀石頭布，我怎麼把這些已有的知識轉化成他們內化自己有的東西，然後再在這個基礎之上創作新的東西出來，這個對於能力較弱的學生來說是難的。另外，除了書本上的知識，小朋友對與世界的知識也是很重要，潮流出現什麼新的東西，他們要認識一下，或者生活上的問題要留意一下。比如比賽中，兩個老師帶三組學生參加比賽。當他們構思一個作品是，想到一個主意是，上網找才發現原來科技上已經有這種設計。對於他們來說，其實已經發揮他們的想象力，但是一上網可以知道不止是公司，甚至很多比賽都已經有很多同樣的設計。他們有時想得天馬行空，但是技術上並不能支持他們去做。有的就是想做，但是沒有技術，或者經驗不夠。	

2. Interview transcript of Teacher B in Chinese

<table>
<tr><td colspan="3">受訪者：Teacher B
訪問者：謝婕兒

晤談日期：11/3/2021
晤談時間：由 12:00 到 13:00
晤談地點：xxx 小學校長室
謄寫員：謝婕兒
受訪者：Teacher B

訪問開場白：老師你好！感謝你參與這次的訪問。這次採訪主要是想了解有從事過視覺藝術科目的老師對融入藝術在 STEM 教育中，能否提高學生創造力的看法</td></tr>
<tr><td colspan="3">00:01</td></tr>
<tr><td>問</td><td>我了解到你在學校裡面有擔任一些關於 STEAM 教育的事務，可以分享一下你的教育背景嗎？你覺得個人背景影響你參與 STEAM 嗎</td><td>Q1</td></tr>
<tr><td>Teacher B</td><td>中學的時候就是讀理科的，所以在日後推行 STEAM 的時候，就有基本的數理知識，令我在執行的時候比較容易，比較不會害怕一些內容比較深的科學知識和理論。預科之後我就讀教育學院，修讀中數常和視覺藝術科，畢業之後進入學校也是教這四科。一進到學校就是視覺藝術科的 Panel，一直推動視覺藝術科的發展。一邊工作一邊讀書，Bachelor 就讀視覺藝術和個人及社會教育。Master 也是視覺藝術教育。所以我的整個學習在視覺藝術教育方面是比較專業的。在學校里我就慢慢地從教四科變成教兩科，就是中文科和視覺藝術科，我曾經也是這兩科的 panel，亦是學校活動組統籌和學校發展組的統籌。所以很多時候新的東西，我都有機會有幫忙推動。</td><td>A1</td></tr>
<tr><td colspan="3">01:23</td></tr>
<tr><td>問</td><td>可以分享一下你在這間學校的 STEAM 經驗嗎？</td><td>Q2</td></tr>
<tr><td>Teacher B</td><td>然後前幾年開始，政府就推 STEM，也提供是 10 萬元給學校。有錢資助，學校就一定要執行。所以我們會考慮怎麼執行較好，10 萬元怎麼用比較好。找了專家朋友談一下，</td><td>A2</td></tr>
</table>

	看看其他學校或者海外地方怎麼去推動。很快就發現，推行 STEAM 比 STEM 好。A 是什麼我們也會探究，學校也很信任我們，我們就很快推行 STEAM，接著就考慮教師培訓和課程的功夫。STEAM 大概推行了 5-6 年。	
02:16		
問	推行 STEAM 過程中，都會遇到什麼困難？你會如何去克服這些困難？	Q3
Teacher B	先要解決老師的專業發展。因為如果老師不懂的話是教不了書的。由於，design thinking 有助推動 STEAM 教育，第一年推行時，我本來以為 design thinking 很容易理解，就找了個專家來講了一個講座，本以為可以，但是後來發現不行，因為老師的思維模式是不能夠只是透過三個小時的講座而改變。那麼，老師帶動學生做 project 的時候，也會很自然有一個既定的想法，就帶著學生跟著自己的方案去做。但是這種模式是不夠理想的，因為我們想要學生做主導，學生想一些千奇百怪的可能性出來。第二年，我們就請多了另一位專家，兩位專家就和老師們進行了一個 20 小時的 workshop，讓老師們親自經歷一次 design thinking 做探究的過程。老師本身也是分了組，親身去到社區看看有什麼問題發現，再想有什麼方案解決。在整個過程中，導師就用 train the trainer 的模式刺激學員想東西，不要一開始就想方案，其實中間有很多可能性的，導師不斷地刺激學員們和把他們拉出既定的框框。這個 workshop 之後，老師們的反饋就是他們也覺得自己從來沒有想到原來他們可以想到，之前想不到的一些方案。過程他們是有收穫的，原來他們透過一些 Design thinking 的工具，老師引導的方式，一些鼓勵和組員之間的合作，的確是可以跳出既定的框框的。這一次老師的學習得益中很自然會用到帶 STEAM 小組的時候，他們會比較有心得，因為他們經歷過。我們也安排一些 backup 的同事，因為有些同事在科學知識或者在思考模式的掌握是比較成熟的，他們會是一個 core team 支援其他帶組的同事。比如有時他們遇到大問題，有阻礙的時候，或者帶動不了學生。Core team 的同事就會幫忙比如看看如何能夠刺激或者幫助到各組學生的需要。第二年 run 完，第三年就很順，因為老師已經有足夠的經驗。我們也從少數的 core 老師，從十幾個變成二十幾個。	A3

	另一個就是課時的問題，因為本身我們學校裡面沒有這些課時給學生和老師做研習，是安排不了的。因為我們學校場地的問題，課時的問題。有的學校會把額外的活動安排到放學之後做，但是因為我們的學生住得很偏遠，他們一定要搭校巴走。就算老師肯放學後留下來帶組，也做不了。所以我們一定要在 school hour 里完成這些工作。那麼老師和學生都會很辛苦，真的是偷一點吃飯的時間或者小息的時間去做這些研習，是真的很辛苦的。到最後完成作品的階段，由於我們第九節是活動課的，就會叫學生不要去活動了，和老師一起去完成作品。但是老師們自己也要上課，老師不是每天第九節課都是有空的，老師也得遷就時間。而且學生是來自不同班別，不同班級，所以時間上很難遷就。這個是行政安排上比較難做到，因為 pack 得比較死，也不是全校性的活動，所以比較難去安排。因此一路來都辛苦了老師和學生們。第一年的時候就比較混亂，到第二年的時候就比較好點了。我們訂立了這個 project 最關鍵的幾個星期，我們就騰空了一些課時出來，讓有參與的學生完成 STEAM 作品，沒有參加的同學就繼續他們的活動課，這樣在行政上就會有小小的幫忙。最大問題就是場地和時間的問題。	
06:40		
問	因為有很多學校只是推行 STEM，而貴校推行的是 STEAM，貴校的 A 是以什麼角色放入 STEM 的？	Q4
Teacher B	Art A 做過 research，也問過學者專家的意見，一開始的時候，大家都會認同 A 是美或者包裝，但是包裝只是那個研究的最後一個階段。我們會相信，不止是美，只有包裝的話，這只在研究或者發明方面的最後一個階段。一邊看文章和一邊和學者交流，我們發現 A 除講求美，亦是講求人文性和創意的發揮，也正正是視覺藝術科的功用，科目的目標。我們一決定 A 的時候，就讓同事去討論一下到底 A 是什麼呢，美化就大家都是認同的，但是怎麼美化包裝就不一定每一位同事都懂，只是有共識產品出來要好看。另一種就是人文性，我們就考慮如何推動人文性，於是我們就引入了 Design thinking。因為 Design thinking 里很重要的東西就是同理心。如何有一個有系統一點的思維模式，如何幫學生能夠想得更多，又能夠把想法變得貼地，想出最好的方案，然後慢慢鑽研，最後有一個產品出	A4

	來。 A 的 definition 很快就拆得出來，因為我的教育背景，我明白什麼是藝術。我知道藝術對我們來說，是很自然發生的事，生活里面就會有，不用去特別強調。比如生活中的事情，自然美的東西才能吸引到人，不適合用，會棘手的東西你不會用。但是當我們要告訴同事的時候，我們就要刻意強調。有時候，比如怎麼把東西美化，老師們未必很熟悉或很擅長。所以帶組的理科老師會和視覺藝術科的同事交談，而視覺藝術科的老師就會給建議，比如用什麼紙，顏色，材料。或者學生直接找視覺藝術科老師的話，視覺藝術科老師就會直接指導學生，就會是這個模式進行的。除 STEAM project，就是視覺藝術科的發展，這個我就比較少參與，通常在視覺藝術科滲入 STEAM 在高年級比較多，我印象比較深的就是用了光繪的主題。就讓小朋友在會吸光的熒光紙上畫煙花，這些就會學了科學的原理，知道磷光為什麼會吸光。小朋友學習這種不用顏色筆就能繪畫的方法，但是他們要控制光能夠留在畫面上停留的時間。其中整個教學方法不同了，要注意的東西也不同的，但是是有趣的，能夠給小朋友一些新的刺激。也有些可能比較簡單的，比如拿一些紙棍去拼砌塔，這些活動課外活動有做，課堂里也有做，就是比較小型的藝術創作。以前也不是沒做，只是現在我們會強調一點或者加一些原理告訴他們。比如以前的視覺藝術科就是，我給一張熒光紙你們，你們就畫。讓學生探索裡面有什麼特別，創作完就評賞。但是現在我們就會用一點點時間去告訴學生原理是什麼。但是我們也會在意，這不是一節科學課，所以不會大部分時間都講科學原理。比如我們在拼塔的時候，我們會讓他們輕輕發現，三角的形態是穩固的。讓他們試試，就會知道兩支是站不住的，四方站得住也不是最好的選擇，他們就會明白怎麼做到對稱，怎麼才能站得穩。總之亂剪就是不可以的，要用尺子量度才能精準。他們也會膠紙貼得很醜。這樣看起來不好看，就會讓他們知道，原來貼膠紙也是要細心的，要剪好才能貼得好看，其實就 A 的這一個方面。我們除會做小型創作，也會做大型的 STEAM 活動，比如大型的 Led 燈，運用投影機做創作等等。因為疫情，我們就教小朋友如何用 ipad 進行創作。因為他們回不了學校，但是視覺藝術課還是要繼續的，所以我們就教他	

	們用 ipad 的 apps 或者繪圖板的那些方法去進行創作。裡面我們教動畫的時候，也會教導學生視覺暫留原理。但是我們不會刻意地說有多少 percent 的課程和 STEAM 有關。我們就是沒有的，在每一個學科里都不會有特別的 policy，但是我們各科都會有，比如中文科就會把和科學有關的文章放進去。	
18:03		
問	學校的 STEAM 就是直接融入每一個科目，而不是單獨一個科目？	Q5
Teacher B	因為我們學校本身就有科學課和常識課，所以科學的比重是重的，所以我們就會再在其他活動裡面推動，比如 STEAM project。今年也有進行 STEAM project 的，但比較難讓學生有成果，這個是一個限制，但是還是會執行下去的，而其他科就是滲透進去。 我們是很堅持視覺藝術課主導的，因為我們看到其他學校的 project，可能視覺藝術的元素相對是少一點，我們是沒有少的，因為我們很強調視覺藝術科就是視覺藝術科，裡面的元素是不可以沒有的。就如很多年前，有見部份學校推行社區為本的時候，整節課就是沒有什麼藝術創作的東西，就是變成介紹社區，如：區內很多垃圾我們要怎麼處理，那一節課就很像常識課或者公民教育課，但不是視覺藝術課。所以很多時候老師就會有這個迷失，教了很多其他科的東西，但是我們就沒有這個情況，因為我們本身寫課程的同事，都是視覺藝術科專科的老師，雖然有兼教的老師，但是因為是由我們弄好教材，有 powerpoint，他們跟著這些教學資料來上課，大家共同備課，整體內容不會差得太遠。	A5
20:22		
問	除了人手方面，學校的課程設計和工具設備方面會不會有什麼困難？	Q6
Teacher B	我們就比較少工課那一邊的東西。因為有很多學校可能會用鋸子和木板，但是我們學校是沒有的，一般情況下是機械和電子的東西比較多，我們會和資訊科技組一起合作。假如創作需要用 micro beat，學校現在就已經有。如想要用 LED 燈的東西，我們視覺藝術科會自己添置。另外，	A6

	ipad 學校有，我們課堂要用就會借 ipad。雖然我們發展得不是很大，但是每個老師都有每個老師的專長，其他學校可能有用鋸子之類，我們就沒有，只會用最簡單的材料，膠紙，等等。有時也會購買一些坊間的教材套，但是會根據教材套再改。	
29:30		
問	STEM 在加入了 A 之後，會不會對學生的創造力影響力更大了？	Q7
Teacher B	這個問題比較難回答，因為我們一開始就有 A 的存在，不能分辨到沒有到有的改變。我們全部老師，就算不是視覺藝術背景出身，我們都很習慣所有的東西都要美的，好看的。那我們只需要強調一種東西就是，你在研究的時候或者在做新發明的時候，你的那個作品是要關顧到對象需要，我們要帶出其中的人文性。不要為了搞 STEAM 而搞，真的要知道人家有這種需要，這個就是同理心的問題。人家有這個需要，然後你想了很多不同的方案，再想想你的對象，你覺得這個東西能不能幫上忙，幫不上忙的話，就再修正。另一種東西就是美感，無論是老師還是學生，大家都習慣要東西美的時候，要用什麼技巧去美化呢，視覺藝術科就能夠幫得上忙。有時候帶組的理科老師未必能夠解決美化上的問題，視覺藝術老師就會幫忙。 而學生方面，我覺得他們除了要有同理心之外，他們怎樣把產品美化已經是一種習慣。在一個作品上，我們會提醒他們，你覺得吸不吸引，他們就會很習慣，加上我們是小組進行，小組上的學生都有不同的能力。一般視覺藝術課，學生做自己的創作，學生的作品在視覺藝術老師的帶領下，作品很自然也會有視覺元素。而由非視覺藝術科的老師帶的活動，我們也會有視覺藝術的老師從旁協助。 如果要看創意方面，由於我們沒法比較有 A 前後的分別，提升小朋友的創意不是因為有沒有 A 的元素，而是老師的教學態度和整間學校的教學氛圍，老師是否容許學生嘗試，不要質疑學生一些無厘頭的想法。如果老師確定了一個固定方案，而學生的回答不是老師的固定方案就告訴他你這樣是不對的，應該這樣做。那麼這樣學生就不會思考，只等著老師填鴨式給予答案。那麼我們就要令老師知道，讓學生講，讓學生想，讓學生試，那麼學生就會慢慢	A7

	去講多一些他們的想法。很多想法是可以做出來，但是有些做不出來的想法也是沒關係的。試完不行不就繼續再試，所以這個真的是學校的氛圍和老師的態度。而小朋友在得到鼓勵之後，其實他們就有膽子去想。老師是需要逼學生去多想，很多學生都習慣了抄，無論什麼科目，視覺藝術課也是這種情況的，你給一個例子，他們就會很自然抄考，而且抄得一模一樣。無論創作的主題和內容是什麼都好，你一給圖，他們就會抄。而且我們學校的學生會抄的很精明，因此，我們學校第一不會給學生參考圖，讓他們自己想，第二做法就是我們給參考圖，說明我出的例子，你們不准用。很強調絕對不能抄，比如我的例子是兔子，學生就不能畫兔子，只能畫其他東西。第三個方法就是我們給大量的輸入他們，當學生有很多很多參考的時候，他們都不知道應該抄哪一幅，那麼就可以避免抄襲的情況。有時候他們也會抄考同學，那我們就會口頭上警告學生，你抄別人的功課，那麼分數會減一半。這個是老師的教學方法，其實事實上不會真的減學生的分數。要不斷的用又稱讚又懲罰的方式去讓學生知道，你要有自己的創意和自己的 input。	
26:23		
問	很多學校都是推廣 STEM，而貴校推廣的是 STEAM，你覺得加入 Arts 在 STEM 教學里，對學生的學習有影響大嗎？在哪方面的有影響？	Q9
Teacher B	我覺得引入 Art 對學生的影響是大的，因為其他科目的課程通常有一個既定的教學模式，標準答案。Art 帶出來的作品，人家一看，就會很有印象。例如：學生在研究時會布一些硬邦邦的數據或者是一些棒形圖，因為有 A，他們會變成一些有趣的圖形去表達，這些就正正是藝術引入的好處。另一方面就是老師，第一年開始的時候就不是很成功，因為老師們很難轉換到另一個教學模式，他們亦會遇到技術問題，學生想做的這一種東西，老師自己都不懂得怎麼弄。因為有些老師不是理科出身的，可能有些科學知識和技術層面未能掌握。幸好是我們學校的老師多是理工背景出身，所以老師之間合作很重要。一個人不可能涵蓋所有的範疇，所有專項的老師都會聚在一起討論，如何互相支援。到第二年的時候，我們就再進一步想。因為老師是很重要角色，他們如何去帶動學生去思考。於是學校再邀請了一位專家開了個 20 個小時的 workshop，每個星期	A9

	都有幾個小時，老師就要經歷一次如何進行一個 project，那個專家除了講理論給他們聽，還有帶動他們一起下到社區里看看裡面有什麼問題，真的經歷學生的過程，但是比較濃縮，可能學生經歷幾個月，他們就經歷幾個星期。過程裡面，專家會鼓勵老師們不一定是用這些方法的，其實還有還有很多很多的可能性，教了他們一些 design thinking 裡面會用的技巧和工具。那也讓老師明白了老師之間的個性和專長不同。有的人會一開始就把 idea 講出來，就等別人繼續做。有的人就會聽了所有人的意見，想很久，才開始發聲，開始默默地去做。從這裡也告訴老師，小朋友也有不同的能力，快慢節奏也不一樣，所以我們在安排任務給學生的時候，也要按照學生的能力去編排。經過這次 workshop 的經驗，很多老師都覺得結果是好的，部分老師覺得經歷了這次 design thinking 的 practice 之後，真的打破了一開始想要一步就達到產品的想法，原來過程中，只要你再逼迫我一下，真的可以想到新的東西，不是之前一步到點的那個方案。那個 trainning 的 program 叫做 train the trainer。老師掌握了之後，就用同樣的方法，帶領他們小組的學生，最後就有成品了。那年就做得比之前好一點，這個模式我們就 run 了三年，然後就到疫情，疫情就停了。這個就是整個 STEAM project，然後成績也是不錯的，學生們也能拿到獎。獎項是其次，最重要的是老師和學生都用了一個 multidisciplinary 的形式去研究，我們也能夠引入 design thinking 這個思維模式，最後產品也是有趣的。這個問題最主要就是牽扯老師的培訓問題。	
26:20		
問	學校提供了怎樣的環境，讓學生學習 STEAM 特色課去促進學生的創造力？比如小組的形式等等	Q8
Teacher B	課堂上視覺藝術科就未必是小組形式，有小組創作也有個人創作。如果是 STEAM project 一般都是集體創作。集體的時候就一定有不同的互動，互動會很多，他們要學會分工，或者分享不同的 idea。剛剛有提及就是學生有的很快就會有 idea，有的就會保持安靜到突然有 idea 才進行創作。所以這個層面要看老師在施教的過程中，怎麼鼓勵每一個學生都參與，這是一個教學策略來的。另外，定主題範圍要大和夠吸引力，學生自然在這個題材的創意發揮會很大，材料未必是一個限制。如果連物料可以有更多選擇	A8

	給學生的話，學生也會有機會可以創出一些特別的作品。	
28:00		
問	學校會不會帶學生去另一些課室以外的地方上課？	Q9
Teacher B	Steam project 是會帶學生去到社區裡面做訪問，拍照，了解社區中有什麼問題，不止一次。比如第一次可能是簡單看一看，然後回到學校討論發現了什麼問題，公園有一堆公公婆婆坐在那裡，他們就會訪問公公婆婆，為什麼你們坐在這裡，不回家呢？然後他們就會總結到公公婆婆，原來是沒有工作的，很悶的才會在公園坐一下。所以學生就會知道老人家是悶的有什麼可以幫到他們。我們的 project 里是會讓學生去到社區里的。	A9
30:00		
問	戶外的環境對學生的創造力影響會比室內大嗎？	Q10
Teacher B	可以到創作情景一定比留在課室里影響力大，因為學生可以親身接觸他們的創作對象，比如視覺藝術科，最簡單的就是我們做完一件作品，我們有機會讓學生的作品能夠參與表演的，我們很重視舞台表演，所以比如上次，在教大有個國際研討會，我們就會讓學生參與一個開幕禮的表演，這些就是將學生的成果公開，學生的學習動力也會高一點。	A10
32：36		
問	貴校的 STEAM 發展是由全校有興趣的學生老師參與？	Q11
Teacher B	我們一開始不會想著全校推行，因為一開始通常都很難推行，不可能有每一個老師一開始就能全年負責。所以一開始我們都從小步和小組開始，每一科滲透。課程主任帶著 panel 去構思，就會比較容易進行。我們進行到現在，現在正計劃明年開始除各科滲透及 STEAM Project 外，會安排特定時間全校普及接觸 STEAM。可以看，這已經是我們推行了五六年之後的事，我們計劃透過不同的小實驗，讓學生一步一步地進行。我們也不確定我們會不會寫出一個完整的課程，因為比較難，我知道有些學校是有獨立 STEAM 課堂的，但是我們想慢慢一步一步來擴大和推廣 STEAM。	A11
34:06		
問	學校會不會有專門評估作品的 marking scheme？	Q12
Teacher B	其實 marking scheme 或者 rubic 一定是根據學習重點去評估的，每一課都會不同，你教什麼就評估什麼。要根據	A12

	課題看看這一個是不是重點，有時候可能那個課題的技巧性比較高，那麼創意的比重就會相較比較低，但是如果課題特別要啟發創意多的，那麼創意比重就會比較高一點。	
36:10		
問	在作品上，你會如何評估學生的創造力，可以展示一下學生的作品解釋一下嗎？	Q13
Teacher B	AR 這裡因為要學生體驗 AR 的感覺，很難再評分會用創意來衡量。比如小怪獸的造型創意比較高，每一隻都是不一樣的。學習目的大家都是一樣，要設計一隻會動的小怪獸，在評估的時候肯定是技巧，會不會使用這個軟件進行創作，造型及色彩這些都是創意，學生作品不是每一隻都是一樣，這樣就可以看到學生的創意。其實很虛無縹緲，沒有人規定小怪獸一定要有手有腳，但是你也會看到老師是有目的地教的，就不是有時學生的作品，二十五個學生都不一樣，不代表學生有創意，因為有可能是老師什麼都沒教，學生們自由發揮。但是真正既定的學習目標里，學生是發揮創意的，你是看得到作品的基本造型，技巧也在，某層度上是看得老師的教學設計，可是學生又能有不同的表現，這種就是好的課程設計。	A13
42:37		
問	對於創意上，還有沒有想分享的？	Q14
Teacher B	另外在施教的過程，老師的鼓勵的非常重要。比如有學生的作品是完成得很好的，那麼老師的鼓勵，可以讓其他同學知道，我要向同學學習，又不能直接抄襲的時候，學生就會努力地去想出更加不同的 idea。除此之外，創意在於老師在教學的過程給了學生的創意空間有多大，老師一定會帶領著學生一起思考，想出更好的解決方案的。在這期間，老師不可能直接給答案，因為 STEAM 不像其他科目，有一個既定的教學內容，所以給學生思考的空間，發揮創意的空間，在於老師的課程設計和實施過程中給了學生多少的空間。最後一點就是課時很重要，因為不僅是老師的時間還是學生的時間，都要配合得很好 STEAM 才能推行得很好。如果課程構思得很好，但是課時上不允許，很多時候 STEAM 也搞不起來。	A14
46:27		
問	老師會不會認為視覺藝術科專科專教的老師對發展 STEAM 是有幫助的？	Q15
Teacher	我會相反的想，如果視覺藝術科專科專教對推動 STEAM 有	A15

B	影響，那麼常識課專科專教應該也會有影響。專科專教是否有影響，我覺得不是。因為 STEAM 是跨學科，如果我將 STEM 融入 Visual Arts，那麼那個老師是專科專教是一件好事，但是如果是跨學科的學習的話，其實應該是有一 Team 來自不同學科的老師協作，才能夠發揮最大的成效。每一個老師都應該有他們的專長，那麼他們結合一起，就是一個通才的老師群，這樣是最好的。	