Article

The Construction and Sustainability of Teachers' Positive Emotions toward STEM Educational Work

Yi Lian [1] , **Kwok-Kuen Tsang [2],*** and **Ying Zhang [3]**

1   Faculty of Education, Chinese University of Hong Kong, Hong Kong 999077, China; yi.lian@ymail.com
2   College of Education Administration, Faculty of Education, Beijing Normal University, Beijing 100875, China
3   College of Urban Economics and Public Administration, Capital University of Economics and Business, Beijing 100070, China; zhangyingbnu@mail.bnu.edu.cn
*   Correspondence: gkk1212@yahoo.com.hk

Abstract: STEM education is an important approach for preparing students for a competitive workforce with essential skills in the 21st century. However, successfully implementing STEM education in primary and secondary schools presents a variety of challenges. The study suggests that a neglected challenge in the literature is how to sustain teachers' positive emotions toward STEM educational work, which may cause teachers to be more engaged in, motived by, and committed to STEM education. Therefore, the study aims to contribute to the literature by investigating the mechanism of the construction and suitability of teachers' emotions toward STEM educational work based on a single case study conducted in Hong Kong from the social constructionist perspective. The major findings of the study indicate that (1) positive emotions toward STEM educational work may be constructed by the teacher's positive interpretation of the work, i.e., STEM educational work as the facilitator of students' overall development and that (2) positive emotions toward STEM educational work may be sustained by enabling school institutions to have the elements of shared power, administrative support, and the value of a whole-person education.

Keywords: teacher emotions; STEM education; social construction; sustainability

1. Introduction

The integrated approach of STEM (science, technology, engineering, and mathematics) education can foster students' essential skills such as creativity, problem solving, and collaboration to develop a competitive workforce in the 21st century [1–3]. Moreover, STEM education may shape students' aspirations for STEM careers and encourage them to pursue STEM careers to meet the increasing need for trained professionals in STEM areas [4,5]. Education researchers identify that STEM education may also enhance students' motivation, interests, and persistence in learning, leading them to become self-directed learners [6]. Since it has these positive effects, STEM education has received increasing attention internationally over the past decade [7,8].

Although educational systems globally have initiated policies to promote STEM education, they have encountered different challenges during the implementation process [8,9]. Teachers are one of the major challenges [10]. Teachers are inclined to be uncertain about how to teach STEM with integrated approaches such as problem- or project-based learning and how to design STEM educations without losing disciplinary integrity [9,11,12]. A similar situation is found in Chinese societies [8]. Dong et al. [13] found that teachers in China face pedagogical and instructional challenges in implementing STEM education because of the limited knowledge and beliefs of STEM education. Geng et al. [14] noted that Hong Kong teachers tend to have a weak sense of self-efficacy belief in STEM education since they receive insufficient training, causing them to lack understanding and the skills of teaching, organizing, and managing STEM activities. Accordingly, as English [15]

noted, the challenge for STEM educational implementation is how to improve teachers' pedagogical knowledge and skills to design and teach STEM.

In addition, teachers' emotions toward STEM educational work are suggested to be important for successful STEM education implementation. As Kim et al. [16] showed, positive emotions such as enjoyment and happiness significantly improved preservice teachers' behavioral and cognitive engagement in STEM education. In this sense, promoting and sustaining teachers' positive emotions toward STEM educational work are essential to successfully implementing STEM education. Nevertheless, since the 1990s, the positive emotions of teachers have been drained by educational accountability initiatives [17,18]. In the context of educational accountability, it may be difficult for educational systems to successfully implement a STEM education in which teachers' positive emotions are sustained. Thus, it is necessary to understand how teachers' positive emotions toward STEM educational work are constructed and sustained in the current context of educational accountability to provide recommendations to improve STEM educational implementation.

However, the role of teachers' emotions in STEM educational implementation is neglected in the literature. Therefore, to advance the understanding of STEM educational implementation, the present study aims to explore the construction and sustainability of teachers' positive emotions toward STEM educational work in the educational accountability context based on a case study conducted in Hong Kong. As the next section describes, the Hong Kong situation is similar to that of many other societies across the globe. Therefore, the findings and implementations of the study may also be relevant to them.

2. Literature Review

2.1. STEM Education, Educational Accountability, and Teachers' Emotions in Hong Kong

Since 2000, the Hong Kong educational system has aimed to promote students' whole-person education, lifelong learning, creativity, and problem-solving skills through learner-centered, problem-based learning, and integrative pedagogical curriculum approaches [19]. Since 2015, similar to other Western and Asian societies—such as the US, Korea, Malaysia, and Singapore—the Hong Kong government has realized that STEM education is an important approach to achieve the aims of education, so it has promoted STEM education in primary and secondary schools [20]. However, similar to its Western and Asian counterparts, the lack of knowledge, skills, and self-efficacy to teach STEM is a challenge for STEM educational implementation in Hong Kong [14]. In addition, the literature implies that negative emotions toward STEM educational work may be another challenge for its implementation in Hong Kong. For instance, Tsang [21] noted that Hong Kong teachers tend to interpret work related to extracurricular activities and programs such as STEM education as noninstructional work. Therefore, they are unwilling to spend much time on it. According to Tsang [21], the phenomenon is related to educational accountability initiatives from the mid-1990s. Similar to many societies across the globe, initiatives are instituted that introduce different accountability measures such as teacher appraisals, school reviews, and performance indicators on teachers' work to ensure school effectiveness in Hong Kong [22]. To avoid being evaluated as ineffective, schools generally require teachers to produce desirable academic and nonacademic outcomes outside classrooms by organizing a wide range of extracurricular and learning activities as well as programs with tight schedules [21]. Without sufficient time for planning and preparation, teachers perceive extracurricular and learning activities and the programs as not providing students with meaningful learning experiences [21]. Moreover, as each activity and program entails much paperwork, such as writing planning and reports, teachers find that the workload induced by the extracurricular and learning activities and programs erodes the time that could otherwise be spent on lesson preparation and marking assignments [21]. Therefore, they are inclined to interpret the work as administratively used to satisfy the accountability measures rather than as instructionally designed to foster students' development, leading to negative emotions toward the work [21].

In this situation, teachers generally feel negative toward their work in Hong Kong [21]. For example, Hong Kong Federation of Education Workers [23–25] showed that over 80% of Hong Kong teachers feel exhausted and stressed, over 40% are frustrated, and nearly 30% are unhappy in teaching. Similarly, Cheng [26] observed that 50% of teachers in Hong Kong feel powerless toward their work and 24% are depressed and anxious by teaching. Research suggested that the ratio of teachers suffering from negative emotions like stress, anxiety, and depression is two to three times higher than the general public in Hong Kong [27,28]. Tsang [21] further indicated that the teachers tend to be satisfied with doing work like organization of extracurricular activities or educational programs outside classrooms. Since the negative emotions affect the psychological well-being and work performance of the teachers [28–32], education researchers have investigated how the negative emotions of teachers are constructed. Although the studies may provide recommendations to prevent teachers to be suffered from the negative emotions, they may not significantly suggest ways to promote teachers' positive emotions leading to successful implementation of STEM education. This is because the construction processes of positive and negative emotions are different [33,34]. In order to have a better understanding of the construction process of teachers' positive emotions toward STEM educational work, social constructionism will be employed as the theoretical perspective to guide the present study.

2.2. Social Constructionism of Teachers' Emotions

Since the 1980s, social constructionism has become one of the domain perspectives in the research of human emotions [35]. According to the perspective, emotions are not objective psychological states affected by bodily and physiological changes; instead, they are socially constructed by agency and institutions [34]. First, emotions are believed to be shaped by agency, i.e., the capability to reflexively make meanings from objects. This idea means that teachers' emotions are feelings toward objects—including themselves, their work, and their social environments—aroused by their interpretations of these objects and consciously experienced and enacted by them in social situations [36]. A positive (negative) interpretation arouses positive (negative) emotions toward the object. For example, if teachers positively interpret STEM educational work as meaningful instructional work, they are inclined to feel positively toward it, and vice versa. Thus, the terms positive and negative in relation to emotions do not convey moral meanings. They are merely used to describe the outcomes of interpretations [34]. Moreover, emotions may become symbols supporting the meanings teachers give to objects and directing their behaviors toward the objects [37]. In the above example, the prolonged experiences of positive emotions may signify to the teachers that STEM educational work is important, so teachers become committed to and engaged in it. For example, Papadakis et al. [38] found that if teachers perceive educational robotics (ER) as a part of STEM education, and as valuable and useful to improve students' learning experiences, they will feel positive toward ER and become more committed to create an innovational learning environment based on the use of ER. Similarly, Kalogiannakis and Papadakis [39] demonstrated that teachers' willingness to teach with smart mobile devices will increase when they have positive perceptions and feelings toward the educational values of smart mobile devices. The literature further suggested that teachers may reflexively monitor their teaching work to achieve the positive meanings they give to their work [40]. If they interpret they can do so or that the school supports them in doing so, their positive emotions are intensified [41].

Second, the social constructionist perspective recognizes the roles of institutions in the construction process of emotions [35]. According to Scott [42], institutions have "regulative, normative and cultural-cognitive elements that ... provide stability and meaning to social life" (p. 57). Institutions are social forces guiding and shaping people's interpretations, behaviors, and feelings [43]. To teachers, school institutions are one of the important institutions affecting their social lives and emotions. In their seminal work, Meyer and Rowan [44] illustrated that school institutions are loosely coupled, implying that school bureaucracy is detached from teachers' work. The authors explain that the loosely cou-

pled institution of schools results from the institutional logic of rationality, which requires schools to function effectively and efficiently. According to institutional logic, schools should develop a bureaucratic outlook as it is defined as the most effective and efficient form of organization, but they should avoid the strict monitoring of teachers' work, as it may generate evidence of school ineffectiveness and inefficiency [44]. In the loosely coupled institutional environment, teachers enjoy a greater level of autonomy in working in line with their interpretations [45], so they generally feel positive, or at least less negative, toward their work [46]. Nevertheless, the emergence of educational accountability initiatives changes the situation. According to Hallett [47], educational initiatives are accompanied by the institutional logic of accountability, which defines the managerial approach of school management as the best means of enhancing school quality. As influenced by this institutional logic, schools have enforced bureaucratic and managerial measures to monitor and supervise teachers' work, resulting in a tightly coupled institution [48]. Eventually, teachers lost their autonomy and became subject to a greater level of administrative control and surveillance [46]. In the tightly coupled institutional environment, thus, teachers tend to be powerless to exercise control over their work, and work that they perceive as instructionally meaningless is assigned to them by school administrators [17,18]. Tsang [21] further suggested that educational accountability initiatives may disempower teachers to identify the instructional meanings of extracurricular and learning activities and programs outside the classroom, leading them to negative interpretations of the work. Therefore, the literature has shown that teachers generally suffer from negative emotions in the context of educational accountability since it institutionally makes it more difficult to do the work they value or to identify the instructional meanings of the work assigned by school administrators, e.g., [17,47].

According to social constructionism, theoretically, teachers' positive emotions toward STEM educational work should be shaped by both teachers' agency (interpretation of STEM educational work) and school institutions. Although some researchers have paid attention to either agentive [14,38,49] or institutional effects [9,10,50], there is the lack of research concerning how teachers' positive emotions are constructed and sustained by both agency and institution. Therefore, the present study would like to fill the research gap by answering the following research questions:

(1) How are teachers' positive emotions toward STEM educational work shaped by their interpretations of the work?

(2) What kind of school institution in which teachers work and how does the institution sustain their positive emotions toward STEM educational work?

3. Materials and Methods

As the theoretical framework depicts, teachers' emotions toward STEM educational work may involve dynamic relationships between teachers' interpretations and school institutions in the context of educational accountability. To capture the dynamic relationship, a case study method was adopted [51]. In the study, HKASS (a pseudonym), a Hong Kong secondary school, was selected as the case for investigation because it had implemented a STEM education before the government issued the STEM educational initiative in 2015, and its performance in the STEM educational implementation was outstanding. The outstanding performance has been reported by the mass media since 2015. Moreover, the government recognized its achievement in the STEM educational implementation, so it invited HKASS to be a professional development school to support other schools in implementing STEM education. Furthermore, based on observations, the teachers were emotionally engaged and committed to the STEM educational work at HKASS. Therefore, HKASS was an information-rich case for the study to explore how teachers' positive emotions toward STEM educational work were constructed and sustained for successful STEM educational implementation in the context of educational accountability.

In particular, the study applied an embedded case design [52]. This design means that the study focused on a subtitled unit of the school, which was the STEM educational team,

because the team was the major unit responsible for doing and coordinating the STEM educational work in the school. The team was composed of six core teacher members from different subject departments—including Information and Communication Technology, Design and Applied Technology, and Integrated Sciences—who held the functional title of STEM teacher. They had weekly meetings to discuss every issue regarding the STEM education. Therefore, focusing on the team and the STEM teachers would provide opportunities to have an in-depth analysis of how the teachers interpreted and felt the STEM educational work and how their interpretations and emotions were shaped by the school institution in which they were embedded.

The data collection was conducted between 1 December 2019 and 30 April 2020. All participants gave their informed consent for inclusion before they participated in the study. The study was conducted in accordance with the Declaration of Helsinki, and the protocol was approved by the Survey and Behavioural Research Ethics Committee of the Chinese University of Hong Kong. The plan was to visit the school two days a week during the period. In the school visits, the first author observed the kind of STEM educational work the STEM team and teachers had to handle and how they planned and did the work by attending the STEM team meetings and school meetings, joining into the STEM lessons and activities, and entering the teaching staff room. In particular, she observed 3 STEM lessons, 5 STEM team meetings, 1 school staff meeting, and 1 STEM open day. Moreover, she had informal chats with the STEM teachers, the nonSTEM teachers, the school principal, and the school vice principal to learn their thoughts, feelings, attitudes, and behaviors toward the STEM educational work. School documents, such as school plans and reports, were also collected during the data collection period after obtaining the school principal's approval. Whilst doing observations, the first author kept writing fieldnotes in the school or immediately after leaving the school to avoid forgetting important details. However, school visits and observations stopped in February 2020 because of the COVID-19 outbreak in Hong Kong. Therefore, she and other authors spent a month on the preliminary data analysis. Based on the preliminary analysis, noted that semistructured interviews were required to elicit richer information about how the STEM teachers and school administrators interpreted and felt about their work and the school institution for further analysis. Thus, the first author invited the school principal, 1 school vice principal, 3 STEM teachers, and 11 nonSTEM teachers from different subject departments to participate in interviews in April 2020. Each interview was approximately 1.5 h and was voice-recorded with consent.

After the data collection, the interviews were transcribed. Then, fieldnotes, interview transcripts, and those collected school documents were the data sources for analysis. All of the data were analyzed first by open coding and then by focus coding with NVivo 11 software. During the data analysis process, the authors met regularly to discuss their interpretations of the data to develop a coding scheme. Moreover, they attempted to ensure the credibility of the analysis by applying the consistent comparative method, which continuously compared incidents in the database to other incidents, incidents to themes, and themes to other themes. and continued refining and modifying the coding scheme during the data analysis process [53]. Finally, four major themes emerged from the data, including STEM educational work, emotions toward STEM educational work, interpretation of STEM educational work, and enabling school institutions.

4. Results

4.1. STEM Educational Work in HKASS

In HKASS, the STEM teachers were not only responsible for the STEM education but also for other subjects in the school. However, when the government promoted STEM education in 2015, the school principal decided to form a STEM team to coordinate the STEM educational work and invited them to join the team. Since then, they have undertaken not only instructional and administrative work related to their own subjects

and departments but also the STEM educational work. Their major STEM educational work is described as follows.

First, they taught a STEM curriculum. In the 2016–2017 academic year, HKASS introduced a school-based STEM curriculum called Maker Class for junior secondary students. The STEM teachers had two lessons (80 min) of the Maker Class per week. To ensure the quality of the Maker Class, the STEM teachers exchanged ideas and collaboratively planned the curriculum in weekly meetings. In the Maker Class in the first school term, they facilitated the students to learn the knowledge and skills of programming, design, and production, and then in the second school term, supervised students to invent products based on the themes of either smart home or elderly service. The teachers also guided the students to perform field studies to identify the real needs of smart homes or elderly individuals and to address the needs. Then, they facilitated the students in preparing written proposals and oral presentations to illustrate their ideas and justify the feasibility of their inventions. Finally, they facilitated the students in translating the proposed inventions into products and then tested the products in real social settings.

Second, they cotaught in other subjects. The STEM teachers were responsible for promoting the integration of STEM elements into the other subjects in the school. Thus, they often joined other subject departments and collaborated with them to teach those subjects with STEM. For example, the STEM teachers were invited to coteach Form 2 (Grade 14) Integrated Sciences (IS) classes in the 2018–2019 academic year. During the year, STEM teacher Mr. Wong (a pseudonym) joined the IS department's weekly meetings and discussed with the IS teachers who taught Form 2 IS how to integrate STEM into the ordinary lessons. Mr. Wong noted that the IS teachers simply prepared all the necessary equipment for the students to do the experiments, and the students simply completed the experiments by strictly following the teachers' instructions. He thought there could be more space for the students to think about how to innovatively conduct the experiments. Therefore, for instance, he assisted the IS teachers in redesigning a lesson about a free-fall experiment. Traditionally, the IS teachers provided timers for the students to measure the time it took for steel balls of different sizes and mass measures to fall to calculate acceleration due to gravity. Following Mr. Wong's suggestion, the timers were not provided, so the students were required to find alternative valid and reliable measures for the experiment. The STEM and IS teachers collaboratively guided the students to complete the task in the lesson. The STEM team planned to collaborate with the Chinese history teachers, in addition to IS, to integrate STEM elements into the Chinese history lessons in 2021–2022.

Third, they coordinated a variety of STEM extracurricular activities, such as game programming, aquaponics, and AI study. Moreover, they collaborated with community partners to provide STEM activities outside the classroom. For instance, since the 2018–2019 academic year, they have worked with a university, businesses, and a foundation to initiate a series of activities for students to experience different STEM-related occupations to explore their STEM-related interests and career development.

Fourth, as teachers at a professional development school, the STEM teachers often represented HKASS in sharing the STEM educational experiences with the public. During the fieldwork, in December 2019, HKASS held a STEM open day. On that day, many people, including parents and other schools' principals and teachers, visited HKASS, especially the Maker Class and STEM-related laboratories and facilities. The STEM teachers served as the tour guides and introduced HKASS's STEM education to the visitors. On that day, the STEM team coordinator, Mr. Cheung (a pseudonym), held a session sharing the experience of HKASS in STEM education with visitors and discussing with them how to improve STEM education in Hong Kong schools. Moreover, sometimes the STEM teachers were invited by EDB to provide STEM professional development workshops to other schools and teachers.

Finally, the STEM teachers had to prepare annual plans and reports to show the overall effects of the STEM educational activities and programs they organized every year. Moreover, they had to produce progress reports that recorded the inputs, outputs,

and outcomes of each STEM educational activity and program throughout the school year. To ensure that they kept the STEM educational work on the right track, they had weekly meetings to share and discuss ideas. Agendas and minutes for each meeting were documented. A monthly staff meeting was held in which the STEM team reported their work to the school administrators. When asked why they had to perform these administrative tasks, Mr. Cheung explained that they needed these documents and records as evidence showing their efforts in STEM education for school evaluation and external review (fieldwork on 14 January 2020).

4.2. Teachers' Emotions toward STEM Educational Work

These findings imply that the STEM teachers had to handle much STEM educational work. According to our observations, they were usually busy doing or coordinating the STEM educational work rather than the work related to their subject teaching during school time. The STEM teachers said they often prepared lessons or marked assignments after school, at home, or on holidays. Although they were burdened by the STEM educational work, they did not seem to be exhausted and stressed by the work. On the other hand, they were passionate and enthusiastic about it. For example, they found that micro:bit was a useful learning tool for students to study programming, so they planned to teach it in the Maker Class. Although no one knew micro:bit previously, every STEM teacher was committed to learning it by themselves and then sharing their learning with one another in the weekly meetings. This case was not unique among them. According to Mr. Cheung (interview on 4 April 2020), they needed to continue to learn proactively and update their new knowledge because ICT develops rapidly and they had to ensure that students could learn the most current STEM knowledge and skills. When they were asked how they felt about the situation, their responses were similar to the following:

> It is not easy. STEM is not my only work. I need to teach other subjects. So I feel stressed to some extent and sometimes I worry that I cannot do it well. But, I am interested in learning new things because I believe that there will be opportunities for students to learn new things if I can learn more. So, I think it is worth it if it can benefit students.
>
> (Mr. Wong, fieldwork on 10 December 2019)

> I enjoy doing STEM education. I think all of us [STEM teachers] enjoy it, because I think STEM is suitable for our students because it is fun. It can motivate students to learn. So, I am willing to . . . for example, buy one micro:bit and play it at home in order to become familiar with it before teaching students.
>
> (Mr. Chan [a pseudonym], fieldwork on 17 December 2019)

4.3. Interpertation of STEM Educational Work

These two extracts indicate that the teachers felt positively toward the STEM educational work because they interpreted it is as a facilitator of students' overall development.

> Actually, we think STEM education is not only about transferring knowledge and skills. It aims to enhance their [the students'] problem-solving competence and creativity. Moreover, we hope we can encourage them to apply the knowledge learned from schools to solve problems they and other people encounter in every life. Children do not like learning because they don't find the meanings. However, if they know what they have learned can help people solve problems, what will they think? They may think learning is meaningful. They may think they are worthy. They may become more confident. All these factors may make them more motivated and committed to study.
>
> (Mr. Cheung, interview on 4 April 2020)

Accordingly, the teachers were passionate and enthusiastic and enjoyed performing the STEM educational work because they interpreted it as being able to positively change

the students' attitudes, confidence, motivation, and self-concept rather than solely imparting STEM knowledge and skills. To some extent, this interpretation might be supported by successful student cases. Since 2015, when the STEM education was implemented in HKASS, the STEM teachers have witnessed students whose personal growth benefited from the STEM education. For instance, the STEM teachers told us that they had a student studying for a bachelor's degree in oceanography in Taiwan. They said the student's academic motivation was low. Nevertheless, she changed after she participated in the STEM extracurricular activity of aquaponics. Through aquaponics, she discovered her interest in oceanography and aspired to study it in the future. Therefore, she started to work hard and ultimately received an offer from a Taiwan university. Mr. Wong (interview on 4 April 2020) also said that he witnessed how the Maker Class allowed some students to learn about their talents and interests in programming, so the students became committed to learning programming and aspired to study and earn a bachelor's degree in computer sciences. To some extent, the successful student cases meant to the teachers that the STEM educational work was meaningful in fostering students' learning and personal growth. Moreover, the successful student cases may signify that the efforts they put into the STEM educational work could have positive influences on students, leading to a sense of achievement.

> Mr. Cheung: You know we have a STEM open day each year. Many people will visit our school on the open day. Our students present the inventions they produced in the Maker Class to the visitors. Although they may be shy and nervous when they present in front of strangers, they enjoy it. I think the open day gives them a platform to learn how to communicate with people about their ideas, display themselves, discover their competence, and build self-confidence in study. So, . . . yes, we need to undertake numerous tedious and trifling things while preparing the open day. But I think it's worth it for them, since I can see they make changes.
>
> Researcher: A sense of achievement?
>
> Mr. Cheung: Yes, a sense of achievement . . . and satisfaction. To me.
>
> (fieldwork on 17 December 2019)

Therefore, the STEM teachers tended to positively interpret the STEM educational work so they felt positive toward it and were committed to doing it. Moreover, the positive emotions may be sustained if the teachers witnessed successful student cases because the cases not only justified their interpretation of the STEM educational work but also brought them a sense of achievement.

4.4. Enabling School Instituions

Although successful student cases may sustain and enhance the STEM teachers' positive emotions, there was no guarantee that the teachers must witness student cases that significantly impressed them every year. Therefore, school institutions should be able to empower teachers to do the work and understand its meanings for the sustainability of their positive emotions [21]. From HKASS, it was identified that an empowering school institution might contain the following elements.

4.4.1. Shared Power

According to our observations, the school shared power with the STEM teachers in performing the STEM educational work. During the fieldwork, we asked the STEM teachers several times about their perceived autonomy in performing the STEM educational work. They generally agreed that the autonomy was high because they were free to plan and decide what to do in terms of the STEM education and how to do it in HKASS. This situation did not mean there were no administrative regulations on or monitoring of their work, but the regulations were suggestive rather than mandatory. For example, the school principal suggested that the STEM teachers plan the STEM education based on a general principle that engaged and encouraged students to solve daily life problems by

the application of learned knowledge and skills. Mr. Chan (interview on 4 April 2020) mentioned that the teachers would consider this principle when they planned and designed STEM activities, programs, and curricula, but they might ignore it if they thought it did not match a particular STEM activity, program, or curriculum.

Moreover, the teachers needed to report their plans, progress, and the outcomes of the STEM educational work to school administrators at the beginning, middle, and end of each school term. However, they did not perceive these monitoring measures as administrative control and surveillance. To them, these measures might just be a formal channel for the administrators to know what was happening in the school and to exchange ideas with the teachers.

> Actually, the principal will ask us what we plan to do at the beginning of each school term. Then, we will tell him what kind of activities we want to do. Yes, he will ask us and we will tell him. For example, this year, I tell him I want to teach something new because I hope my students know more. I also want my students to learn through playing, so I plan to lead my students to play during lessons. Making lessons more interesting and funny. Not so serious. I hope they can enjoy the lessons. So, I tell him. He says okay, let's try. So, I think . . . autonomous . . . we [STEM teachers] are quite autonomous. We just let the principal know what and how we are doing and he generally allows us to do it.
>
> (Mr. Chan, interview on 4 April 2020)

The school administrators valued the outcomes of STEM education a great deal. In one interview (3 April 2020), for instance, the vice principal stated, "We need to ensure the educational outcomes of STEM education." This idea was repeated another four times. Nevertheless, the school administrators did not strictly monitor the teachers. On the contrary, they worked with the teachers to reflexively evaluate the STEM educational work and explore how to improve it rather than blaming the teachers if they found the work did not match the expected outcome.

The findings suggested that the STEM teachers shared power in the STEM educational work with school administrators in the school. Therefore, they were involved in the whole work process of the STEM educational work from planning to implementation and evaluation. Even though administrative regulations and monitoring were in place, they were minimal to the STEM teachers. Therefore, the STEM teachers tended to be able to appreciate the purposes of their STEM educational work and to align it to the meanings they gave to the STEM education.

4.4.2. Administrative Support

According to the data, the administrators of HKASS supported the STEM teachers to experiment with different ideas of STEM education. As the vice principal said, they welcomed the teachers to initiate new ideas.

> You can tell me what you want to do. Please propose. Tell me what help you need. If you need money, I will give you money. If you need any support, I will give you the support. If I don't have enough money or don't know how to help you, I will try to find resources and help outside the schools.
>
> (interview on 3 April 2020)

Indeed, the STEM teachers agreed that the school administrators were supportive. They said the vice principal continued to look for external resources from universities, businesses, foundations, and charities to help them successfully enact different ideas in STEM educational activities, programs, and curricula. Therefore, the STEM teachers had opportunities to collaborate with different sectors to organize a variety of STEM activities and programs to improve the teaching and learning experiences in STEM.

> At the end of each school term, we will have a meeting to evaluate the performance of our work within the STEM team. The vice principal will join us as he is our team member. He represents the perspectives of school administrators in the discussion. Therefore, we can discuss some school administrative problems that may constrain our work and try to determine how the school administrators may help us solve the problems.

> (fieldwork on 19 December 2019)

Therefore, the teachers may have enjoyed working in the school since they perceived that the school institutionally supported them in enacting the meanings they gave to the STEM educational work by experimenting with different ideas of STEM education.

4.4.3. Shared Value of a Whole-Person Education

The findings further revealed that the school value of a whole-person education contributed to the sustainability of the STEM teachers' positive emotions. The school value was articulated on the school website and in every school development plan as follows:

> The school aims to nurture students' ethics, intellects, physiques, social skills and aesthetics to have a perfect personality and prosperous life. We believe education is valuable, and each student is an independent individual who is worthy of respect. All teachers in our school work from the educational philosophy of a whole-person education. We are student-oriented and attach importance to the mental development of students. By integrating discipline and guidance, we cultivate students to have good morals and create a pleasant learning environment. Moreover, we provide opportunities for lifelong learning and design appropriate courses according to students' abilities, interests and needs to help students make good use of their spare time and develop their potential and to equip them with the skills and abilities to become lifelong learners.

The school value was not merely a symbolic statement that appeared in school documents but was enacted in the school. To realize this value, the school institutionally initiated different educational programs to help students cultivate their attitudes, social skills, morality, and aesthetics, and to explore and develop their interests and potential. Indeed, STEM education was one of these educational programs. Another large-scale program was called the Stars Academy, which invited students to participate in a wide range of social services, overseas exchanges, and sports and art activities outside the classrooms. As observed, many of the teachers joined the Stars Academy or similar programs and spent much time doing the related work in the school. When asked why they were willing to do the work, the teachers generally said it was beneficial to students' growth and development.

In this sense, the teachers shared the school value of a whole-person education, and the school value was inclined to become a cultural framework guiding the teachers in interpreting and doing their work. In this situation, STEM education was generally interpreted as work that supported a whole-person education and students' overall development. Thus, the nonSTEM teachers generally supported the STEM educational work. In the Maker Class, for example, when the STEM teachers needed help teaching students how to write proposals and prepare oral presentations about their inventions, the language teachers offered to help. Similarly, the design teachers were committed to helping the STEM teachers teach students how to create a pleasing design for their invention in the Maker Class when the STEM teachers needed help. In this situation, the STEM teachers might be passionate and enthusiastic about the STEM educational work and find it enjoyable because they found that many people in the school valued STEM education as an important element of education and offered help in doing the STEM educational work.

5. Discussion

STEM education is believed to be an important approach to prepare students with essential skills for a competitive workforce in the 21st century [1–3] and to meet the increasing need in STEM areas [4,5]. However, successfully implementing STEM education in primary and secondary schools entails different challenges. This study suggests that a neglected challenge in the literature is how to sustain teachers' positive emotions toward STEM educational work. The sustainability of positive emotions is a particularly important issue in the context of educational accountability because the latter tends to drain teachers' positive emotions toward their work, leading to low work motivation, commitment, and engagement [17,18]. Therefore, it is valuable to investigate how teachers' positive emotions toward STEM educational work are constructed and sustained.

Based on a case study conducted in Hong Kong, the present study finds that the positive emotions toward STEM educational work may be constructed by the positive interpretation of the work, i.e., STEM educational work as the facilitator of students' overall development. According to Tsang and Jiang [54], when teachers witness that their work positively influences students' growth, their positive emotions will be aroused and sustained. Similar to their observation, the present study also identifies that STEM teachers may feel positive toward STEM educational work; however, the workload is high and heavy if they find the work can benefit their students' development. This phenomenon is not only because successful student cases may verify their interpretation of STEM educational work [37], as the findings imply, but also because the cases create a sense of achievement or positive self-concept for teachers. This explanation is supported by teachers' emotions literature. According to the literature [55–58], students' growth and development may be a symbol signifying that they successfully make a difference in students' lives leading to positive self-concept that in turn intensify their positive emotions in teaching. In this sense, the STEM teachers may interpret the cases of students' growth as the results of their efforts exerted on the STEM educational work leading to a sense of achievement or positive self-concept that arouse intense positive emotions. However, the literature has suggested that teachers find it difficult to sustain positive emotions in the context of educational accountability because such accountability may intensify administrative work, leading teachers to devalue the educational values of their work and displace them with administrative values, resulting in difficulties for teachers in understanding the meaning of their work [17,18,21,59–63]. Although the findings implied that teachers must manage a heavy administrative workload for STEM educational work for accountability purposes, they still feel positive about the work. The analysis suggests that these feelings may relate to the school institution. According to the findings, different from the literature [44,46,64–67], the school institution is neither purely loosely coupled nor tightly coupled. It has the administrative measures to monitor and regulate teachers' work, but the teachers may not perceive the measures as administrative control and surveillance over them. The findings indicate that the school administrators share power and values with the teachers and support them in performing the STEM educational work, so the teachers can negotiate the ideas and meanings of the STEM education and collaboratively enact them with the school administrators. Therefore, this pattern of coupling between a school administration and its teachers may be called collaborative coupling, i.e., the school administration does not impose the work from above but involves the participation of teachers [68]. Collaborative coupling enables school institutions since it tends to empower teachers to do STEM educational work and experiment with different ideas in line with their interpretations of the work by participating in and influencing the whole process of STEM education with support. Therefore, teachers may feel positive toward STEM educational work, even though the work may be accompanied by extra and heavy workloads that erode the time they spend on instructional work.

6. Conclusions

The study asks how teachers' positive emotions toward STEM educational work are shaped by their interpretation of the work and what kind of school institution, and how the institution may sustain the positive emotions. Based on a single case study conducted in Hong Kong, the study showed that the positive emotions toward STEM educational work may be shaped by teachers' positive interpretation of STEM educational work, i.e., STEM educational work as the facilitator of students' overall development. This positive interpretation is inclined to make teachers feel positive and be committed to the work. Moreover, when they witness their students' growth, they may interpret it as the result of their efforts put on STEM education leading to a sense of achievement or positive self-concept. The sense of achievement or positive self-concept may further intensify their positive emotions. In addition, the findings also illustrate that enabling the school institution may be the crucial factor sustaining teachers' positive emotions toward STEM educational work since the institution is inclined to create an environment in which teachers are capable to negotiate the ideas and meanings of STEM education and enact them with school administrators in line with their interpretations of STEM educational work.

Accordingly, the study has both theoretical and practical contributions. Theoretically, it provides new insight into STEM educational implementation. Different from previous studies that focus only on the roles of teachers' knowledge, skills, self-efficacy, and attitude in STEM educational implementation in primary and secondary schools [4,5,10,13,38], the study suggests that teachers' emotions are also an important factor influencing the outcome of STEM education since they significantly shape teachers' motivation, commitment, and engagement in STEM educational work. From the social constructionist perspective, the study advances our theoretical understanding of how teachers' positive emotions toward STEM educational work may be constructed by their interpretations of the work and sustained by enabling school institutions. In particular, the study illustrates that the enabling school institution should have the following elements: shared power, administrative support, and the shared value of a whole-person education. These elements together may empower teachers to participate in the whole process of STEM educational work and negotiate the meanings of the work with school administrators, resulting in opportunities for teachers to enact their interpretations of STEM educational work.

Practically, the research findings have implications for school administrators. According to the findings, school administrators should give greater power to teachers to do STEM educational work, give teachers greater support to implement STEM education, and develop the shared values of a whole-person education in the context of educational accountability because these steps may sustain teachers' positive emotions toward STEM educational work. For example, school administrators may invite STEM teachers to plan and evaluate STEM educational work in addition to simply asking them to implement the work. Moreover, school administrators may provide only broad guidelines or directions for STEM teachers to plan the work to ensure that it matches the school organizational goals. Meanwhile, school administrators should create communication opportunities to exchange ideas with STEM teachers and listen to what they need to support STEM education implementation. Furthermore, school administrators should institutionally enact the value of a whole-person education schoolwide.

Finally, the study encountered limitations, although the study provides new insights and propositions to understand teachers' emotions toward STEM educational work. As a single case study conducted in Hong Kong, first, the major limitation of the study is that the findings may not be statistically generalizable [52]. Therefore, future studies should test the findings statistically with survey methods. Based on statistical analyses, future studies may verify or falsify the propositions to provide a robust theory of teachers' emotions toward STEM educational work. Moreover, researchers may consider conducting another case study based on replication logic. This logic means that researchers can select schools that are similar to or different from the one examined in the study and then replicate the present study to see if any new insights emerge regarding unit saturation [52]. If researchers can

do so, their research findings may be analytically generalizable [52]. Therefore, another possible approach is to develop a set of robust propositions to explain the phenomenon. Second, teachers may also have negative emotions toward STEM educational work. Since the negative emotions may discourage teachers to be committed to STEM education [21], it is also important for us to learn how the negative emotions of teachers may be constructed in order to provide recommendations to avoid them. However, the present study does not provide detailed analysis of teachers' negative emotions toward STEM education. Therefore, further studies should pay attention to investigate the construction mechanism of teachers' negative emotions toward STEM educational work.

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