Implementation Challenges of STEM Education: from Teachers' Perspective

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Abstract: How to effectively support teachers in implementing STEM education is regarded as an urging issue in school education. To address this issue, we need to gain a better understanding of teachers' implementation challenges of STEM education. This qualitative research collected views from the teachers who participated in a STEM education training programme. After the programme, four teachers took part in the semi-structured interviews. The study revealed that their lack of (i) pedagogical content knowledge (PCK) and (ii) external support were the main challenges that they were facing. Suggestions to facilitate teachers' STEM education implementation in schools, as well as research implications, are proposed and discussed.

Keywords: STEM education, implementation challenges, school education, teachers' views

1. Introduction

Literature suggested that teachers have faced many challenges and obstacles when implementing STEM education (Geng, Jong, & Chai, 2019; Lesseig et al., 2016; Seals et al., 2017; Shernoff et al., 2017). Teo and Ke (2014) pointed out several challenges of STEM teaching in different Singapore schools. The challenges included creating a new subject from scratch and using new technologies in teaching. Shernoff et al. (2017) interviewed 22 teachers to understand what they need from STEM teachers' professional development activities. They listed out teachers' difficulties, including lack of (i) pedagogical content knowledge (PCK) and content knowledge, (ii) time for collaboration and planning, and (iii) knowledge about assessment. Additionally, Geng et al. (2019) have surveyed teachers' self-efficacy and concerns about the implementation of STEM education in Hong Kong. According to their study, teachers' challenges included insufficient PCK for interdisciplinary learning and lack of instructional designs promoting engineering discipline. The role of teachers in STEM education is very important as they are the designers. We need to better understand the challenges that teachers are facing for better STEM education implementation (Shernoff et al., 2017). The main goal of this study is to investigate the challenges that STEM teachers have faced in Hong Kong, and in turn, to propose some possible suggestions for addressing the challenges. The core research question of the study is: "What challenges do Hong Kong teachers face when implementing STEM education?".

2. Research design

2.1 Research participants

Four participants took part in the research, see Table 1. They came from a STEM training programme organized by a research-intensive university in Hong Kong. In the programme, there were three instructors from the university and 49 teachers from the schools. The teachers had a diversified teaching background, including Chinese/English language education, mathematics education, general studies, and visual arts, and shared a common goal to learn more about STEM education. We adopted the convenience sampling method to approach the participants. Interview invitations were sent to all the learners after their STEM training programme.

Table 1. *Interviewees' Information*

	Teacher 1	Teacher 2	Teacher 3	Teacher 4
Seniority	18 years	14 years	8 years	28 years
Gender	Male	Male	Male	Male
Major	Physical	Business	Psychology	Computer

2.2 Research procedure

This study adopted a qualitative approach to investigate the research question. We used semi-structured interviews to collect the view of participants. Each interview lasted about 45 minutes. We got the participants' consents to audio-record the interviews. The teachers were interviewed either at the teachers' schools or the university. The researcher has adopted an interview guide for the interviews. The interview guide, which was developed by two researchers from the university, aimed to collect teachers' concerns about implementing STEM education in schools. A question like "What challenges do you have when implementing STEM education in schools?" is included in the interview guide. All the interview data were transcribed verbatim and analyzed with the guidance of grounded theory (Lambert, 2019) in the later steps of the research.

3. Results

3.1 Lack of PCK

The teachers found that they did not have sufficient PCK and related teaching experience to implement STEM education. They expressed that they were not well prepared and should improve their related teaching skills and understanding of STEM learning for better implementation. See the excerpts: "*I am worried about teachers' capabilities to implement STEM education practice at the current stage*" (teacher 1). "*The schools do not have STEM experience, so their teachers may not understand what STEM is*" (teacher 3). The teachers expressed that there were insufficient teacher training workshops for them to improve their PCK. "*The teacher education institutions in Hong Kong should take their responsibilities to help teachers develop their STEM teaching skills*" (teacher 1). "*If there is no related professional training for teachers, they can hardly teach STEM. We need more teachers who can teach in the STEM area; it is the first task to implement STEM education*" (teacher 3).

3.2 Lack of external support

The teachers perceived that lacking external support was a challenge for them to implement STEM education. The support should allow teachers to exchange teaching ideas, learning materials, STEM resources, as well as to get feedback from teachers in other schools, students, parents, and other stakeholders. In other words, the teachers lacked STEM teaching communities. See the excerpts: "*I think teachers are facing many constraints from the external environment that stop them from implementing STEM education*" (teacher 2). "*I felt the community of practice in STEM education has not been established. Ideally, teachers with various strengths of different disciplines could communicate together to make their STEM education ideas better*" (teacher 1). "*Some students from the disadvantaged background may find it difficult to get enough guidance, equipment, and time for STEM from their families*" (teacher 4). Besides, "*some schools may unwilling to give time to STEM because students are already overwhelmed with the examination pressures*" (teacher 3).

4. Discussions

Our research finding suggested that the teachers' first challenge was lack of STEM education PCK. This discovery is consistent with Geng et al.'s (2019) study in which almost half of the teacher participants thought themselves were not ready for STEM education (see also Chai et al., 2019). Providing professional development for teachers can improve their PCK, and further enhance teachers'

beliefs and attitudes, as well as easing their anxiety to adapt to the new trend (Chiu, 2017; Chiu & Churchill, 2016).

We also recommended the government to establish some public STEM centers for the teachers to build connections with other STEM educators, as teachers' community of practice will be beneficial for them to learn from each other and design better lesson plans (Jong, 2019; Jong et al., 2008, 2010). Providing teachers with more opportunities to collaborate with others to plan their lessons (Shernoff et al., 2017) was mentioned in the previous research as a measure to improve teachers' STEM teaching practice. The public STEM centers act as an external support platform for teachers.

The last suggestion was the public should realize the value of STEM education and embrace it in school education. Public awareness is a critical external support for teachers to implement STEM education. The STEM centers should welcome the public to experience schools' STEM works and allow them to better understand the impact of STEM education on students and society.

5. Conclusion

Overall, the two major implementation challenges of STEM education identified in this research were on teachers' PCK and external support. We suggested providing professional development activities focusing on PCK, building public STEM centers, and arousing public awareness to support teachers to overcome the challenges. Regarding the research limitations, for example, all the interviewees were male teachers with more than five years of teaching experience, weakening the representativeness of the research samples. It was due to the low acceptance rate of the interview invitation, at 8%. Future researchers should use a purposeful sampling method or expand the invitation pool to have more diverse representativeness.

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