

# Developing STEM teachers' TPACK skills through scaffold co-designing activities

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**Abstract:** This study is to explore whether and how to scaffold co-designing activities between teacher-researcher collaborations in STEM inquiry-based project can transform teacher's TPACK-related skills. In this study the scaffolding focus on those can external represent students' learning process, such as collaborative concept mapping tool, thinking mapping tool or argumentative diagram tool. Some recruited STEM teachers will designing and implementing domain-appropriate and skills-building scaffolds in STEM instruction with the guidance of researchers in learning science. During the whole co-design and implemented process, the discourse data, reflective notes data, classroom video data, TPACK questionnaire data and interview data will be collected and analyzed. The study can provide some insight for teacher professional development, but also can lay foundation for the design of learning environment for teacher's profession development.

**Keywords:** co-design, scaffolding, Design-Based Implementation Research, TPACK

## 1. Introduction

STEM education includes problem-based learning that purposefully situates scientific inquiry and the application of mathematics in the context of technological designing/problem solving (Sanders, 2009). Therefore, to promote the effect of STEM education for learners, teacher should equip TPACK-related skills to handle STEM education. However, STEM teachers faced many constraints. Many teachers lacked sufficient professional knowledge or skills about STEM education because they had no enough prior relevant professional or instructional experiences in their practices (Nesmith & Cooper, 2018). On the other hand, positive outcomes of STEM education can only be achieved when teachers integrated scaffoldings to structure the complex learning processes (Kaendler, Wiedmann, Rummel, & Spada, 2015). Instead, teachers often provided students minimal guidance during STEM instruction (Kirschner, Sweller, & Clark, 2006). Considered that little research has been devoted to identifying the supports that teachers need to teach about complex systems in the classroom (Yoon et al., 2017). The study aims to find a way to help teachers in designing and implementing domain-appropriate and skills-building scaffoldings in STEM instruction. It will not only elevate the competences of STEM teachers, but also elevate the quality of STEM education.

## 2. Theoretical background

Co-design is the kind of work between teachers and researchers to design, implement and evaluate innovative educational experiences to fill local educational needs and also gain some valuable opportunities to reflect and refine their instructional practice (Matuk, Gerard, Lim-Breitbart, & Linn, 2016). Nowadays co-design of innovative learning environments serve as contexts and catalysts for teacher professional development, which can lead to teacher agency, and flexible, adaptive, principled pedagogy (Wong, Gao, Chai, & Chin, 2011). Based on the notion of learning by design, when teachers engaged in design process with the help of researchers, it can help them make intimate connections among content, pedagogy and technology in a collaborative way (Agyei & Voogt, 2012). Moreover, according to social construction theory, co-design between researchers and teachers is a kind of social interaction. It can help teacher gain fresh perspectives and advance both knowledge and action on instruction, but also can prompt them to rethink their practices, and explore, derive and pilot creative alternatives (McKenney, Kali, Markauskaite, & Voogt, 2015). In the context of design scaffoldings to

support STEM education, researcher had much theoretical knowledge of scaffoldings, which should be used to in STEM instruction. While, teachers may did not understand how to integrated scaffoldings in STEM instruction. Therefore, how to enable teacher design scaffoldings during STEM education by co-design is a promising way for professional development. The study intends to examine whether and how the method of co-design of scaffoldings between teacher-researcher collaborations in STEM problem-based project transform teacher's TPACK.

### 3. Methodology

Participants include teachers from a public middle school in Eastern China. The research team will work closely with the participating teachers to co-develop STEM curricula for a semester with four steps. In the first step, teacher was introduced to the background information of scaffolding. The next step is to co-design STEM education integrated with scaffoldings. In the third step, teacher will enact their lessons plan in their class. In the four step, teacher will communicate with each other with their reflection during the whole process. After each step, teacher will write reflective notes to recode what they learned and think. Besides, during the whole process, the research team will communicate with each teacher group and provide them some help timely according to their requirement. During the whole co-design and implemented process, the discourse data, reflective notes data, classroom video data, TPACK questionnaire data and interview data will be collected and analyzed.

### 4. Challenges and Questions

Some context and practical factors may bring some resistances with the collaboration between researchers and teachers. How to make researchers and teachers understanding each other is the tough issue to address. Moreover, different types of data will be collected. How to synthetical analysis those kinds of data to get understanding the development of STEM teachers' skill is very important. Thirdly, how to get some implication for large scale STEM professional development program show be considered more seriously.

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