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Exploring Elementary Teachers' Eagerness and Reluctance to Integrating Computational Thinking

Introduction and Literature Review

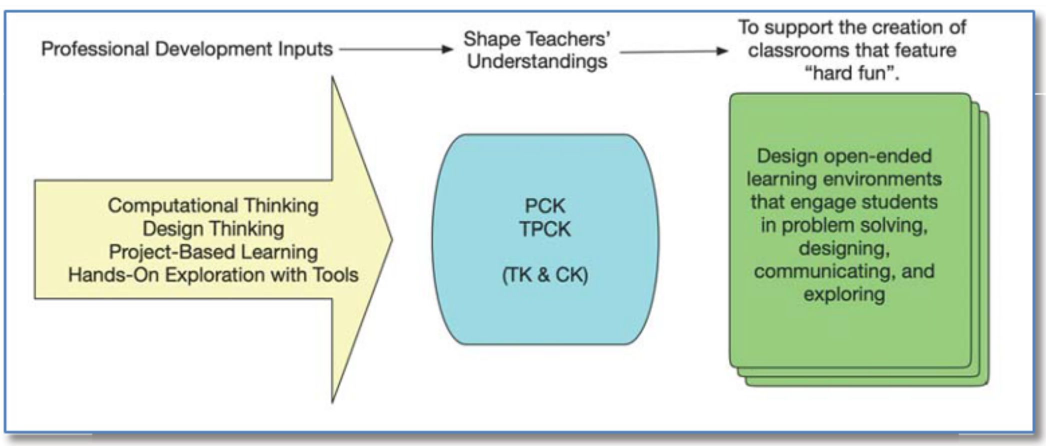
Computational thinking (CT) is a growing field of educational research. While the number of professional learning (PL) opportunities have increased for bringing CT into K-12 learning, there are gaps in understanding of how to support teachers in integrating CT into their everyday math and science curriculum and classroom practices (e.g., Garcia-Pefialvo et al., 2016). In this paper, we aim to investigate six elementary teachers and their willingness to change their practices in the context of a longitudinal professional learning project aimed at supporting pedagogical knowledge development in computational thinking. We conceptualize willingness to change as a reluctance or eagerness to integrate computational thinking into math and science classes.

Willingness or reluctance to change teaching practices is well documented in teacher professional learning research (e.g., Daresh 2001; Eaker et al., 2002). There are many factors that have been identified as affecting teachers' reluctance or enthusiasm for change, including time, lack of proper resources or materials, incongruent belief systems, or the idea that changes do not have an intended positive effect on students learning (Hoban et al., 2005; Macdonald, 2002; Sparks, 2005). Research shows that incorporating CT in science and mathematics teaching and learning requires teachers to understand (1) CT concepts and thinking; (2) their relevance and utilization in each specific discipline; and (3) how to incorporate the newly developed knowledge and understandings into their curriculum and practice in culturally and linguistically meaningful ways, enabling students to learn and apply these skills in contextually relevant ways (Yadav et al, 2016; Weintrop et al., 2016). However, research suggests that to support meaningful change in teacher practices through PLs, more needs to be understood about why some teachers are able to enact change or show reluctance so that necessary support in those areas is provided (May & Zimmerman, 2003).

Because CT is a relatively new concept in K-12 education, there is limited research about the knowledge, skills, and dispositions needed for teachers to take up CT practices (Ketelhut et al., 2020; Weintrop et al., 2016). Little is known about why some teachers show eagerness while others are more reluctant to change instructional practices in ways that allow them to integrate computational thinking into their classrooms (Reichert et al., 2020, Simmonds et al., 2019). To meet our research goals of supporting elementary teachers in integrating CT into their math and science lessons, we have developed longitudinal professional learning (PL) model that is situated in teachers' existing curriculum, driven by teachers' interest, and focused on the subject content (I.e., math or science) to be taught in a way that engages teachers as learners of that content (e.g., Desimone, 2009; Kennedy, 2016). For the purposes of this proposal, we used the definition of CT set forth by the International Society for Technology in Education (ISTE) which describes CT as a formulation of a problem in a way that enables people and computers to solve it (ISTE & CSTA, 2011). The definition entails the development of a set of dispositions including (1) Confidence and persistence in dealing with complexity; (2) Willingness and tolerance for ambiguity and open-ended problems; (3) Communicating and working with others to achieve a common goal or solution. The goal of this study was to examine why some teachers were more willing to take up PL practices related to CT and integrate them into their classrooms, while others showed reluctance.

Theoretical Framework

Our professional learning model builds on the existing decades-long research about the design of effective PL (e.g., Borko, 2004; Authors, 2013; Desimone, 2016; Authors, 2016). We have designed our PL approach based on the Theory of Change shown in Figure 1. Participating teachers engaged in professional learning which included a series of workshops, with coaching sessions between each, aimed at developing two kinds of teacher knowledge (e.g., Mishra & Koehler, 2006; Shulman, 1986): pedagogical content knowledge (PCK), which is the specialized knowledge teachers need to know how to teach specific content knowledge, and technological-pedagogical content knowledge (TPCK), which is the specialized knowledge teachers need to develop in order to incorporate technologies into the content knowledge instruction. We designed experiences such that they allowed teachers to engage as learners in hands-on CT projects featuring design-thinking and project-based learning in the context of their own curriculum. By engaging the teachers as learners, we aimed to support them in designing environments that were similar in their own classrooms.



Methods and Data Sources

Context and Design

The goal of the professional learning was to introduce grades 3-5 teachers to computational thinking (CT) to support the integration of CT into math and science instruction. The research objective was to contribute to the understanding of effective teacher professional learning (PL) by designing and developing a PL model that supports teachers in integrating CT into formal classroom settings by building it into the mathematics and science curriculum delivery for grades 3-5. The professional learning model included (a) engagement of elementary teachers in designing and carrying out these CT-embedded math and science lessons; (b) focused on embedding CT in the mathematics and science curriculum using design thinking and problem-solving approaches for all students in grades 3-5; (c) engaged teachers in developing a deeper understanding of mathematics and science concepts and practices as they engage in embedding CT into those content areas using design and problem-solving approaches (Borko, 2004; Lee & Buxton., 2013). In doing so, we drew on design-based (DBR) (Barab & Squire, 204; Cobb et al., 2003; Design-Based Research Collective, 2003). Based on the research design, we were particularly interested in the development of theory and knowledge related to teacher professional learning about CT and classroom implementation of CT activities/projects.

Research Data and Analysis Methods

We relied primarily on qualitative data to explore teachers' learning and enactment of CT in the context of their teaching through the systematic design and study of the teacher learning activities and tools. The participants in the study included teachers from four Title 1, "minority-majority," elementary schools in Massachusetts. We worked with the district and school administrators to recruit the teachers to participate in the study.

For this study, we systematically reviewed video recordings of PL sessions, interviews with teacher participants and workshop facilitators to document goals, objectives, learning progressions, challenges, and successes, and observational and video recordings of classroom instructions. The data included in this study comes from over 80 hours of video data of PL sessions, individual and group coaching sessions with teachers, artifacts from PL and coaching sessions, individual interviews, and classroom videos and observations.

We began our analysis by reviewing our research team's observational notes/memos from PLs and coaching sessions, looking through teacher artifacts, and watching selected videos of the professional learning and classroom observation footage. In this process, we identified and selected teachers who showed eagerness or reluctance in talking about CT skills and integrating them into the curriculum and enacting them. Although all these teachers chose to participate in the PL sessions, not all of them showed eagerness to incorporate CT into their lessons. In this initial stage, we operationalized "eagerness" as an expression of desire or willingness to integrate CT skills into the curriculum or take action in efforts to bring CT into math and science lessons. We operationalized "reluctance" as expressions of hesitance due to various obstacles without any intentions to overcome these obstacles. We identified a total of six teachers, three who showed reluctance to integrate CT into their classrooms and three teachers who showed eagerness to integrate CT into their classrooms. We examined all of the data sources that featured these six teachers to investigate the verbal and nonverbal discourses that communicated reluctance and eagerness in an effort to find emergent patterns to code. We then organized the emerging codes and categorized them (Table 1 and 2). As we worked with these emerging patterns, we began to identify patterns of codes and categories and examined the emergence. We then looked at our classroom observations, artifacts, and additional data from coaching sessions to triangulate our findings. Below are the preliminary findings presented.

Results

As shown in Tables 1 and 2, all teachers, regardless of whether they showed eagerness or reluctance (based on the way we operationalized these constructs) faced structural challenges and barriers such as lack of time, technical and building support, as well as curricular constraints such as the need to prepare students for various standardized tests. Teachers also faced challenges related to new knowledge and skills, especially as it related to plugged CT activities, such as coding with Photon (educational robots for computational thinking, see https://photon.education/), learning drag-and-drop programming, and technical issues with downloading and utilizing new App onto their Chromebooks. Overall, all teachers had to navigate time barriers, technical and logistics barriers, and learn new pedagogical expertise including new knowledge, skills, vocabulary, and practices that required time and getting used to. While all teachers shared the challenges and brainstormed the ways to overcome them, our findings show that what differentiated teachers who showed eagerness to change from the ones who were reluctant were what they attributed as the main challenges and how to work with those challenges. The teachers who showed eagerness were more likely to attribute the difficulties to their own lack of skills and often asked for help from their peers and coaches. In contrast, the teachers in the reluctant group all shared perceptions about the students and their lack of knowledge and skills as the main challenge. During PLs, coaching sessions, and teacher interviews, reluctant teachers specifically discussed their belief that students lacked basic skills, with multiple teachers mentioning that non-reading in English and the difficulty of telling left from right as barriers to their integration. Alice, a pseudonym, one of the teachers who showed reluctance, shared that she has not brought CT into the classroom after a year of PL due to what she sees as a lack of work ethic among her students, stating that her students will "do almost nothing ever unless you're sitting with them, so that worries me a little bit because I'm not going to be able to sit with the three of them to do computational thinking." Teachers' backgrounds in STEM did not seem to be a significant mediating factor in their reluctance or eagerness. In fact, the teachers who were reluctant to bring educational robotics into their classrooms generally had stronger math and science backgrounds than the other teachers.

Our data analysis revealed that teachers who showed eagerness to integrate CT discussed the challenges their students faced as an opportunity to think about possible scaffolds or how to be responsive to the student's needs rather than just reducing those challenges to the deficits. Moreover, teachers who showed a willingness to change and eagerness were more likely to focus on their own need to become more comfortable with technology. All three teachers identified as showing eagerness for change within our PLs were more likely than their reluctant counterparts to ask for help from facilitators and coaches, share their lesson plans and ideas related to CT, and participate in resource sharing. Our findings also show that teachers who showed eagerness to change extended CT activities beyond what was proposed during the PL, drawing direct links to what they were learning in the PL to what they will do in their classrooms as they talked with excitement about bringing tech and CT to their students.

Scholarly Significance

Currently, the dominant narratives within the literature on teachers' reluctance to change within PL spaces suggest major? factors such as a lack of time and money (May & Zimmerman, 2003). In our study, all teachers worried about students' previous skills or knowledge, but it was that teachers who showed eagerness to take on new practices didn't let those worries prevent them from implementing, while others did. Our findings suggest that deficit views of students may be a reason that can inhibit teachers' enthusiasm for the reforms espoused in PLs, hence working with teachers on this area might be an important step forward.

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Table 1
Eager Teachers

Title	Categories of findings
Actions and Discourses of eager Teachers	Introduced the Photon and CT skills in their classes
	Introduced characteristics of the Photon with social-emotional learning
	Designed lessons plans to integrate Photon and CT
	Showed excitement about students using Photon at STEM class
	Used Photon for coding activities in science and mathematics classes
	Showed excitement for students to learn CT skills
	Showed excitement for their students to learn about CT
	Developed and shared instructional materials about CT
	Encouraged students to use CT skills
	Shared their lesson plans and ideas about how to incorporate CT into lessons
	Brainstormed to support students using pair and group work
	Identified potential challenges students may face and brainstorm scaffolding ideas
	Being Comfortable with group work and "chaos"
Challenges Eager Teachers Faced	Time constraints
	Overpacked schedule of both teachers and students
	Logistic constraints
	Adapting to new technology
	Coding skills
	Adopting and using CT vocabulary
	Lack of institutional/building support
	CT concepts and vocabulary
	Fear of failure while bringing CT and Photon based lessons to their classroom

Table 2
Reluctant Teachers

Title	Categories of findings
Actions and Discourses of Reluctant Teachers	Shared their lesson plans and ideas to incorporate CT into lessons
	Identified potential challenges students may face
	Brainstormed scaffolding ideas for students
	Being comfortable with group work and "chaos"
	Worried about lack of students' basic reading skills
	Worried about lack of students' basic math skills
	Worried about lack of students' group work skills
	Worried about students' behaviors
	Worried about students' previous knowledge and skills sets
	Worried about not losing control over the class
	Worried about damages students can do to Photon or technology
Challenges Reluctant Teachers Faced	Time constraints
	Overpacked schedule of both teachers and students
	Logistic constraint
	Adopting new technology
	Coding skills
	Adopting and using CT vocabulary
	Lack of Institutional Support
	Communicating CT vocabulary effectively
	Believed students are not ready to use Photon and CT
	Worried more work required from teachers
	Fear of failure while bringing CT and Photon based lessons to their classroom