Teacher Reflections on a 3C Professional Development Model for Integrating Computational Thinking in Early Childhood and Elementary Classrooms

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Abstract: The purpose of this paper is to explain how we adapted our novel 3C PD Model (Code, Connect, and Create) for teacher professional development (PD) around computational thinking (CT) integration for elementary teachers. We will share PD design choices that support early childhood and elementary teachers in learning about CT knowledge, skills, and dispositions and making content connections to CT. We will also detail how we have helped teachers begin planning for CT-integrated lesson implementation. We will share empirical data from a post-PD survey that includes teacher reflections on their participation in the 3C PD Model. We conclude by making recommendations and offering implications for PK-5 PD providers that aim to increase teachers' pedagogical content knowledge (PCK) around CT and integration.

Introduction

Weaving computational thinking (CT) into PK-5 classrooms has increasingly become a focus of attention over the last decade (Luo et al., 2022; Yadav et al., 2018). To broaden access and ensure high-quality CT experiences occur in elementary classrooms, stakeholders must first attune to those closest to this work: early childhood and elementary teachers. Yet, despite the growing body of literature focused on computer science (CS) education, digital literacy development, and the integration of CT in disciplinary standards, research around early childhood and elementary teacher professional development (PD) that is inclusive of all content areas and supports that serve as accelerators and barrier breakers is nascent. To foster teacher learning around CT integration, we designed an early childhood and elementary-focused teacher PD project.

Unboxing CT is a four-year National Science Foundation-funded research project that aims to investigate CT teacher learning and curriculum integration opportunities for early childhood and elementary teachers–that is, the key aspects of PCK around integrating CT. This project addresses the critical need for science, technology, engineering, and mathematics (STEM) literacy and skills for all students (National Science and Technology Council, 2018) by investigating effective models of PD that improve STEM teaching and learning. One of the project goals is to understand how PD design and activities support teachers' advancing understanding of ways to integrate CT into disciplinary teaching. This paper examines how the 3C PD Model (Code, Connect, and Create, see

PD Design for description) was modified to attune to the context of elementary education and the needs of PK-5 teacher learning. Ultimately, sharing our findings can serve as the foundation for the design of more scalable elementary teacher PD around CT integration.

PD Design

Prior to a four-day, face-to-face summer PD session, the project team reviewed and refined the 3C PD model (Jocius et al., 2020) to focus on early childhood and elementary teacher needs and experiences. The 3C PD Model was selected since it would be supportive of teachers' professional learning around CT, foster the formation of an emerging elementary teacher community of practice, and serve as a launch pad for future school year PD sessions and project goals knowing that teacher need opportunities to engage with thinking and activities that they will utilize with students, but in a way that engages them as adults and practitioners (Borko, 2004). They also needed the space and place to evaluate and reflect on new and existing instructional practices they could leverage for CT integration (Lampert et al., 2013). The 3C PD Model centers around three foci that we see as vital for teacher learning for CT integration. As the name inclines, there are three distinct sessions at the heart of this PD model. The ***Code session*** aimed to teach about four key CT elements, pattern recognition, abstraction, decomposition, and algorithms using the PRADA framework (Dong et al., 2019. In the Code Session, teachers had differentiated groups where teacher facilitators unpacked individual CT elements and supported teacher learning and applications of those elements by learning to program in Scratch! During ***Connect sessions***, teacher PD participants were organized into self-selected grade band groups and experienced model lessons by other teachers which aided them in seeing CT integration and connecting CT to existing practices, disciplinary standards, and classroom objectives. PD participants shifted groups once again for ***Create sessions*** which were intentionally organized to support grade-level, school-level, or district-wide initiatives. Create sessions were instrumental for teachers to have one-on-one support from the project team and fellow teacher facilitators while developing their launch plan which involved identifying project-created lessons, they could remix for their classroom context and held space for authentic coaching conversations around CT integration for the upcoming school year.

Over four days, the 3C PD Model was employed, anchored by a whole group morning meeting style session that served to build a community of practice (Lave & Wenger, 1991) amongst early childhood and elementary teachers (n = 75) while also modeling an unplugged CT integrated lessons launched with a piece of children's literature. In addition to the morning whole group session and differentiated 3C sessions, we also included support sessions on educational technology tools entitled Codeo Rodeo and a session for critiquing and choosing appropriate resources during a Book & Bot Fair. Adjusting the 3C PD Model, which we had seen success within prior projects for secondary teachers, allowed us to move towards achieving identified project goals. One of which was to host a PD that highlighted early childhood and elementary teacher practice by first introducing them to new resources and tools, modeling pedagogical methods for CT integration, and supporting the teacher PD participants as they experienced those tools first as users and learners and then providing them with examples that had been used by elementary teachers in the field, and culminating each day with the space and place to plan CT infusion in their classrooms, schools, and communities.

Methods

This study is part of a larger, four-year research project entitled *Unboxing CT*. It focuses on understanding how elementary teachers in various contexts integrate computational thinking into classrooms and the learning trajectories they travel along as they develop strong PCK surrounding CT. This session reports findings from the first summer professional development project during a four-day intensive PD held for 75 teachers, mostly from rural contexts across one Southeastern state. The research questions were:

1. **How was the adapted 3C PD Model conducive to creating an elementary teacher community of practice that could support teachers in planning CT integration for elementary classrooms?**
2. **Which elements of the 3C PD Model were most impactful on teachers' experiences?**

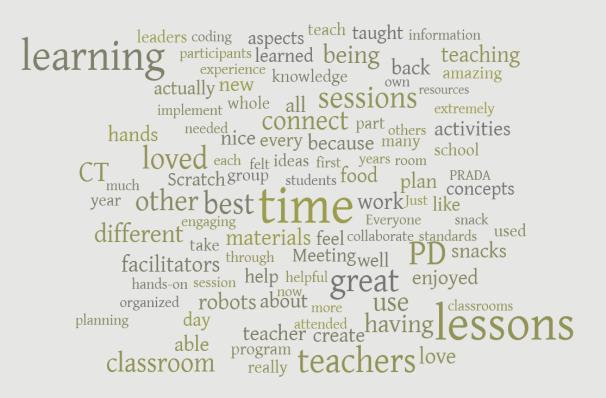
Data collection for this mixed-methods analysis focused primarily on teacher pre-PD and post-PD surveys which 67 out of 75 teachers completed (n=67). We utilized descriptive statistics and qualitatively analyzed open-response questions on the pre-PD survey, daily feedback surveys, and post-PD surveys, which were administered via Qualtrics. Data analysis of the daily feedback surveys occurred both during the PD to be responsive to teacher needs and offer real-time support and after the conclusion of the PD. The post-PD survey was the primary data source for this study, but other aforementioned data sources were utilized to triangulate findings. We focused our analysis on three specific post-PD questions: a Likert scale about overall PD quality, an open-response question about what teachers felt were the best aspects of this PD and an open-response question about what teachers thought could improve the PD. We employed open, initial coding (Charmaz, 2015) utilizing a constant-comparative method (Corbin & Strauss, 1990) to analyze open-response questions on the survey. This analysis led to category development and emerging themes related to how the format of the PD was supportive of teacher CT learning and allowed them to be introduced and onboarded into a community of practice for elementary CT integration. Using a constructivist grounded theory approach (Charmaz, 2015), our survey results analysis helped gather insights into teachers' perspectives of the 3C PD Model.

Findings

To address the research question, we display findings in two distinct buckets. One is about PD satisfaction as a whole, and the other is about how the 3C PD Model specifically aided teachers in learning about CT and prepared them to integrate CT in their own classrooms. Overall, teachers (n=67) were satisfied with the quality of the PD, with 89.6% (n=60) of them rating it as Excellent, 7.5% (n=5) as Great, and 3.0% (n=2) as Average. Figure 2 below shows the frequency of words, which is evidence of how teachers placed immense value on the PD design consideration to emphasize collaboration and learning alongside and from fellow elementary educators during the three different sessions.

Figure 2

Word Cloud Representing Teacher Responses to the Post-PD Survey Question, "What were the best aspects of this PD?"



Responses to the open-response survey questions were varied, but each "C" in the model was represented. All comments, but two, comments were sorted into responses that evidenced a desire to continue learning about CT (often despite their previous lack of comfort with coding or robotics), jump into implementation armed with the resources, tools, and plans they had created, or demonstrated genuine appreciation for a PD that was tailored for elementary teachers and their specific needs. Responses to the question about PD improvement gave insights into what teachers wanted more of (tinkering with tools and resources) and what teachers most valued (supported time to experience the tools as a learner, being a part of a community, and time to plan for integration).

Table 1

Sample of Teacher Quotes about One or More Elements of the 3C PD Model

3C PD Model Design Connection	Teacher Participant Quote
Connect, Create	*I really like how we had a chance to see model lessons as well as have applicable ideas along with time to create and plan directly after Create.* - 2nd grade teacher
Whole Group Session, Connect	*The first thing that I enjoyed about this PD was the whole group time in the morning. It was nice easing into the day by hearing a read-aloud and participating in an activity that tied with the book. The next thing I enjoyed was the connect session. I liked seeing lessons I could use for Kindergarten specifically. It was nice meeting other educators and collaborating how to implement CT in the classroom.* - K teacher
Codeo Rodeo, Create	*I loved how the teachers were given the opportunity to work and tinker with the robots. Additionally, teachers were given the time to plan and collaborate with other professionals for the benefit of their students*. - 4th grade teacher
Code, Connect	*I learned so much about CT and PRADA that I am excited to return and use the lessons I learned and the materials and books I received*. - PK-5 STEAM Teacher
Connect	*This is the first conference I've been to where everything was engaging from beginning to end. I learned so many new ideas that I could literally take back and use in my classroom tomorrow because the teacher leaders actually taught the same standards as me because they were from my state. If they weren't the lessons were very adaptable for my standards.* -5th grade teacher
Code, Connect	*I love that this was very teacher-driven. I felt supported in what I needed as a teacher rather than things being tailored toward the masses. I am fired up about CT! Everyone was so nice and helpful. I feel like I can reach out at any time this year for additional help.* -3rd grade teacher
Code, Connect	*The information and explanations of CT was clear and understandable. The way the facilitators connected it to the classroom and how we can incorporate the lessons were informative. -4th grade teacher*
Code, Connect	*Time spent hands on materials, Scratch and in collaboration directly affects my approach to teaching this year. -5th grade teacher*

Conclusions and Discussions

Supporting elementary teachers in their professional learning around CT and integration of CT into their classrooms requires a multifaceted approach beyond a 4-day summer PD; however, based on the above findings, utilizing a 3C PD Model framework enables elementary teachers to explore materials and tools that can position instruction around computational thinking at the forefront, gives them opportunity to see the possibilities for CT integration in their content areas and grade bands and experience CT as a learner, and provides them a guided space to reflect and create plans for weaving CT into their instruction.

As we had hoped, the 3C PD Model also was an estuary for a budding PK-5 CT community of practice in our state. Data that showed although teachers wanted more time (always a finite resource in a classroom) to tinker and explore tools that may require CT and to see more pre-developed lessons, the desire to implement their learning and continue on a pathway of professional learning was awakened by the books, the bots, and the synergy created by the community of teachers and facilitators.

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