

Using Participatory Design to Facilitate In-service Teacher Learning of Computational Thinking

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Abstract: Teaching computational thinking (CT) in K-12 curricula requires supporting teachers in developing relevant knowledge and skills. In this paper, we present a participatory design approach for in-service teachers' professional development which takes a *distributed expertise* stance in engaging teachers as co-designers of their learning. Our qualitative analysis revealed that teachers valued the learning community that emerged, their evolved perceptions regarding integrating CT in subject matter, and their *transformative agency* in reimagining teaching CT.

Introduction

Integration of Computational Thinking (CT) practices is changing the nature of many disciplines and is increasingly making its way into K12 education (Weintrop et al., 2016). For the purposes of this paper, we define CT as thinking pertaining to the use of modern computational tools and practices in the context of various disciplines. Integrating CT in a subject matter as opposed to a separate course or in extra- or co-curricular programs, has the benefits in 1) providing meaningful contexts to learn CT; 2) making complex concepts in the subject matter more accessible to students; and 3) reaching a wider audience, mainly women and minorities (Weintrop et al., 2016). Most existing professional development (PD) programs use a one-size-fits-all content as it is not feasible to differentiate the PDs on all diverse teacher context and background (Jacob & McGovern, 2015). They do not support teachers to develop ownership and agency over the newly introduced curricular material (Voogt et al., 2015).

In this exploratory paper, we present the initial evidence of the potential impact of using a participatory design approach to facilitate PD for in-service teachers' learning of CT. By "participatory," we mean that the facilitators (CT experts) and teachers are all participants in this learning community with a shared goal of co-constructing the ideas to integrate CT in teachers' current practices in their local context. First, we explicitly take a *distributed expertise* stance in which all participants (teachers and facilitators) bring in distinct expertise and value (Kyza & Nicolaidou, 2017). In-service teachers bring the expertise of their pedagogical content and classroom context through experience. The facilitators, with their technological expertise in CT, contribute to advance teachers' technological content knowledge to explicitly support students' learning in CT. Second, we support teachers in developing *transformative agency* to break from the current forms of CT activities and reimagine CT practices that are appropriately designed for their classrooms (Severance et al., 2016). Compared to past work in participatory co-design, the collective object of our design efforts shifts from the creation of tools to teacher learning of the technological content. Third, our PD design has explicit efforts to foster *researcher-practitioner collaboration* (Gomez et al., 2018). While facilitators who are also the researchers in an effective CT PD would bring in ideas that are theory-driven, teachers would contribute with their pragmatic views about adapting those in their practice.

Our research question in this paper is: *In what ways has the participatory design supported teachers' learning in integrating CT practices in their subject matter?*

Methods

EXACT is an intensive 30-week, continuing credit teacher CT PD program offered by the school of education in the University of Pennsylvania. At the time of this paper submission, the program was at its 25th week. From open advertisement, we recruited six teachers (four female and two male) who teach grades three through eleven from four northeast and two southern United States schools and have, on an average, twenty-one years of teaching experience. They teach a range subject matter including physical science, biology, chemistry, and technology and come from a diverse set of schools ranging from 99% ethnic/racial minority to almost entirely white. School-level percentage of low-income students ranges from 7% to 100%.

45-minute semi-structured *teacher interviews* were conducted on the 18th week that probed their opinions on their experience participating in the program so far. Since this is the first research on using a participatory approach to a formal teacher PD in CT, we wanted our analysis to be qualitatively rich and grounded in the data.

An extensive analysis of all the data sources is forthcoming.

Results and discussion

At the heart of participatory design is the community of all participants (facilitators and teachers) with a *distributed expertise*, actively working towards a shared goal in an authentic setting. Our analysis revealed that teachers viewed learning together with other participants as an important aspect of their experience. They expressed a sense of belonging - as Emily (pseudonym) says, “We are on the same boat; we are learners, we have similar challenges.” We identified three key design features of the program that the teachers thought promoted the community building. First, weekly video-based synchronous sessions provided a platform for teachers and facilitators to participate in a real-time co-construction of CT technological knowledge that was the most relevant to teacher needs. Second, self-paced exploration of the technological content outside the synchronous session was strengthened by the non-synchronous discussions on an online forum. Third, facilitators’ active efforts for inclusion of teachers as co-designers of the curricular materials as well as their learning experiences created a genuine co-design experience for all the participants.

Throughout the course, there was a shift in teachers’ perceptions about the relevance and utility of CT in their practice and on their students’ learning of CT. As Blanca puts it, “[We] tend to overlook the use of data to problem solve in subject areas other than math or science. Made me more aware as an educator to this use.” We identified three subcategories in this. First, teachers had increased belief in their ability to use CT within their existing curricula. Second, teachers’ participation in the program as co-designers and their constructivist explorations of the CT content with the hands-on technological material such as CT assignments, in-class coding, and data project resulted in a shift in their perception of their students. Third, since some of the teachers were teaching their regular classes while taking this course, this parallel enactment provided them with an opportunity to experiment their newly learned ideas in their classes.

Integration of CT in their classroom requires teachers to reimagine their role in terms of their own agency in changing the classroom activities that involve incorporation of new CT practices. This quote from Linda’s interview provides a great example of how we saw teachers thinking of their *transformative agency*. “We do so many things in a school district. This course made me step back and think. What is the end goal? What should my students need to learn?...What is in the curriculum? Is there a path they can take?” Our analysis revealed that they were taking agency in shaping their own learning in this program. We identified several instances of teachers making explicit connections between these new CT practices and their prior knowledge, and identifying ways to advance their knowledge to change their classroom practice.

In conclusion, the participatory design approach helped us build a community of CT learners with a *distributed expertise* and a shared goal of supporting teachers’ learning in integrating CT practices in their subject matter. It supported teachers’ evolving perceptions on classroom integration of CT and led teachers to develop *transformative agency* in advancing their prior CT practices with a vision to reimagine new forms of teaching CT in their local context. Research on effective CT PD practices particularly for in-service teachers is limited. Given the need for large-scale integration of CT in K12 curricula, there is an immediate need for this. From the analysis of this *researcher-practitioner collaboration*, we contribute towards building a framework for effective in-service teacher CT PD. We believe that to produce enhanced CT knowledge and practice, a CT PD needs to involve the collective participation of the teachers in co-designing opportunities for them to develop an in-depth CT technological knowledge. This program was intensive and had a small number of participants. To scale up such programs by appropriately modifying the design features will require further research.

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