

## A Tale of Two PDs: Exploring Teachers' Experiences in Co-designing Computational Activities

Sally P.W. Wu, Northwestern University, [sally.wu@northwestern.edu](mailto:sally.wu@northwestern.edu)  
Bonni Jones, Utah State University, [bonni.jones@usu.edu](mailto:bonni.jones@usu.edu)  
Hillary Swanson, Utah State University, [hillary.swanson@usu.edu](mailto:hillary.swanson@usu.edu)  
Michael S. Horn, Northwestern University, [michael-horn@northwestern.edu](mailto:michael-horn@northwestern.edu)  
Uri Wilensky, Northwestern University, [uri@northwestern.edu](mailto:uri@northwestern.edu)

**Abstract:** At two professional developments (PDs), we position teachers as curriculum co-designers to support the integration of computing into traditional K-12 classrooms. Four case studies of teachers' successes and challenges over a four-week period showed that each teacher required differentiated support to address personal fears and concerns. Results suggest flexibility and team discussions may particularly support teachers in co-design and enhance future PDs focused on developing computational activities for students in the K-12 classroom.

### Introduction

Much work advocates for integrating computational activities in traditional K-12 classrooms because such activities can provide students with authentic learning experiences, deepen learning of content, and increase equity in a future increasingly dependent on computing (Grover & Pea, 2013; Weintrop, et al., 2016). However, the integration of computational activities requires substantial support for teachers to adequately learn new skills and technologies (Kali, McKenney, & Sagy, 2015). Recent work addresses this issue by engaging teachers in collaboratively designing computational activities alongside researchers as a means of increasing teacher ownership and technological pedagogical content knowledge (Cober et al., 2015). Co-design positions teachers as subject matter experts, involves them in writing underlying code, and allows them to eventually build computational activities themselves. Given the diversity of co-design, more work is needed to understand how to support teachers as individuals while progressing towards a common goal (Chval et al., 2008; Kali et al., 2015). To this end, we investigate teacher experiences at two different summer institutes that provided PD through engaging teachers in collaborative design of computational activities with researchers. We examine teachers' challenges and successes as they co-designed computational activities over the four-week PDs.

### Method

Two universities each conducted a four-week summer institute that positioned teachers as co-designers of computational activities for their students. University 1 paired 11 high school teachers from a large US Midwest city with researchers to co-design computational thinking (CT) activities in PD henceforth referred to as CTSI (CT Summer Institute). University 2 engaged three middle school teachers from the Intermountain West to co-design theory-building (TB) activities with one PI and four graduate students in PD henceforth referred to as TBSI (TB Summer Institute). Both PDs introduced computational activities and tools in the first week by asking teachers to explore models in existing CT or TB units and discuss how the activities in the units supported student engagement. The latter three weeks focused on co-design of new CT or TB units.

At CTSI, teachers worked on their units in small co-design teams by subject area with at least one CT researcher and undergraduate assistant. All 11 CTSI teachers met weekly for CT workshops and feedback sessions. We analyzed teacher responses on a Google Forms survey collected during a Weekly Reflection held on Fridays: "What went well for you or your work this week?" and "What was a challenge for you this week?"

At TBSI, the teachers and researchers met every morning for Scrum team-building sessions, and every Friday afternoon for a Weekly Reflection meeting. During both meetings, teachers responded to the questions: "What did you enjoy?" "What did you find challenging?" "What did you learn?" "What goals do you have?" "Do you have any feedback for improvement?" Meeting discussions were recorded, transcribed, and analyzed.

We identified teachers who developed computational activities each week and completed a unit by the end of the four-week PDs as well as teachers who struggled in one or more weeks in the co-design process.

### Results

We highlight one teacher from each summer institute who was "successful" (Brooke and Mary, pseudonyms) or "struggled" (Evan and Rebecca) at our PDs. In Week 1, Brooke from CTSI and Mary from TBSI both felt "excited" about computational activities and integrating them into their classes. Yet, they both struggled in Week 2 when planning their unit. Brooke decided to reverse the sequence of her class activities, which took time. Mary

originally felt she had to “know all of the things to make a simulation.” Once her co-designer had built her model, her vision shifted to focus on the big ideas: “to build these models means you have to think of all the parameters and all the things that are interacting which can lead to some really big ideas and understanding.” By Week 4, Mary was back to feeling “excited about the things I want [students] to pull out when the students do the model.” Brooke took on building her own computational models with support from co-designers, making her “really proud of the unit coming together and of how collaborative it was” (Week 4).

In contrast, Evan (CTSI) and Rebecca (TBSI) faced various challenges when developing computational activities during the four-week PD. For Evan, his challenge in Week 2 was “[s]taying focused on working on [his] unit, really beginning to think what [he] want[s] the kids to get out of it.” After more regular discussions with his co-design team, he started working on activities in Week 3, noting: “this unit is NOT going to be perfectly polished, finished by next Friday.” By Week 4, he was “[w]orking with [his] co-design team to finalize most of [his] unit” which was completed in the fall. Early in Week 1, Rebecca expressed concerns with coding (“What have I gotten myself into? I’m diving in very scared because I don’t code.”), theory building (“This is the first time I have conceptualized what theory building means in the classroom. I have always thought that theory building is something someone else does and my job is to bring students to understand those theories.”), and unfamiliar tools. She started developing activities, but by Week 4, she still did not have an understanding of her computational activities until a researcher developed a graphic novel ebook, which used a storytelling analogy to explain the process of building a computational model. Rebecca stated: “The ebook to explain coding is really good and I think it is helping me a ton! I was able to understand more about what is not right with my own blocks. I went back to the first model and felt way more confident.” Her unit was completed shortly after the institute.

## Discussion

Results showed that our teachers were able to ultimately integrate computational activities (and even design their own computational models!) through co-design. However, their progress drastically differed due to various challenges, including confusion about computing (Rebecca), staying focused (Evan), and concern over building computational models (Mary). Some teachers, such as Rebecca, face multiple obstacles that require additional resources and support. Such divergence in teacher progress and outcomes align with findings from prior research on co-design PDs, which showed diversity in teacher pathways (Naimipour et al., in press).

Co-design allowed us to address the different needs of teachers through individual adjustments and just-in-time resources during our PDs. Because K-12 teachers are often not trained in computational skills and may face fears about computing, we must address their individual needs, knowledge, skills and beliefs as learners and designers. With such qualitative understanding of individual needs and ways to support them, we can further develop PDs that center on building close relationships with teacher partners and address their challenges through co-design so that they can engage with and integrate computational activities in the K-12 classroom successfully.

## References

- Chval, K., Abell, S., Pareja, E., Musikul, K., & Ritzka, G. (2008). Science and Mathematics Teachers’ Experiences, Needs, and Expectations Regarding Professional Development. *Eurasia Journal of Mathematics, Science and Technology Education*, 4(1), 31-43. <https://doi.org/10.12973/ejmste/75304>
- Cober, R., Tan, E., Slotta, J., So, H. J., & Könings, K. D. (2015). Teachers as participatory designers: Two case studies with technology-enhanced learning environments. *Instructional Science*, 43(2), 203-228.
- Grover, S., & Pea, R. (2013). Computational Thinking in K-12: A Review of the State of the Field. *Educational Researcher*, 42(1), 38-43.
- Kali, Y., McKenney, S., & Sagi, O. (2015). Teachers as designers of technology enhanced learning. *Instructional science*, 43(2), 173-179.
- Naimipour, B., Guzdial, M., Shreiner, T., & Allendale, M. I. (in press). Engaging pre-Service teachers in front-end design: Developing technology for a social studies classroom. In 2020 Annual Frontiers in Education Conference. IEEE.
- Weintrop, D., Beheshti, E., Horn, M., Orton, K., Jona, K., Trouille, L., & Wilensky, U. (2016). Defining Computational Thinking for Mathematics and Science Classrooms. *Journal of Science Education and Technology*, 25(1), 127-147.

## Acknowledgments

We thank the participating teachers and research teams at our two universities. This work was supported by National Science Foundation (CNS-1138461, CNS-1441041, DRL-1020101, DRL-1640201, DRL-1842374, DRL 1842375) and the Spencer Foundation (#201600069). Copyright 2021 International Society of the Learning Sciences. Presented at the International Society of the Learning Sciences Annual Meeting (ISLS) 2021. Reproduced by permission.