I Felt Like We Were Actually Going Somewhere

Adapting Summer Professional Development for Elementary Teachers to a Virtual Experience During COVID-19

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ABSTRACT

In fall 2019, the National Science Foundation awarded Southern Oregon University a two-year Computer Science for All Researcher Practitioner Partnership grant focused on integrating computational thinking (CT) into the K–5 instruction of general elementary and elementary bilingual teachers. This experience report highlights the process of transitioning one essential component of the project—an elementary teacher summer institute (SI)—from in-person to online due to COVID-19. This report covers the approach the team took to designing the SI to work virtually, the challenges encountered, the experiences of the 15 teachers involved through observations and surveys, and the opportunities for refinement. This report will be of potential interest for other computer science (CS) education researchers who also may be working with elementary teachers to incorporate CS and CT activities into their instruction.

CCS CONCEPTS

• Social and professional topics~Computational thinking

• Social and professional topics~K-12 education

KEYWORDS

elementary teachers; integrating computational thinking; COVID-19; teacher professional development; virtual engagement

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1 INTRODUCTION

In spring 2020, the United States witnessed a massive increase in COVID-19 cases across the country, which shut down much of everyday life and in-person events. This paper illustrates how one National Science Foundation–funded Computer Science for All Researcher Practitioner Partnership (CSforAll:RPP) project responded to this challenge for a planned in-person five-day computational thinking (CT) professional development (PD) for local elementary teachers.

The research project began in fall 2019, when the National Science Foundation (NSF) awarded Southern Oregon University a two-year CSforAll:RPP grant focused on integrating CT into the K–5 instruction of general elementary and elementary bilingual teachers [1]. For the first year, the project team consisted of four elementary teachers from the Ashland and Phoenix-Talent School Districts, the university researchers, and two external evaluators. That first year had three phases: building CT content knowledge, co-creating lesson plans that integrate CT across elementary subjects, and developing a five-day in-person CT "Summer Institute" (SI) to train 15 new teachers for the following school year. The SI, specifically, had the following primary goals: introducing CT concepts to the 15 elementary teachers and modeling cross-content K-5 English, Spanish and bilingual lessons that incorporate CT concepts.

In late March 2020, due to COVID-19, the university and the two school districts were required to immediately shift to virtual learning for all students. For the project, this represented a significant change in the delivery mechanism intended for the elementary teacher PD and led our team to set two additional goals for the SI: provide support to teachers in their use of online technologies and create a virtual environment that was engaging and collaborative. The team was inspired by the organizers of the RESPECT 2020 conference and preconference workshops [2] who made a transition to an interactive online format in a matter of days. This experience report covers the design and delivery of a virtual PD, with the goal of providing lessons learned to inform other CS educators and PD providers of the strategies we found to be the most successful.

The key takeaways from our experience are as follows: (a) there is a need to proactively address elementary teachers' barriers to technology adoption; (b) shared physical experiences and a combination of individual and group activities lead to active online engagement; and (c) computational thinking (CT) is an effective tool for designing and developing a successful virtual professional development (PD) experience for elementary teachers.

2 RELATED WORK

The development of the five-day summer institute focused on CT for elementary teachers, and its adaptation to a virtual environment drew from academic works related to the definition and use of CT, how CT has been implemented as teacher PD, and how anxiety around teaching math, science, and technology is addressed. In the following sections, we lay out the evidence base in these three key areas as the foundations used to develop the virtual SI.

2.1 CT Background

Computational thinking and how to teach it were the primary foci of the SI. Introduced by Wing in 2006, CT has been widely adopted [3] as a cross-curricular, problem-solving toolkit [4] to prepare students for the modern technological economy [5]. CT can be taught to meet standardized testing goals and is more easily integrated into core academic content than computer science (CS) [6, 7]. For elementary teachers in the United States who are tasked with teaching most academic subjects, this integrated approach is generally preferred. Instead of trying to fit a stand-alone CS curriculum into their instructional calendar on top of other required content, teachers can integrate CT concepts into core academic content in an unplugged (without a computing device) fashion that engages students who historically have not had access to traditional CS instruction [8, 9, 10]. However, even with this potentially more equitable, unplugged approach for elementary teachers, Caeli and Yadav suggest that teachers follow up with plugged CT (with a computing device) to ensure students recognize the computing part of "computational thinking" [11].

2.2 CT as Professional Development (PD)

Research in computational thinking professional development suggests that CT should be clearly distinguished from educational technology use [12], data practices [13], and coding [14]. Of the numerous component parts of CT [15, 16, 17], pattern recognition, abstraction, decomposition, and algorithms (PRADA) were identified by Dong et al. [14] as succinct yet substantial elements of CT suitable for elementary teacher understanding. Waterman et al. [7] found successful engagement by students using similar concepts. To connect CT to coding, Bean et al. [18] recommended that teachers are introduced to a careful progression of coding concepts through Scratch, a block-programming environment widely used to introduce programming and engage students in CT [15].

Yadav et al. [6] have also developed an elementary CT integration toolkit (to provide guidance on how teachers can integrate CT into core academic content), a Lesson Screener (for teachers to see how a lesson may already incorporate CT), and a Lesson Planner (to help teachers plan for CT integration into their lessons). Rich et al.'s [19] study identified the elementary teacher strategies of framing, prompting, and inviting to reflect on CT, as well as two dimensions of CT integration, implicit versus explicit and focused versus broad. Waterman et al.'s [7] study highlights a CT integration framework of identify, enhance, and extend. The combination of the two latter studies provides complementary parts of CT integration: Waterman et al.'s framework covering lesson design and Rich et al.'s practices covering specifics of lesson delivery.

Peel et al.'s [20] study done in a high school context detailed how both CT and core content understanding can be magnified by thoroughly analyzing the intersection of CT sub concepts with specific core content and through intentionally prepared transfer within lesson contexts. Additionally, Goode and Margolis recommend that, in a high school focused CS professional development program, teachers rehearse their lessons in small groups according to the "teacher-learner-observer model" [21] with other teachers acting as students followed by group sharing upon lesson completion.

2.3 Anxiety About Math, Science, and Technology

Elementary teachers in the United States have surprisingly high rates of mathematics and science teaching anxiety [22, 23, 24]. Anxiety about doing math can be an impediment to math achievement, and this anxiety in teachers carries negative consequences for the math achievement of their students, especially female students [22]. Those teachers who demonstrate discomfort with mathematics content (not just the teaching of mathematics) are less likely to embrace innovative practices in their classrooms that could be beneficial to their students [24].

Similarly, Goode et al.'s [25] research on online PD for high school CS instructors provides guidance for overcoming technology reticence among teachers. Creating a virtual "space that is more structurally welcoming to participants" can enhance their online experience. Promising teachers a "no getting lost policy" by providing training and just-in-time technology support can reduce concerns about an inability to navigate online [26]. Addressing this anxiety for teaching with math, science, and technology were foundational in developing the virtual SI.

3 GOING VIRTUAL

The original goals for the in-person SI included introducing the CT concepts of **pattern recognition**, **abstraction**, **decomposition**, and **algorithms** to the new cohort of elementary teachers and modeling English, Spanish, and bilingual cross-content lessons that incorporated CT concepts. The SI was divided into two distinct parts in summer 2020: three full days in mid-June (SI1) and two full days in late August (SI2). SI1 focused on introducing teachers to primary CT content knowledge, and SI2 focused on remediating CT content knowledge and preparing teachers to integrate the CT content into their instruction.

In the pivot to an online PD conference, we constructed a virtual summer institute (SI) that built on results from the literature described previously. Our team had to extend its goals for the SI to include instructing teachers how to navigate online platforms, modeling effective virtual teaching, and finding unique ways to engage teachers. In addition, we wanted to create an overall structure that felt as if the attendees were sharing a mutual physical space and co-experiencing the SI with their bodies as well as their minds. As the team started to plan the virtual SI, we used CT as a tool to design and develop the content needed and strategically plan the overall teacher experience. The team took a three-pronged approach to the online PD: (a) addressing potential teacher anxiety to new technology; (b) building community (virtually) through common physical experiences; and (c) using CT concepts to plan and deliver the virtual SI.

3.1 Addressing Anxiety About New Technology

The project team recognized that in a virtual SI, it was important to ensure that teachers would receive the necessary support to overcome barriers to integration of unfamiliar technology [27]. To address this anxiety, we conducted a one-hour "Tech Check" class with participating teachers a week before the SI so that they could gain familiarity with the three online platforms that would be used: Zoom, Google Drive, and Slack. Led by one of the team's elementary teachers, the class gave SI teachers experience with each platform and allowed us to debug some technical issues that otherwise may have occurred during the SI. In this class, teachers practiced using each technology as they would be expected to during the SI. Zoom was the online conference platform; Google Drive contained all the documents and slide decks for the talks and activities; and Slack, an online messaging application, was used for communication and navigation links.

The team was committed to Goode's idea that no teacher "will get lost" because of the technology used [26]. This heavily influenced communication with and tech support for the SI teachers. Each day of the SI, we emailed an agenda and also posted it to Slack, with links to the day's presentations, resources needed for the activities, and clear details about who was grouped together for each activity. Also, the Slack workspace hosted permanent links to all surveys and assessments, and dedicated channels for teachers to communicate with each other and the team. Lastly, one team member was the primary technical support contact throughout each SI and could be contacted via Slack, the main Zoom room for SI teachers, or cell phone.

3.2 Building Community (Virtually)

Building community in a teacher PD can be challenging even in person. In addition to making sure that the teachers had the technical support they needed to navigate the platforms used, we also wanted to make sure that participants were actively engaged as much as possible during the virtual SI. The team was concerned about "Zoom fatigue" (the colloquial term for exhaustion due to extended video conferencing) and teacher engagement, so we scheduled a 30-minute break in the morning, an hour-long lunch, and a 30-minute break in the afternoon.

To increase engagement of teachers, connections with each other, and a deeper understanding of the material throughout the virtual SI, the team prioritized physical experiences, including a common "party pack" that was delivered to all teachers and team members. The party pack contained plastic leis in four different colors, colored pencils, candy, Lego bricks, marshmallows, toothpicks, alphabet flip cards, popcorn, and a glass tumbler (for a celebratory drink at the end of the SI). Party pack components were used as educational tools and to coordinate teachers in shared physical activities. Participants **decomposed** (CT concepts will be bolded) their candy and Legos in various ways and used either Legos or marshmallows and toothpicks for an initial **algorithm** activity focused on writing and following instructions for building structures. During a break in SI1, teachers were asked to pop their popcorn so it could accompany a Netflix (the video streaming service) activity that involved both **pattern recognition** and using data to develop **algorithms**. Another example of shared physicality included the use of alphabet flip cards to respond to icebreakers and virtual polls. Additionally, during the lunch break following the **pattern** presentation in SI1, teachers were given an assignment to walk outside and use their phones to take photos of patterns they found and upload them on Slack. Later, they used the colored pencils for drawing **abstractions** of all four CT concepts.

The team wanted to give teachers a sense of agency and the feeling of an in-person PD, so we set up links to dedicated Zoom meeting spaces which we called "rooms". All content presentations occurred in the "Main room," and the ensuing discussions and activities happened in color-coded discussion rooms (e.g., Yellow room, Purple room). The four teachers on the project team each facilitated their own color discussion room, designated by a lei color. All participants received four leis in the party pack that coordinated with each color discussion room, and they were asked to don the lei that was the color of the discussion room they were assigned. The leis functioned to create a group identity and to provide a quick visual indicator to the facilitator if a teacher was in the correct discussion room. The project team also had access to the "Green room" and a Green room channel on Slack that participants could not access. These were spaces where the team could check in during breaks and troubleshoot any issues that arose.

Configuring the Zoom rooms in this manner prevented problems that can occur when participants accidentally drop out of breakout rooms: it is easier to get back into a Zoom meeting than a breakout session. Perhaps more importantly for an online conference, the team wanted to give teachers a sense of agency. Leaving the main room themselves and clicking on the link to their color discussion room was something that the participants chose to do rather than automatically being moved into a breakout session. It enabled them to have a modicum of control over their time because they could, for example, get a drink of water before jumping into the discussion room, much like a conference participant might do in-person when going to different session.

3.3 Using CT Concepts to Develop the SI

As we focused on identifying the appropriate content knowledge necessary for elementary teachers to integrate CT into their elementary class instruction for SI1, the team relied on CT concepts as a tool to design that content and to create the overall teacher experience. Initially, we **decomposed** the SI content by assigning each CT concept (**pattern recognition**, **algorithms**, **decomposition**, and **abstraction**) to different team members. Those smaller groups developed content, including introductory presentations and activity slide decks, for the CT concepts while other team members filled the role of user testing. They listened to presentations, worked through all the activities and provided feedback, especially focused on areas of confusion, which allowed the team to find critical problems and fix them before the actual event.

After working in smaller units, the team came together and developed the following pedagogical **pattern** for each concept: a short presentation on the concept with the entire group, a longer activity in smaller groups, and then questions to promote both intra- and intergroup discussion. For some concepts, like **decomposition**, we assumed that less time would be needed for introduction and more time should be spent in activities. After debugging (another CT concept), the team **abstracted** a more holistic pedagogical approach for the virtual SI: whole group sessions should be shorter than activities, and discussion and reflection are key to the learning process.

For SI2, the team revised the planning **algorithm** to accommodate a shorter timeframe for preparation. This led us to **decompose** the planning process into smaller chunks that could be handled asynchronously by individuals to maximize the work that could be accomplished in the shorter time period. We assigned blocks of time (with a specific purpose) to every team member. Each person was then responsible for leading the design and development of their portion of the SI. This approach was more challenging as it required greater communication among individuals and enhanced coordination to stitch together the various components into a seamless PD.

To ensure SI1 and SI2 ran smoothly, the team conducted complete dress rehearsals, centered on testing and debugging, for a number of days before each summer institute. To minimize the time required for this, we focused on a high-level **abstraction** of the actual event by simulating the key parts of the SI, including giving abbreviated versions of the presentations, "walking" through transitions, distributing and clicking links for the interactive portions of the presentations, and viewing activities and surveys. These dress rehearsals included practicing anticipated problems such as an attendee being "dropped" out of the Main room and the Zoom meeting host's computer crashing. These processes helped us debug all kinds of issues, from Zoom room passwords and settings to the access and organization of our Google Drive folder—many of which were critical to ensure a positive attendee experience.

Not all problems can be predicted, however, as the team discovered when introducing basic examples of coding in the Scratch platform (a block-based graphical programming language) in one of the sessions. During the Scratch activity, a number of teachers struggled to code on their own. At the end of that day, the team reviewed the problem and determined that explicit support with the CT concepts would help the teachers complete the task. This led the team to change the approach we took using Scratch in SI2. We utilized the Zoom color discussion rooms to allow teachers to choose the level of support they needed for Scratch coding. Facilitated group conversation allowed teachers who were not as comfortable sharing their confusion to hear how others approached the session's coding activity.

4 METHODOLGY FOR SI FEEDBACK

There were three instruments for gathering data and evaluating the SI. (1) A "temperature check" question was administered after each CT concept was presented to query the participants' understanding of the concept. (2) At the end of SI1 in June and the end of SI2 in August, an evaluation survey was administered to assess the teacher experiences in the SI. The surveys consisted of both closed- and open-ended questions. (3) Starting on the second day of SI1, the team recorded the main content sessions and the small-group activities. The external evaluators conducted structured observations of recordings and provided feedback on the SI.

5 SI FEEDBACK AND LESSONS LEARNED

This experience report covers feedback from all five days of the SI but focuses on survey and observation results from the first session in June (SI1). The team received survey responses from 14 of the 15 teachers who attended any of the SI sessions. The results from the SI1 evaluation survey and observations of session recordings from the external evaluator provide an assessment of the effectiveness of our approach to transitioning a five-day in-person CT professional development training to an online format. Below we present the findings regarding technology barriers and support, online engagement, and the active use of CT as a tool to design and engage elementary teachers in a virtual SI.

Also, each section highlights comments made by participating teachers to the two open-ended survey questions: "What aspect of the SI was most helpful and why?" and "Any additional comments about the Summer Institute?"

5.1 Proactively Address Elementary Teacher Barriers to Technology Adoption

Elementary teachers in the United States, as previously mentioned, have high rates of mathematics and science teaching anxiety already [22, 23, 24]. Computational thinking is a new academic topic for most elementary educators to teach. Compounded with the switch to virtual teaching during COVID-19, many teachers were likely to experience a great deal of teaching anxiety. As part of the virtual SI planning process, the team wanted to minimize teacher anxiety, guided by Goode's idea that no teacher "will get lost" because of the technology used [26]. Addressing this anxiety was foundational to the virtual SI, so teachers could effectively learn CT concepts and how to integrate them into their instruction.

Early on, the team prioritized establishing a system of support to ensure teachers could navigate the virtual platforms used in the SI (Zoom, Slack, and Google Drive). The pre-SI Tech Check class taught teachers how to navigate the three platforms and debug any connectivity issues so they could participate in the virtual SI with minimal technology concerns. Prior to COVID-19, Zoom was not used as an online teaching tool in either participating school district (Ashland or Phoenix-Talent), thus many of the teachers were not initially familiar with it. As indicated in **Figure 1**, by the end of SI1, all responding teachers agreed or strongly agreed that they knew how to participate and communicate online in Zoom.

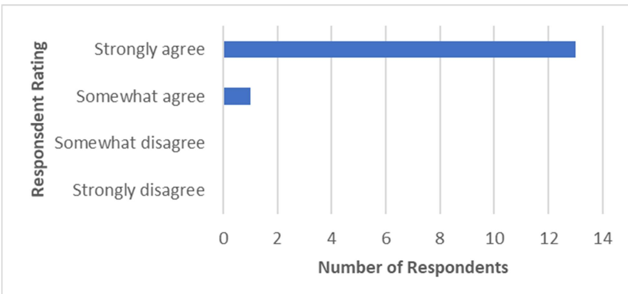

Figure 1: Survey results for the statement "I understood how to use the Zoom app to participate and communicate in sessions."

The impact of tech support was evident in teachers' responses to the open-ended questions in the survey: eight of the 14 teachers called out the value of the tech support and the ways in which the conference was organized to support those who are less adept at using online technology. Three people attributed their success directly to the team member (an experienced elementary school teacher) who conducted the Tech Check class. One teacher stated, "The moving from room to room was easy once I got help from [the team teacher] with the software." Another teacher stated that the most helpful aspect of the SI was "being able to get help instantly from [a member of the SI team] or really anyone as I needed it." Others pointed to "the safe learning environment that was mindful of the technology gap" and the helpfulness of "the agenda with all the hyperlinks!!" plus "the online forum …designed to make it as user friendly as possible."

5.2 Infuse the Physical into the Virtual

The team aimed to infuse as much shared physicality as possible into the virtual environment of the SI. The "party pack" delivered to all participating teachers contained Legos, marshmallows, toothpicks, colored pencils, and items to create a sense of fun and bonding (such as the colored leis, candy, and a drink tumbler). As shown in **Figure 2,** participating teachers somewhat or strongly agreed that these items enhanced their virtual SI experiences. Responses to the open-ended survey questions spoke to the role of the items in the party pack in SI1 in creating a positive experience in a virtual environment: "I like creating with the manipulatives" and "I appreciate the many details that made this experience more personable: the party pack with popcorn [and] the water tumbler." One teacher summed up the whole intention of the party pack: "Love the leis and the party pack. I think this piece was key to building community virtually— [which is] very hard to do."

The external evaluator who provided feedback on the virtual SI facilitation indicated that "[t]he use of leis to identify which 'color room' was a novel way to help participants visually organize themselves in the virtual environment as well as infuse some casual fun into the event."

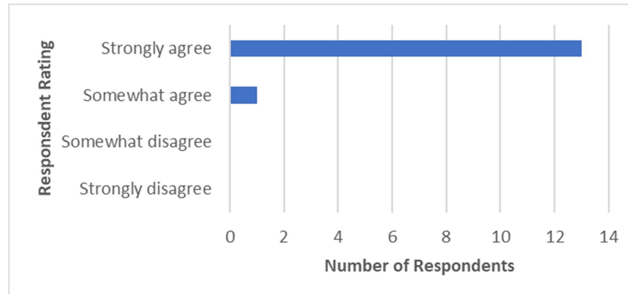

Figure 2: Survey results for the statement "The 'party pack' enhanced my experience as a virtual participant in the Summer Institute."

The team believes that participating teachers benefited from the Zoom room configuration developed for SI1, which we designed to mimic an in-person structure by requiring the teachers to move themselves between distinct virtual rooms with individual links that could be clicked on for access. The separate Zoom discussion rooms' utility became apparent in SI2 when we tried breakout rooms to accommodate smaller discussion groups. We found that quickly altering the configuration of breakout groups in Zoom, based on these smaller group activities, was challenging to a smooth delivery as it required the main facilitator to individually assign each participant to a breakout room. Some teachers were assigned to the wrong breakout room, causing confusion. Ultimately, the team debugged this issue by creating additional dedicated Zoom discussion rooms to accommodate the smaller groups.

Although we built this structure for the teachers, it actually benefited project team members. The title of this paper, "I Felt Like We Were Actually Going Somewhere," is a comment about the color Zoom rooms from one of the four elementary teachers who was on the team. The Green room, with restricted access only for team members, was an invaluable space to rehearse, regroup, problem-solve, and make last-minute changes.

A part of the SI involved teachers rehearsing lessons they developed that integrated CT in small groups according to the Goode and Margolis "teacher-learner-observer model" [21]. In the literature, this process is done in-person to simulate the classroom experience, with other teachers acting as students (learners) during the lesson. The virtual format proved especially beneficial and realistic for participating teachers because it allowed them to practice lessons in the same way (virtually) they would be teaching. Goode and Margolis [21] also emphasized that a key factor in the success of their CS teacher professional development program was creating a professional learning community through ongoing interactions with their teacher peers. While the SI was virtual, the teacher participants were still able to meet "face-to-face", via Zoom, to start developing their professional learning community.

5.3 CT is an Effective Tool for Designing an Engaging and Effective Online PD Experience

The team used CT as a tool for the planning process and making just-in-time modifications, which resulted in a virtual teacher PD that was tightly organized and well-received by participating teachers. In the open-ended survey responses, ten of the 14 teachers spoke specifically to the organization and effectiveness of the SI in their responses. One teacher unexpectedly drew on CT to explain "This [summer institute] was exceptionally well organized; I can tell that the organizers spent a great deal of time planning (probably using their decomp skills effectively) and organizing so that it flowed (probably a fair amount of debugging). I appreciate how material was presented in a concise manner." Another summed up her experience in this way: "I felt the Summer Institute was very well planned, organized, and, most importantly, informative." Finally, perhaps the most significant comment came from this teacher: "It was worth the 5 days on Zoom!"

The team hoped that this virtual PD experience would serve as a model for participating teachers, who assumed they would be teaching virtually for the 2020-2021 school year. As evidenced by the responses presented in **Figure 3**, all 14 teachers who responded to the survey somewhat or strongly agreed that the SI enhanced their ability to teach online. Virtual instructional practice took on added significance in the SI because the teachers developed lessons that would be delivered, for the first time for many, in a virtual environment. One teacher put it this way, "Building and using the online platform with the emphasis on inclusion was very helpful. This new world of online teaching is made less scary as we practice." Another wrote, "You guys did a great job of setting this up remotely. I might have enjoyed a backstage tour of how you guys managed Zoom for small groups, how you set up Slack rooms, etc. so I would better be able to integrate these elements into my teaching."

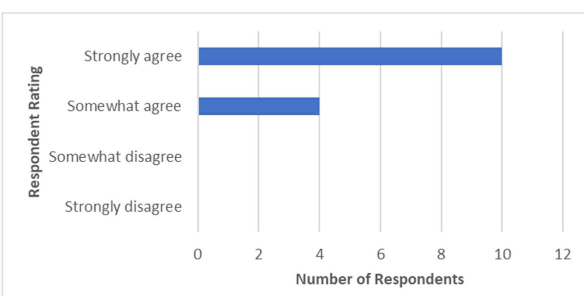

Figure 3: Survey results for the statement "My experience with online technology from the Summer Institute will enhance my teaching ability in the future when using distance learning."

In addition, participating teachers reported (see **Figure 4**) that they had a solid understanding of each CT concept in the "temperature check" questions administered after each concept was taught. The figure shows the self-reported teacher understanding of CT concepts, including decomposition, pattern recognition, algorithms, and abstraction. On a scale of 1 (meaning "not at all") to 5 (meaning "I could teach someone else"), more than 90% of responding teachers reported understanding the CT concepts of decomposition, pattern recognition, and abstraction at a 4 or 5 level. It is clear that the teachers need more support with algorithms; we plan to address this in the coming year. Overall, this level of understanding of the CT concepts is a positive result for participating teachers which, hopefully, means less anxiety about implementing these concepts into their instruction.

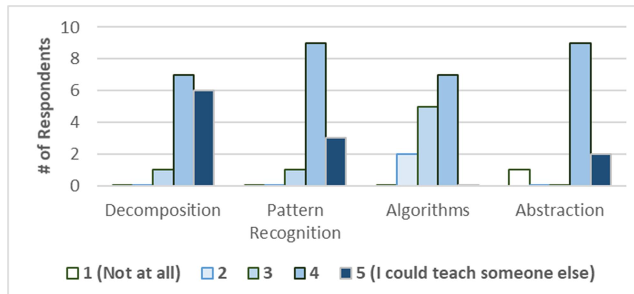

Figure 4: Survey results: Participants were asked to rate how well they understood each CT concept on a scale from 1 (*not at all*) to 5 (*I could teach someone else*).

6 CONCLUSION

This experience report highlights the approach that our project (focused on integrating CT into the K–5 instruction of general elementary and elementary bilingual teachers) took to transition a summer elementary teacher professional development from in-person to online because of COVID-19. We hope that this report will be of potential interest for other researchers and PD providers who also may be working virtually with elementary teachers to incorporate CT into their instruction. The most important takeaways that we learned are as follows:

(1) Researchers and professional development (PD) providers need to proactively address elementary teachers' barriers to technology adoption in the virtual PD's design and delivery.
(2) Infusing shared physical experiences using common physical objects available to all participating teachers, creating a structured schedule with frequent breaks, and incorporating whole group, small group, and individual-focused activities can result in active virtual engagement.
(3) Pattern recognition, abstraction, decomposition, and algorithms are important foundational computational thinking (CT) concepts for participating elementary teachers to learn and were an effective framework for designing and engaging teachers in a virtual PD.

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