CPR2: Spring 2021 and Summer Institute 2021 Findings

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Contents

This memo includes results of data collection from classroom implementation of Collaborative Partnership to Teach Mathematical Reasoning Through Computer Programming (CPR2) content in spring 2021 (first cohort) and from Summer Institute 2021 (second cohort).

Overall, spring 2021 teachers were able to implement CPR2 without major disruptions, with students successfully writing mini-programs for even/odd/consecutive lessons in alignment with Step 2 of the CPR2 Instructional Model. Teachers varied in their presentation of mathematics content and technical information, and there was limited use of assessment techniques.

Participant reactions to Summer Institute 2021 were positive and improved as compared to 2020. Teachers felt appropriately challenged and prepared to teach CPR2 activities in the upcoming year, although some were concerned about students not catching on to the generalization or getting "stuck" on the programming activities or proof-writing. Teachers wanted ongoing access and support from activity leaders, mentors, and colleagues. In Summer Institute 2021 teachers had much more opportunity to practice teaching than in the previous year. They largely followed a teacher-led lecture model in their practice sessions. Some incorporated questioning strategies and descriptive feedback.

Recommendations

The design sessions and iterative revisions of CPR2 have led to improvements in how it is taught and learned. Opportunities for further development include:

1. Incorporate assessment strategies—so that teachers will know when students are getting the programming as well as whether they are increasing their understanding of generalization in mathematics.
2. Support teachers in discussing generalization explicitly with their students and then assessing student understanding.
3. Give teachers the opportunity to support students in student-centered discussions during CPR2 lessons.
4. Produce resources that teachers requested, such as a one-pager with the most common Python code samples/programming terms, a proof "outline" or similar resource to support proof-writing, and a compilation of participants' example proofs.

Spring 2021 Findings

Lesson Observations

Background: The purpose of the spring lesson observations was to continue to describe how teachers who attended the 2020 Summer Institute implemented CPR2, in what ways they supported student engagement and learning, and whether students participated in CPR2 lessons in ways that supported CPR2 learning objectives.

Design: We used the same observation protocol from fall 2020, which consisted of two parts: 1) time-stamped running notes to document activities, teacher and student talk, and notes about the learning environment and issues relevant to understanding the lesson; and 2) a debrief organized by descriptive categories aligned with the project's constructs table. The debrief categories were based on the CPR2 instructional model and on other aspects of instruction that we believe support the CPR2 instructional model, including facilitating rich classroom discussions that allow for student questions and reasoning, checking for student understanding, and addressing student misconceptions. Observers took running notes and then wrote summaries for each of the debrief categories.

Data Collection & Analysis: Due to COVID-19 restrictions, we conducted lesson observations virtually. Observers were able to see either the front of the classroom (usually the screen and the teacher) or the teacher's desktop. Importantly, observers did not see students and often the audio quality substantially limited the student talk observers were able to hear. Our observation findings therefore do not fully capture aspects of student engagement, teacher-student interactions outside of front-of-class teacher-led activities, or peer interactions.

We observed six teachers implementing two to four lessons for a total of 15 observed lessons. Three of the six teachers taught the CPR2 lessons with the same group of students as they had in the fall, while the other three teachers taught the CPR2 lessons to a different group of students. The teachers who taught the same group of students as the fall continued the Even-Odd-Consecutive (EOC) lessons where they last left off, whereas those who taught a different group started back with the Intro to Programming lesson.

To analyze the data, we created a summary debrief for all observations for each teacher. One SRI researcher reviewed all debrief categories across all teacher summaries and described themes and/or variation for each debrief category (e.g., what kinds of questions did teachers ask students, or to what degree did teachers provide student opportunities to write general expressions to represent the mathematical relationships they discovered). The findings below summarize the themes and variations we saw across all teacher observations.

Findings

Overall, teachers delivered the EOC CPR2 lesson content using University of North Alabama (UNA)-provided materials the way it was modeled during the CPR2 Summer Institute in May and June, 2020. Teachers generally delivered the EOC CPR2 lesson content using teacher-led direct instruction. There were few observed opportunities for students to authentically struggle and explore their own ideas beyond writing the mini-programs. We did not observe much EOC instruction supporting students' conceptual understanding of mathematical concepts and mathematical generalization, or discussion of students' proof-writing. We rarely observed teachers checking for student understanding beyond "walking the room." One observed teacher, however, spent more time than other teachers exploring student ideas, allowed for more student exploration of problems and programming, asked students more open-ended questions, and facilitated discussions.

1. **We observed no problems with student behavior or other significant classroom disruptions.** The most common characterization of the classroom environments, to the extent observers could tell given the online format, was that they were respectful. Three of the classrooms were characterized as having a friendly atmosphere. One teacher in particular was described as being "warm, friendly, and relationship-focused" as well as "thoughtful and inclusive." One teacher, while described as casual and respectful of students, appeared to be experiencing frustration and stress and exhibited a "slightly cold or business-like" demeanor.
2. **Teachers consistently implemented only Step 2 (writing mini-programs to explore mathematical concepts) of the CPR2 instructional model:** For students to learn, understand, and apply mathematical concepts, including generalization, teachers need to identify mathematical concepts in the lesson and lead students through reflections on problems and solutions. Students can then reconstruct mental structures and organize them into novel schemas. Across all six teachers, observers reported that teachers did not explicitly identify, define, or discuss generalization. The only example observed of mathematical concepts being addressed was one teacher who briefly provided definitions of even and odd numbers. Another teacher talked about "general expressions for even and odd" but did not define generalization to students nor explain the processes by which one could arrive at the general expressions.

   Students had opportunities to write mini-programs and in some cases to tinker and explore on their own in all six teachers' classrooms. In one classroom in particular, the observer noted:

   > The teacher did a clear job of modeling her programming for the students and talking through her coding adjustments/changes as she worked. She was explicit about where students should be changing their code and…she seemed to be circulating and

> talking to students about their programming. The teacher also had students share their even and odd examples (4n, 6n, etc.) and modified her code in front of the class to show she was following students' code examples.

3. It was not clear, however, in this example or in any of the observed classrooms, whether students' programming afforded them opportunities to explore mathematical concepts.

   Students had some opportunity to write general expressions in five of the six classrooms. They were asked to create expressions based on the odd and even numbers, but it was not clear whether students truly had opportunities to explore the mathematical relationships and represent their own discoveries in general expressions.

   In three of the classrooms, students did not have opportunities to develop conjectures and write arguments. In the other three classrooms, students were given time to write conjectures, but activities around conjectures consisted of the teacher demonstrating or lecturing about conjectures but not providing opportunities for students to share their conjectures or discuss them in class.

4. **Teachers made few connections to classroom content.** In four of the classrooms, the teacher did not provide learning goals, activity goals, or connections to prior learning. However, in one classroom the teacher began by talking about the connections between math and programming, talked about cybersecurity careers, and connected the lesson to the prior lesson. In another classroom, the teacher recapped what they had worked on previously but did not discuss broader goals.

   Emphasis on correct answers, versus tinkering and exploring, was notable in three of the classrooms. An exception was one classroom in which the teacher strongly encouraged student voice, solicited multiple answers, and explored diverse problem-solving approaches.

   Five of six teachers facilitated heavily teacher-led discussions, with a focus on teacher reasoning and a few opportunities for students to share or explore their own ideas. One teacher, however, facilitated inclusive whole-class discussions in which she solicited student ideas, included multiple student responses to demonstrate that programming involves different problem-solving approaches, and welcomed student questions.

5. **We did not observe systematic checks for student understanding or instructional adjustments based on students' needs.** Across the six classrooms, there were few instances of teachers facilitating student agency to explore, make mistakes, and check their reasoning. Some teachers, after presenting or demonstrating programming ideas and steps, had students work on their own. There were few observations of students exploring or discussing their mistakes or their reasoning. One exception was a classroom in which the teacher was very responsive to students and provided a significant amount of time for students to work on their own, tinker, and explore, as well as to share out their answers and reasoning.

Five of the six teachers primarily asked "fill-in-the-blank" questions, with teachers' own reasoning dominating. One exception was a teacher who asked open-ended questions such as, "What did you try?" or "How could we do this?" that did not have single answers. The observer noted: "Overall some of the best teacher questioning I've seen in CPR2 to date."

Given the online format, it was difficult to ascertain whether students were struggling, expressing misconceptions, or having other challenges. Some teacher talk suggested instances of addressing student struggle (e.g., one teacher prompted students to check their equations with multiple numbers; one teacher corrected students; and one teacher responded to a student saying, "This is hard" and "That's okay, we can do hard things"), but overall we don't have enough data to infer particular themes.

The main forms of checking student understanding observers noted was teachers "walking the room" (five teachers) and calling on students (three teachers). Five of the six teachers appeared to have made no adaptations to their instruction based on checks for student understanding. One of the teachers was, according to the observer, highly responsive to students' need for time to tinker.

6. **We observed minimal active student engagement, which is likely affected by the online observation format.** The online format of the observation made it difficult to evaluate student engagement. Based on teacher and student talk that was audible, observers noted that student engagement in five of the six classrooms was characterized by students primarily following teachers' directions. One classroom was the exception, in which students appeared to be actively engaged based on the level of student talk, the number of students who contributed, and the quality of student responses.

   In all six classrooms, we rarely heard students ask questions. Again, this is likely affected by the online format. Due to audio quality, we don't have data on what kinds of questions students did ask; what observers heard suggested questions were procedural in nature.

7. **Teachers' grasp of the mathematical and programming content varied significantly.** Two of the teachers appeared to have a good grasp of both the programming and math content. For example, one of those teachers was able to quickly incorporate students' variables into her code. Several teachers appeared confident about the content, but observers noted this seemed to be because they adhered closely to the lesson script. Three of the teachers made subtle mistakes related to the content. For example, one teacher was exploring how to make even vs. odd numbers and was testing 2n+1, 2n+2, 2n+3, etc. with students. She said something akin to, "whenever we add an odd constant, we always get odd numbers." This is only true because the variable term (2n) is an even number. If she had tried this with 3n, she wouldn't have been able to make such a rule.

Student Assessment Analysis

Background: One of the goals of CPR2 is to increase "student performance in problems involving [mathematical] generalization." We intend to measure students' mathematical generalization skill during the efficacy study through a student assessment specifically designed to measure this skill. In the fall 2020 memo, we reported low overall performance on items we piloted. In spring 2021, we worked to develop a student assessment that would more closely align with CPR2.

Design & Piloting Goals: The fall 2020 assessments were comprised of Mathematics Assessment Resource Service (MARS) items. In this 2021 iteration, we retained two of the MARS items and added seven released items from the National Assessment of Educational Progress (NAEP) 4th and 8th grade math assessment. We searched for items under "number properties and operations" and "algebra" in the content areas and, where available, "conceptual understanding" and "problem solving." The UNA and SRI teams reviewed the items to ensure the questions were a reasonable match with the CPR2 program; of the 11 reviewed items, nine were retained for the student assessment.

The NAEP provides performance data for their released questions[1], and we used it to determine if the questions were an appropriate difficulty for the sample.

Data Collection: We obtained responses from 78 students who completed the assessment and consented to have their data used for research purposes. Of these, 58 students completed the assessment as a pretest and 20 students completed the assessment as a posttest.[2]

Findings

The questions seem to be appropriate for this sample, as the students scored similarly to the NAEP sample. Overall, students provided the correct answer between 34.6% and 46.2% of the time on multiple choice items with five answer options (six questions total), between 39.7% and 51.3% on questions with four answer options (two questions), and 30.8% of the time on an open response item validated to allow answers between 0 and 6. We do not have any concerns about significant ceiling effects (i.e., students doing so well at baseline that we cannot measure improvement) or significant floor effects (i.e., students doing so poorly at baseline that the questions are inappropriate to their mathematical background).

[1] U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 2017 Mathematics Assessment.
[2] We confirmed pretest/posttest assessment administration based on teachers' observation schedules and timestamps when students completed the assessment.

Summer 2021 Findings

Efficacy Study Sample Tracking

This section provides the current state of the teacher sample. In spring of 2021, UNA recruited 49 teachers. After randomization, there were 25 treatment and 24 control teachers. At the time of writing this memo (July 19, 2021), nine teachers (five treatment, four control) have left the study for a variety of reasons (see Table 1).

Three control teachers are currently at risk of being eliminated from the study on July 31, 2021. This is because they have not completed both of the required baseline measures (Learning Mathematics for Teaching [LMT] assessment, Teacher Background Survey). If they do not complete these required measures by the end of the month, then we need to consider them as having left the study because the school year will begin soon and teachers may be exposed to new professional development that decreases the contrast between the treatment and control conditions.

Table 1. Teacher sample after randomization and July 26, 2021

	Treatment	Control
Recruited	25	24
Retained	20	20

Teacher Background Survey

Background: SRI Education conducted a Teacher Background Survey sent to treatment and control teachers before Summer Institute 2021. The purpose of the survey was to collect information about the participants' teaching background and previous professional development experiences related to math, computer science, and generalization.

Design: The Teacher Background Survey was the same survey as last year's Pre-Summer Institute Questionnaire given to the 10 pilot teachers. The SRI, UNA, and Horizon Research, Inc. (HRI) teams reviewed the teacher background survey prior to summer 2021 and did not see any need to adjust the questions asked.

Data Collection & Analysis: SRI emailed Qualtrics links for the Teacher Background Survey to treatment and control participants after they completed the LMT and before Summer Institute 2021. The UNA staff and research associates at SRI provided email reminders to complete the survey 1 week after sending the survey to participants and completed two other rounds of follow up to participants. As of July 19, 2021, 37 of the 40 non-attritted teachers in the sample completed the background survey, leading to an 92.5% response rate. We are currently waiting for three control teachers' responses to the background survey.

Findings

In this section, we highlight the overall findings from the Teacher Background Survey. Please see Appendix B for specific values from the survey. Findings are currently based on the 37 responses (20 treatment, 17 control) we received from teachers.

1. **On average, the teachers have 11 years of teaching experience.** Respondents in both treatment and control conditions have similar years of teaching experience. More teachers have experience teaching math than computer science or programming. On average, teachers have 10 years teaching math and less than 1 year teaching computer science. Teachers on average have taught at their current school for about 6 years.
2. **At least half of the respondents have a master's degree or higher.** Teachers in treatment and control conditions have similar educational attainment. About 40% of teachers who responded to the survey have a bachelor's degree or some courses past a bachelor's degree. About 50% of teachers who responded to the survey have a master's degree and about 5% have a doctorate.
3. **Most of the respondents have a degree in education, and about half have a degree in mathematics.** There were 12 teachers with both mathematics and education degrees. There is a slight difference in treatment and control teachers' fields of study. More treatment teachers received a math degree than control teachers; however, control teachers had a wider variety of degrees including those in statistics and computer science.
4. **Of the 37 respondents, 19 teachers received math professional development and three received computer science professional development in the last 12 months.** For those who received math professional development, respondents reported the most common formats were a professional development/workshop or online course/webinar. On average, respondents who received professional development spent 21 hours in math professional development in the last 12 months.
5. For those who received computer science professional development, respondents reported the most common formats were a professional development/workshop or online course/webinar. On average, respondents spent 32 hours in computer science professional development in the last 12 months.
6. **Half of the respondents said they signed up for CPR2 to learn how to incorporate math with computer science.** Other specific reasons included a desire to learn: ways to increase student engagement in computer science and/or math, how to improve their own mathematical pedogeological practices, how to program, and methods for teaching generalization. Many respondents also provided broad answers such as a desire to find better ways to equip their students and learn new ways to teach in general.
7. **Most treatment teachers anticipate using individual Chromebooks to teach CPR2 lessons.** There were 17 treatment teachers who planned to have students use

Chromebooks, six others intended to use laptops, five proposed tablets, and two responded that students would use desktops. There were 11 treatment teachers with either a 1:1 technology program at the school or who had computers in their classroom readily available for each student to use. Four treatment teachers had a shared computer cart, and only one teacher was unsure of the technology access in their classroom or school.

Daily Participant Feedback Survey

Background: SRI staff conducted daily participant feedback surveys on each of Days 1-7 of Summer Institute 2021. The purpose of the surveys was to collect formative feedback that UNA could use to adjust Summer Institute agendas, activities, and prework.

Design: We used the same daily feedback survey from Summer Institute 2020 for this past summer. SRI staff reviewed the daily feedback survey prior to summer 2021 and did not see a need to adjust the questions asked. The team members at UNA and HRI similarly reviewed the daily survey questions and reached the same conclusion. The daily survey questions can be found in Appendix C at the end of this memo.

Data Collection & Analysis: SRI staff emailed Qualtrics links for the daily survey feedback to teachers during the closing activities for each of Days 1-7 of the Summer Institute 2021. UNA provided verbal reminders during their closing comments reminding teachers to complete the survey, except on Day 4, which featured practice teaching in different breakout rooms. Overall response rates were high with a minimum of 18 teachers (>90% of 20 treatment teachers) responding to the daily survey on all days other than Day 4, when 15 teachers (75%) responded, likely due to the different structure of the day and the lack of a formal closing routine.

An SRI researcher who attended all Summer Institute sessions analyzed the feedback daily. He reviewed the daily feedback surveys for themes within each question and emailed UNA each day with a summary of the themes.

Findings

1. **Participants were overwhelmingly positive about the content and facilitation of the Summer Institute 2021.** Participants overwhelmingly responded with 5's and 6's on the 1-6 Likert-style questions (6 being the most positive option) on each of Days 1-7. These responses were supported by participants' responses to the open-ended questions, which included many appreciative comments about CPR2 content and the institute's instruction.
2. **Based on participant feedback, Summer Institute 2021 was significantly improved from Summer Institute 2020.** Participants in 2020 initially reported mixed reactions to the prework assignments in terms of both content and length. The UNA staff changed the design of the prework assignments in response to participant

feedback, resulting in strong positive feelings about the prework by the end of 2020 session. During 2021, respondents were consistently positive about the prework assignments throughout the entire institute.

3. Participants in 2020 noted a lack of opportunity for them to practice teaching CPR2 content themselves during the institute. As a reminder, the Summer Institute 2020 was originally scheduled as an in-person event with several days of teaching practice with summer camp students included in the event. The COVID-19 protocols required UNA to quickly transition the Summer Institute to a virtual event, and the teaching practice events could not be replicated in a virtual environment. For 2021, UNA planned Days 4 and 8 to be virtual teaching practice days, providing participants with opportunities to practice teaching CPR2 content with CPR2 lesson materials. During 2021, participants appreciated that teaching practice time was included in the institute's program.
4. **Teachers reported being appropriately challenged by the material.** The UNA staff anticipated participating teachers would report being challenged and anxious throughout the Summer Institute 2021 with an overall upward trend in confidence over time. The daily feedback surveys confirmed this expectation. For each of Days 1-7, most teachers reported that the math and/or programming content was new to them and reported feeling challenged by the day's content. The reported challenges appeared to change over time, suggesting that teachers grew comfortable with content as the institute progressed; there were also fewer overall challenges reported over time, suggesting a general increased level of confidence.
5. **Teachers identified several opportunities for additional resources to be created to support teaching CPR2 in their classrooms.** Teachers were broadly appreciative of the resources provided by UNA during the Summer Institute to support classroom instruction, and they submitted requests for additional resources to be created/provided in the daily feedback surveys. The most common resource requests were to provide the following: a coding "cheat sheet" or one-pager with the most common code samples/programming terms; a proof "outline" or similar resource to support students in learning how to write a proof; and a compilation of participants' example proofs from the Summer Institute that they could refer to during the year.

Summative Participant Feedback Survey

Background: SRI conducted a summative participant feedback survey on Day 8 of Summer Institute 2021. The purpose of the summative feedback survey was to assess participants' overall impressions of Summer Institute 2021, preparedness to implement CPR2 in their classrooms, anticipated challenges with implementation, and needs for additional supports or resources to support implementation. The summative survey differs from the daily surveys in that it asks participants to reflect on CPR2 holistically rather than on each day's content, and respondents have fully experienced the Summer Institute content when responding to the summative survey.

Design: We used the same summative feedback survey from Summer Institute 2020 as our foundation for 2021. We added questions to the 2021 survey focused on facilitating student discussions, teaching proofs, and the alignment of CPR2 content to math and computer science standards. The UNA and HRI team members reviewed and approved the updated summative survey questions. The summative survey questions can be found in Appendix D at the end of this memo.

Data Collection & Analysis: SRI staff emailed Qualtrics links for the summative survey feedback to teachers during the closing activities for Day 8 of the Summer Institute 2021. The UNA team members provided a verbal request during their closing comments reminding teachers to complete the survey and describing its importance to the study. SRI staff conducted email follow up for 1 week following Day 8 to support a higher response rate. The response rate was reasonable with 15 teachers (75% of 20 treatment teachers) responding to the summative survey.

An SRI researcher who attended all Summer Institute sessions analyzed the summative survey feedback. He reviewed the summative survey results for themes within each question, which are described below.

Findings

1. **Participants experienced the Summer Institute 2021 as having positive impacts on their knowledge and teaching.** Participants responded very positively about how the Summer Institute increased their knowledge of computer programming, knowledge of mathematical generalization, and confidence with teaching computer programming. The lowest average score for this set of Likert-style questions was 5.7 out of 6.
2. **Participants overwhelmingly reported feeling confident and prepared to teach CPR2 content in their classrooms.** The lowest average score for this set of Likert-style questions was 5.1 out of 6 (which still indicates substantial agreement) in response to "My school will expect me to use the information provided in this training to teach generalization." The lowest average score for the rest of the questions, which were about the teachers assessing their individual confidence/preparedness and addressing state standards, was 5.4 out of 6.
3. **Participants expected few challenges with implementing CPR2 in their classrooms.** The average score to the Likert-style "barriers" questions was 1.8 ("very little challenge") on a 1-4 scale with lower numbers indicating lesser challenges. The two barrier questions with average scores of at least 2 were "Lack of time to implement the activities" (2.1) and "Challenges with debugging code" (2.0). The open-ended question about anticipated challenges confirmed these findings, as most teachers reported that they do not anticipate any significant/major challenges.

4. **Participants overwhelmingly reported that the Summer Institute 2021 met, if not surpassed, their expectations.** The expectations teachers reported having for the institute were well-aligned to CPR2 content, including learning mathematical generalization, programming, how to teach programming, and how to bridge the gap between computer science and mathematical thinking.
5. **The most common request for additional support was for ongoing contact/access with CPR2 instructors, mentor teachers, and fellow participants.** Other requests for additional supports came from individuals. These included: a resource for common coding/programming functions such as print statements, more debugging exercises, and having a timeline from SRI/UNA for required activities during the 2021-22 school year.

Summer Institute Observations

Background: The purpose of the Summer Institute Observations was to describe the professional development sessions that treatment participants received with regards to active involvement, collaboration, and connection to classroom practice. In Spring 2021, there were two collaborative design sessions focused on CPR2 and its connection to teachers' curriculum or course of study as well as increasing student-driven discussions. Information learned from the design sessions was incorporated into the content of the 2021 Summer Institute.

Design, Data Collection & Analysis: We modified the Summer Institute Observation Protocol from 2020. Part of the modifications included consolidating the "Direct Instruction" and "Participant Practice" debrief sections into one section. We also updated the questions to reflect topics discussed in the two spring 2021 design sessions. The final Summer Institute Observation protocol consisted of two processes. First, at least three SRI researchers attended each Summer Institute session and recorded timestamped running notes documenting CPR2 instruction by activity leaders (UNA instructors and mentor teachers), participant responses, and breakout sessions. Second, one SRI observer answered a series of debrief questions using these running notes as evidence. Then, the other SRI observers reviewed and added further details and perspectives to the debrief answers. The debrief questions were generated by SRI staff to reflect key content, instructional practices, and implementation details relevant to CPR2. The UNA and HRI team members reviewed the debrief questions and confirmed they were appropriate.

Following 2020's Summer Institute model, this year's Summer Institute was held online via Zoom. We continued to observe the sessions virtually. There were usually three to four observers per day over the course of eight professional development days from June 1 through June 29. After each session, one observer stayed to observe and take notes on the mentor and UNA leader debrief and planning session, which usually lasted approximately 30 minutes. We were unable to observe individual mentor and participant sessions, in which mentors and participants worked together on prework assignments and planning for their practice teaching assignments.

To analyze the data, one analyst reviewed all debrief categories across all eight sessions and described themes and/or variation for each debrief category (e.g., if the activities were implemented as designed, or to what extent the participants experienced lessons as teachers). The findings below summarize the themes and variations we saw across all Summer Institute observations.

Findings

1. **Strengths from 2020's Summer Institute continued to be strengths in this year's Summer Institute.** Like last year, sessions were still consistently implemented as designed with respect to content, timing, and roles. Mentor teachers continued to be instrumental to the participants' experiences through communication, support, and learning that occurred during and outside of Institute sessions.
2. **Participants had more opportunity to practice teaching than last year.** Most teachers were able to deliver lessons to their "students" in breakout sessions, using questioning techniques and providing feedback. Some teachers were able to receive descriptive feedback from their colleagues about their lessons.
3. **Participants were most likely to be actively engaged during breakout sessions, which constituted about 45 minutes of each session.** Activity leaders often led participants through the CPR2 instructional model of question, program, explore, conjecture, and proof. Activity leaders did not explicitly mention which steps of the model they were on to the participants. During the breakouts, participants had the opportunity to write programs, conjectures, and proofs while completing response sheets. (By "actively engaged," we mean that participants problem-solved or otherwise acted on their own initiative, rather than primarily watching and listening.) Last year, participants spent about 30 minutes actively engaged during each session of the Summer Institute, compared to 45 minutes this year.
4. **Activity leaders and participants used primarily a teacher-driven instructional style.** Similar to last year, activity leaders used a predominantly teacher-centered instructional style. Observers noted relatively few instances of explicit modeling of student-centered discussions. Activity leaders emphasized that participants should facilitate student-focused discussions, student-driven tinkering, and exploration, but there was limited opportunity for participants to practice how they could do this in their classrooms. Participants' practice teaching was largely lecture-style with questioning.
5. **Activity leaders provided evaluative feedback and some descriptive feedback.** Participants mostly received evaluative feedback (praise, in this case) after their practice teaching. Some feedback was descriptive, pointing out specific features of instruction. During Day 8's practice teaching, the breakout room leaders varied in how they led the practice sessions. In some rooms, there was time allotted after teachers taught to reflect on the lesson and give constructive feedback to the participant. In other

breakout rooms, however, participants, mentors, and activity leaders praised the teacher and moved onto the next practice lesson.

6. **The Summer Institute did not focus on assessing student learning.** Participants generally did not practice interpreting the CPR2 work to understand what students were learning, discussing formative or summative assessment of student work, and measuring whether the CPR2 lessons had an impact on students' understanding of generalization.

Teacher Focus Groups

Background: The purpose of the teacher focus groups is to help us understand how CPR2 professional development supports teachers in learning to use programming as a tool to develop mathematics generalization skills and to identify ways it could be improved.

Design: The protocol for the teacher focus groups was like the one from the 2020 pilot year, with a few modifications based on those results. Topics included teachers' backgrounds, conceptions of mathematical generalization and how they teach it, reactions to the summer institute, how prepared they felt to implement CPR2 lessons in their classrooms, and what challenges they anticipated.

Data Collection & Analysis: SRI interviewed 14 of the 20 teachers who participated in the 2021 Summer Institute in five small groups via videoconference. All attendees were invited to sign up for a focus group. The interviews took place during the final week of the Institute and lasted approximately 1 hour. Interview transcripts were coded using a combined inductive and deductive process (Graebner, Martin, & Roundy, 2012), with the protocol questions serving as the analytical frame. We looked within and across the interviews to identify emergent themes, paying special attention to those that could enhance our understanding of findings from other data sources.

Findings

- **For the most part, teachers held a common conception of mathematical generalization.** Teachers largely defined mathematical generalization in terms of the ability to see, communicate, and use patterns when engaged in math problem-solving activities. A few teachers expressed generalization in vague terms, such as "generalization is taking a wide topic and generalizing it down to just one main focus."
- **Teachers indicated mathematical generalization is an important skill worthy of classroom time.** All the teachers we spoke with cited at least one benefit of developing generalization skills. A few pointed out that the goal of developing mathematical generalization is aligned with their new math curriculum. One said, "Yes, the task [of generating general expressions] is going to be daunting at first, … but in the

end, if we can get to a feeling of success and see the big picture of things, I think it's so valuable."

- **Teachers cited students' aversion to struggle and their lack of foundational knowledge as the primary challenges to developing mathematical generalization skills.** Teachers' own lack of deep mathematical knowledge was also seen by some as a hindrance to fostering mathematical generalization. As one teacher said, "If the teachers cannot understand the math behind the patterns, they cannot teach the patterns. If the teachers cannot communicate patterns to students, then students cannot learn how to communicate patterns themselves."
- **Teachers were positive in their descriptions of the Summer Institute.** Teachers described the Summer Institute as 'beneficial,' 'intense,' 'challenging,' 'engaging' and 'a constant barrage.' For the most part, they enjoyed the experience. One teacher said, "I really like how CPR2 is so rigorous. We're all learning something. We're *learning* and we're excited about it, we're going to be excited with our kids."
- **While the Summer Institute experience was intellectually invigorating for the teachers, some expressed concerns about translating CPR2 for their students.** One teacher said, "I still feel a little intimidated by it just because I know I know the outline of it, but I do need to mess around with it more for me to feel confident and comfortable enough to be able to teach it to my kids."
- **Like last year, teachers anticipated that proofs would be one of the biggest challenges.** In general, teachers were less worried about their students struggling with Python programming or recognizing patterns. Out of the seven teachers who listed challenges, four specifically highlighted proof-writing at the middle school level. One teacher said, "The greatest struggle will be with the math proof part of it. I don't think students will have issues with the coding and tinkering, but the 'more mathy' area will have the greater challenge… I don't see much proof-writing being practiced in middle school classes, so anything new is going to be a challenge."
- **About half the teachers said they left the Summer Institute prepared to teach CPR2. Others felt the pacing and online format limited their preparation.** Seven teachers said they felt 'ready' and/or 'confident' about implementing the lessons, but not all agreed. One said that the pacing of the Summer Institute was much faster than what they would do with their students. This teacher felt it would be hard to know how to adjust that pacing to fit their students' needs. "My concern is going from seeing a pattern to seeing an expression, then to moving to a proof. We were rushed on these parts, which got in the way of exploring. I wasn't blind to the generalization, but the students may not see it as quickly. What UNA modeled was appropriate for teachers with better backgrounds and math understanding, but likely disconnected from the amount of scaffolding needed for students with lesser math backgrounds and understanding." Another teacher said that the online format of the

Summer Institute made it hard to see how students would react. “Kids are going to get stuck. I’m going to get frustrated because I don’t know what questions to ask the kids to get them to understand what the goal is. It was easy for teachers to pick up on this, but students will get stuck and confused in different ways.”

Artifacts

Background: SRI reviewed all pre-work and work assigned to participants over the 8 days of Summer Institute 2020 and Summer Institute 2021. For Summer Institutes 2020 and 2021, we reviewed and scored each item for opportunities to learn. In addition, for Summer Institute 2021, we scored teacher work on select assignments for the extent to which teachers engaged successfully with the assignment.

Opportunities to Learn Rubric Design: To determine the extent to which teachers could be expected to engage in the topics identified in the research questions, we conducted an “Opportunity to Learn” analysis. That is, we looked at the assignments themselves and coded them according to a 3-point scale on whether the assignment facilitated learning for the following topics: math generalization; programming as a tool to teach math generalization; assessments; engaging teachers as students; classroom implementation; and aligning CPR2 to standards, pacing guides, and curriculum. For the specific rubric, please see Appendix E. The general format of the scale was:

- 0: the assignment makes little or no attempt to address [the topic].
- 1: The assignment could be interpreted to address [the topic] and a response could include [the topic].
- 2: The assignment clearly addresses [the topic], which is needed to provide an adequate response.

The opportunities to learn rubric were designed and piloted in 2020. We made the following edits to the rubric for Summer Institute 2021 opportunities to learn artifact scoring: (1) added a new “programming” to differentiate between programming as a tool for generalization and programming assignments that teach Python, and (2) changed “classroom implementation issues” to “classroom implementation” to focus on opportunities to discuss CPR2 implementation beyond issues.

Teacher Assignment Rubric Design: The goal of this analysis was to provide the SRI and UNA teams insight into the activities teachers were assigned, especially when analysis of artifacts can provide information not available through the other components of the Summer Institute analysis, and to provide evidence as to how the Summer Institute addressed the relevant CPR2 Research Questions.

We created rubrics to score elements of 13 assignments. On these assignments we scored work for all 20 teachers (if submitted). We selected assignments in which teachers had the opportunity to demonstrate knowledge of generalization (one assignment), convincing

arguments (seven assignments), general expressions (three assignments), practice teaching reflection (one assignment), and course of study (one assignment). For the specific rubric in each type of assignment, please see Appendix F. The general format of the scale was:

- 0: the answer makes little or no attempt to address [assignment] or is incorrect.
- 1: The answer makes some attempt to address [assignment] but is only partially correct or is incomplete.
- 2: The answer correctly addresses [assignment] and considers all aspects and parameters of [assignment].

Data Collection & Analysis: We used the assignment repository in Canvas to download the text provided to teachers for all 43 of the assignments during the 2021 Summer Institute, as well as teacher responses. We were able to collect and analyze all these assignments, including those done live with mentors. The assignments themselves were each coded by two researchers using the rubrics described in the sections above. The team assumed that for assignments completed offline the groups followed discussion directions. For example, for group discussions with mentors, the team assumed the group met with their mentor and discussed the assignment according to the instructions. After one round of both researchers coding, comparing codes, and coming to agreement on a representative sample of assignments, both researchers coded all assignments. There was a high level of agreement, and on the small number of items for which there was disagreement the researchers met and came to consensus. This process was used both for 2020 and 2021 data. For the individual teacher assignment scoring in 2021 we followed the same process. Please see Appendix E for the specific scores for opportunities to learn and Appendix F for specific scores for each assignment.

Findings

Opportunities to Learn Findings

1. Teachers had multiple opportunities to learn or show learning of programming and to learn or show learning of programming as a tool for generalization.
2. Teachers in Summer Institute 2021 had more opportunities than in 2020 to learn or show learning of classroom implementation issues. In 2020, four assignments were scored a with a 1 or 2; in 2021, 14 were scored with a 1 or 2.
3. Teachers in Summer Institute 2021 had more clear opportunities than in 2020 to learn or to show learning of how to align with standards, assessment, curriculum, or pacing. In 2020, only two assignments were scored as a 1 and one was scored as a 2 for opportunities; in 2021, four assignments were scored as a 2.

Teacher Assignment Findings

1. **Teachers had a wide and varying range of knowledge about generalization at baseline.** As a prework assignment to Day 1 of the Summer Institute, teachers were asked to give an example of generalization and to give an example that shows generalization is important to students. Nine teachers scored a 0, five scored a 1, and six scored a 2. Teachers were only able to demonstrate this knowledge in this one discussion, so we were unable to track any growth in this area from the artifacts.
2. **For the most part, teachers were detailed and specific in assignments related to classroom implementation.** For the assignment in which teachers considered where CPR2 would fit into their course of study, 12 teachers scored a 1 and 8 teachers scored a 2. Those who gave less detailed answers listed standards that were relevant but did not explicitly state where the CPR2 lessons fit into the standards. When asked to reflect on how their teaching went, nine teachers scored a 1 and 10 teachers scored a 2. Teachers who received a score of 1 often were not detailed or specific about what they needed to improve or what went well.
3. **Throughout the Summer Institute, teachers could successfully write general expressions.** On assignments asking teachers to write a general expression, most teachers scored a 2. See Appendix F for specific values under the general expression rubric.
4. **Teachers struggled slightly with making convincing arguments but showed some growth.** For most assignments requiring teachers to write convincing arguments, about half of the teachers scored a 0 or 1 in the beginning. Toward the middle, teachers hit their stride and followed similar formats in writing their convincing arguments, resulting in more than half of the teachers receiving a score of 2 on the assignment. At the beginning of Summer Institute 2021, teachers were asked to "write a convincing argument for the conjecture *every odd number greater than 1 can be written as the sum of 2 consecutive integers*." Only four teachers scored a 2. At the end of the Summer Institute, the same question was asked to teachers, and nine teachers scored a 2. See Table 2 for specific values.

Table 2. Teacher scores from the "Convincing Argument Rubric" at the beginning and end of Summer Institute 2021 for the assignment "write a convincing argument for the conjecture every odd number greater than 1 can be written as the sum of 2 consecutive integers."

Score	Day 2 Prework	Day 7, Response Sheet 12
0	6	6
1	9	4
2	4	9

Note: n = 19. One teacher did not submit a response for either assignment.

Fall 2021 Upcoming Activities

Fall 2021 In-Person Observations

Background: Part of the 2021 data collection activities included observations of CPR2 classroom instruction. There is a possibility that in-person treatment teacher observations of CPR2 lessons could occur in the 2021-2022 school year.

Design: Using Google Maps, we dropped a pin at each school that had at least one treatment teacher. Using Google's estimated time to travel between school sites, we color-coded the pins to group schools that were within driving distance from one another. Please see Appendix G for a screenshot of the map.

Options

Based on our mapping, there appears to be a cluster of schools around Huntsville and Montgomery that could be cost-effective for us to conduct in-person observations.

1. **There are six treatment teachers in or near Huntsville.** At two locations, there are two treatment teachers at each school. These schools are all within 30-45 minutes from each other, which makes it potentially possible to observe them in a single trip for a week.
2. **There are three treatment teachers in or near Montgomery.** The three schools are less than 30 minutes from each other, which makes the logistics of scheduling them for a week of observations easier than option 1.
3. **There are five treatment teachers scattered between Huntsville and Montgomery or near the two cities that potentially be observed if scheduling permits.** These schools are 1-2 hours away from another school near Huntsville or Montgomery. Depending on how many SRI researchers plan on conducting observations and teachers' scheduling, it may be possible to observe a couple teachers at some of the schools farther away from the cluster.

Appendix A: Student Assessment Piloting Results

Responses for Item #1 (multiple choice): "If *n* is any integer, which of the following expressions must be an odd integer?"

Responses	Overall %	Overall *n*
n+1	23.1%	18
2n	1.3%	1
2n+1	37.2%	29
3n	26.9%	21
3n+1	11.5%	9

Note: Overall *n* = 78.

Responses for Item #2 (multiple choice): "According to the pattern suggested by the four examples above, how many consecutive odd integers are required to give a sum of 144?"

1 + 3 = 4

1 + 3 + 5 = 9

1 + 3 + 5 + 7 = 16

Responses	Overall %	Overall *n*
9	9.0%	7
12	35.9%	28
15	24.4%	19
36	23.1%	18
72	7.7%	6

Note: Overall *n* = 78.

Responses for Item #3 (multiple choice): "If *n* represents an even number greater than 2, what is the next larger even number?"

Responses	Overall %	Overall *n*
$n + 1$	2.6%	2
$2n + 1$	20.5%	16
$2n$	21.8%	17
$n + 2$	37.2%	29
$n2$	17.9%	14

Note: Overall *n* = 78.

Responses for Item #4 (multiple choice): "Which of the following is always an odd integer?"

Responses	Overall	
	%	*n*
The product of two odd integers	34.6%	27
The product of two consecutive integers	16.7%	13
The sum of three even integers	10.3%	8
The sum of two odd integers	16.7%	13
The sum of three consecutive integers	21.8%	17

Note: Overall *n* = 78.

Responses for Item #5 (open response, bounded): "If the product of 6 integers is negative, at most how many of the integers can be negative?"

Responses	Overall	
	%	n
0	0.0%	0
1	3.8%	3
2	2.6%	2
3	19.2%	15
4	7.7%	6
5	30.8%	24
6	35.9%	28

Note: Overall *n* = 78.

Responses for Item #6 (multiple choice): "Which expression is the greatest when *n* is a negative number?"

Responses	Overall	
	%	*n*
$n - 2$	20.5%	16
$2n$	7.7%	6
$n2$	32.1%	25
$n/2$	23.1%	18
$2/n$	16.7%	13

Note: Overall *n* = 78.

Responses for Item #7 (multiple choice): "A car can seat *c* adults. A van can seat 4 more than twice as many adults as the car can. In terms of *c*, how many adults can the van seat?"

Responses	Overall %	Overall *n*
$c + 8$	12.8%	10
$c + 12$	14.1%	11
$2c - 4$	15.4%	12
$2c + 4$	46.2%	36
$4c + 2$	11.5%	9

Note: Overall *n* = 78.

Responses for Item #8 (multiple choice): "Each of the 18 students in Mr. Hall's class has *p* pencils. Which expression represents the total number of pencil's that Mr. Hall's class has?"

Responses	Overall %	Overall *n*
$18 + p$	25.6%	20
$18 - p$	5.1%	4
$18 * p$	51.3%	40
$18 / p$	17.9%	14

Note: Overall *n* = 78.

Responses for Item #9 (multiple choice):

□	△
4	9
5	11
6	13
7	15

Which rule describes the pattern shown in the table?

A. □ + 5 = △
B. □ + □ = △
C. □ + □ + 1 = △
D. □ + □ + 2 = △

Responses	Overall %	Overall *n*
A	35.9%	28
B	20.5%	16
C	39.7%	31
D	3.8%	3

Note: Overall *n* = 78.

Appendix B: Teacher Background Survey Responses

We received responses from all 20 treatment teachers and 17 out of 20 control teachers. One of the treatment teachers did not respond to all questions, which is why some answers have only n = 19 treatment teachers. For one question, one control teacher did not respond, which is why n = 16 for one question.

Responses for Question #1: "Number of years spent teaching…"

Variable		Overall	Treatment	Control
Any grade level and any subject	Max	37	37	32
	Mean	11.4	12.0	11.4
	Min	1	4	1
At current school	Max	30	30	30
	Mean	5.9	5.9	7.5
	Min	1	1	1
Math	Max	37	37	30
	Mean	10.4	10.8	10.8
	Min	1	1	1
Programming and/or computer science	Max	4	4	3
	Mean	0.4	0.5	0.2
	Min	0	0	0

Note: Overall *n* = 36, treatment *n* = 19, and control *n* = 17.

Responses for Question #2: "What is the highest level of education you've attained?"

Degree	Overall	Treatment	Control
Bachelor's degree	25%	26.3%	23.5%
Some courses past bachelor's degree	13.9%	10.5%	17.6%
Master's degree	52.8%	57.9%	52.9%
Ph.D. or other doctorate degree	5.6%	10.5%	0%
Other degree	2.8%	0%	5.9%

Note: Overall *n* = 36, treatment *n* = 19, and control *n* = 17. One respondent wrote "Educational Specialist" for "other."

Responses for Question #3: "What, if any, of the following additional certifications do you have?"

Certification	Overall	Treatment	Control
National Board	5	0	5
STEM Certificate	0	0	0
Other	9	5	4

Note: Overall responses *n* = 14, treatment *n* = 6, and control *n* = 8. Other responses include: AMSTI, Computer science thru code.org, online teaching, Google, math, currently working on NCTB, and ESL

Responses for Question #4: "Have you been awarded one or more bachelor's and/or graduate degrees in the following fields? (With regard to bachelor's degrees, count only areas in which you majored. Do not count endorsements or certificates.)"

Field	Overall	Treatment	Control
Education (general or subject specific)	29	15	6
Mathematics	18	10	8
Statistics	1	0	1
Computer Science	1	0	1
Engineering	2	1	1
Other	5	3	2

Note: Overall *n* = 37, treatment *n* = 20, and control *n* = 17. Other responses include: business administration - finance/accounting, economics and business, human development and family studies, accounting, and economic development.

Responses for Question #5: "If "Education" selected, what type of education degree do you have?"

Type of education degree	Overall	Treatment	Control
Elementary Education	8	5	3
Secondary Mathematics	16	9	7
Secondary Science	0	0	0
Other	5	1	4

Note: Overall *n* = 37, treatment *n* = 20, and control *n* = 17. Other responses include: interdisciplinary studies, middle level education, middle grades math/science, and continuing ed.

Responses to Question #6: "Have you received any type of professional development apart from this summer institute related to math during the last 12 months?"

Response	Overall	Treatment	Control
Yes	19	12	7
No	18	8	10

Note: Overall responses *n* = 37, treatment *n* = 20, control *n* = 17.

Responses to Question #7: "If yes, please select the format(s) of the professional development apart from this summer institute related to math during the last 12 months?"

Professional Development Format	Overall	Treatment	Control
I attended a professional development program/workshop.	16	11	5
I attended a national, state, or regional mathematics teacher association meeting.	2	2	0
I completed an online course/webinar.	17	12	5
I participated in a professional learning community/lesson study/teacher study group	3	3	0
I received assistance or feedback from a formally designated coach/mentor.	5	2	3
I took a formal course for college credit.	3	0	3
Other	1	1	0

Note: Overall responses *n* = 15, treatment *n* = 10, control *n* = 5. Other response: leadership

Responses to Question #8: "What is the total amount of time you've spent on professional development related to mathematics or mathematics teaching in the last 12 months?"

	Overall	Treatment	Control
Max	100	100	30
Mean	20.7	21.8	16.6
Min	3	6	3

Note: Overall responses *n* = 15, treatment *n* = 10, control *n* = 5.

Responses for Question #9: "Have you received any type of professional development apart from this summer institute related to math during the last 12 months?"

Response	Overall	Treatment	Control
Yes	3	2	1
No	34	18	16

Note: Overall responses *n* = 37, treatment *n* = 20, control *n* = 17.

Responses for Question #10: "If yes, please select the format(s) of the professional development apart from this summer institute related to computer science during the last 12 months?"

Professional Development Format	Overall	Treatment	Control
I attended a professional development program/workshop.	2	1	1
I attended a national, state, or regional computer science teacher association meeting.	1	1	0
I completed an online course/webinar.	2	1	1
I participated in a professional learning community/lesson study/teacher study group	1	1	0
I received assistance or feedback from a formally designated coach/mentor.	0	0	0
I took a formal course for college credit.	0	0	0
Other	0	0	0

Note: Overall responses *n* = 3, treatment *n* = 2, control *n* = 1.

Responses for Question #11: "What is the total amount of time you have spent on professional development related to computer science or computer science teaching in the last 12 months?"

	Overall	Treatment	Control
Max	90	90	5
Mean	31.7	47.5	5
Min	5	5	5

Note: Overall responses *n* = 3, treatment *n* = 2, control *n* = 1.

Responses for Question #12 (open-ended): "What did you hope to learn or achieve by signing up for CPR2?**"**

Reason	Overall	Treatment	Control
Methods for teaching generalization	1	1	0
How to incorporate math with computer science	13	7	6
Ways to increase student engagement in computer science and/or math	5	3	2
How to improve their own mathematical pedagogical practices	4	3	1
Programming	2	1	1
Other (general)	11	5	6

Note: Overall responses *n* = 36, treatment *n* = 20, control *n* = 16. Other (general) responses include: better ways to equip my students, I enjoy professional development, and new ways to teach.

Responses for Question #13: "What technology do you plan to have students use for CPR2 lessons?"

Technology	Treatment
Chromebook	17
Laptop	6
Tablet	5
Desktop	2

Note: All 20 treatment teachers responded to this question.

Responses for Question #14: "How do you plan for your students to access technology to engage in CPR2 lessons?"

Type of access	Treatment
With computers in my classroom that each student can use	6
With our school's 1:1 technology program, in which each student has his/her own school-supplied device	9
A computer cart that I share with other teachers	4
Unsure	1

Note: All 20 treatment teachers responded to this question.

Responses for Question #15: "After completing your undergraduate degree and prior to becoming a teacher, did you have a full-time job in a mathematics-related field (for example: accounting, engineering, computer programming)? If yes, please describe."

Response	Overall	Treatment	Control
Yes	4	1	3
No	33	19	14

Note: Overall responses *n* = 37, treatment *n* = 20, control *n* = 17. Previous mathematics-related field careers include: accountants and production engineer.

Responses for Question #16: "Do you participate in any informal STEM training or STEM activities (e.g. hobbies, citizen science, volunteer work)? If yes, please describe."

Response	Overall	Treatment	Control
Yes	23	13	10
No	14	7	7

Note: Overall responses *n* = 37, treatment *n* = 20, control *n* = 17. Some of these informal STEM training or STEM activities include: AMSTI, tutoring, TI Innovator workshop, teaching at STEM camps, and TECHFIT (a program where students learn to compute programs to create exercise games).

Appendix C: Daily Feedback Survey

Thank you for attending CPR2 Summer Institute 2020!

Please take a few moments to answer the following questions. Your responses will help us understand your experience with the Summer Institute and provide feedback on additional supports you may need to implement CPR2 in the classroom. Your responses are confidential. We will summarize the results and report them only in aggregate.

	To what extent do you agree with the following statements about today's session?					
	Does not apply	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1. The presenter(s) stated the goals of today's activities at the beginning of the session.						
2. If applicable, the presenter(s) met the stated goals of today's activities						
3. The presenter(s) demonstrated expertise in today's topic.						
4. The presenter(s) were well-prepared and organized.						
5. The presenter(s) effectively responded to participants' questions, comments, and learning needs?						
6. The presenter(s) maintained a safe and respectful environment.						
7. I am confident that I can implement the things I learned today in my classroom.						
8.I can envision what I learned today fitting into my teaching practice						
9. The materials from today's session were clear and user-friendly.						

10. What challenges do you anticipate in implementing CPR2 content you learned today (if any)?

11. Please provide feedback on the prework.

12. Please provide feedback on the homework.

13. Please describe what was challenging or new for you about today's session. Please explain.

14. Please describe any technical difficulties you had with today's session.

15. Please let us know what feedback or questions you have about today's session. What would you like to have seen more of/less of?

Appendix D: Summative Participant Feedback Survey

	To what extent do you agree with the following statements regarding the Summer Institute?					
	Does not apply	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1. I felt supported by instructors as I developed my understanding of the concepts addressed in the Summer Institute.						
2. My interactions with the other participants helped me understand how to apply the institute concepts in my teaching.						
3. The Summer Institute increased my understanding of computer programming (Python).						
4. The Summer Institute increased my comfort level with computer programming (Python).						
5. The Summer Institute increased my confidence in teaching computer programming (Python).						
6. The Summer Institute deepened my understanding of math generalization.						

	To what extent do you agree with the following statements regarding implementing CPR2 in your classroom?					
	Does not apply	**Strongly Disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
7. I am confident that I can implement CPR2 in my classroom after this Summer Institute.						
8. My school will expect me to use the information provided in this training to teach generalization.						
9. I feel more prepared to incorporate mathematical generalization into my teaching.						
10. I feel more prepared to facilitate student discussion about math generalization.						
11. I feel more prepared to facilitate student proof writing.						
12. I believe that the CPR2 lesson plans address the state math or CS standards for the grades I'm teaching.						

	To what extent do you expect any of the following challenges when you implement CPR2 in your classroom?				
	Not at all	Very little	To some extent	To a great extent	N/A
13. Lack of time to implement the activities					
14. Lack of support from administrators					
15. Insufficient technology access					
16. Challenges with debugging code					
17. Low student interest in the activities					
18. Lack of alignment to grade-level standards					

19. What other challenges do you anticipate in implementing CPR2 content you learned during the Summer Institute (if any)?

20. What were your expectations for CPR2? To what extent were they fulfilled?

21. What additional supports, resources, etc. do you need to successfully implement CPR2 content you learned during the Summer Institute?

Appendix E: Opportunities to Learn Rubric and Scores

Opportunities to Learn Rubric

	0 The assignment makes little or no attempt to address [topic].	1 The assignment could be interpreted to address [topic] and a response could potentially include [topic].	2 The assignment clearly addresses [topic], which is needed to provide an adequate response.
Facilitated learning or allowed teachers to show learning [or prior knowledge] of math generalization			
Facilitated learning or allowed teachers to show learning of programming			
Facilitated learning or allowed teachers to show learning of programming as a tool for generalization (beyond CPR2)			
Facilitated learning or allowed teachers to show learning of [classroom] implementation			
Facilitated learning or allowed teachers to show learning of student assessment			
Engaged teachers as students of the math and programming content, as though they are students themselves			
Facilitated learning or allowed teachers to show learning of effective [classroom] instruction			
Facilitated learning or allowed teachers to show learning of how to align with standards, assessment, curriculum, or pacing			

Opportunities to Learn Scores for Summer Institute 2021

	0 The assignment makes little or no attempt to address [topic].	1 The assignment could be interpreted to address [topic] and a response could potentially include [topic].	2 The assignment clearly addresses [topic], which is needed to provide an adequate response.
Facilitated learning or allowed teachers to show learning [or prior knowledge] of math generalization	21	4	17
Facilitated learning or allowed teachers to show learning of programming	13	9	20
Facilitated learning or allowed teachers to show learning of programming as a tool for generalization (beyond CPR2)	16	8	18
Facilitated learning or allowed teachers to show learning of [classroom] implementation	28	5	9
Facilitated learning or allowed teachers to show learning of student assessment	39	0	3
Engaged teachers as students of the math and programming content, as though they are students themselves	30	5	7
Facilitated learning or allowed teachers to show learning of effective [classroom] instruction	38	8	3
Facilitated learning or allowed teachers to show learning of how to align with standards, assessment, curriculum, or pacing	37	0	4

Appendix F: Summer Institute Teacher Assignment Rubric and Scores

Teacher Assignment Rubrics

	0 The answer makes little or no attempt to address [assignment] or is incorrect.	1 The answer makes some attempt to address [assignment] but is only partially correct or is incomplete.	2 The answer correctly addresses [assignment] and considers all aspects and parameters of [assignment].
Generalization			
Convincing Argument			
General Expression			
Course of Study			
Practice Teaching Reflection			

Teacher Assignment Scores

Rubric	0 The answer makes little or no attempt to address [assignment] or is incorrect.	1 The answer makes some attempt to address [assignment] but is only partially correct or is incomplete.	2 The answer correctly addresses [assignment] and considers all aspects and parameters of [assignment].	Missing The answer was not submitted
Generalization	9	5	6	0
Convincing Argument	27	40	69	4
General Expression	1	11	45	3
Course of Study	0	8	12	0
Practice Teaching Reflection	1	10	9	0

Appendix G: Treatment Teachers' Schools Map

[Removed from public posting of the document for participant privacy.]