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# A Comprehensive Professional Development Program for K-8 Teachers to Teach Computer Science

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# A Comprehensive Professional Development Program for K-8 Teachers to Teach Computer Science

## 1. Introduction

The Adapt, Implement, and Research at Nebraska (AIR@NE) project, funded by the NSF CSforAll Researcher-Practitioner Partnership (RPP) program, examines the adaptation of a validated K-8 Computer Science (CS) curriculum in diverse school districts statewide. Our Research-Practitioner Partnership is primarily between the University of Nebraska-Lincoln, the Lincoln Public Schools, and other diverse school districts across Nebraska. Our primary goal is to study and document how different districts, including rural, predominantly minority, and Native American reservation, adopt the curriculum and broaden participation in CS. In addition, the project is developing instructional capacity for K-8 CS education with diverse learners. Our research also adapts and develops teacher and student CS assessments, and documents case studies using design-based research methodology to show how an adaptive curriculum broadens CS participation.

Our Professional Development (PD) program for K-8 CS teachers is comprehensive. It consists of three summer courses for each cohort and a series of workshops during the academic year. Of the three summer courses, two are administered in the first year for a cohort: (1) an introduction to computer science course where teachers learn fundamental CS topics and programming in a high-level programming language (e.g., Python), and engage in problem solving and practice computational thinking, and (2) a course in pedagogy for teachers to learn how to teach K-8 CS, including lesson designs, use of instructional resources such as dot-and-dash robots, and assessments. Then, the following academic year after the summer, the PD program holds a series of workshops on five separate Saturdays to support teacher implementation of their lesson modules during the academic year, reflect and improve on their lessons, reinforce on CS concepts and pedagogy techniques, review and adopt alternative instructional resources, and share insights. These Saturday workshops also facilitate further community building and resource sharing. The third course occurs in the second year for a cohort, involving dissemination of research results from the team to the teachers, opportunities to discuss new resources and approaches on teaching CS concepts and computational thinking, and sharing of experiences and insights after teachers have completed one academic year of teaching CS. Unlike the first two courses that are required of teachers, this third course is an opt-in course that combines more in- depth pedagogy and elements of leadership. Thus far, we have had two cohorts and used the design methodology to revise our PD program, making our design more robust based on the lessons learned over the two years. The course materials, assessment, and survey instruments have also been improved.

While the project is on-going we have data that indicates the impact of the work so far. There were significant pre-post gains for both cohorts in teachers' knowledge of computer science concepts and computational thinking. Scores on the computational thinking assessment were higher than those for CS concepts, which was to be expected given their CS teaching experience. Moreover, in both cohorts, the teachers' confidence in teaching CS improved significantly.

## 2. Description of Professional Development Program: Two Cohorts

Our Professional Development (PD) program for K-8 teachers to teach CS consists of two parts. The first part involves two courses across two weeks in the summer, whereas the second part consists of five Saturday workshops during the academic year. Due to interruptions caused by the Covid-19 pandemic, the designs of our PD program were different for our two cohorts.

### 2.1. Cohort 1: Summer 2019 – Spring 2020

#### 2.1.1. Course 1

In the summer, the first-week course covered Computer Science (CS) and Computational Thinking (CT) topics. The schedule can be found below in Figure 1. The course was taught by a professor from a Midwestern university and a team of four teaching assistants (TAs): one graduate and three undergraduates. All activities, assignments, and announcements were available for the teachers via the online learning tool, Canvas.

The teachers had homework assignments related to the content taught each day. The homework was assigned at the end of each day and was due at midnight on the same day. There was no assignment on the last day to allow time to finish the final project before the start of the second course. The first three homework assignments included an additional extra credit assignment, which extended the original assignment. These assignments allowed the teachers to experience the struggles their students will go through while working with technology and show them the importance of resilience while working with CS (Sentance and Csizmadia, 2017). There was a cumulative exam on the last day consisting of CS and CT knowledge tests. This exam was taken by 29 teachers pre-program and by all 44 teachers on the last day of the first course. This made it possible to measure the 29 teachers' change in CS and CT content knowledge.

There were also three group activities based on Computational Creativity Exercises (CCE), designed to develop the teachers' CT skills through collaboration (Peteranetz et al. 2018). These exercises are akin to "CS Unplugged" exercises for open-ended problem solving using computational thinking and creative thinking skills (Miller et al. 2019). Yadav et al. highlighted the importance of providing the teachers with CT concepts instruction in CS PD (Yadav et al. 2014).

Furthermore, the instructor demonstrated how to teach each CS concept with examples and active learning (e.g., computational thinking with CS unplugged activities, loops with image processing examples, recursion with Towers of Hanoi example, etc.) and these are considered best practices of teaching these concepts. These demonstrations combined with the CS training are regarded as the most important pieces of K-12 CS PD (Sentance and Humphreys, 2015).

Lastly, a final group project was assigned that allowed teachers to pick one CS topic and one CT topic and create a lesson for their respective grade levels. The lessons were then presented in small groups which included at least one member of the instruction team and one other teacher

group. As part of the final project and after the presentations were delivered, the teachers individually created assignments to go along with their lesson plans.

<table>
<tr><th></th><th>Monday</th><th>Tuesday</th><th>Wednesday</th><th>Thursday</th><th>Friday</th></tr>
<tr><td rowspan="5">Morning</td><td>Introduction</td><td>Homework 1 Discussion</td><td>Homework 2 Discussion</td><td>Homework 3 Discussion</td><td>Homework 4 Discussion</td></tr>
<tr><td>Team Building</td><td rowspan="3">Arrays (1D, 2D)/Loops</td><td rowspan="3">Functions</td><td rowspan="3">Search/Sort</td><td rowspan="3">Recap</td></tr>
<tr><td>Computional Thinking</td></tr>
<tr><td>Python Instruction/Install</td></tr>
<tr><td>Variables, Simple I/O, Data Structures</td><td>Arrays (1D, 2D)/Loops</td><td>Teaching and Learning Assignment Assigned</td><td>Search/Sort</td><td>Tests (1.5 hours allowed)</td></tr>
<tr><td>Lunch</td><td>Lunch</td><td>Lunch</td><td>Lunch</td><td>Lunch</td><td>Lunch</td></tr>
<tr><td rowspan="4">Afternoon</td><td rowspan="3">Selection</td><td>Search</td><td>Functions/Recursion</td><td>Search/Sort</td><td>Teaching and Learning Assignment Worktime</td></tr>
<tr><td>Everyday Object CCE</td><td>Storytelling CCE</td><td>Pathfinding CCE</td><td rowspan="2">Teaching and Learning Assignment Presentations</td></tr>
<tr><td>Search</td><td>Functions/Recursion</td><td>Teaching and Learning Assignment Worktime</td></tr>
<tr><td>Homework 1 Assigned</td><td>Homework 2 Assigned</td><td>Homework 3 Assigned</td><td>Homework 4 Assigned</td><td>Final Project Assigned</td></tr>
</table>

Figure 1. Summer PD program's first-week CS/CT content course schedule.

### 2.1.2. Course 2

The second-week course was held at a local school district conference center. The course was taught by four different CS teachers—a college professor, a high school teacher, a middle school teacher, and an elementary school teacher. Presentations were arranged so each instructor had a chance to talk about teaching the concepts of loops, variables, conditionals, and functions at their respective grade level, allowing teachers to understand curricular progressions across the K-12 grade span.

An outline of the course schedule can be found below in Figure 2. Daily reflections were completed online at the end of each day and were graded for completion. Teachers were also divided into grade-level groups and were tasked with presenting a lesson they would deliver to their respective grade-level. The final assignment was an individual implementation plan that required the teachers to explain how they would be integrating CS into their curriculum in the following academic year.

### 2.1.3. Saturday Workshops

The project included five half-day workshops held on Saturdays across the academic year. The purpose of these workshops was to support participants in enacting the CS they learned in the

| | Monday | Tuesday | Wednesday | Thursday | Friday |
|---|---|---|---|---|---|
| Morning | Goals | Standards | Pedagogy | Classroom Management | Differentiation/CS4ALL |
| | Pedagogy | Teaching Robotics | Teaching Robotics | Group Lessons | Group Lessons |
| Lunch | Lunch | Lunch | Lunch | Lunch | Lunch |
| Afternoon | Concept: Loops | Concept: Variables | Concept: Conditionals | Concept: Functions | Implementation Planning |
| | Standards & Extracurriculars | TED Talk | Assessment | Lib Guides | Closing Survey |

Figure 2. Summer PD program second-week CS pedagogy course schedule.

summer, as well as to return to major CS topics (e.g., conditionals, flowcharts, variables, event-driven programming, etc.). An explicit focus of the activities was on K-8 curriculum and ways the CS concepts can be enacted with students via plugged and unplugged lessons. The curriculum focus also included numerous discussions about how to adapt provided curriculum to make it appropriate for students with varied background experiences. During the last two Saturdays for Cohort 1 (March/April 2020) and then for all of Cohort 2's Saturdays (fall 2020/spring 2021) an additional focus became discussing how to enact CS lessons in remote learning environments, including asynchronously. Initially workshops were held in person, before COVID-19 pandemic required shifting to the online Zoom conferencing platform. The workshops were designed to be very interactive and discussion-based, with only short presentations by instructors (including slides with helpful links that were shared with participants).

### 2.2. Cohort 2

The PD program was held on two consecutive weeks in June 2020 and ran daily from 8:00 a.m. to roughly 5:00 p.m. Due to the COVID-19 virus and social distancing guidelines, the program was taught online via Zoom video conferencing technology. The instructor used one camera to show his face and one camera to share slides, code, examples, document cameras, and teaching aids. Zoom breakout rooms were used heavily to facilitate group activities. Similarly, we also have in place five Saturday workshops across the academic year. Due to changes caused by the pandemic, these workshops have been held online, as discussed earlier in Section 2.1.3 above, with similar topics to those for Cohort 1, with additional topics on remote learning.

#### 2.2.1. Course 1

The program structure covered CS concepts using JavaScript in the morning session and CS pedagogy in the afternoon session. This section will focus on the morning, CS content session, corresponding to Course 1 as described earlier in Section 2.1.2. The schedule for the morning can be found below in Figures 3 and 4. The morning session was taught by a local high school teacher, a team of three teaching assistants (TAs): one graduate and two undergraduates, and two top-performing teachers from the previous cohort. All activities, assignments, and announcements were available for the teachers via the online learning tool, Canvas.

| | | | | | |
|---|---|---|---|---|---|
| **Morning Course Topic** | Basic Syntax, Variables | Functions | Conditionals | Loops | Flow Charts |
| **Afternoon "Plan"** | | Hour of addressing morning content - Elementary & Middle Functions | Hour of addressing morning content - Elementary & Middle Conditionals | Hour of addressing morning content - Elementary & Middle Loops | CSTA Standards |
| | 6/8 | 6/9 | 6/10 | 6/11 | 6/12 |
| | **MONDAY** | **TUESDAY** | **WEDNESDAY** | **THURSDAY** | **FRIDAY** |
| **8:00 AM** | Introductions. Get-to-know-you activity. | Morning welcome activity. | Morning welcome activity & Quiz #1. | Morning welcome activity. | Morning welcome activity & Quiz #2. |
| **8:30 AM** | Introducing JSFiddle. Basics of HTML, CSS, JS. | Condensing code with functions. Function inputs. | Conditionals discussion: fortune teller Google Form. if, else, else if distinctions | While | Basics of flow charts |
| **9:00 AM** | Printing ("HelloWorld"). Creating Variables. | Generating output with functions. | If, elseif, else Practice | Practice | "Formal" flow charts |
| **9:30 AM** | Getting input and storing it. | Variable scope. | Logical Operators | For | Making a program from a flow chart. |
| **10:00 AM** | Operators. Arithmetic, comparison, boolean, increment. (Printing outputs of operations) | Built-in functions: String functions | Practice in groups | Break | Making a program from a flow chart. |
| **10:30 AM** | Resource: w3Schools https://www.w3schools.com/js/ | More String functions, explore W3Schools | Logical pathways within a function (ensuring return). Ternary Operator | Continue | Making a flow chart. |
| **11:00 AM** | Built in Math constants and functions. Random. | Parsing | Practice in groups | Practice activities | Making a flow chart and programming. |
| **11:30 AM** | Practice in groups | Practice in groups | Practice in groups | Practice in groups | Practice in groups |
| | | | | | |
| **Assignment:** | Math calculations | Functions Tasks | Leap Year/Fortune Teller | Palindrome/Primes | SecretMessage |

Figure 3. Cohort 2 Summer PD program's CS/CT content morning course schedule – Week 1.

| | Lists, Objects | Recursion | Sorting | Basics in a second language | Project/Test |
|---|---|---|---|---|---|
| | Pair programming in the classroom | Differentiation and assessment - CS4All | Project based learning | | |
| | 6/15 | 6/16 | 6/17 | 6/18 | 6/19 |
| | **MONDAY** | **TUESDAY** | **WEDNESDAY** | **THURSDAY** | **FRIDAY** |
| **8:00 AM** | Morning welcome activity & Quiz #3 | Morning welcome activity. | Morning welcome activity & Quiz #4 | Morning welcome activity. | Morning welcome activity & Quiz #5 |
| **8:30 AM** | Simple Arrays. Indexing. | Basics of recursive algorithms, stop condition | Sorting algorithms introduction: overview - https://www.toptal.com/developers/sorting- | Discuss other languages. https://www.tutorialspoint.com/codingground.ht | Research Survey |
| **9:00 AM** | String Split, Array functions | Fibonacci, Factorials | Writing an insertion sort. | Programming language exploration in pairs - pick a language and learn about it. Write a loop to | Research Survey |
| **9:30 AM** | Iterative Algorithms | Memory load of inefficient recursive algorithms. | Writing a selection sort. | Work time. | Break / Recap of two weeks' content. |
| **10:00 AM** | Enhanced for loops | Tower of Hanoi | Discuss bubble sort. | Present to the rest of the group. | Recap of two weeks' content. |
| **10:30 AM** | JavaScript Objects | Discuss merge sort. | Discuss quick sort. | Finish presentations. | Post-exam |
| **11:00 AM** | More enhanced for loops. | Interpret a recursive program to identify its function (Euclidean algorithm for GCD.) | Algorithm efficiency. | Regular Expressions, if time. | Post-exam |
| **11:30 AM** | Practice in groups | Practice in groups | Practice in groups | Regular Expressions, if time. | Post-exam |
| | | | | | |
| **Assignment:** | Register | Palindrome2 | Alphabetize | Text Analysis | Final Project |

Figure 4. Cohort 2 Summer PD program's CS/CT content morning course schedule – Week 2.

The teachers had homework assignments related to the content taught each day. The homework was assigned at the end of each morning and was due at midnight on the same day. Each homework assignment contained an extension that was optional but was put in place for the advanced teachers to challenge themselves. There was a cumulative exam on the last day consisting of CS and CT knowledge tests. This exam was taken by all 24 teachers pre-program and on the last day of the first course. The pre- and post-test made it possible to measure all 24 teachers' change in CS and CT content knowledge.

The morning session typically consisted of 15-30-minute lectures followed by 10-15-minute group problem solving activities. An example of one group activity (breakout session) from our Day 6 lecture on arrays can be found in Figure 5. Four CS content quizzes were administered throughout the program to help the instructors understand the teachers' understanding of past concepts as the program progressed. Additionally, a final group project was assigned that

required teachers to create a hangman game. The project was put in place to allow the teachers to take something away from the class that they can show family members, friends, and their classrooms and inspire them to explore computer science further by adding components to their game.

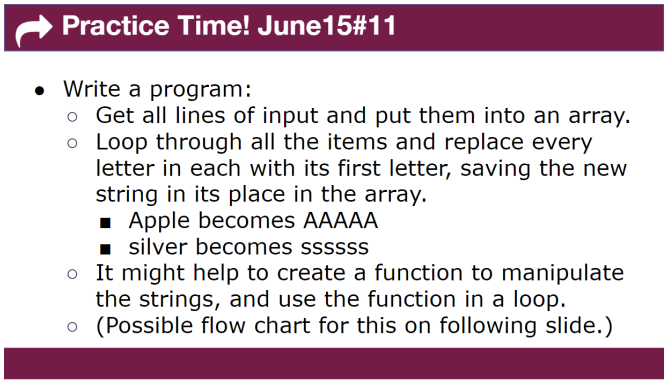


Figure 5. Cohort 2 Summer PD program Day 6 breakout session example.

### 2.2.2. Course 2

This section will focus on the afternoon pedagogy session. The course was co-taught by six different CS teachers – three high school teachers, two middle school teachers, and an elementary school teacher. During the first week of the program, the lecture concentrated on a single CS concept and the CS concept aligned with the content taught during the morning CS concepts session. The purpose of the lectures was to show the teachers how to teach the concept to their respective grade levels. Therefore, the elementary, middle, and high school level instructors each discussed the concept and how it can be presented in their grade levels classrooms. During the second week, the focus shifts more towards robotics and tools the teachers will be able to use in their classrooms. Teachers were also divided into grade-level specific groups and were tasked with creating and presenting a lesson plan for their respective grade-level to the rest of the class. The final assignment was an extension of the lesson plan they presented. The final assignment asked the teachers to write-up an implementation plan with lesson samples, demographics of their schools, and some reflections.

An outline of the course schedule can be found below in Figures 6 and 7. Daily reflections were completed online at the end of each day and were graded for completion.

| Morning Course Topic | Basic Syntax, Variables | Functions | Conditionals | Loops | Flow Charts |
|---|---|---|---|---|---|

| Susan | Alan | Valerie | Kyleigh | Dan | Patrick |
|---|---|---|---|---|---|
| | 6/8 | 6/9 | 6/10 | 6/11 | 6/12 |
| | **MONDAY** | **TUESDAY** | **WEDNESDAY** | **THURSDAY** | **FRIDAY** |
| **1:00 PM** | Computational Thinking Activity: Overview - Digital Breakout | Computational Thinking Activity: What's The Rule? | Computational Thinking Activity: Picture This! | Cohort 1 Panel - Patti, Olivia, Bethany | Computational Thinking Culminating Activity |
| **1:30 PM** | Debrief on Digital Breakout. Overview of afternoon course. | Small group discussion - CT Activities/Strategies | Small group discussion - CT Activities/Strategies | Cohort 1 Panel - Valerie, Patrick, (Matt, Lisa?) | Small group discussion - CT Activities/Strategies |
| **2:00 PM** | Content in the Classroom: Variables (Elementary) **Break at the end** | **Break** | **Break** | **Break** | **Break** |
| **2:30 PM** | Content in the Classroom: Variables (Middle & High) | Content in the Classroom: Functions (Elementary) | Content in the Classroom: Conditionals (Elementary) | Content in the Classroom: Loops (Elementary) | Content in the Classroom: Flow Charts (all levels) |
| **3:00 PM** | Grant details (Gwen/Wendy) | Content in the Classroom: Functions (Middle & High) | Content in the Classroom: Conditionals (Middle & High) | Content in the Classroom: Loops (Middle & High) | Building a successful CS program from the ground up - Multiple examples |
| **3:30 PM** | | | | | |
| **4:00 PM** | Independent Learning Time | Independent Learning Time | Independent Learning Time | Independent Learning Time | Independent Learning Time |
| **4:30 PM** | | | | | |
| **Assignment:** | Personal Learning Goal, Talk about experience level, Reflection on Variables | Reflection on Functions | Reflection on Conditionals | Reflection on Loops | Reflection on Flow Charts & the week overall |

Figure 6. Cohort 2 Summer PD program's CS pedagogy content afternoon course schedule – Week 1.

| Morning Course Topic | Lists | Recursion | Sorting | Basics in a second language | Project/Test |
|---|---|---|---|---|---|

| Susan | Alan | Valerie | Kyleigh | Dan | Patrick |
|---|---|---|---|---|---|
| | 6/15 | 6/16 | 6/17 | 6/18 | 6/19 |
| | MONDAY | TUESDAY | WEDNESDAY | THURSDAY | FRIDAY |
| 1:00 PM | Ozobot Introduction | Dash or Cue Introduction (split elem and middle) | Other Robot Options- Patrick and Susan and ?? | High School Robotics Class | What to do going forward? |
| 1:30 PM | Ozobot Lessons for the Classroom | Dash or Cue Lessons for the Classroom | CS4All & CSTA discussion | Group 1 Lesson | Group 5 Lesson |
| 2:00 PM | Break | Break | Break | Break | Break |
| 2:30 PM | Content in the Classroom: Lists | Content in the Classroom: Recursion | Content in the Classroom: Sorting | Group 2 Lesson | Group 6 Lesson |
| 3:00 PM | CS Teaching Strategies (Pair Programming, etc.) | Differentiation & Assessment | Project based learning | Group 3 Lesson | Group 7 Lesson |
| 3:30 PM | | | | Group 4 Lesson | Group 8 Lesson |
| 4:00 PM | Independent Learning Time and Group Planning Time | Independent Learning Time and Group Planning Time | Independent Learning Time and Group Planning Time | Independent Learning Time | Independent Learning Time |
| 4:30 PM | | | | | |
| Assignment: | Reflection on Lists & Pair Programming | Reflection on Recursion & Differentiation/Assessment | Reflection on Sorting/Project based learning | | |

Figure 7. Cohort 2 Summer PD program's CS pedagogy content afternoon course schedule – Week 2.

## 3. Impact of PD Programs

### 3.1. Cohort 1

An extensive project evaluation was conducted by an outside evaluator using qualitative and quantitative data collection and analysis methods with the purpose of yielding evidence of the impact of our PD program. An end-of-course survey asked participants to rate the course on various characteristics and the degree to which participants would be able to apply what they learned in their own institutional context. In addition, there were two focus groups, conducted during the second week of the summer institute, which focused on how teachers became involved in the project, perceptions on value and utility of what they were learning, key learning of content and pedagogy, confidence and comfort in teaching CS to students, and how the project was leveraging their community and school efforts to teach CS.

End of course evaluation results showed increases in knowledge from the beginning of each course to the end of the course; there were increases for each statement. Figure 8 shows results for the computer science content course; Figure 9 for the pedagogy course.

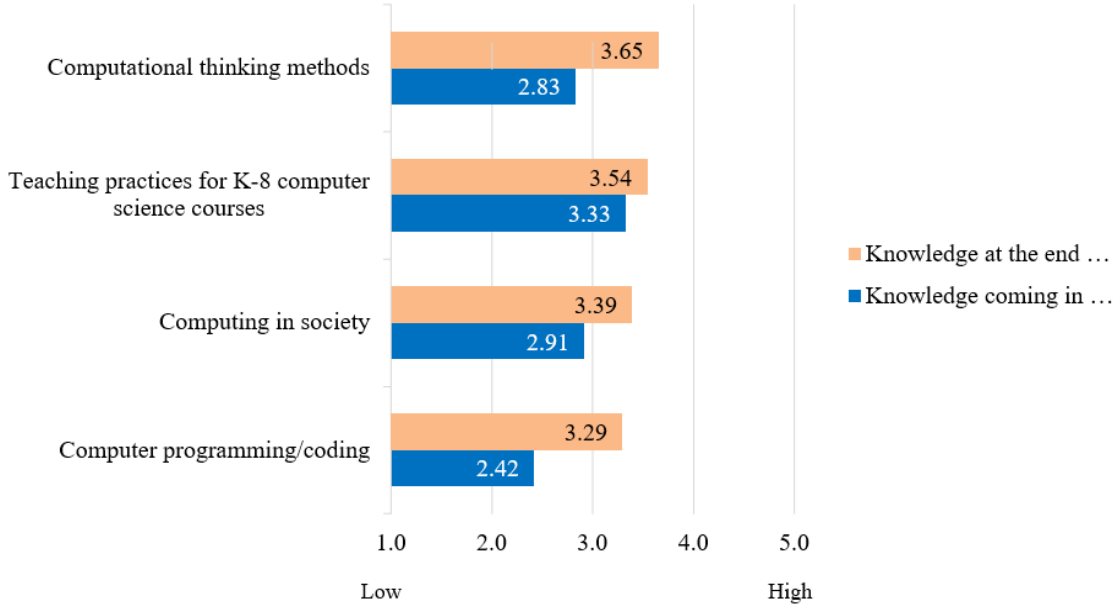


Figure 8: CS Content Course Mean Knowledge Rating (N = 24)

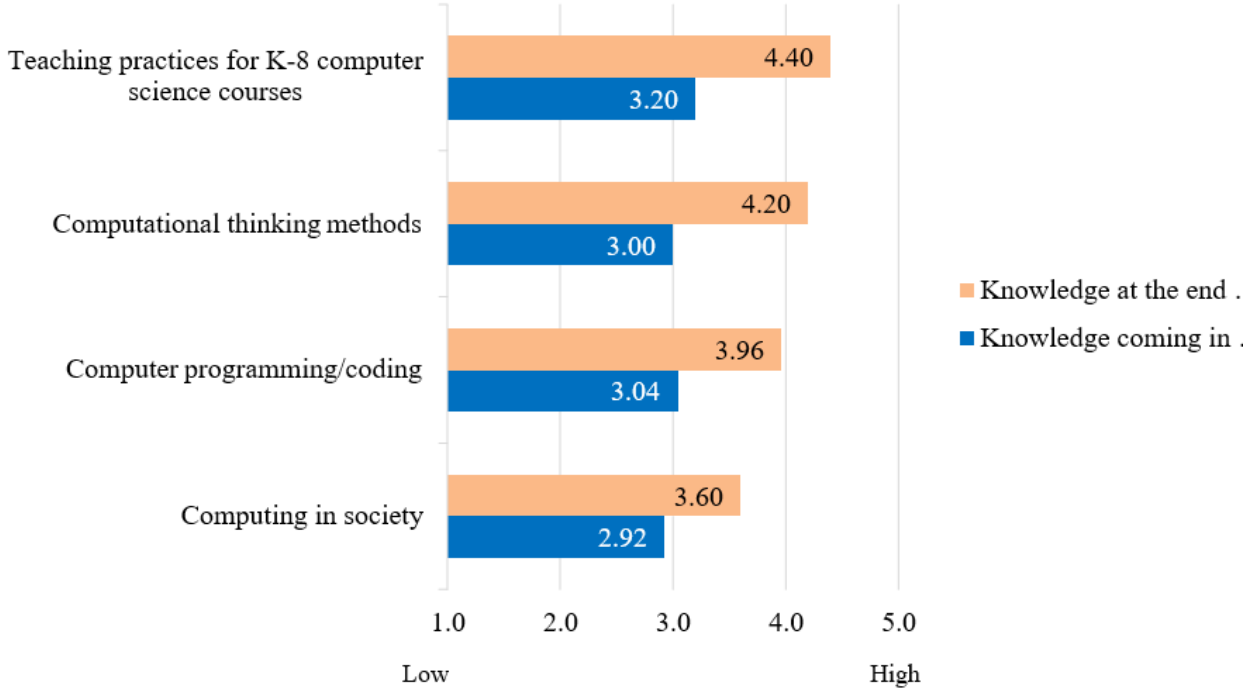


Figure 9. CS Pedagogy Mean Knowledge Ratings (N = 24)

### 3.1.1. Participant Focus Groups

Two focus groups of seven participants each were conducted to allow participants to reflect over both courses. For many teachers, this set of courses were their first exposure to CS concepts and pedagogy. Respondents identified this combination of courses as tremendous opportunities to learn what to teach about CS and where, how to teach CS, and what computational thinking looks like. For those already familiar with CS concepts and pedagogy, being able to gain insights into the K-12 scope and sequence and becoming familiar with how others are teaching CS concepts at different grade levels was extremely beneficial. The courses enhanced their own understanding of how to adapt lessons by experiencing how each of the instructors at different grade levels was illuminating different concepts and skills at grade level and allowed teachers to think more about their own classrooms or teaching situations.

When asked how prepared they felt teaching computer science to their students, respondents indicated they were learning the language of CS along with new concepts and skills, which helped them feel more prepared to teach computer science to their students. Being able to see, touch, and engage with new tools and ideas helped participants to feel energized about teaching computer science. For many, having a better sense of where to start, and how to progress across grade levels helped them feel better prepared, especially for teachers in situations where they are the only one responsible for teaching computer science in their school. Many felt, as a result of participating in our PD program, they now had enough information to (a) ask more and better questions and have conversations in their schools; (b) better infuse things into their own CS curriculum; and (c) help others better understand the need for technology and computer science.

## 3.2. Cohort 2

Similar to procedures for Cohort 1, Cohort 2 teachers completed a comprehensive end-of-course evaluation. Quantitative results are shown below in Figure 10. In addition to the more quantitative ratings, open-ended questions probed individual reflections. Respondents were appreciative of the opportunities to work with colleagues in small groups with the assistance and guidance of group facilitators along with the help provided for them outside of class time. Respondents indicated they were not given answers to their questions, but rather were encouraged to work collaboratively to find the answers, with appropriate and timely guidance provided at opportune moments. Many respondents appreciated how the learning environment helped them to feel what their students would feel and how to manage productive struggle for themselves and their students. There was no question the respondents felt challenged, but also proud of being able to do something they had never done before. Finally, being able to work with people from different schools and districts helped to form a community of practitioners that will be there long after the summer institute. Respondents hoped their participation would allow them to better meet student needs by providing a coordinated CS curriculum within their school. Many indicated they hoped to be able to use lessons in their own classrooms to help their students improve their problem solving and algorithmic thinking processes. Many hoped they can impact their school and district positively and share what they learned with fellow teachers so CS can be incorporated into their general curriculum.

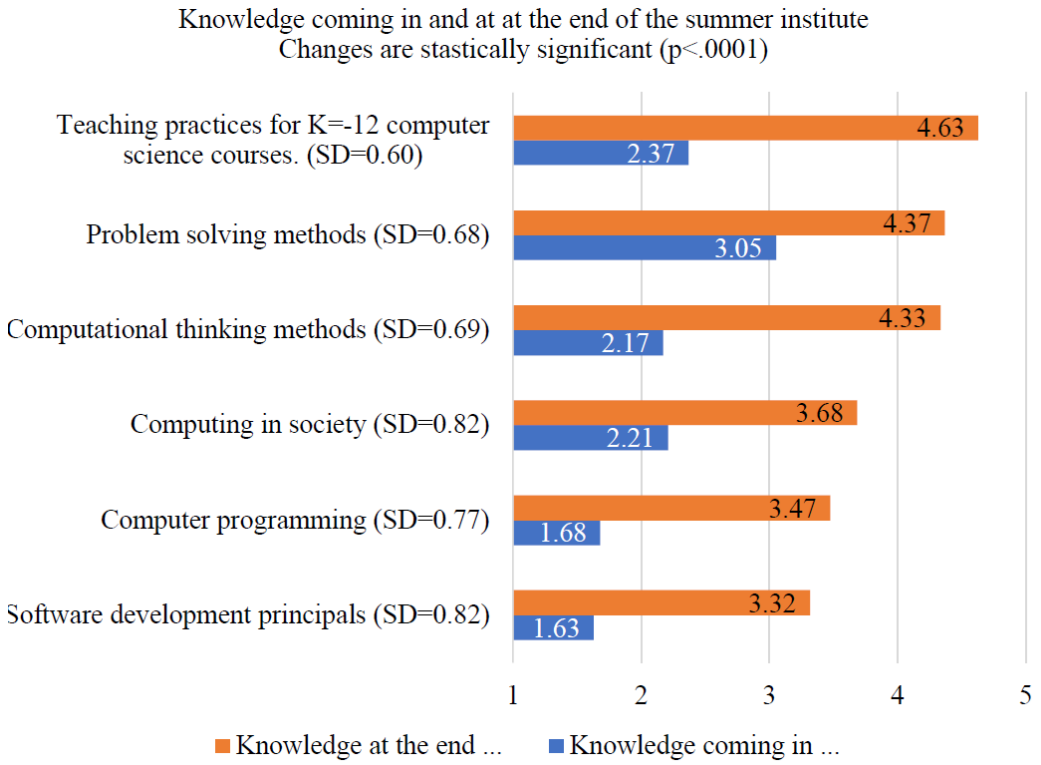


Figure 10. End of Course Evaluation for Cohort 2 (N = 19)

In general, evaluation results for Cohort 2 showed that being able to see, access, and become familiar with the CS curriculum that Lincoln Public Schools (LPS) uses was a wonderful addition to their learning. Respondents indicated that while they may need to make some adaptations to fit their own school requirements and time constraints, the shared curriculum materials give a lot of guidance and ideas so respondents felt they were better prepared to "hit the ground running." When asked about their confidence and ability to improve student outcomes in CS, respondents were in complete agreement that their confidence and ability have grown beyond their expectations. They were pleased to share they now felt better prepared and capable of bringing CS into their schools and classrooms in Fall 2020, working with other teachers and using plugged and unplugged activities that will make CS come alive for their students. They identified how they learned different ways to explain topics and concepts and gained so many strategies to help their students be successful in CS.

### 3.3. Saturday Workshops

Participants in the Saturday workshops that took place in November (2019), January (2020) and April (2020) were asked to complete an evaluation survey with both scaled and open-ended questions. Participants rated their level of agreement on a 5-point scale from "strongly disagree" to "strongly agree." Overall, participants had a positive perspective of the Saturday workshops as shown in Figure 11.

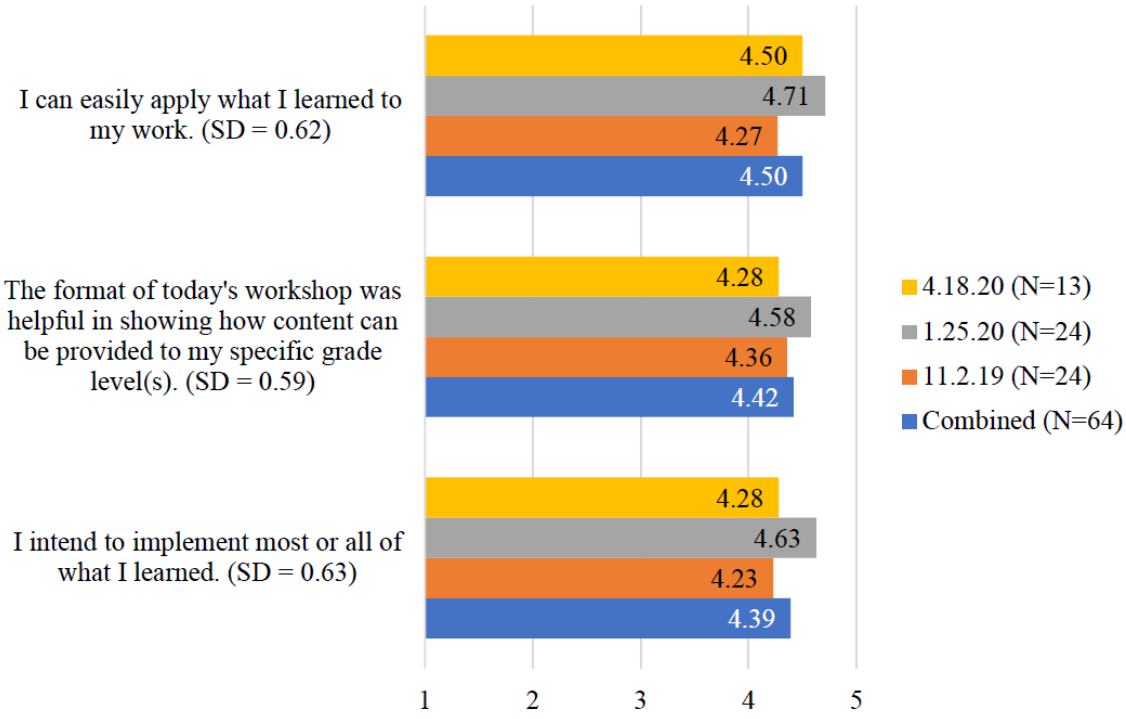


Figure 11. Results of Saturday Workshops

## 4. Conclusions

In this paper, we have described our Professional Development (PD) program for two cohorts of K-8 computer science teachers. The PD program consists of two summer courses and five Saturday workshops during the following academic year. We have analyzed the impact of the PD program on the two cohorts qualitatively. The results are encouraging. There were statistically significant improvements in knowledge attainment in terms of both computer science concepts and pedagogy. We also observed that in our focus groups, teachers had more confidence in CS and CS instruction, and had enough information to also revise their own CS curriculum and help others to understand the need for technology and CS.

Our on-going work includes more comprehensive analysis of teachers' performance and investigations into how teachers from different school districts (e.g., urban vs. rural) learn and perform differently if at all, as well as recruitment and development of Cohort 3. There will also be revision of our PD program in terms of the design of our courses and Saturday workshops based on feedback from the teachers. There will also be efforts in facilitating and sustaining a community of practice for the teachers.

## Acknowledgements

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