Empowering Out-of-School-Time Educators: A Computer Science Professional Development Toolkit Pilot Study

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Executive Summary

Click2Science PD (C2S) offers a variety of resources designed to support "skills that staff and volunteers need to facilitate high-quality STEM programming" (Click2SciencePD, n.d.). As the field of Out of School Time (OST) Science, Technology, Engineering, and Math (STEM) education grows, so must the resources offered by C2S must grow. With the increase in interest and attention on Computer Science (CS) within the OST field, frontline staff and volunteers require professional development (PD) surrounding skills that enable them to facilitate high quality CS activities. C2S developed a suit of resources included in a CS Toolkit to help provided such PD.

The current evaluation focuses on piloting these new resources in four different states (Alabama, Pennsylvania, Virginia, and West Virginia). Several trainers from each state participated in a Train-the-Trainer program where they learned to use the recourses in the Spring of 2019. From Spring to Summer of 2019, each state was to train 100 frontline staff, teachers, and volunteers using the C2S CS Toolkit resources. Once the trainings were complete, user feedback was collected from both the trainers and the trainees via focus groups/interviews, lesson plans, and self-confidence surveys.

Overall trainer feedback on the C2S CS toolkit resources was positive. They loved the videos and thought the resources were satisfactory. Trainers that had more experience teaching seemed to be more willing and had an easier times making adaptions and modifications to the PD, while trainers with less teaching experience frequently requested more supplemental materials that would make it easier for them to deliver the PD (e.g. PowerPoints, answer keys, etc.). All trainers requested more guided tinkering time and instruction on the actual CS activities that were included in the training than the initial train-the-trainer program provided.

Similar to the feedback provided by the trainers, the feedback provided by the trainees was overwhelmingly positive. Participants benefitted from a statistically significant average positive increase in

self-confidence levels concerning all the facilitation skills targeted by the CS Toolkit resources. Many of the trainees reported that they were excited to use their new skills as well as to teach them to their peers.

The data collected to evaluate the piloted C2S Computer Science PD Toolkit shows that these resources can make a positive impact on the perceptions of frontline staff and volunteers. Because of the scope of the current project, including time constraints, only information on trainer and trainee perceptions were feasible to be assessed. Although this evidence is promising, further research needs to be conducted to determine to what extent the resources make on the ability and practices of frontline staff and volunteers.

Section I: Trainer Feedback

The first component of the pilot evaluation of the C2S Computer Science PD Toolkit was to collect feedback from the trainers. Trainer feedback sources include focus groups and interviews, as well as trainer lesson plan document analysis.

Methodology

Participants

During the pilot, there were 19 trainers that attended the train-the-trainer program. The trainers were from four participating states (Alabama, Pennsylvania, Virginia, and West Virginia). The train-the-trainer program was a virtual meeting led by a C2S staff member to inform the trainers about the Computer Science PD Toolkit resources and how to use the PD resources with frontline staff and volunteers. Four interviews/focus groups were conducted with 42% (8) of the trainers. Twelve lesson plans from PD led by the trainers were provided by 10 of the 19 trainers.

Focus Group/Interview Procedures

Trainers were emailed asking for their participation in a virtual focus group via Zoom (an internet platform that was used during the train-the-trainers meeting). Trainers who responded to the email request were placed into a focus group or interview based on their availability. The interviews and focus groups lasted between 30 to 45 minutes and were recorded and transcribed for later analysis. The interviews and focus groups were semi-structured, following a list of questions and probes, but allowing a conversational flow to occur between the interviewer(s) and participant(s).

Interview/Focus Group Goals

The goals for this portion of the evaluation were to: (a) collect descriptive information about how PD resources were used, and (b) identify any challenges in administering the C2S Computer Science Toolkit resources.

Lesson Plan Document Review Procedures

All the trainers that participated in the Computer Science Toolkit Trainer Institute were provided with a survey link that enabled them to submit their lesson plan from the PD they led. The survey asked several questions about how the PD was held (i.e. virtually or in-person), as well as any adaptions and/or modifications they made to the resources. A link was provided for them to upload a copy of their lesson plans, if they chose to do so.

Lesson Plan Document Review Goals

The goals for the lesson plan document review were to: (a) describe the adaptions and modifications that were made to the resources, (b) determine if the resources were administered virtually (e.g. via Zoom), and (c) determine which resources were used.

Results

Interviews/Focus Groups

During the focus groups and interviews, several common threads were discussed. Some were expected because they related to the questions asked, others came up naturally in conversation.

Adaptions/Modifications

The adaptions and/or modifications trainers made to the resources frequently came up, as it was one of the questions posed by the interview protocol. Participants reported having to modify the activates because of the age level of the youth their trainees served:

> *"the monster activity is that's a difficult one to tweak for different ages. That's a very I would say five to eight or five to 10-year-old, maybe. And so that was difficult. I had that for the training as well. When I taught it but I had several...and computer Science teachers and middle school teachers and that one was one that I don't think they saw value in because it was so young geared towards the younger learners"*

As well as modifying the activities due to prior levels of experience with some of the activities (i.e. Scratch) or skills (i.e. writing lesson plans):

"there were still some places within it that it felt like the participants needed to have some preexisting knowledge. It wasn't just jump in and do. And so we spent a good bit of time going back and kind of talking a little bit about what scratch the platform and how to use it. And you know what making sure that the training is completely at ground zero. If that's where your audience is…it seemed like it was expecting people to know, a little bit more when they came in."

"Those people seem to have a lot of scratch background knowledge and it seemed like the afternoon activities were also very scratch based which we felt like was a bit repetitive for them, since they already had that knowledge. So we ended up adapting then for them to go over other things rather than just working in Scratch pretty much during the morning and then again in the afternoon… barefoot computing and that was within the tinkering part of the lessons."

"So when we were working with our group with the pre service teachers, since they are current college students who are getting ready to go out and be elementary educators and they had been in [Participant 2] sections where they were working on science in the elementary classroom we…did not necessarily do the STEM template or activity template because they were going to be learning through their coursework, how to create lesson plans and we didn't necessarily, you know, feel like they needed that template, since they were going to be making their own lesson plans."

Some trainers noted that they had to restructure the information, being cognizant about what they were including due to the time constraints of their training.

"the toolkit was it is such a vast amount of information. That it took me an entire day to pare it down enough to teach it the way that I was asked to teach it. So it was a very vast amount that had to be pared down some way to be able to train it in eight hours because that's what I was asked to do turn it around and train it in eight hours."

"*there was more than I could fit into an eight-hour day"*

Even trainers that modified little of the CS Toolkit recourse, they still were not totally faithful to the scripts.

"she stuck to the agenda, but maybe not necessarily exactly the times. I think she did have some like improvising in there. She didn't exactly stick to the script 100% of the time."

"I liked the script that it gave us. I didn't use it the whole way."

All the trainers either talked about how they created a PowerPoint to be used during their trainings or suggested if that one could be provided in the future to help support their PD.

"So I made my PowerPoint with the information that we needed to train. And I…had arrows pointing to scratch exactly where to click and what to do."

"I did the exact same thing [create a PowerPoint*] because I feel like we needed something to visually direct people through."*

> *"*[I] *ended up developing like a whole PowerPoint to go along with everything. And I think that, including that would be helpful. Like if you created like the step by step guide that they had created was great as a facilitator .If you didn't have background knowledge in that it would be much easier to pick it up and run with it if there were, you know, kind of pre created PowerPoints, and then facilitator notes in there too. So that might make it easier for somebody in the future.*"

Virtually Versus In-Person

Overall experiences with delivering the PD resources were positive, but there were several issues that came up when delivering the PD virtually, such as the use of viewing parties versus one-to-one computer viewers and the lack of preparedness on the trainees' part.

> *"You asked about how it was done whenever we did it virtually. Okay so there were definitely good things, and there were bad things about doing it virtually. So we tried to email out like the handouts and stuff ahead of time. So I don't know if people just don't check their emails or what, but some people didn't have the stuff printed out and ready to utilize. So that was a struggle because then they would say, oh, can you re-email it to us. So that took a little bit of time. Other things that I hadn't really thought about going into the virtual trainings was so most people logged in from home and they are a single user watching the zoom. However, there were also some counties that decided to host like watch parties, but whenever you have a big room full of people who are just watching one computer when you have the online activities. The individuals don't get to have that individualized experience, which I feel like kind of took away from that hands-on learning"*

Several of the participants noted that the guide for the in-person PD had some errors, telling the trainers to do things that could only be done if they were delivering the PD virtually.

> *"There were separate ones for if you were doing it face to face versus if you were doing it virtually and it looks like they must have drafted the virtual one first and then made the face to face one. So there were still some language within the face to face, one that said like have them put this in the chat box."*

Two trainers discussed how they used two people, one who taught and the other who managed the online chatroom and answered questions to help the virtual PD run smoothly.

> *"In our group is that I did the teaching and I had my PowerPoint shared on my screen. But then I had another moderator completely moderate the chat rooms like I didn't even look at the chat rooms at all because I was teaching And if someone had a question. And they would say, you know, hey, [Participant's name]l. We have a question, and they would tell me what the question was. So there was basically someone moderating the chat room the whole time that you know I was presenting and then I could focus on what I was doing. So it worked out really well that way."*

Train-the-Trainer

During one of the focus groups, the trainers began to discuss the train-the-trainer program that was done virtually to teach the trainers how to use the resources included in the toolkit. Many felt that the C2S representatives assumed that all the trainers came in with some CS experience:

> *"The initial training I had…I don't think it was sufficient at all. Really. Because they just went entirely too fast for somebody that's complete new to all of this. And I got very frustrated and very worried and lost whenever I first had the training. But once I was able to sit down and read through some of it and ask some question, it was a little bit better. But I definitely think science this is something thatpeople are kind of eh to being with, with computer science and math. I can see this putting a bad taste in some peoples mouth and turning them away"*

> *"The initial training was not sufficient. But I learned from that And I said, okay, when we are training these 100 people across the state, something has to change. We can't do it like that. So I made a PowerPoint with the information that we needed to train and that's what I used."*

> *"I came out frustrated with that thinning, what is it that I'm supposed to teacher. I don't even understand what that training was…It just when so quickly…kind of left us wonder what it was that you were supposed to be doing."*

> *"I would have like to actually participate in the activates we were doing with the* [trainees] *rather than just have it and just figure it out."*

Some trainers felt like they left the experience depending on members of their team that had more CS training, not fully understanding the concepts and activities at the end of the train-the-trainer.

> *"My biggest issue, I would say, if I wouldn't have had a computer science professor with me to fall back on, I wouldn't have been nearly as comfortable with something the things I was doing, especially scratch because it does not walk you through scratch very well. And for somebody that, like me, wasn't familiar with it at all, it was a bit of a learning curve."*

One of the participants noted that you *"needed to know zoom pretty well"* to be able to provide the training and set up the breakout rooms and have it all run smoothly.

Palindrome Activity

A single activity, the Palindrome activity was mentioned during all the interviews and focus groups. It appeared that trainers had significant issue with this activity because of the lack of an answer key and how long it took them, as well as the people they trained to figure it out.

> *"the palindrome activity…they didn't give any answer keys. Including answer keys in there too so that people don't have to spend a whole bunch of time going back and researching all of that"*

"the palindrome activity…they were having trouble making the connections. I mean I was having trouble making the connections at the higher level…but they seemed to miss the connection even after the explanation of the pattern matching."

"I didn't have a complete version which would have probably been better. But I honestly didn't know if my solution would have been 100% correct."

Lesson Plan Document Review

Much of what was said in the interviews and focus groups was reflected in the lesson plans submitted for review. While some trainers (2) reported that they did not make any adaptions to the resources in the C2S CS toolkit, several trainers reported different adaptions within the training. For example, one trainer substituted the 'Discovery Learning' activity (https://studio.code.org/s/csp5-support/stage/9/puzzle/1) for the Tinkering activity. This trainer later reported in an interview that she did this because she did not believe that the Tinkering activity would have been age appropriate for the youth her trainee worked with, whereas the Discovery Learning activity was a better fit.

Several trainers reported re-wording some of the scripts and questions to fit their individual situations and contexts. Also, a large number of trainers reported modifying the breakout session structure provided in the resource. One individual explained that breakout session was not necessary because their group was small enough to have open discussion amongst the entire group. Another individual had trainees pair up with a partner instead of getting into small groups.

Several trainers chose to leave out particular resources according to the background their trainees. One trainer chose not to focus on the STEM planning template since the audience was pre-service teachers who were being trained in their college coursework on how to write STEM lesson plans. Instead, they spent time providing them with ideas or resources/organizations that they could turn to for more CS PD in the future or for collaboration/borrowing equipment. Another trainer did not teach their group about the lesson plan, because they were all preparing to be teachers and they didn't feel they needed to be taught that information.

These kinds of adaptions were more commonly seen with the trainers who were working with trainees from formal education backgrounds versus informal education backgrounds.

Many trainers took some liberties with the amount of time they spent on each activity and section. For example, one trainer spent extra time on the 'Animate a Name' section of the 'Computer Science: It's easier than you Think' module. They did this because they wanted to ensure their trainees oriented to the website, curriculum, and teacher resources before moving on to other resources. Another trainer spent extra time demoing the resources and how they could be used during a computer science active learning experience.

Several trainers reported spending extra time on Scratch, providing extra information for all the trainees to understand what it takes to implement within the classroom. One trainer reported having to shorten her discussions and activities on a solely virtual PD session because many of the trainees were having trouble staying engaged.

Summary: Trainer Feedback

Summary

Overall, the feedback on the C2S CS toolkit resources was fairly positive. Participants loved the videos and thought the resources were satisfactory. Trainers that had more experience teaching seemed to be more willing and had an easier time making adaptions and modifications to the PD, while trainers with less teaching experience frequently requested more supplemental materials that would make it easier for them to deliver the PD (e.g., PowerPoints, answer keys, etc.). No matter how versed trainers were in teaching, all seemed to want more guided tinkering time and instruction on the actual CS activities that were included in the training than the initial train-the-trainer program provided.

Limitations

There were a few limitations to the evaluation. The first limitation was that we were unable to solely conduct focus groups as originally planned. The focus groups occurred in June, which meant many of the

trainers were running or working in summer camps, putting a large restraint on their availability. To get as much feedback as possible, the decision was made to add interviews for the trainers who could not attend any of the scheduled focus groups. In the focus groups, the interactions between the trainers resulted in a great discussion of the resources in the CS Toolkit compared to the interviews, which could have influenced our final results.

Also, all of the trainers were expected to submit their lesson plans for the document review, but not all the trainers submitted them. It is possible that these missing lesson plans could contain important adaptions and modifications that are missing from these results.

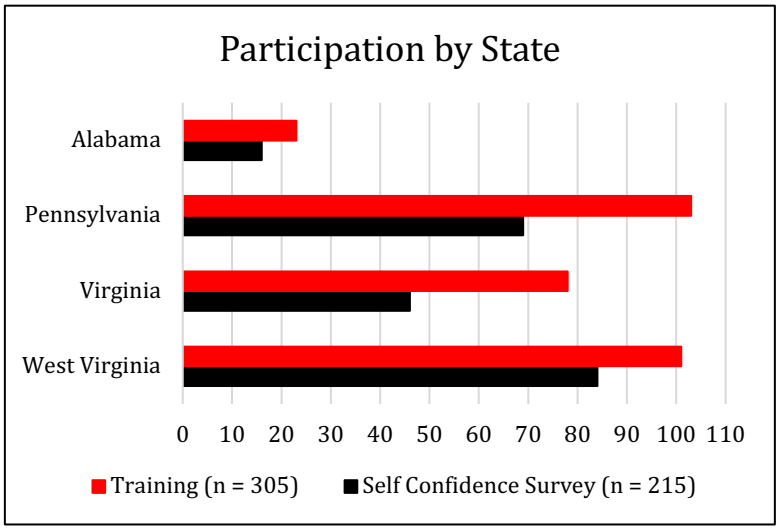
Section II: Trainee Feedback

The second component of the pilot evaluation of the C2S CS Toolkit included soliciting feedback from frontline staff, teachers, and volunteers who received the PD using the CS Toolkit resources. The sections below provide a brief description of the overall mythology, description of the survey, and present findings from the self-confidence survey.

Methodology

Participants

During the pilot, 305 frontline staff, teachers, and volunteers from the four participating states, attended a PD using the resources from the Computer Science Toolkit. Specifically, 23 participated in Alabama's trainings, 103 from Pennsylvania, 78 from Virginia, and 101 from West Virginia. Of those that participated in the training, 217 individuals participated in the Click2Science self-confidence survey regarding their skills in facilitating computer science activities, including 16 responses from Alabama, 69 from Pennsylvania, 46 from Virginia, and 84 from West Virginia, and 2 participants did not provide a state in which they received training.



Self-Confidence Measure Procedures

A retrospective survey was created for frontline staff and volunteers to provide an estimate of their confidence level regarding their skills in facilitating computer science activities both before and after participating in an official *Click2SciencePD* training. The survey questions asked staff members to indicate on a confidence scale (Not at all confident – Extremely confident) first how confident they feel AFTER the

skill's training, and then to indicate how confident they felt BEFORE the training. Relevant research on retrospective surveys has shown it is best to have respondents indicate how they feel immediately after the training/intervention (because it is fresh) and then to reflect and indicate how they felt before the training. The measure also included open-ended questions regarding the training, including what the most significant thing they learned from the PD experience, what the most challenging part of leading computer science activities is, and how they will apply the skills they learned in the training.

The measure also included several demographic questions. These questions allowed curriculum implementers to accurately describe the type of trainees that participated in the Computer Science PD. Information such as the type of youth they serve, the role in their program, as well as their own level of education were included in this part of the survey.

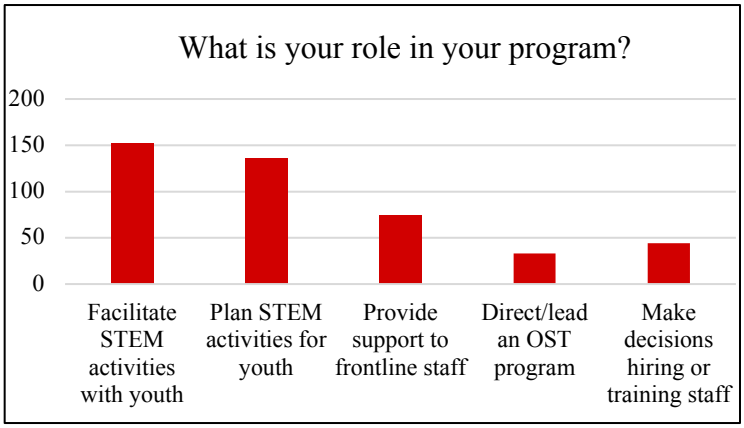
Self-Confidence Measure Goals

The goal of this portion of the evaluation was to: (a) provide estimates of trainees' pre- and post-training levels self-confidence on computer science related skills (b) collect trainees feedback on the PD resources provided in the C2S Computer Science Toolkit.

Results

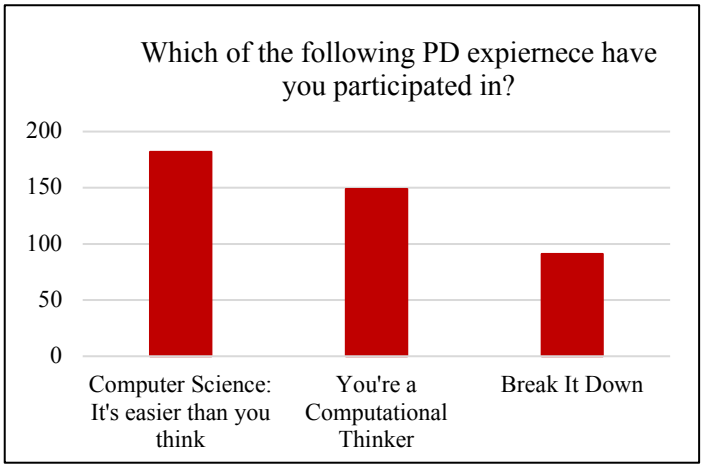
Self-Confidence Measure

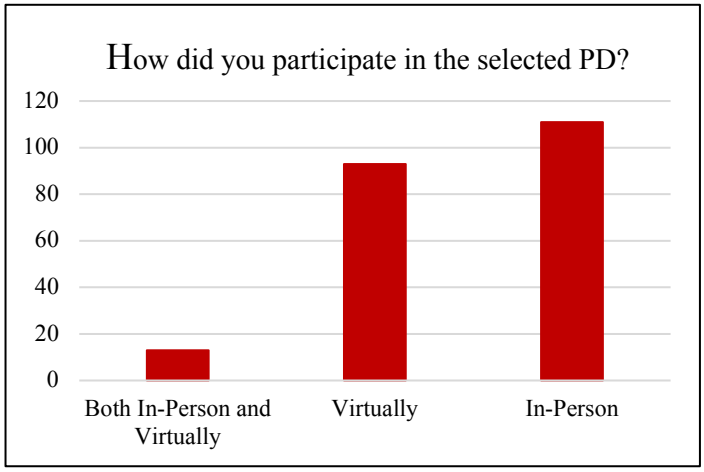
Demographics



Of the 217 individuals who participated in the survey, it was found that a majority of respondents either *facilitates* STEM activities with youth or *plan* STEM activities for youth in their program. A limited number of respondents also provide support to frontline staff, direct/lead an OST program, or make decisions hiring or training staff members. A summary of all responses for this question (*what is your role in your program? Select all that apply)* is found in the figure.

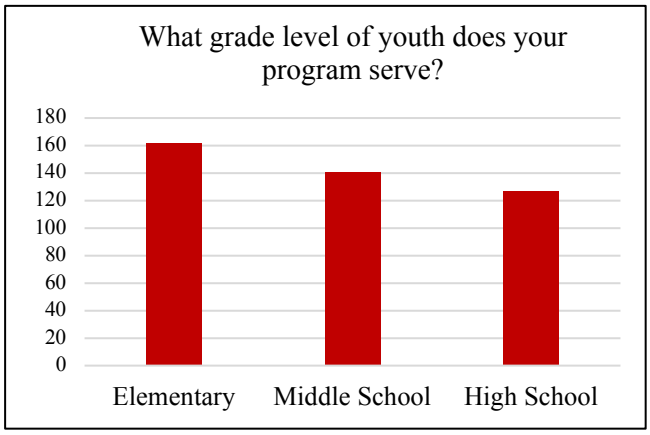
Next, respondents indicated in which of the PD experiences they participated. As expected, because the trainers were instructed to begin with the module 'Computer Science: It's easier than you think', 182 (83.9%) respondents indicated that they participated in the module. One hundred and forty-nine (68.7%) respondents reported participation in the 'You're a computational thinker' module. Only 91 individuals (41.9%) reported participating in the 'Break it Down' module. Respondents also specified how they participated in the selected PD. The survey suggested that a majority of respondents participated in the



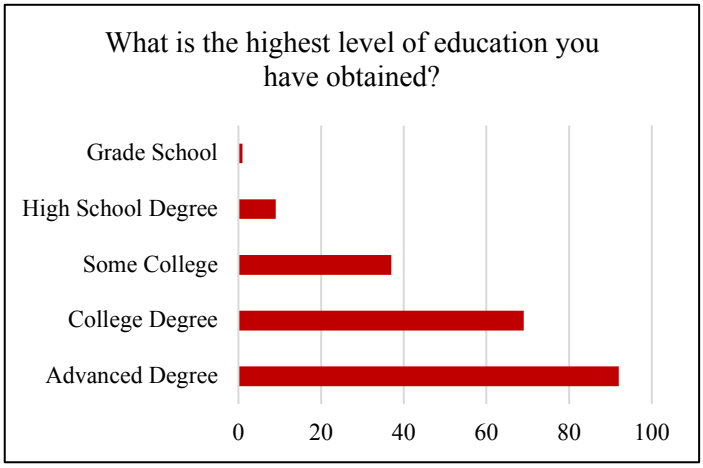


selected PD either solely in-person (51.2%) or virtually (42.9%), whereas just 6.0% participated both in-person and virtually.

Respondents provided demographic information on the grade level served by their program/site. Respondents were asked to select each grade level that applies to their program. Of the 217 trainees, 162 respondents (74.7%) indicated that their program serves elementary aged youth, whereas 141 respondents (65%) indicated that their program serves middle school aged youth, and 127 respondents (58.5%) indicated that their program serves high school aged youth.



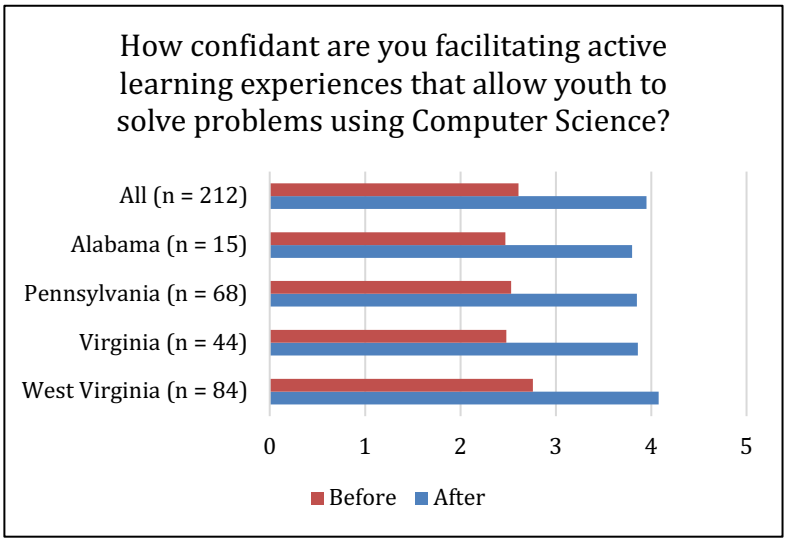
Finally, respondents answered several questions about their educational attainment and experience related to youth development. Of the 206 respondents, one respondent (.5%) indicated they completed grade school, 9 respondents (4.1%) indicated they graduated high school, whereas 37 (17.1%) indicated they have some college, 69 (31.8%) indicated they are a college graduate, and 92 (42.4%) indicated they have an advanced degree. Additionally, we found that participants in the training had various levels of experience working in youth development, as seen in the figure.



Self-Confidence Scale

Respondents had the opportunity to respond to four questions that assess their levels of self-confidence on computer-science facilitation skills pre- and post-training. Figures for the summary of responses before (indicated by the red bars) and after (indicated by the blue bars) the training are provided below. The mean response (ranging from 1-5) is for those who responded to the question (1 = not at all confident, 2 = slightly confident, 3 = moderately confident, 4 = very confident, 5 = extremely confident).

The first question was written to assess participant level of confidence in their ability to facilitate an active Computer Science learning experience. The mean response for all the participants fell between *slightly confidant* to *moderately confidant* before the training, while the after-training level were just below the *very confidant* level. A mean difference of 1.34 (*SD* = 1.02) greater than a standard deviation demonstrates that there was a significant change between pre- and post-levels of self-confidence for the trainees. Similar results were seen across all of the states.

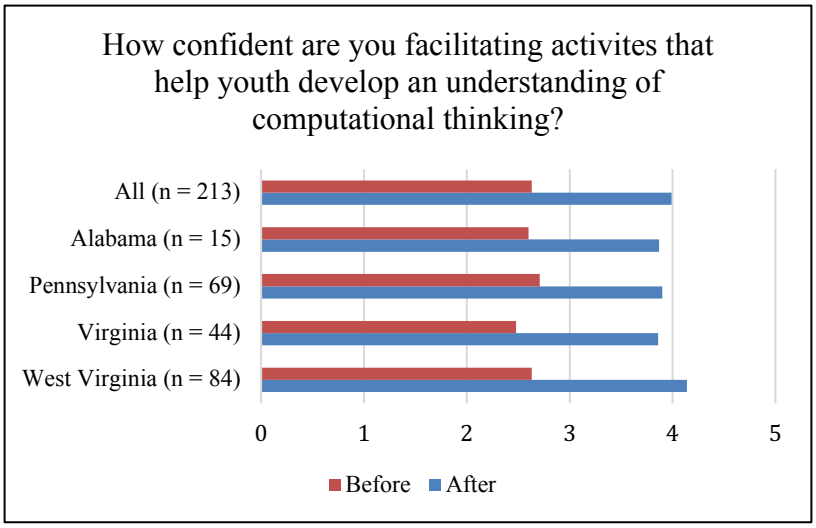


Question 1: Ability to facilitate an active Computer Science learning experience

State	Item Means (*SD*) for Question 1		Mean Difference (*SD*)	*t Statistic* (*df*)
	Before	After		
All	2.61 (.98)	3.95 (1.16)	1.34 (1.02)	19.07(212)**
Alabama	2.47 (1.13)	3.80 (1.15)	1.33 (1.11)	4.64 (14)**
Pennsylvania	2.53 (1.28)	3.85 (1.28)	1.32 (.98)	11.09 (67)**
Virginia	2.48 (.98)	3.86 (1.09)	1.39 (1.08)	8.49 (43)**
West Virginia	2.76 (1.16)	4.08 (.76)	1.54 (1.02)	11.88 (83)**

** *t* is significant at a p < .001 level; **t* is significant at a p < .01 level

The next question assessed trainees' level of confidence in their ability to help youth understand computational thinking, a very important aspect of Computer Science and the topic of one of the three modules developed for the PD. The mean response for all participants once again fell between *slightly confidant* to *moderately confidant* before the professional develop and just below *very confidant* levels after. A mean difference of 1.36 (*SD* = 1.08) demonstrates that there was a significant change (larger than a standard deviation) between pre- and post-levels of self-confidence for the overall group. These results are similar to the results seen in all the states that participated in this PD pilot.

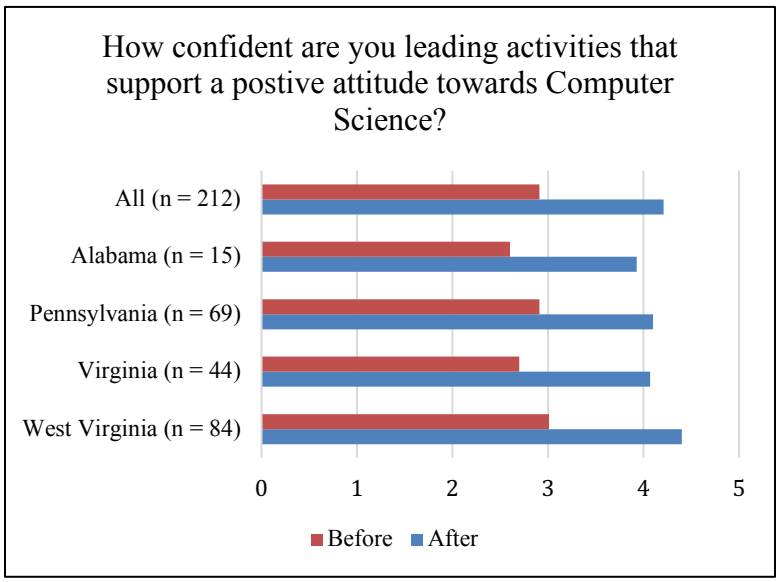


Question 2: Ability to help youth understand computational thinking

State	Item Means *(SD)* for Question 2		Mean Difference *(SD)*	*t Statistic (df)*
	Before	After		
All	2.63 (1.93)	3.99 (1.16)	1.36 (1.08)	18.33(212)**
Alabama	2.60 (1.83)	3.87 (1.19)	1.27 (1.63)	4.22 (14)*
Pennsylvania	2.71 (1.26)	3.90 (1.13)	1.19 (.97)	10.13 (68)**
Virginia	2.48 (1.07)	3.86 (1.00)	1.39 (1.19)	7.76 (43)**
West Virginia	2.63 (1.21)	4.14 (.64)	1.51 (1.10)	12.56 (83)**

** T is significant at a $p < .001$ level; * T is significant at a $p < .01$ level

The third question assessed participants' levels of confidence in their ability to lead activities that would leave youth with a positive attitude towards Computer Science, an important step in developing a STEM identity. The average response for all participants was right below *moderately confidant* before the training, while the after-training level were between the *very confidant to extremely confidant* levels. A mean difference of 1.30 (*SD* = 1.01) demonstrates that there was a significant change between pre- and post-levels of self-confidence for the overall group. Once again, these results are similar to the results seen in all the states that participated in this professional development pilot.

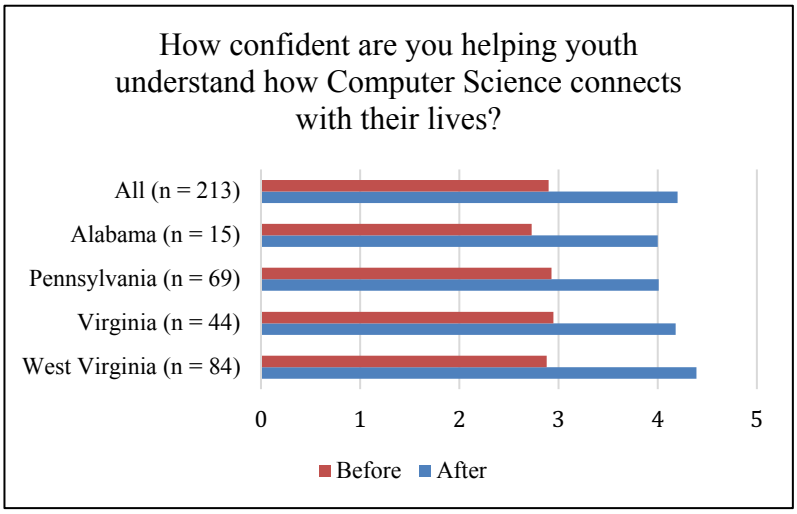


Question 3: Ability to lead activities that would leave youth with a positive attitude towards Computer Science

State	Item Means (*SD*) for Question 3		Mean Difference (*SD*)	*t Statistic (df)*
	Before	After		
All	2.91 (1.22)	4.21 (.92)	1.30 (1.01)	18.79 (211)**
Alabama	2.60 (1.18)	3.93 (1.16)	1.33 (.90)	5.74 (14)**
Pennsylvania	2.71 (1.26)	4.10 (1.07)	1.19 (.93)	10.63 (68)**
Virginia	2.70 (1.19)	4.07 (.99)	1.37 (1.11)	8.08 (42)**
West Virginia	3.01(1.21)	4.40 (.62)	1.39 (.12)	12.12 (83)**

** T is significant at a $p < .001$ level; * T is significant at a $p < .01$ level

The final self-confidence question assessed participants' levels of self-confidence in their ability to help youth connect computer science to their everyday lives. The mean response for all participants was just below *moderately confidant* before the training, whereas the after-training level were just above *very confidant* levels. A mean difference of 1.30 (*SD* = 1.01) demonstrates that there was a significant change between pre- and post-levels of self-confidence.



State	Item Means for Question 4 *(SD)*		Mean Difference *(SD)*	*t Statistic (df)*
	Before	After		
All	2.90 (1.17)	4.20 (.92)	1.30 (1.01)	17.66 (212)**
Alabama	2.73 (1.16)	4.00 (.93)	1.27 (.27)	4.75 (14)**
Pennsylvania	2.93 (1.28)	4.01 (1.078)	1.09 (1.04)	8.67 (68)**
Virginia	2.95 (1.06)	4.28 (.97)	1.22 (1.08)	7.57 (43)**
West Virginia	2.88 (1.17)	4.39 (.71)	1.51 (1.09)	12.69 (83)**

** T is significant at a $p < .001$ level; * T is significant at a $p < .01$ level

Open-Ended Feedback: Question 1

Respondents also provided responses to three open-ended questions regarding the modules in which they participated. First, they answered the question **"What was the most significant thing you learned from your PD experience?"** Several main themes were found among participants' responses. Each of the themes is presented below, with some participant quotes to help illustrate each theme.

Applying new teaching practices and helping students learn

Respondents continually commented how they learned new strategies and teaching practices, which, in turn, helped their students better learn computer science concepts. For example, participants learned:

> "*How to successfully approach different kinds of situations based on how students response to success, frustration and learning,*"

"*The different approaches and activities to teach children about what computational thinking is and how it applies to their daily lives*."

Other respondents learned specific strategies for facilitating computer science activities.

"*Break down the problem and how to solve the problem in ways that the kids can understand*."

"*Support children by letting them have time and your encouragement not to give up*."

"*How to make computer science ideology accessible to students without much computer science experience."*

Participants commented how they were happy they could *"provide an enjoyable and educational computer science curriculum"* to their program, and how they could teach students to "*work as a team player and learn from each other for new ideas.*"

Applications to everyday life

Another theme that was common among participants was how the information they learned in the modules had extended application to everyday life. For example, participants commented:

"How computer science and problem solving can be used in more than just a computer specifically. That there are a lot of aspects of life that use all sorts of different technology and that simple to complex tasks require computational thinking and problem solving."

"How important Computer Science is to our real life activities and how important it is for children to realize this as they develop interests in careers

"Computer science is an umbrella of various ways to work through a problem. It relates to almost every aspect of our lives."

"The different approaches and activities to teach children about what computational thinking is and how it applies to their daily lives."

"Computer Science is basic to many of the things we do in our daily lives."

Many participants were surprised by how common computer science concepts are in everyday life and how the modules helped emphasize that for them.

Learning new concepts and strengthening old concepts

Several participants explained how they learned several new computer science concepts and were able to strengthen their knowledge of concepts they had previously learned about, but did not feel confident

in. Some participants even expressed how they were previously using computer science concepts in their curriculum, without even knowing it.

> *"The definitions of computational thinking and how I already use computational thinking in so many ways without even knowing that I am doing it. I will be more aware of it now that I can define it."*

> *"I learned the terms for things I have done for years and didn't know were computational thinking. I can now take the information home and spend time getting comfortable with coding and creating algorithms."*

> *"Broadened my view of what computational thinking is and I now have ideas for relating it to our clubs."*

Learning that STEM is not as challenging as initially thought

Another important area of knowledge that was learned by participating in the modules was the idea that teaching STEM is not as challenging as many facilitators initially though. Many facilitators seemed to have high anxiety or fear about teaching STEM and computer science concepts. However, as many explained, participating in the modules allowed them to learn that STEM and computer science concepts are not as scary or daunting as they had thought.

> *"That others have the same issues as I have. This makes me realize that I am not so challenged with STEM as I thought."*

> *"Computer Science is not as scary as originally thought to be. The computational thinking portion was the part I took the most away from."*

> *"The skills necessary for computer science are very basic and everyone has them in some capacity whether they know it or not."*

> *"I learned that algorithms are not as scary as they sound, and computer science is about problem solving."*

> *"Taking away the fear of the unknown and grasping that Code is simply a set of instructions."*

Finding valuable resources or new activities

Many participants explained that the resources and activities that were included within the modules were the most significant thing they learned by participating.

> *"I would say that the computer science and coding resources that we were given information on were the most significant thing that I learned from this professional development experience- such as the*

Scratch and Scratch Jr. programs, as well as the other activity ideas such as the monster algorithm activity."

"Learning about all the programs out there for free that the kids in my programs can use to help them get ahead of the game while having fun and figuring out if they are passionate about computer science."

"I really enjoyed learning about new resources for CS via Google and Scratch. I only had experience with coding via Microsoft Virtual Basic, Matlab, LaTeX, Code.org, and Maple. It was refreshing to see this."

"The most significant thing I learned is all the free resources that are available online. The Google CS First and Scratch are two that I will definitely be taking advantage of."

"That there are a lot of resources that I can get to help me prepare lessons for Computer Science."

Open-Ended Feedback: Question 2

Respondents next answered the question **"What will be the most challenging part of leading Computer Science activities?"** Several themes were found amongst participant comments, which are described below.

Lack of confidence/competency with material

The most common theme found for this question was the idea that many facilitators lack confidence in leading STEM and computer science activities. Many individuals felt like they themselves lack the skills and abilities to learn computer science activities, so leading these activities is an even greater challenge.

"Learning the computer science activities myself. I am not computer smart, and i feel many children these days sit at a higher level than i do with computer science."

"Computer Science is still overwhelming to me; once I get started, it'll be fine. Overcoming my fear of messing up with my students or not teaching the activities appropriately."

"Ensuring I am trained enough to help my students during the activities. If they have a problem I should have enough knowledge to help them."

"Making sure I understand what I am teaching. Computer Science is not my specialty, so making sure I know enough to get me through."

"Me finding the time to practice and learn more before I feel confident in teaching this in a class."

"Having time to practice myself and become more confident in my own abilities before teaching."

Other participants commented how it is difficult because the youth in the programs often have more experience working in computer science, which is frustrating to those who lead the activities.

> *"Student are better at technology than I. Several time I did not get past the first problem and time was up."*
>
> *"When the youth know more than I do an ask questions that I don't know the answers to."*
>
> *"The possibility of having kids who know more than me about scratch or other computer related activities."*
>
> *"Realizing how much the kids know and being able to stay a step ahead of them!"*
>
> *"Answering questions that you don't understand because of not having a computer science background."*

Limited funding, access to technology, and staffing

Many participants expressed the idea that not all of their programs have adequate funding to provide the support students need to learn computer science concepts. The first problem is simply not having enough technology or computers for each of the youth in their programs.

> *"Not all counties in 4-H get enough funding and or have access to the technology needed to participate in these activities."*
>
> *"Getting enough equipment to have a meaningful experience for a larger group. I believe that it will be very popular and to engage everyone will take some strategic planning."*
>
> *"Ensuring that all the technology is present at the facility you will use for your activities and knowing that they all work correctly."*
>
> *"Having enough devices that are compatible with software and programs, and other tech hurdles; specifically for the "plugged In" exercises."*
>
> *"Currently, not having any equipment (laptops, ipads, etc...) to conduct a workshop or class."*

Another challenge is having a reliable internet connection for the online activities. For teaching many computer science concepts, an internet connection is essential, but funding issues and connectivity in rural areas is a significant challenge that programs often deal with.

> *"Availability of internet. That's why the resources are so valuable – being able to do CS with activities that don't require internet access is extremely helpful."*

"Connectivity is a major challenge for rural areas. I like that the resources included unplugged activities and Offline Versions of the activities."

"Getting the access of the internet in all the areas that activities can be used."

Another finding was the idea that programs often struggle with enough staff members to properly lead computer science activities. Several participant comments help illustrate this point:

"Finding volunteers. I can do my part but I can't reach the number of youth that I think can benefit from this."

"1 person teaching/leading a classroom on something new to them. 25 students to 1 facilitator means lots of computer questions."

"The most challenging part will be doing these activities on my own with a class full of children."

Limited time available for activities

In a related finding, programs often struggle with having enough time in their schedules to teach properly computer science activities.

"Finding the time and space in my middle school to work this into the schedule. There isn't a time that's designated for this. I'll have to work with teachers to schedule a time to work with them and their students"

"Time…Teachers often think Computer Science is an 'add-on' instead of thinking of ways to integrate it into what they currently do. Resources…We are not 1-1 with technology."

"Having the time to do it."

"I work for a school system, so having time during the day to actually teach it, and the lab, computers necessary to do this."

Unsure how to present content to kids

Several participants commented how they often have difficulty choosing which activities/resources to use when presenting the material to youth, and how the differing levels of youth's knowledge in their programs often leads to difficulty when teaching computer science concepts. Others commented how it is difficult to maintain student engagement or encourage youth to keep trying when they are stuck on a project.

"There are so many resources, so deciding what to use and what is best for the group of students I am working with and deciding where to start."

"How to incorporate the scratch into a club with different skill levels and keep everyone learning."

"Finding ways to use this information and present it as entertaining to the kids. While this was covered, I had a hard time grasping the concepts."

"I think the most challenging part of leading CS activities is getting students to understand the connection between programming and the mathematics classroom."

"Making sure students don't get scared at the first signs of being stuck on a project."

"Different levels of experience of your users and the need to communicate with all of them."

Open-Ended Feedback: Question 3

Finally, respondents were asked "**How they would apply the skills they learned from the PD experience."** Several interesting responses illustrated how respondents intend to apply the skills they learned in the training. Three main themes emerged from participant responses.

Using specific activities or resources

Many participants explained how they would take specific resources or activities (E.g. Scratch, Palindrome activity, Debug it) and start to use them within their programming.

"I would definitely love to use the Scratch website and let kids learn about coding. I think in today's gage it is important for them to understand how coding works and what it is. I think the kids would really enjoy using the website to interact and practice coding and that is what keeps their attention."

"I like the Computational Thinking using the figuring it out and the game with no instructions. I will use these activities to help the youth to understand the breakdown and steps of computer science."

"I would like to apply scratch learning into day camps in my county, and possibly do a workshop in my own club that I can show them how computer programming can be interesting."

"I will use the resources provided. I will implement the unplugged and plugged activities. I hope to take the coding skills into robotics and drones."

"As I begin to think about activities I will review the materials shared today. I particularly like the STEM Planning sheet."

"I plan on taking some of these Google activities and implementing them in my classroom for the next school year."

"Use Scratch activities more frequently; Discuss computer science opportunities with students; Help students internalize a STEM identity."

"Offer these activities during summer camp at parks and Rec, summer school, and girls and boys club."

Improve teaching practices

Several participants discussed how receiving training via the modules will help them improve their teaching practices. For example, several individuals indicated that participating in the training allowed them to become more confident in their abilities, in turn, influencing their feelings that they could be better facilitators.

> *"I will apply them by being able to confidently teach my kids more about computer science and introduce them to new ways of thinking and problem solving to help them in the classroom and their real lives."*
>
> *"It has allowed me to look at how I give directions to kids. It has given me more confidence to be positive influence with the kids."*

Others commented how participating in the modules allowed them to realize how important it is to relate computer science concepts to everyday life.

> *"I will look for ways to relate whatever I'm teaching or facilitating regarding computer science to everyday life so that it makes more sense to me and the kids."*
>
> *"Making it fun and tying it into real life examples are the keys to success."*
>
> *"I will be using some of the programs I learned about to teach students about the fun and exciting things that they can do with STEM."*

Others commented more generally about how the modules will allow them to improve their teaching practices.

> *"I will use strategies used by our instructor, making adjustments as needed for the differences in the age, attention and skill levels of the participants in the group. Encouraging observation, by students as well as trainers/assistants, will facilitate on-task participation and work completion, while providing essential feedback to redirect, reinforce and/or acknowledge understanding of concepts being taught. Ensuring that all learners participate in practice exercises with constant feedback, encouragement, and recognition for successful completion of tasks will help maintain high interest in task completion."*
>
> *"By showing children that it may be tough in the beginning to figure out the code but once you get the code down the system will work."*
>
> *"Teaching the concepts to the students and helping them get a better understanding of computer science."*
>
> *"I will take better consideration of my students' emotional/frustration levels during the lesson."*

Sharing with staff and others

The final theme that was found for this question was the idea of participants sharing what they learned from the modules with others who lead STEM activities. Some participants explained they will share the resources and activities with other facilitators and clubs.

> *"I will use these skills, once I am more comfortable to do professional development with my staff so they can also feel comfortable sharing with the children and using the lesson plans shared to get the children in our after school program involved and loving coding!"*

> *"I will work with my 4-H club and will share with other clubs. Hope to train my teens to do the activities with me and to take a leadership role with the elementary and middle school clubs."*

> *"I would like to increase awareness of the ease of accessibility of CS, to encourage others to pursue proficiency in CS in areas they have interest."*

> *"I plan on doing a program this summer for families and utilizing this as one of our afterschool activities."*

> *"Hopefully, get with teachers and be able to go in to their classroom to bring the opportunities to them."*

> *"Share my past CS experience with co-workers and learn from the info that will share back."*

Others explained how they will develop PD opportunities to transfer the knowledge they learned in the modules to others.

> *"I will conduct an entry level professional development to my after school staff to begin to introduce coding to the students for the 2019-2020 school year."*

> *"I am presenting professional development sessions to teachers in my county this summer on CS and will utilize these materials."*

Summary: Trainee Feedback

Summary

The feedback provided by the trainees was overwhelmingly positive. Participants benefitted from an average positive increase in self-confidence concerning all the facilitation skills targeted by the CS Toolkit resources. This increase in self-confidence was reflected in the open-ended questions as well. Many participants reporting they were excited to use their new skills, as well as to teach them to their peers.

Limitations

The use of an online survey management software caused some unforeseen issues when determining missing data. In particular, there were several important 'select all that apply' questions within the demographic questions in the survey. The survey software coded these responses as either 'yes' or 'missing'. Therefore, it was impossible to determine whether missing values meant no or they were actually missing. Thankfully, these errors could only have occurred in the demographic sections therefore having little effect on the self-confidence scales and open-ended questions.

Section III: Limitations and Next Steps

The date collected to evaluate the piloted C2S Computer Science PD Toolkit shows that these resources can make a positive impact on the prescriptions of frontline staff and volunteers. Due to the extreme time constraints on the current project, only information on trainer and trainee perceptions were able to be assessed. Although this evidence is promising, further research needs to be conducted to determine to what extent the resources make on the ability and practices of frontline staff and volunteers. Specifically, a longer evaluation should be conducted to determine whether the PD resources in the C2S Computer Science Toolkit has an effect on trainees' skills and practices. In the current study the majority of trainees reported that they had not had an opportunity to apply what they learned during their PD with youth but had plans to apply the skills in the future. Therefore, it would be benefitable to include some time for trainees to facilitate computer science program for youth and collect some pre- and post-training youth survey data or Dimension of Success observation to assess program quality.

As suggested in previous C2S evaluations (Hawley et al., 2017), a deeper dive into the fidelity of the training also needs to be examined. Trainers reported a wide variety of different adaption and modification to the resources in the focus groups/interviews as well as lesson plans submitted. It is possible that these differences could have resulted in different changes in perception. While we attempted to collect some fidelity data through demographic information and trainer lesson plan, it proved difficult to connect trainer reports of adaptions and modification with the trainee's survey responses. Also, it appeared that trainees did not understand the type of training they received in terms of the fidelity questions as many answered that they had received "on-demand lesson," a C2S resource that is not currently offered in the toolkit.

Further expansion of the C2S CS Toolkit is also recommended. This expansion includes training resources to be used by future trainers as well as continuing to create more PD resources for the toolkit. Many of the participants, being teacher themselves, remarked that many of these PD resources could also be

used with K-12 formal educators. It might be worthwhile to explore what using C2S PD resources with formal educators as well as informal educators might look like.

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