Evaluation Report 2019-20

EVALUATED BY
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This report includes the following:

BootUp Professional Development Report

District A (June 2020)

Evaluated by:

Peter Rich, PhD
Brigham Young University

1. Executive Summary

In the summer of 2019, BootUp partnered with a Colorado school district (District A) to provide professional development (PD) to elementary classroom teachers on how to teach elementary coding. BootUp PD consists of several day-long workshops spread throughout the school year. Workshops are supported by teacher and student resources, hands-on activities, in-classroom modeling, and peer site visits. This report provides an independent analysis of BootUp's efforts to train District A teachers during the 2019-2020 school year.

Stakeholders

Three primary stakeholders were considered in this evaluation: District A, teachers participating in the BootUp training, and BootUp facilitators. Secondary stakeholders would consist of those affected by the training indirectly (e.g., students and other faculty). This report focuses primarily on District A participating teachers' experiences in learning to code through the BootUp professional development workshops.

Key Findings

1. District A teachers started with a high valuation of the importance of coding and this increased through experience;
2. About half of District A teachers are teaching coding once a week or more often, while the other half teach once a month or less;
3. All participating District A teachers increased in their confidence to teach elementary coding through BootUp PD participation;
4. District A coding teachers found teaching demonstrations and hands-on activities to be the most helpful methods to learn to code;
5. Teachers describe their success with learning to code in terms of high student interest in and success with coding;
6. Teachers are less confident in their understanding of conditional logic and abstractions;
7. Teachers need more practice fostering computational practices such as debugging;

2. Methods

This evaluation was performed by Peter Rich, PhD, of Brigham Young University. Dr. Rich teaches undergraduate and graduate courses on the design, development, and psychology of instruction. Dr. Rich's research over the past decade has focused on how to teach coding to elementary-aged children, resulting in over a dozen publications on this topic. For this evaluation, BootUp coordinated the desired outcomes and research questions with Dr. Rich. Beyond that coordination, BootUp has allowed Dr. Rich complete independence to analyze and interpret data collected via teacher surveys.

2.1. Data collection

Prior to the first training of the year, teachers completed an instrument called the "Teachers' Beliefs about Coding and Computational Thinking" (TBaCCT). The TBaCCT is a validated instrument created to measure changes in teachers' value for and confidence in teaching coding and computational thinking in the classroom (Rich, Larsen, & Mason, *in press*).

2.2. At the final BootUp workshop of the year, teachers again complete the TBaCCT. They also answer several additional questions about their: (a) coding-related teaching practices throughout the school year, (b) confidence with specific coding concepts, practices, and perspectives, and (c) personal experiences teaching coding, and (d) feedback and evaluation of BootUp's professional development.

2.3. Data Analysis

Both quantitative and qualitative data were collected via pre and post surveys for this evaluation. Quantitative data were primarily summarized using descriptive statistics, while qualitative data were analyzed by using an emergent cross-comparative analysis (Rich, 2012). Pre and Post quantitative data were further analyzed using a paired sample t-test to gauge statistical significance. Cohen's *d* was also calculated to determine the effect size of the noted changes.

Rich, P. J. (2012) Inside the black box: Revealing the process in applying a grounded theory analysis. *The Qualitative Report*, 17(49), 1-23.

3. Results

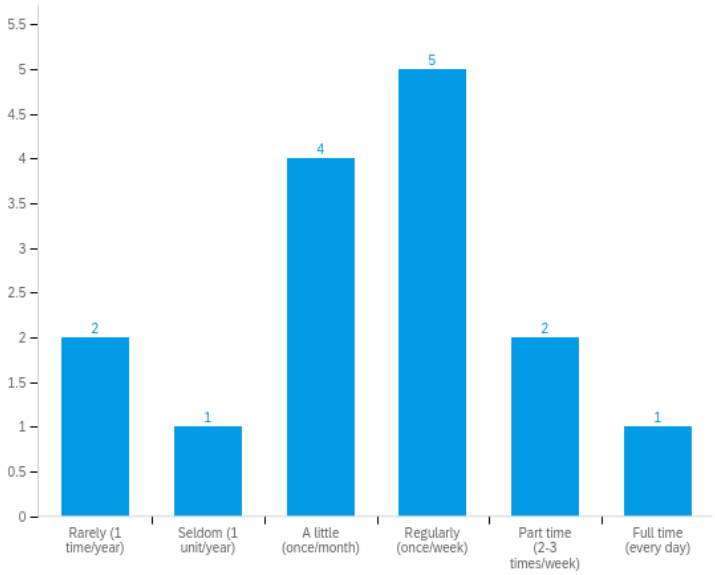
In the following sections, we first present a profile of the participating teachers. We then discuss teachers' classroom practices and their experiences in teaching coding. We follow up with an analysis of teachers' confidence for coding and for teaching it in the classroom. Finally, we present teachers' evaluation and feedback of the various components of BootUp's professional development experience.

3.1. Teacher Demographics

Overall, 16 teachers completed the year-end survey, which was completed at the BootUp training on March 4. District A teachers mostly represented two different groups of teachers: certified classroom teachers (N = 7) and media specialists (N = 7). In addition to this, one teacher self-identified as a STEM/STEAM teacher and another as the district instructional coach. These participants represent a group of experienced classroom teachers. Thirteen (81%) of teachers reported having earned a master's degree, while the other three all had earned a bachelor's degree. On average, teachers reported 19 years of teaching experience, having taught the same grade for half (9.5) of those years[1]. The majority of teachers also reported teaching multiple grades of students (usually K-5), indicating that they are specialists. Despite this, the average participant only had a single year of experience teaching coding by the end of the 2020 school year. In summary, *this was an experienced group of teachers but nearly all were learning to teach coding for the first time this year.*

3.2. Teaching Practices

In this section, we report District A teachers' practices in actually teaching coding throughout the year. Teachers self-reported that about half taught coding once a week or more often while the other half taught once a month or less (see Figure 1). Further analysis reveals that this same pattern emerged when asked how often District A teachers taught coding to the same group of students (with 8 teaching once per week and 7 teaching less than once per week). Nearly all teachers reported that their classroom coding lessons were 31-45 minutes long.



[1] The average was calculated using medians to account for the effect of outliers

3.3. Classroom Coding Experience

In this section, we take a more qualitative look at teachers' experience as they taught coding. Specifically, we asked teachers to report their successes and challenges.

3.3.1. Main Successes

When asked what successes they had experienced with coding this past school year, ⅔ of teachers couched their replies in terms of their students. Student-centered Successes tended to emphasize students' interest in coding and their increased knowledge for coding, as exemplified by the following quotes.

Student Interest in Coding

- **The students' enthusiasm for coding is very high** and they are always excited to see what they can create- overall student engagement is very high!
- **Students love it! They are eager to learn.** I count that as a success.
- My **students love it. They ask for it.** I am feeling more and more comfortable using it.
- **The students get excited and become very engaged.** I have worked with one teacher in Kindergarten and she is very excited about incorporating code into her lessons.

Increased Student Knowledge

- "I have some students that have written an app. They taught themselves. I had students that said they were bad at coding on day 1 and now they teach others. **Teachers are allowing students to present assignments in Scratch, because the kids asked if they could do that instead of a PowerPoint. The teachers said they were the best projects they have ever seen.**"
- I've been teaching it daily for twenty minutes a day to 3rd, 4th, and 5th graders. **I have seen some really awesome stuff come out of their coding work.**
- **I expected my 4th and 5th graders to be successful, but it's been very exciting to see the 1st graders doing well and getting excited about it.**
- Whenever the light bulb appears over the heads of children is a success for all of us. I notice that some children just dive in and work and work. Others, think about what they are learning and then begin the coding task or project. **Coding levels the learning field for children. I revel in this diversity!**

Teacher-centered successes tended to emphasize that a teacher had learned to integrate coding with other subjects. For example:

- More projects that are tied to curriculum and authentic responses/creations.
- The ability to cross curriculum with coding.
- I have had success with unplugged activities, integrating Scratch and Makey Makey, student collaboration as well as collaborating with other teachers. I am also pushing myself to try new things that are out of my comfort zone which is always an adventure.

3.3.2. Main Challenges

A reversed pattern emerged with teacher challenges. Whereas successes were couched in terms of students ⅔ of the time, challenges were couched in terms of the teacher ⅔ of the time. Teachers primarily struggled with their own coding knowledge and with time.

Teacher Knowledge

- **I often don't know the answers**, but the kids usually will help me figure it out.
- I feel that **my knowledge is inadequate** to answer specific questions. I am learning alongside most of my students. I certainly could use more training.
- Sometimes **I can't help debug stuff** so I have to ask for help or really go into it and work on trying to figure out the issues.
- Sometimes **the debugging process is a challenge**. I want to have all of the answers, but I do not at this time.

Time

- The challenge I have had teaching code is **trying to find time to play with the programs** so I can help the students and teachers. Another challenge is just trying to get teachers to try something new.
- **Finding time to do it.** Time will be built into my schedule next year. :o)
- I become frustrated with our school day being so short as teachers are not willing to integrate something new into their day. I understand this, yet I truly wish that teachers were more welcoming to other teachers collaborating on computer coding classes. Next year...we will see what a new administration dictates and how receptive teachers will be to trying new things.
- Finding the time to fit it into the day as much as I would like.
- Time, lack of technology.

Another important pattern that emerged in regards to challenges was actually student knowledge (which was one of teachers' main successes, curiously enough). Specifically, teachers appeared to struggle with the diversity of students' ability levels. Consider the following teacher quotes about their students' knowledge of coding:

- Challenges are that **students' skill set are at different levels.** Meeting with all the grade levels makes it a challenge to know skill sets of kids. Other challenges are having enough time to work with students. Then there are the students that have a low threshold to try and problem solve when things don't go right the first time. That is a life skill to learn...Coding will always be a challenge like any other content area to meet the needs of the students and meet them at their different levels.
- **Some kids have a difficult time understanding the underlying concepts of coding,** and of course, there are always frustrations when trying to get the program to do what you want it to do. Helping students through those feelings of frustration is sometimes challenging.
- **Breaking students' pre-formed habits** in how they chose to do algorithms for coding.
- Learning **a good starting point for different grades.**

3.4. Confidence with Coding

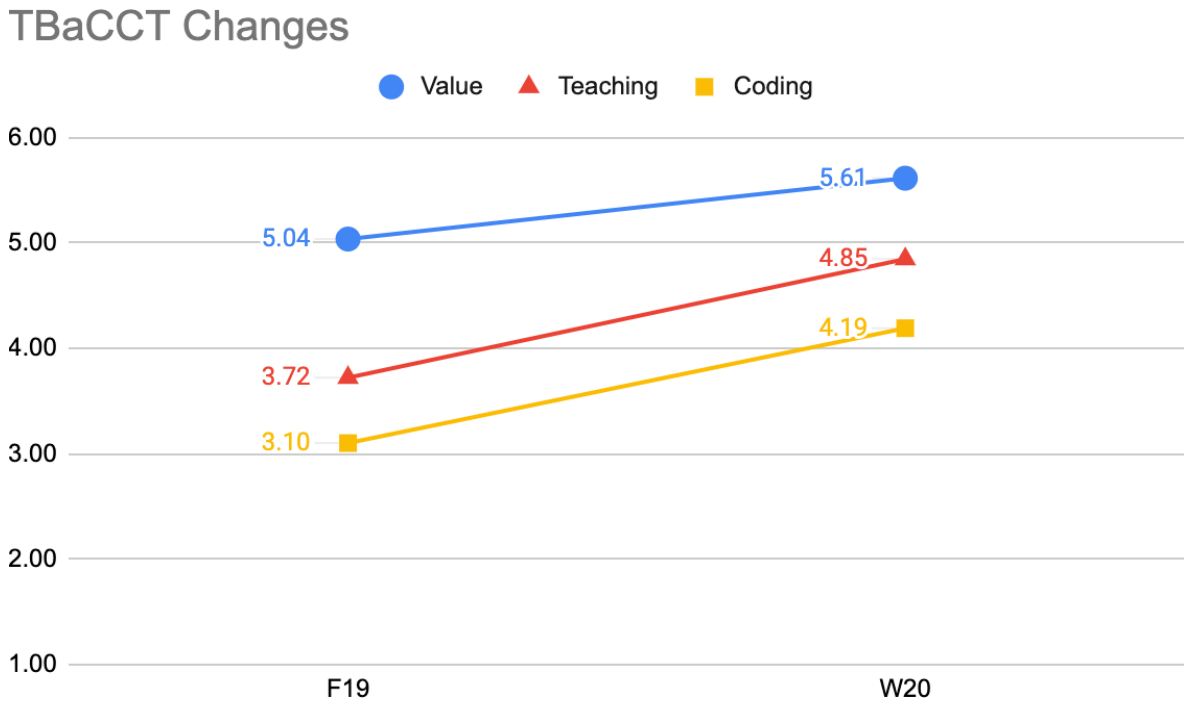
In this section, we report District A teachers' confidence with teaching coding. There were two main ways in which we measured this confidence across a variety of measures. To measure growth over time, we used the Teachers' Beliefs about Coding and Computational Thinking (TBaCCT) scale. This scale asks questions in such a way that teachers can answer questions about their confidence with coding and teaching coding prior to learning about these. Teachers completed the TBaCCT at the first workshop and again at the final in-person BootUp workshop of the year. At the final workshop, we also asked teachers more specific questions about their confidence with coding that required a better understanding of coding itself (and coding-related jargon). Results from each of these are described in the following subsections. Overall, it can be stated that District A teachers' confidence to teach computing grew significantly—both statistically and practically—through their participation in BooUp PD during 2019-2020.

3.4.1. Teachers' Beliefs About Coding and Computational Thinking

The TBaCCT measures 4 aspects of teachers' beliefs about computing: values, coding efficacy, computational thinking efficacy, and teaching efficacy. Beliefs are important to measure as they are related to and influence action. For example, beliefs about the value of a subject not only influence whether or not a teacher will actually address that subject, but also the importance that teacher communicates about a particular subject to her students. In the TBaCCT, we measure teachers' value beliefs by asking questions such as, "Computing content and principles CAN be understood by elementary school children." A teacher who does not agree with this statement will approach the teaching of coding much differently than one who does. In the TBaCCT, teachers answer the extent to which they agree with each statement on a scale of 1 (strongly disagree) to 6 (strongly agree). Teachers also answer questions about their own confidence with coding and computational thinking as well as their belief in their ability to teach coding. Overall, there are 36 questions that inform these constructs.

An average score above a 5 in any of the areas measured by the TBaCCT should be considered extremely strong. As noted in Figure 2, District A teachers began the year with a very high valuation for teaching coding. This observation is supported by many teachers' comments about how they felt about computing prior to the BootUp workshops (see section 3.5.2). Despite this initially high valuation, teachers actually increased in the overall importance that they ascribed to coding. This increase was both statistically ($p < .001$) and practically significant (*Cohen's d* = .918). Statistical significance indicates that this change was unlikely due to occur by chance. Practical significance (using Cohen's *d*) is a measure of the magnitude of the change. Measurements in Cohen's d are standard deviations. This means that District A teachers' valuation of coding at the final BootUp workshop increased 9/10 of a standard deviation. In educational studies, a.4 effect sizes above .4 are considered the standard for success. Effect sizes above .8 are considered to be very strong (Hattie, 2016).

Figure 2. Teachers' Changes in their Beliefs about Teaching Coding



As noted in Figure 2, District A teachers were much less confident in their self-beliefs about coding. Specifically, they were nearly neutral in their confidence with coding concepts in general (3.10/6.00) and only slightly more confident in their ability to teach coding (3.72/6.00). This should be unsurprising given teachers' reported inexperience with coding. This higher confidence to teach a subject they were unfamiliar with is common amongst experienced teachers and highlights the difference between content knowledge and pedagogical knowledge. In both cases (coding knowledge and teaching knowledge), teachers' confidence increased over the course of the year. Efficacy for coding ($p = .004$, Cohen's $d = 1.01$) and Teaching ($p = .001$, Cohen's $d = .756$) both increased statistically and practically in strongly significant ways. In lay terms, District A teachers went from barely being confident to teach coding to being confident. While there is still room for growth into a strongly confident area, this amount of growth in confidence to teach coding in a matter of months bodes well for future growth.

3.4.2. Teachers' Coding and CT-specific Confidence

At the end of year survey, we were able to dig deeper in regards to District A teachers' confidence for coding principles, practices, and perspectives. These three constructs pertain to content knowledge, pedagogical content knowledge and dispositions that are relevant to computer science education, as promoted by the https://k12cs.org/ framework. We used the same 6-point scale so as to avoid neutral responses.

Tables 1 and 2 report on teachers' specific content knowledge of coding and computational thinking. By the final BootUp PD workshop, District A teachers had crossed into the "confident" region (4.00-4.99), as opposed to the barely "somewhat confident" region (3.00-3.99) they started at. The only exception was with the notion of abstraction, which appears to be the area where District A teachers are less confident with their computational thinking at this point.

Table 1. Teachers' Confidence for Specific CT Concepts by the Last PD

CT Knowledge				
How confident are you in YOUR OWN computational thinking knowledge of...				
	Mean	SD	Max	Min
...pattern recognition	4.47	1.30	6.00	2.00
...algorithms	4.07	1.44	6.00	2.00
...decomposition	4.07	1.33	6.00	2.00
...evaluation/analysis (debugging)	4.00	1.41	6.00	1.00
...abstraction	3.80	1.32	6.00	2.00

Table 2. Teachers' Confidence for Specific Coding Concepts by the last PD

Coding Concepts				
Rate your confidence with each of the following coding concepts				
	Mean	SD	Max	Min
Sequence	4.67	1.11	6.00	3.00
Loops	4.60	1.55	6.00	1.00
Algorithms	4.20	1.47	6.00	1.00
Variables	4.13	1.25	6.00	2.00
Functions	4.07	1.03	6.00	3.00
Conditionals	4.00	1.36	6.00	2.00

In regards to coding-specific content knowledge, District A teachers are most confident with sequences and loops. They demonstrated some confidence for algorithms and variables and are just confident with functions and conditionals. This should come as no surprise for a few reasons. First, variables, functions, and conditionals are all more advanced coding concepts (though fundamental to coding). Second, these ideas were not introduced until later BootUp workshops. Thus, District A teachers would have had much less training and practice with these concepts. Sequences and loops, on the other hand, are concepts that teachers make use of in almost every coding project. It will be interesting to track teachers' growth in their content knowledge over the next few years. If the type of coding projects they engage their students only make use of sequences and

loops only, it may be that we see a greater separation between their confidence for basic and more advanced coding concepts.

3.4.3. Teachers' Confidence for Teaching Coding and CT

Tables 3 and 4 report on teachers' pedagogical content knowledge of teaching coding in specific ways. Namely, to what extent do teachers feel confident in their ability to engage in practices that promote effective computational thinking. Also, how well do they foster productive dispositions as they engage with coding?

Table 3. Teachers' Confidence to Foster CT Practices by the last PD

CT Practices				
How confident are you in your ability to...				
	Mean	SD	Max	Min
...collaborate around computing	4.53	1.25	6.00	3.00
...foster an inclusive computer culture	4.07	1.62	6.00	1.00
...recognize and define computational problems	4.00	1.41	6.00	2.00
...communicate about computing	3.87	1.30	6.00	2.00
...test and refine computational artifacts	3.47	1.60	6.00	1.00
...create computational artifacts	3.33	1.45	6.00	1.00
...develop and use abstractions	3.20	1.21	5.00	2.00

Table 4. Teachers' Confidence to Promote CT Perspectives by the last PD

Perspectives				
Rate your confidence in TEACHING each of the following computational practices/perspectives...				
	Mean	SD	Max	Min
Creating	5.20	0.77	6.00	4.00
Collaborating	5.20	0.77	6.00	4.00
Persistence	4.93	0.96	6.00	3.00
Tinkering/Remixing	4.60	1.06	6.00	3.00
Debugging	4.13	1.25	6.00	2.00

Table 3 shows the area where teachers felt the least confident of our measured constructs. While they felt more comfortable collaborating with computing, they were less comfortable communicating about computing (i.e., talking about it in real-world contexts) and in areas that required more content knowledge and experience, such as testing and creating computational artifacts and using abstractions. These practices are specifically more creative in nature and could be placed at the highest level of Bloom's

taxonomy of the cognitive domain. Thus, they represent higher order thinking that is required by coding teachers. It is likely that as they gain more experience coding and (especially) debugging programs, they will grow in their confidence in fostering these practices.

While Table 3 reveals that teachers may be less confident in their own ability to create, Table 4 actually shows that they are quite confident in their ability to help their students create and collaborate. They also demonstrate higher confidence in their ability to encourage persistence and an attitude of tinkering. Consistent with the above discussion, they are least confident in their ability to debug. This observation was evident in teachers' open-ended feedback about their challenges, where several mentioned that they were not yet comfortable in debugging students' programs. The ability to debug is strengthened over time as teachers build up a pedagogical content knowledge of coding and the common mistakes that students make in the different projects. As teachers themselves grow in their ability to debug, they may also become more confident fostering a debugging attitude in their students.

3.5. Teacher Evaluation of BootUp PD

District A teachers had the opportunity to provide formative feedback to BootUp facilitators after each workshop through a simple open-ended form that solicited feedback on what they liked and what could be improved. BootUp facilitators reviewed these comments following each workshop and made adjustments based on teachers' feedback.

In this section, we report on teachers' *summative* feedback on the BootUp Professional Development workshops. On average, District A teachers reported attending 3.69 BootUp PD workshops throughout the year. Teachers were asked to rate the workshops overall and also to rate the different components of the BootUp PD model. These ratings were all done on a 10-point scale. For the sake of evaluation, anything above an 8 is considered a good rating. Ratings in 7-8 range indicate that something was generally considered good, but could use some improvement. Items rated below 7 should be thoroughly examined to consider how they might be improved or removed from the PD model.

3.5.1. BootUp Ratings

Overall, District A teachers rated the BootUp PD training favorably, giving it an 8.53 rating in comparison to other PDs they have participated in. When asked to justify their rating, teachers provided a variety of different answers. For some, it was the hands-on and engaging nature of the training. For others, they felt that the training was relevant to contemporary needs and jobs. Some appreciated the time they were given to practice, but wished they could have more time and more training. A few cited the BootUp resources. Thus, it appears that all District A teachers appreciated the BootUp training, but they each found different professional reasons for their valuation of the workshops.

Table 5 breaks down teachers' ratings of the various BootUp PD components. District A

teachers rated all BootUp components favorably. They especially found the model teaching and hands-on learning aspects to be useful. They were less enthusiastic about teacher discussions and peer coaching. It appears, however, that not all teachers participated in peer coaching. Since there was not an option to indicate that a teacher did not experience a particular component, it is believed that these teachers marked "0" for that component. Thus, it may be that peer coaching was seen more favorably amongst those teachers who participated in that experience.

Table 5. District A Teachers' Summative Evaluation of the BootUp PD Components

BootUp Component	Mean	Min	Max	SD	Count
Model Teaching BootUp facilitators demonstrating the lesson as a teacher.	9.07	7	10	1	15
Hands-on Learning Practice completing projects during PD	8.93	7	10	1.06	15
Coder Resource Student materials, including video walk-throughs and debugging slides.	8.53	5	10	1.41	15
Videos: Walk-throughs of completed projects and how to work out each section of a coding project.	8.47	6	10	1.36	15
Sharing Projects/Ideas: Time given during PD to discuss and share ideas with peers.	8.47	5	10	1.54	15
Site Visits: BootUp facilitators visit teachers at their schools and offer formative feedback/support.	8.2	0	10	2.56	15
Topic Discussions: In-person and online venues provided for teachers to discuss specific coding questions and ideas.	7.27	0	10	2.26	15
Peer Coaching Peers visit a colleague at their own school and offer feedback.	7.07	0	10	3.19	15

3.5.2. Before and After

To better understand teachers' experiences with BootUp, it is helpful to paint a picture of

how teachers' felt before and after the workshops and then to examine how they felt they grew during that time. Table 10 shows a side-by-side comparison of how teachers felt about teaching coding before and after the training. Each row represents comments from the same teacher. There were two different types of teachers. About half the teachers began with a level of intimidation, unsurety or trepidation for coding. The other half already believed it to be fun or important. Even in these cases, we can see that teachers felt a marked level of improvement, interest, or confidence to teach coding after having participated in the BootUp workshops (see Table 6).

Table 6. Before/After Comparison of District A Teachers' Thoughts about Teaching Coding

Before	After
Intimidated	
I don't have time to teach coding. I don't know where to start. I don't have enough technology. Kids will struggle with coding. **I have to know everything about coding before I teach others.**	Oh my gosh, **coding is so much fun! It's okay if I struggle.** Often the kids will figure it out and teach me. I have students coding outside of class on independent projects (not assigned). **I am so thankful I have this opportunity and now 620 students at my school get this opportunity.**
I was **worried I would not have all the answers.**	I can **learn from the students** and they can learn from each other.
I didn't know anything about it... so I didn't have feelings about coding at all!	**Wow! So cool. Would love to be able to integrate all that I have learned into the classroom**. I can see that it is a valuable for students to learn.
I always was interested in learning more, **but kind of intimidated by it.**	I see that **it is accessible to all abilities and levels.**
unsure about my competence.	**confident** that I can do this with my students.
...**unsure** of the "why's" and "how's" of teaching coding.	**Coding is an exciting part of any curriculum for students of all ages**. I am considering sponsoring an after school coding club next year.
I did not know much about it, and **was not comfortable teaching it.**	I feel **much more comfortable than before**, however I think it will take more time and practice with kids before I feel completely comfortable and confident.
Where do I start?	**Start with Scratch Jr. and Scratch**. I also like the non-tech activities.
Already Excited	
It's important for students to be as computer literate as possible. However, **it's not always practical for homeroom teachers to be the person giving the instruction.**	**Coding can be incorporated into many content areas** and can be used often in the homeroom classroom.
I used coding for a couple different standards.	**I use coding across curriculum.**
confident that kids would connect with it and use it to demonstrate competency in content areas.	**More confident** with the open-endedness of Scratch.
Coding is a fun and essential tool to expose to elementary students to gain skills oh how to do step by step procedures to solve a problem. It was a fun thing to do that was out of the box.	My feelings are still the same as above. However, **I can make more connections to tie coding in with other content areas** to show learning and extend their computer science/coding skills. I have also incorporated more unplugged activities as well.
This is exciting and I want to learn more.	This is exciting and **I want to learn more and get**

	more teachers to integrate into their classes.
Excited, interested in using it.	**Even more excited** since I have a better idea about integrating it throughout the curriculums.
Experience with coding is necessary for students, *especially starting in elementary school.* Learners use problem solving skills, creativity, and critical thinking.	The same. **I want to expose my students to even more coding opportunities.**

When asked how their confidence to teach coding changed over the year, teachers nearly universally indicated an improvement. Interestingly, they attributed this growth to three sources, with many teachers citing multiple sources. Namely, teachers felt they had grown more confident to teach coding due to the *BootUp training*, but also due to actually *implementing it in the classroom*. Several teachers also cited the fact that they had *wonderful colleagues* whom they could consult with about teaching coding or observe.

4. Conclusion

This evaluation gathered quantitative and qualitative data from District A teachers who participated in BootUp professional development workshops throughout the 2019-2020 school year. Based on the evidence provided herein, the training has been successful, both statistically and practically. Teachers reported growth in their beliefs about the importance of teaching coding, even though they began with a relatively high valuation already in place. Teachers were barely confident in their ability with their coding content knowledge and pedagogical content knowledge and increased significantly in both of these areas. Teachers are the most confident with their ability to teach sequences and loops. They still feel slightly unconfident in their ability to teach more advanced coding concepts, such as abstraction and debugging. Teachers describe their success with coding in terms of their students. Many teachers expressed surprise that even their youngest students love and are able to code.

Despite these successes, there remains room for growth. Only about half of District A participants reported teaching coding once a week or more often. This means that there is still uneven access to coding education for District A students. Teachers' greatest challenges in their efforts to teach coding are embodied in their own lack of knowledge of and experience with coding. However, some teachers are realizing that they do not need to know everything in order to effectively teach elementary coding. As one teacher who initially felt she needed "to know everything about coding before teaching others" put it, "coding is so much fun!...it's ok if I struggle."

District A teachers described several conditions that they felt led to their success this year. They highly valued the BootUp facilitator's modeled lessons as well as the hands-on learning opportunities during the workshops. They also appreciated each others' experience, with many teachers indicating that they felt comfortable talking with their peers about computing. Teachers who were the most successful were those who taught coding more often. In the end, the BootUp trainings appear to have been effective and have resulted in District A teachers' increased confidence to teach elementary coding.

BootUp Professional Development Report

District B (June 2020)

Evaluated by:

Peter Rich, PhD
Brigham Young University

1. Executive Summary

In the summer of 2018, BootUp partnered with District B to provide professional development (PD) to elementary classroom teachers on how to teach elementary coding. BootUp PD consists of several day-long workshops spread throughout the school year. Workshops are supported by teacher and student resources, hands-on activities, in-classroom modeling, and peer site visits. This report provides an independent analysis of BootUp's efforts to train District B teachers during the 2019-2020 school year.

There are 5 key findings from the efforts of BootUp with District B teachers during the 2019-2020 school year. Namely…

1. Almost all District B teachers who participated in the BootUp PD trainings are now regularly teaching coding in their classes, though only about 55% teach it weekly to the same group of students;
2. District B teachers were overwhelmingly positive about their BootUp PD experience this year;
3. District B teachers demonstrated growth in their confidence to code and to teach coding in nearly every measured area;
4. District B teachers learned that "5-6 year olds can code!" (as one teacher put it). In fact, the majority of teachers listed students' excitement for coding as their main success.
5. District B teachers ranked nearly all aspects of BootUp PD highly favorably, though peer site visits appeared to be less well-received.

The remainder of this report details the methods used to achieve these findings, how these findings were reached, and data from teacher surveys throughout 2019-2020, as well as a comparison to teachers' knowledge and beliefs about coding when they first began in the 2018-2019 school year.

2. Methods

This evaluation was performed by Peter Rich, PhD, of Brigham Young University. Dr. Rich teaches undergraduate and graduate courses on the design, development, and psychology of instruction. Dr. Rich's research over the past decade has focused on how to teach coding to elementary-aged children, resulting in several publications on this topic. For this evaluation, BootUp coordinated the desired outcomes and research questions with Dr. Rich. Beyond that coordination, BootUp has allowed Dr. Rich complete independence to analyze and interpret data collected via teacher surveys.

2.1. Data Collection

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At the final BootUp workshop of the year, teachers again complete the TBaCCT. They also answer several additional questions about their: (a) coding-related teaching practices throughout the school year, (b) confidence with specific coding concepts, practices, and perspectives, and (c) personal experiences teaching coding, and (d) feedback and evaluation of BootUp's professional development.

2.2. Data Analysis

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3. Results

In the following sections, we first present an overview of the participating teachers. We then discuss teachers' classroom practices and their experiences in teaching coding. We then follow up with an analysis of teachers' confidence for coding and for teaching it in the classroom. Finally, we present teachers' evaluation and feedback of the various components of BootUp's professional development experience.

3.1. Teacher Demographics

The District B teachers who participated in the BootUp PD during the 2019-2020 school year are an experienced and highly certified group of teachers. Thirty teachers completed the year-end survey. The average teacher reported having taught professionally for 15.5 years (with 13.5 of those teaching the same grade)[1]. However, the average teacher only

[1] Medians were calculated rather than means to offset the effect of outliers.

had 2 years' experience teaching coding, demonstrating how new they all are to this topic. Table 1 shows the distribution of District B teachers who completed the year-end survey across the grades they teach. All teachers reported that they are certified classroom teachers. Twenty-four reported having earned a master's degree, while the remaining 6 had earned their bachelors.

Table 1

District B teacher grade distribution

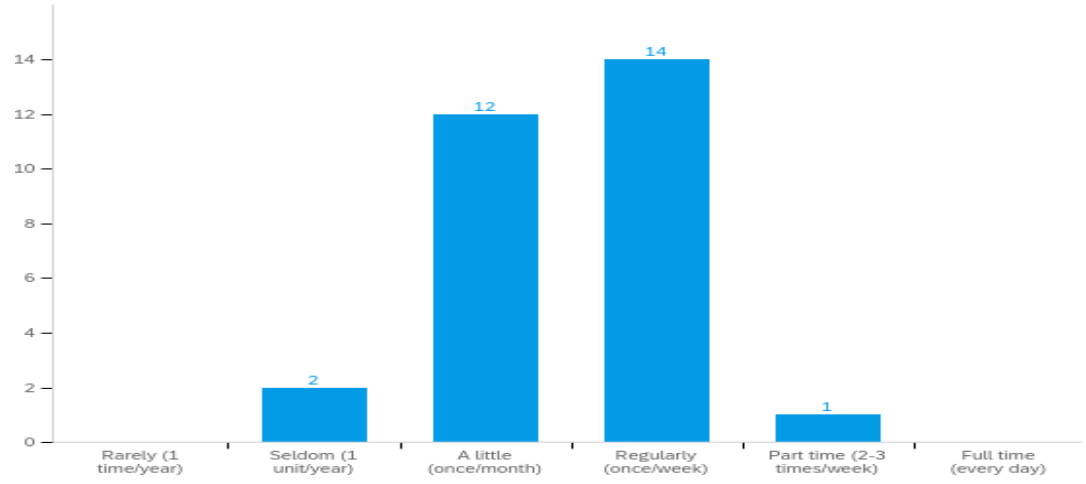
Grade	Teachers
Kindergarten	6
1st	5
2nd	5
3rd	5
4th	5
5th	4

3.2. Teaching Practices

Half of District B teachers reported teaching coding weekly or more often, with most of the rest reporting they teach coding about once a month. These lessons are typically taught to the same group of students. Thus, the majority of District B elementary students are likely participating in coding activities at least once a month, with half of these students participating weekly. Most (65.5%) of coding lessons tend to be on the shorter side (16-30 min), with the remaining lessons mostly lasting 31-45 minutes. Two teachers reported engaging their students in longer lessons (45+ min).

Figure 1

How often District B teachers are teaching coding.



3.3. Classroom Coding Experience

To find out what teachers' qualitative experience was like, we asked teachers about their *successes* and *challenges* in teaching coding. To analyze their answers, we categorized each response thematically. It was possible for a single response to report on multiple themes. While responses resulted in a variety of answers, some themes occurred more predominantly across teachers. The first theme that stuck out was the contrast between teachers' responses regarding successes vs. challenges. While 70% of teachers' comments regarding their successes focused on students (and 30% on teachers), the pattern was flipped for challenges (76% teacher-focused challenges). Thus, it might be said that District B saw success through their students' eyes and struggles through their own.

3.3.1. Main Successes

Teachers' main successes overwhelmingly focused on student excitement for coding. Teachers across all grade levels reported high student interest and engagement with coding, as noted by the following teacher comments:

Table 2

Teacher Comments About Student Excitement for Coding

Grade	Teacher Quote
K	**Kids love coding!** They get excited and anxious to learn new things!
K	**The students love blue bot and Scratch Jr.** They are being exposed to language they will continue to use for years to come and gain confidence that they can be successful with coding and other technology. The productive struggle the students go through in debugging and making their sprite do the 'right' thing teaches perseverance and lends itself to collaboration with peers who may not socialize with each other in other settings.
1st	**I have seen students gain an excitement and enthusiasm for coding**, especially a few students that don't necessarily do well academically; but have found their niche and confidence in coding.
1st	**My students are excited to animate and create algorithms!** They are willing to take risks, get things wrong, look for solutions and communicate with each other their discoveries/creations.
1st	I've had a lot of success with reverse engineering in my classroom. It is amazing to me what my students are able to problem solve without my guidance. **Student engagement is phenomenal during reverse engineering projects.**
1st	**Students are excited as they are presented with projects to code in my classroom.** They sometimes struggle, which is a success as other students share their knowledge and collaboration happens. I facilitate and everyone learns.
2nd	**My students love it and I think they think the learning is much more engaging. They are excited to do it! Therefore, I am excited to teach it!**
2nd	**Students are excited about working through problems and finding solutions without my help.** I believe their grit has increased.

3rd	**The kids are super engaged and MOST love coding.** They have a high interest and I have seen improvement with their problem solving and creative abilities.
3rd	**The kids' interest level is exciting to watch.**
4th	**Seeing kids get excited after planning their story,** and then being able to tackle their projects independently.

In addition to excitement, there were 4 other successes that at least 5 teachers reported. Namely, they noted that through engaging in coding activities, students **collaborated**, **problem solved**, demonstrated **creativity**, and **persevered**, as noted in Table 3.

Table 3

Other Common Successes District B Teachers Reported

Grade	Quote
	Collaboration
K	[Coding] **lends itself to collaboration with peers** who may not socialize with each other in other settings.
1st	I have seen my students do **amazing teamwork and use great communication skills.**
1st	Students are excited as they are presented with projects to code in my classroom. **They sometimes struggle, which is a success as other students share their knowledge and collaboration happens.** I facilitate and everyone learns.
3rd	**Increased collaboration**, stretching to learn, interactions across grade levels.
5th	I have liked watching the students become **peer teachers** and assist others in the classroom with coding, as well as younger grades.
	Creativity
K	I'm amazed at how well the **students jump right in and their problem solving skills and their creativity.**
1st	They understand that some things take a few tries to get it right and that that's okay. **This also allows opportunity for some creativity and fun!**
3rd	I have seen **improvement with their problem solving and creative abilities.**
5th	It's been great to see **how quickly and how creatively the students challenge themselves and others.**
5th	Coding has allowed some of **my students to excel in creating things**.
	"Productive Struggle"
K	Watching young students try new things and **learning from their mistakes.**
K	The **productive struggle** the students go through in debugging and making their sprite do the 'right' thing **teaches perseverance**
1st	They understand that **some things take a few tries to get it right and that that's okay.**
1st	**They sometimes struggle, which is a success** as other students share their knowledge and

	collaboration happens.
3rd	Seeing students who struggle in school find success while doing coding, and seeing students who everything comes easy to have to struggle.
	Problem Solving
K	I'm amazed at how well the students jump right in and **their problem solving skills** and their creativity.
1st	I've seen them **problem solve together**, help each other, and continue to try new things.
1st	It is amazing to me what **my students are able to problem solve without my guidance**.
2nd	Students are **excited about working through problems and finding solution**s without my help. I believe **their grit has increased.**
3rd	I have seen **improvement with their problem solving** and creative abilities.

3.3.2. Main Challenges

While teachers' successes focused on students, their challenges were teacher-centered. District B challenges can be narrowed to two specific issues: knowledge and time. Knowledge-based challenges refer to teachers' lack of or insecurity about their coding knowledge, which time-based challenges refer to the difficulty of integrating coding into their otherwise busy schedules.

Table 4

Teachers' Knowledge- based Challenges Around Coding

Grade	Teacher Quote
1st	**I don't always feel like I know or can remember from PD to PD how to do the different aspects of coding**, but I have students that seem like naturals that can just problem solve on their own and teach others.
2nd	**I still have a lot to learn**, but that is great! I think being open to the fact that this takes time to get better. It also takes interacting with the materials to better understand it!
2nd	**My students tend to know more than I do** in certain areas.
2nd	**Keeping up with the kids!** They always amaze me and **I am continually learning from them.**
2nd	**Not being knowledgeable of coding** and not comfortable with
technology 3rd	**My limited abilities** make it hard at times to help the kids.
4th	**Some of my students catch on at a faster pace than I do** and work are faced with problems that neither of us can debug.
4th	**Answering questions of what code should be used in certain circumstances**. Just still not familiar with everything.
4th	**Understanding of various keys and their functions.**
5th	**I cannot always answer the students' questions**.
5th	**I do not have a good grasp on how coding works,** therefore I have to depend on others to help me with it.

Table 5

Grade	Teacher	Teachers' Challenges With Time for Coding
K		The biggest challenges to doing coding is **finding the time to do it** and having enough devices for students to get enough practice on it. Sharing is hard but also valuable at times.
1st		**Sometimes I have not been able to correctly gauge how long a lesson will take us.** Occasionally, the project takes longer than we have time for, and other times the students are much faster than I anticipate. Since our days are somewhat tied to our larger schedule, this has been a learning curve for me, but not an insurmountable problem at all.
1st		Challenges would be **getting time to do it in my already tight schedule.** I know it's important and I'm finding more ways to implement Scratch Jr. and blue bots into my curriculum.
2nd		**Finding time is sometimes a challenge to fit coding in the classroom**. I would still like to find other ways to creatively integrate content they need to cover in the classroom with coding activities.
3rd		**Challenges have been with time to work with our grade level team between our training.** We are provided time, but it is usually to complete the previous task. It is getting better the more time we get. We are hoping to be able to add this to our PLC time but with the many other agenda items, it usually gets left out. We will continue to find a balance.
3rd		**Finding the time to fit it into my curriculum** on a consistent
basis. 4th		**1. Time**
5th		**Finding the time to do it**.

3.4. Confidence with Coding

We measured teachers' confidence with coding in several ways. The TBaCCT was administered at the beginning and ending of the year as a comparison measure. The end of year measure also asked questions with coding-specific jargon that teachers may not have been able to answer at the beginning of the year. Inasmuch as this evaluation reports on the 2nd year of training, we were able to compare teachers' confidence over time. The key take-away from this analysis is that **District B teachers have grown more confident with their own coding knowledge and with their ability to teach coding each time we have measured their confidence on nearly every measure.**

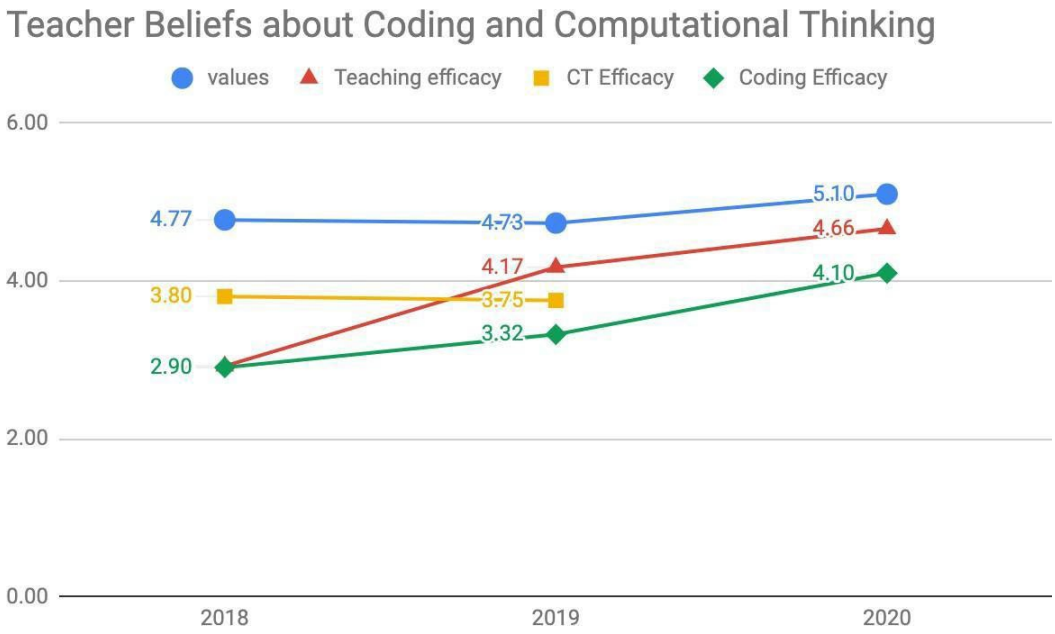
A brief explanation of each measure and its questions follows. For each set of questions, teachers were presented with a statement and asked to indicate to what extent they agreed or disagreed with that statement. All of the measures are based on a 6-point Likert-type scale, ranging from strongly disagree to strongly agree (or in the case of confidence questions "no confidence" to "complete confidence"). A 6-point scale was

used to avoid neutral answers. Answers over 3 represent presence of confidence, whereas answers less than 3 represent the lack of confidence for a particular topic. The long-term goal is to help teachers eventually average in the 5-6 range, though it's not expected that teachers will reach this level of confidence until they have taught computing for at least a few years.

3.4.1. Teachers' Beliefs

This first chart (see Figure 1) shows District B teachers' growth in their beliefs about teaching coding and computational thinking from their first training in 2018 to their final training in 2020. The TBaCCT asks teachers questions about the value of teaching coding to elementary-aged children, questions about teachers' confidence with coding and computational thinking (CT), and questions about their confidence to teach coding and CT. District B teachers demonstrated a high valuation for coding from the get-go. Initially, teachers showed a lack of confidence with their own coding knowledge and their ability to teach it to children. By the end of their first year, their confidence with coding knowledge had inched into the "somewhat confident" zone, while their confidence to *teach* coding had jumped considerably. After another year of BootUp training, teachers' confidence with coding and with teaching coding has increased considerably. District B teachers' confidence to teach coding is steadily increasing toward the 5+ higher confidence range. Meanwhile, they have moved beyond unconfidence to "somewhat confident" with their own coding abilities. Thus, there has been considerable growth in District B teachers' confidence with coding and teaching it in their classrooms, though there remains room for further growth.

Figure 2



It is important to note that data regarding teachers' confidence with Computational Thinking (a problem solving approach used by programmers), was lost during the final 2020 administration. Thus, we cannot compare growth over time on this construct. Fortunately, we included another question on the year-end data that provides more detail on teachers' ability to foster computational thinking.

3.4.2. Teachers' Coding and CT-specific Confidence

Figure 3 and Figure 4 show teachers' growth in their confidence with specific coding and computational thinking concepts. We did not initially ask about these in the pre-survey because the questions require a knowledge of coding to begin with. ***A comparison of teachers' confidence from the end of one year to the next, however, reveals an increase in every measured coding or CT concept.***

District B teachers started with a higher self-efficacy for sequence. This is one of the more basic coding concepts and is practiced in every elementary coding program. Teachers were less confident with more advanced concepts such as variables and conditionals, which is to be expected, as these concepts are not used as often in elementary programs and are more abstract. In fact, **all three of the more advanced foundational coding concepts (functions, variables, and conditionals) were the areas where teachers showed the most growth this year.** This is very promising, as it shows growth beyond just basic coding.

Figure 3

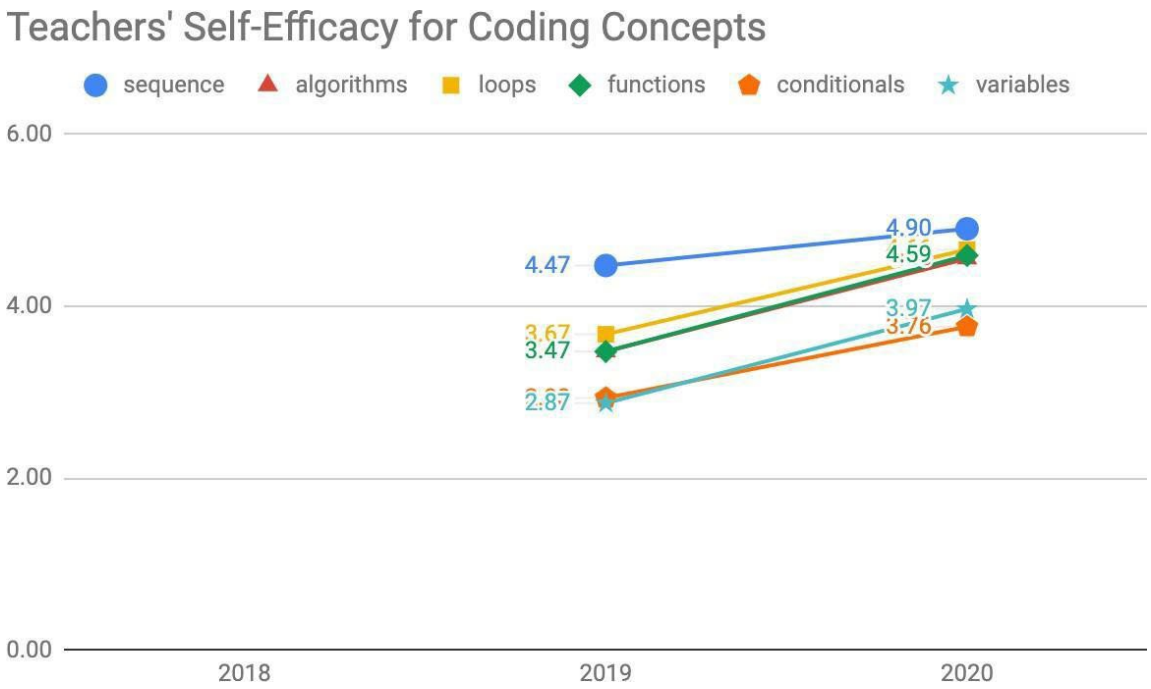
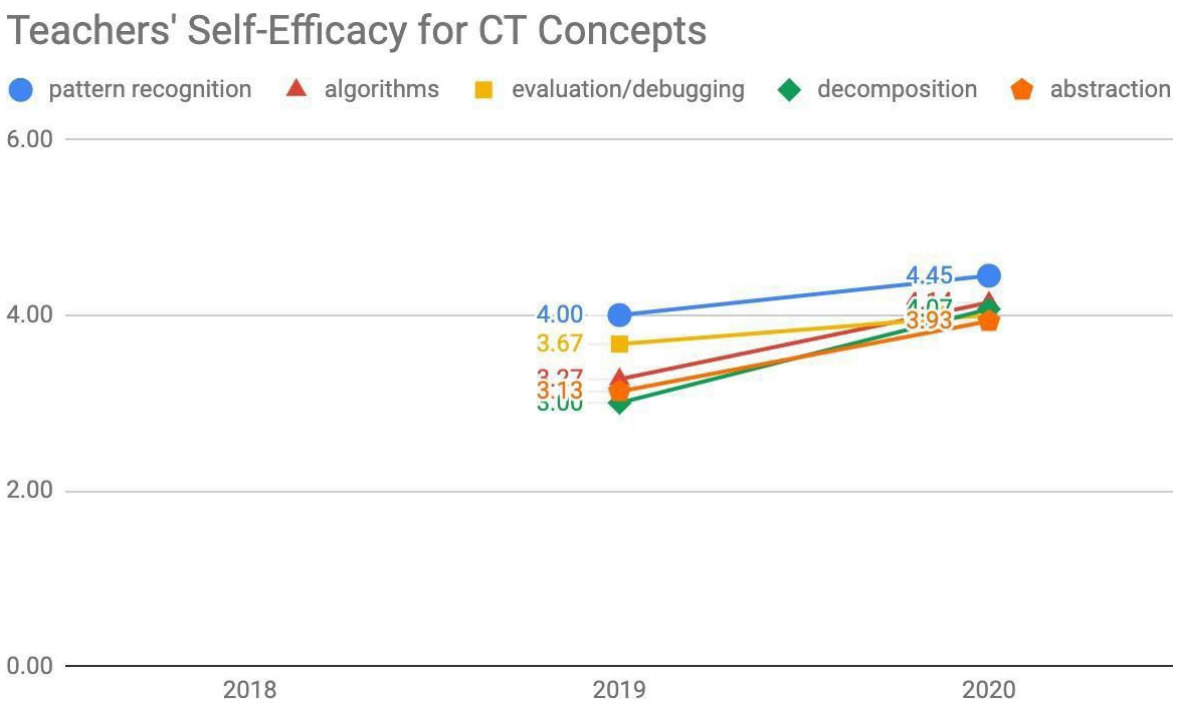


Figure 4



3.4.3. Teacher's Confidence for Teaching Coding and CT

A popular framework for interpreting the learning that occurs during coding was provided by Brennan and Resnick (2012), of principles, practices, and perspectives. **Principles** refer to the conceptual content-based understanding and were measured by the questions reported in the prior section. **Practices** refer to effective ways of approaching problems computationally, such as through collaboration, communication and creation (three important 21st-century practices). The practices we asked teachers about are those chosen and represented in the k12cs.org framework (see k12cs.org). **Perspectives** refer to the dispositional characteristics that one might experience while learning to code, such as persistence in the face of difficulty, debugging problems, and tinkering/remixing others' code.

Figure 4 shows a near 1-point jump in confidence to foster computational practices in their classrooms from District B teachers between the end of their first and second years of BootUp training. Whereas teachers previously were unconfident in their ability to develop and use abstractions, create, test and refine computational artifacts, they now are showing cautious confidence in fostering these practices in their coding classes. This growth was nearly uniform across the board of computational practices and is likely due to District B application of coding in the classroom.

Figure 5

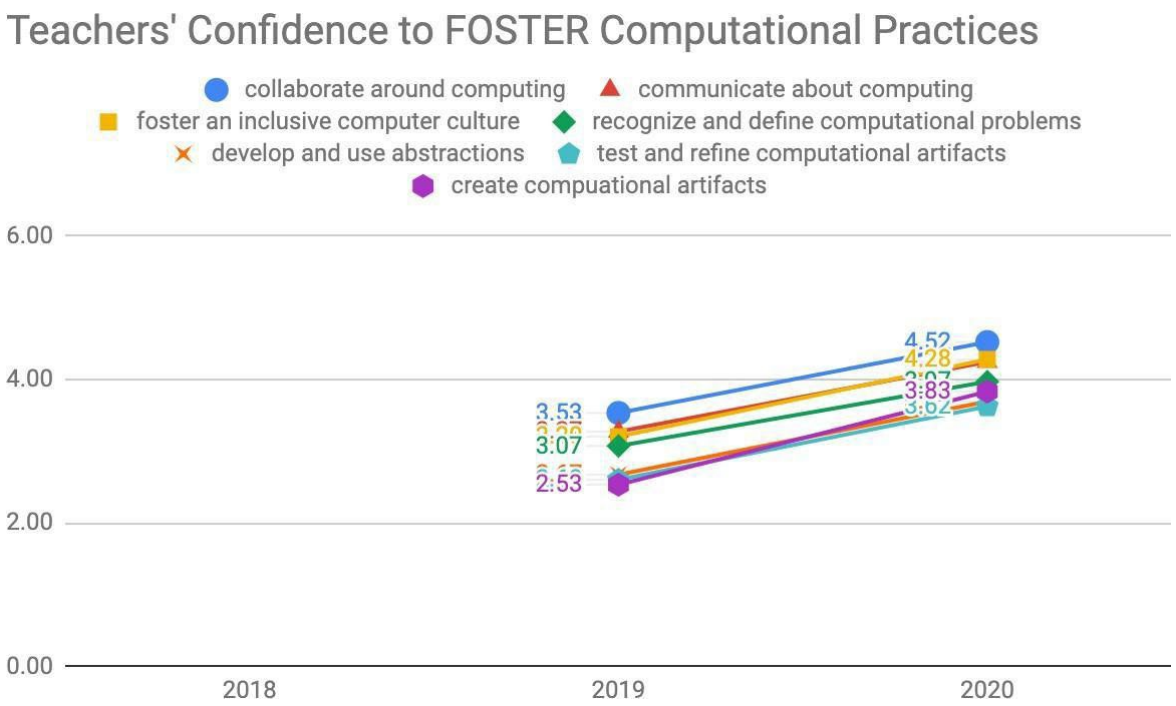
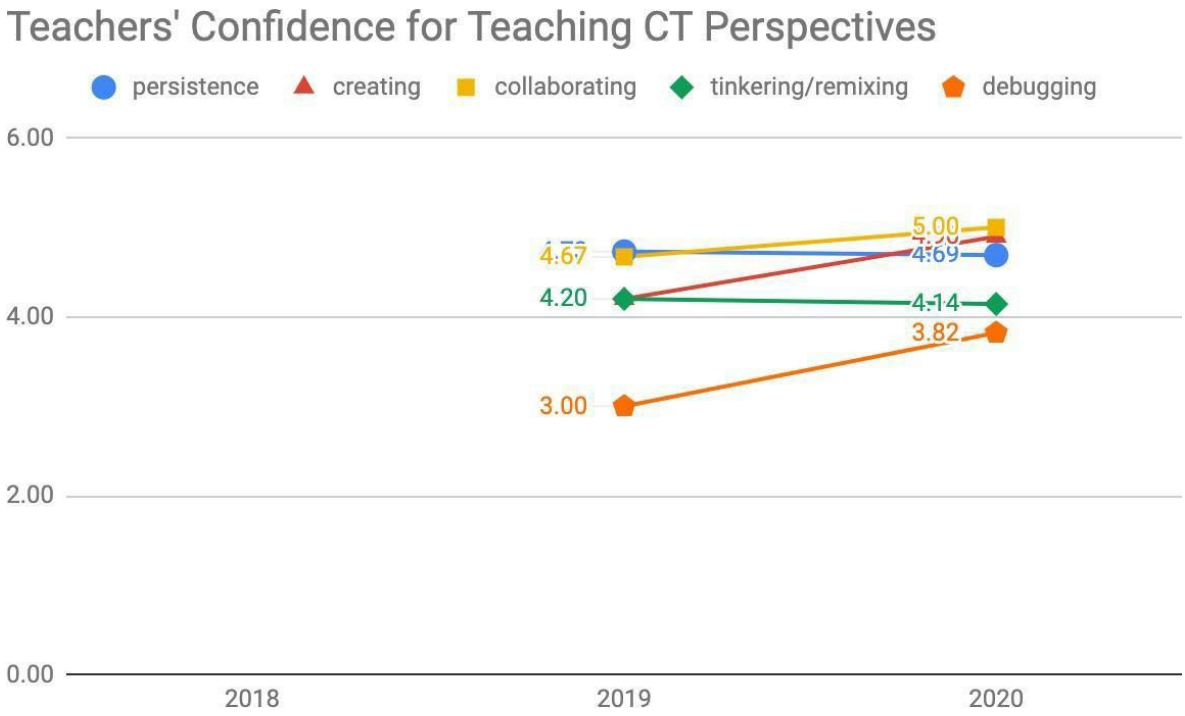


Figure 5 reports on teachers' ability to teach specific CT perspectives. Teachers reported growing confidence in collaborating and creating, especially, even reaching the 5-point threshold in collaborating. Likewise, while teachers were still very unsure about their ability to teach debugging last year, they grew the most in their confidence to teach this perspective in their coding classes. Despite this growth, they are still in the less confident range, demonstrating a need to continue strengthening teachers' confidence to help students foster a debugging attitude.

Curiously, teachers reported no significant difference in persistence or tinkering/remixing. Admittedly, teachers already demonstrated a somewhat higher confidence for teaching persistence. As evidenced by teachers' comments about successes, persistence is a topic that several teachers have qualitatively observed in their students. Tinkering/remixing is another area that showed no appreciable growth (it decreased a little, but is statistically the same). The reason for this may have been revealed in teachers' comments about challenges; namely, many District B teachers still feel inadequate in their coding abilities, which would suggest that they may not be comfortable helping to modify others' code.

Figure 6



3.5. Teacher Evaluation of BootUp PD

In this section, we review feedback provided by District B teachers regarding their experience with BootUp PD. In addition to the feedback collected for this evaluation, teachers also provided feedback after each workshop, which was reviewed by BootUp facilitators who responded to the feedback to make formative adjustments to following workshops.

On average, District B teachers reported participating in 4 BootUp workshops this year. BootUp PD consists of several different components. BootUp's PD model evolves as they work closely with districts to incorporate teacher feedback. After each training, teachers provided formative feedback to BootUp facilitators, who responded to this feedback and incorporated it in their subsequent meetings. In addition, we asked District B teachers to rate each of the BootUp PD components at the final training of the year (see Table ##). Any component rated above an 8 should be considered a success. Ratings in the 7-8 range should be considered effective, but could be improved slightly. Components rated lower than a 7 should be considered less effective and in need of revision.

Overall, District B teachers found most BootUp PD components to be effective, rating all but two practices above an 8. Teachers were especially complimentary of the hands-on

learning practice offered during PD. Teachers also appreciated seeing BootUp facilitators demonstrate how to teach, whether through a site visit or as a model during a workshop. Topic Discussions were rated in the 7-8 range, suggesting that they were mostly effective, but could use some minor revisions. Peer site visits, however, were not rated very favorably. It could be that such visits take teachers away from their own classrooms or that they are uncomfortable teaching in front of their peers. Whatever the reason, it's clear that this is a component of BootUp PD that could use some more serious revision in order for teachers to find it useful.

Table 4.
District B Teachers' Summative Evaluations of Specific BootUp PD Components

BootUp Component	Avg.	Min	Max	SD	Count
Hands-on Learning *Practice completing projects during PD*	9.17	6	10	1.12	29
Site Visits *BootUp facilitators visit teachers at their schools and offer formative feedback/support.*	8.9	3	10	1.6	29
Model Teaching *BootUp facilitators demonstrating the lesson as a teacher.*	8.66	5	10	1.58	29
Videos *Walk-throughs of completed projects and how to work out each section of a coding project.*	8.55	6	10	1.45	29
Sharing Projects/Ideas *Time given during PD to discuss and share ideas with peers.*	8.55	3	10	1.67	29
Coder Resource *Student materials, including video walk-throughs and debugging slides.*	8.41	5	10	1.38	29
Topic Discussions *In-person and online venues provided for teachers to discuss specific coding questions and ideas.*	7.29	2	10	2.37	28
Peer Coaching *Peers visit a colleague at their own school and offer feedback.*	5.83	0	10	2.79	29

Teachers were also asked to compare this professional development experience to other PD experiences they had participated in (on a scale of 1-10). Anything above an 8 would be considered successful and above average. Overall, District B teachers rated the BootUp PD experience at an 8.14/10. When asked to provide a rationale for this rating, the majority of responses were overwhelmingly positive. The main reasons for their positivity were (a) the hands-on nature of the trainings, and (b) the facilitator's relatability and responsiveness to teachers' needs. The three following quotes illustrate these feelings, which were similarly stated in some form by the majority of teachers.

> “It wasn't just a one time thing. We have the chance to come back and review and expand. We also get to be hands on and actually do Scratch Jr. or blue bots, which makes me much more likely to do it in the classroom.”

> “Our facilitator has been wonderful. She is knowledgeable and personable. She is willing to walk into our classrooms to teach or guide a lesson. She gets involved with the students right away, creating a connection with them.”

> “Brenda has been amazing and very helpful. She slows down and repeats when necessary, but also speeds up when needed to. She allows us time to talk about how we can incorporate this in our classroom and allows us to collaborate. She is available to us anytime.”

We also asked teachers to compare what they thought about coding before and after training. Before training, teachers had a general sense that learning to code was valuable, but felt intimidated at having to teach it themselves. After training, teachers reported feeling “empowered” and “more confident.” We further asked how their confidence had changed throughout the year. *Every single teacher* reported an increase in their confidence to teach coding. Overall, teachers’ responses could be summarized as cautiously confident, as evidenced by this teachers’ comment,

> My confidence to teach computing has increased due to the wonderful instructional support we have been given, the detailed lessons on Boot Up, and the courage to allow for hands-on experiences.

4. Conclusions

This evaluation gathered quantitative and qualitative data from District B teachers who participated in BootUp professional development workshops throughout the 2019-2020 school year. Based on the evidence provided herein, it would be difficult to conclude anything other than that the training has been successful. Teachers have reported growth in nearly all measured areas not only over the past year, but since they began the workshops the year prior. Teachers are the most confident with their ability to teach sequences, loops and functions. They still feel slightly unconfident in their ability to teach more advanced coding concepts, such as variables and conditional logic, though their confidence in these areas climbed considerably. Teachers’ greatest challenges in their efforts to teach coding are embodied in their own lack of knowledge of and experience with coding. However, some teachers are realizing that they do not need to know everything in order to effectively teach elementary coding. As one teacher put it,

> “I don’t need to be an expert on coding to teach coding. I need to provide windows of opportunities to expose students to coding.”

In other words, District B coding teachers are learning to be facilitators of coding.

Perhaps most importantly, District B teachers reported positive teaching experiences. Their successes focused clearly on student excitement for coding in the classroom, with some teachers pointing out that students who struggle in other subjects have excelled with learning to code. Before participating in BootUp professional development, many teachers reported being intimidated by the idea of having to teach code. After participating in BootUp professional development, they have changed their tune to be one of excitement and cautious optimism. More teachers are finding ways to integrate coding into their regular classes, with one first-grade teacher claiming,

> "I look for ways to incorporate coding vocabulary and technology experiences within my curriculum, so that students are making connections with their learning and applying what they know."

Despite the successes, there remains room for growth. In addition to insecurities about their own coding knowledge, teachers expressed concern about how to find the time to teach coding amidst all the other content they teach. Additionally, not all BootUp components appeared to have been as effective for District B teachers, especially peer site visits, which were ranked lower at the end of this year than the first.

Finally, teachers were overwhelmingly positive about their experience with BootUp PD. When compared with other professional development experiences, BootUp PD ranked above average. In this report we did not share all the positive comments about teachers' experience with the BootUp facilitator because those comments themselves would have filled another report. Perhaps it's more telling that there were no negative comments about the facilitator at all. According to District B teachers, the facilitator was courteous, knowledgeable and responsive to teachers' concerns, changing pacing and content as needed.