Hindsight 2020

GUIDEBOOK FOR VIRTUAL PROFESSIONAL DEVELOPMENT FOR COMPUTER SCIENCE TEACHERS
LESSONS LEARNED FROM SUMMER 2020

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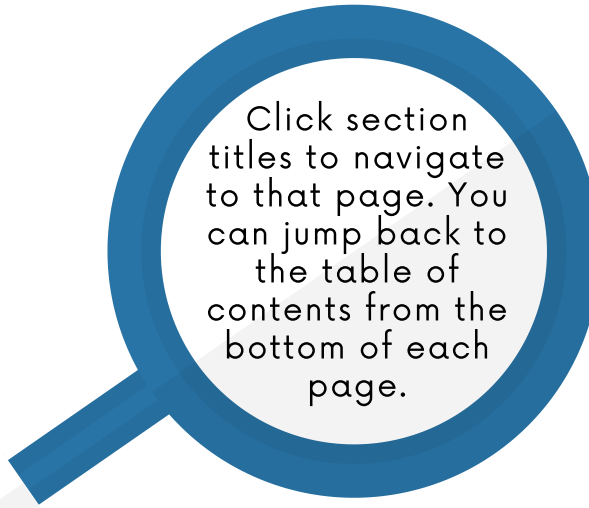- Kiersten Petersen - Education Development Center

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INTRODUCTION

This guide is based on the findings from the Hindsight 2020 study, which examined the summer shift in computer science professional development (CS PD) from face-to-face in 2019 to virtual in 2020 as a result of the pandemic.

USING THIS GUIDEBOOK

We organized this guidebook around several key themes that arose from our analysis of the Hindsight 2020 inventory, follow-up conversations with PD providers, and three in-depth case studies of providers.

This guidebook is intended to help prompt discussion of the variety of factors that could be considered in the development and improvement of CS PD, whether virtual, in-person, or hybrid, and highlight the collective wisdom of PD providers gathered via our Hindsight 2020 study. This guidebook is not designed to be the final word on best practices for the virtual CS PD experience but to spur conversation within project teams when planning PD.

THEMES

PLANNING FOR VIRTUAL CS PD
- Facilitator Training
- Scheduling
- Tools

DELIVERING PD CONTENT
- Teacher Community

EVALUATING PD
- Demographics
- CK/PCK
- Beliefs

EACH THEME PRESENTS:
- A summary of the theme and its key points
- Short examples from PD providers in our study
- Key questions that arose for the PD providers
- Additional helpful resources

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EVIDENCE-BASED BEST PRACTICES FOR PD

While this study uncovered specific adaptations made by CS PD providers in response to the pandemic, many of these alterations were aligned with design elements associated with effective PD [5] and best practices for the delivery of virtual PD such as coaching and expert support, active learning activities, opportunities to collaborate, and adequate time for teacher learning and reflection. Studies have found [2] that both teachers and administrators alike agree on five characteristics of effective PD.

What makes impactful PD?

Teachers and administrators identified five key characteristics of effective teacher PD.

1. relevant to teachers' interests and needs

2. interactive with hands-on opportunities to practice new knowledge and skills

3. delivered by someone who understands the teaching experience

4. respectful of teachers as professionals

**5.** sustained as part of an ongoing learning opportunity

Bill & Melinda Gates Foundation, 2014

"the point is that truly effective professional development may stem not from a single list of 'best practices' but instead from a collection of core elements that must be adapted to the unique characteristics of a particular school"
-Guskey [8]

IMPROVING YOUR PD

Teachers' impacts on student learning has been shown to be much greater than any other variable by two to three times [14]. They can be taught to be persistent about their students' learning, to develop their self-efficacy, and to contribute to their professional support system [11]. There is also empirical evidence on their direct impact on students' learning of CS [26, 16].
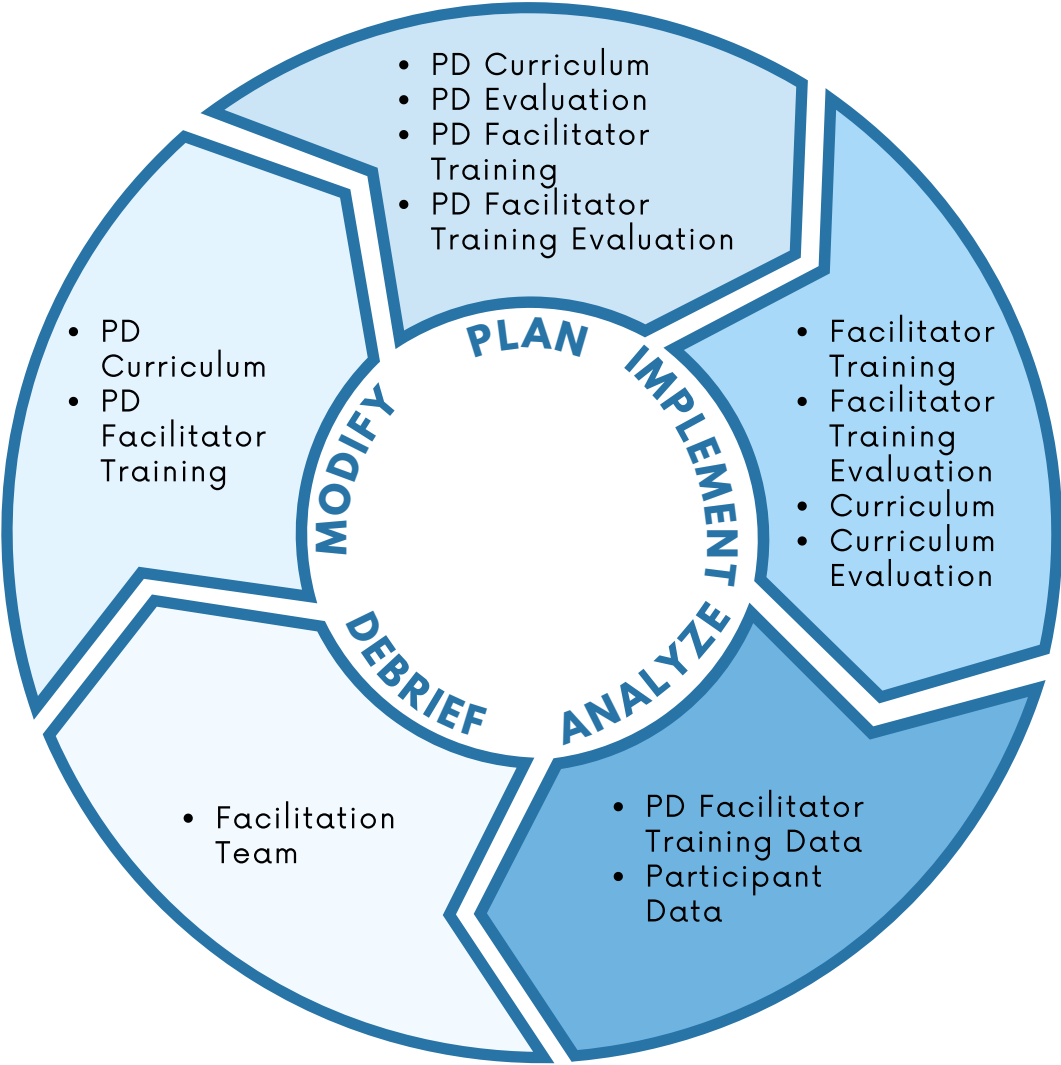
While teacher impacts are critical, they work within a complex environment. Each district and school community has their own set of needs and values, and current structures in schools and districts can also influence the delivery of CS. Becoming more aware of these needs, values, and structures can enable local PD providers to align evaluation accordingly.

THE HINDSIGHT 2020 STUDY

Funded through a NSF Eager grant, the purpose of this project was to analyze and to learn from the unique experience of summer 2020 PD programs for CS teachers. During this time, many, if not all, programs were forced to unexpectedly pivot from in-person to virtual instruction due to the COVID-19 pandemic. The goal of this project was to gather lessons learned from these rapid changes in order to help inform future online PD efforts, which will be essential in the face of future situations which limit face-to-face PD, and to support a virtual approach as a scaling mechanism for teacher PD.

This project collected demographic, outcome, and reflective data from evaluators and/or administrators of PD programs using an inventory that compared data for 2019 and 2020. The inventory asked for a description of PD activities, including changes made, the process for transitioning to online PD, and lessons learned as a result of this pivot. Case studies representing a variety of approaches to online learning provided the stories behind the data and illuminated example practices.

To have been eligible for inclusion, PD projects needed to meet these requirements:
- the PD prepared teachers to implement CS curriculum in a K12 classroom
- CS PD was offered in 2019 in person*
- the PD in 2020 included some synchronous virtual activities
- the PD offering was at least eight hours long, and
- the instructional model and/or curriculum changed in response to the pandemic.

Twenty-nine PD inventory forms were submitted, many representing multiple types and/or sessions of PD.

Hindsight 2020 focuses solely on CS PD providers. While we can imagine that those offering PD in other disciplines experienced similar challenges and opportunities in 2020, we only collected data from CD PD providers. In addition, we did not explore how CS curricula for students was changed due to the remote nature of the 2020-2021 school year and how teachers were prepared (or included) in making curricular decisions. This is an important area for future inquiry.

Three case studies were conducted to complement the data collected through the PD Inventory in order to provide a more holistic understanding of the summer 2020 PD. The two primary objectives of the case study are to (1) Understand the changes made from the 2019 delivery of PD to the 2020 delivery and (2) Understand decision making behind different approaches that illustrate the year to year change.

THE CASE STUDIES

CASE STUDY #1

This PD program received funding from the NSF as well as from local sources. It targeted K – 8th grade teachers. It did not prepare teachers to teach a specific curriculum, but rather instructed them on computer science and computational thinking concepts that could be integrated into their existing courses. A comparable PD program was not offered in 2019 (although the PD provider had two years' experience offering CS PD), so in 2020, it brought together teachers who had not participated in PD as a group before and served 113 teachers from one district/region. A stipend and continuing education credits were offered. The PD program spanned four days, with 15 synchronous contact hours, although that number varied by teacher since not all participants attended all of the sessions. Once the decision was made to transition to an online format, the provider had 2-3 months to make the transition.

CASE STUDY #2

This program received state funding, targeting 6th - 12th grade teachers and preparing them to teach either the CS Discoveries or Computer Science Principles courses. It brought together teachers who had not participated in PD as a group before, and it reached 110 teachers in 2019 and 162 teachers in 2020, with an 81% completion rate. Incentives included a financial stipend, continuing education credits, and a fee reduction. The PD program extended over five days, with 40 synchronous contact hours. After the decision to transition online was made, the provider had over three months to make the transition.

CASE STUDY #3

This program received funding from the NSF. It targeted high school teachers, and it prepared them to teach the Exploring Computer Science curriculum. Their PD spanned five days with 19 synchronous contact hours. Once the decision was made to transition to an online format, the provider had 2-3 months to make the transition.

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Engaging in online PD activities over a prolonged period online was both novel and challenging for many. Insight gathered from the Hindsight 2020 team and advisory board members who have worked in the online learning field for many years include these concepts:

INSIGHTS FROM HINDSIGHT

Set expectations from the start (such as: we are all learners, we are here to support one another).

Model strategies in PD that can also be used with students.

Be committed to shared learning goals, but also be flexible and adaptable in meeting the needs of the learners.

Focus on active learning and interactive activities.

Don't adopt a tool just because it is novel. Determine the purpose of the PD, then select the tool.

Remember that less is more. Keep it simple.

PD DURING A PANDEMIC

Major disruptions like a pandemic can also lead to introspection and innovation. As you will see in study findings highlighted in this guide, summer 2020 created an opportunity to reflect, retool, and sometimes reinvent PD.

It is important to recognize that this past year has been unpredictable and stressful for many. The pandemic forced providers to quickly pivot formats, and the year was also a time of heightened awareness related to racial injustice as well as political and social unrest. Many PD participants were feeling the stress of these events alongside additional childcare responsibilities due to pandemic-related closures.

TECHNOLGY FOR PD

Technology can support effective PD by helping teachers to develop a sense of community, improve their knowledge of subject and pedagogical content, and promote self-reflection on learning and instructional practices in a collaborative, flexible way [3]. While effective PD will espouse most of the design elements and characteristics above, it may look different given the context and audience. As Guskey points out, "the point is that truly effective professional development may stem not from a single list of 'best practices' but instead from a collection of core elements that must be adapted to the unique characteristics of a particular school" [8] or in this case, PD context.

PLANNING FOR VIRTUAL CS PD

PD providers may need to revise their PD schedules, exploring such considerations as overall duration, the balance of synchronous and asynchronous activities, tool selection, the inclusion of physical computing experiences, and the accessibility and logistics of physical materials.

What logistical considerations are important for planning virtual CS PD?

SCHEDULING

DURATION AND FORMAT

According to our data, while most PD providers transitioned their existing PD schedule and agenda to a virtual implementation, a few providers responded to the COVID-19 restrictions on in-person PD by adjusting their PD schedule, either spreading it over additional days or condensing the PD into fewer days. Additionally, some providers opted for non-consecutive PD experiences, e.g. sessions on Tuesday and Thursday of each week for two weeks. See the next page for examples of how to structure forty hours of PD.

When planning the schedule the priority should be accomplishing the learning objectives with the available time and tools/technology instead of the actual replication of "seat hours."

PD SESSIONS - MODEL 1

SUN	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SAT
4	5	6 8AM – 12PM 1PM – 5PM	7 8AM – 12PM 1PM – 5PM	8 8AM – 12PM 1PM – 5PM	9 8AM – 12PM 1PM – 5PM	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	31

PD SESSIONS - MODEL 2

SUN	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SAT
4	5	6 10AM – 12PM 2PM – 4PM	7 10AM – 12PM 2PM – 4PM	8 10AM – 12PM 2PM – 4PM	9 10AM – 12PM 2PM – 4PM	10
11	12	13 10AM – 12PM 2PM – 4PM	14 10AM – 12PM 2PM – 4PM	15 10AM – 12PM 2PM – 4PM	16 10AM – 12PM 2PM – 4PM	17
18	19	20	21	22	23	24
25	26	27	28	29	30	31

PD SESSIONS - MODEL 3

| SUN	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SAT
4	5	6 10AM – 2PM	7 10AM – 2PM	8 10AM – 2PM	9 10AM – 2PM	10
11	12	13 10AM – 2PM	14 10AM – 2PM	15 10AM – 2PM	16 10AM – 2PM	17
18	19	20 10AM – 2PM	21 10AM – 2PM	22 10AM – 2PM	23 10AM – 2PM	24
25	26	27 10AM – 2PM	28 10AM – 2PM	29 10AM – 2PM	30 10AM – 2PM	31

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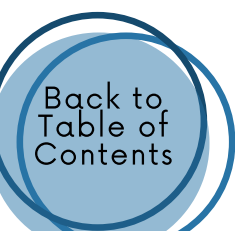
Sample program agenda (used here with permission): This agenda, used in summer 2020, featured a first week focused on computer science and computational thinking:

	MON	TUE	WED	THU	FRI
MORNING	Introduction	Homework 1 Discussion	Homework 2 Discussion	Homework 3 Discussion	Homework 4 Discussion
	Team Building	Arrays, Loops	Functions	Search / Sort	Recap
	Computational Thinking				
	Python Install / Instruction	Arrays, Loops	Teaching and Learning Assignment Assigned	Search / Sort	Tests (1.5 hours allowed)
	Variables, Simple I/O, Data Structures				
LUNCH BREAK					
AFTERNOON	Selection	Search	Functions / Recursion	Search / Sort	Teaching and Learning Assignment Worktime
		Everyday Object CCE	Story Telling CCE	Pathfinding CCE	
		Search	Functions / Recursion	Teaching and Learning Assignment Worktime	Teaching and Learning Assignment Presentations
	Homework 1 Assigned	Homework 2 Assigned	Homework 3 Assigned	Homework 4 Assigned	Final Project Assigned

This agenda, from the same program, was used in the second week for computer science pedagogy:

	MON	TUE	WED	THU	FRI
MORNING	Goals	Standards	Pedagogy	Classroom Management	Differentiation / CS4All
	Pedagogy	Teaching Robotics	Teaching Robotics	Group Lessons	Group Lessons
LUNCH BREAK					
AFTERNOON	Concept: Loops	Concept: Variables	Concept: Conditionals	Concept: Functions	Implementation Planning
	Standards and Extracurriculars	TED Talk	Assessment	Lib Guides	Closing Survey
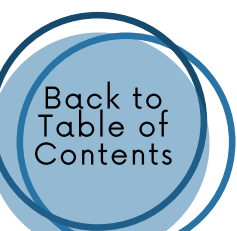
The pros and cons of extending PD. In some cases, extending the PD over a longer period allowed teachers more time to practice, permitting them to build skills and confidence in one concept before moving on to the next. For some providers, extending the overall duration of the PD allowed for increased community engagement through more teacher-to-teacher interaction. In other cases, providers observed that extending the PD for too long reduced teacher engagement, with participation dropping over time.

Facilitator availability may also influence this decision, and in some cases, facilitators felt burned out or felt that the PD demanded too much of their time, dominating their entire summer according to the study data.

Insights from case study #3:
The PD provider explained that empathy was at the core of their thinking and decision making with regard to issues of equity and inclusion. The priority in working with teachers was to ensure that everyone could equally access the information that was presented to them; that meant having both the psychological bandwidth to engage and clarity around accessing course materials and navigating the online platforms with ease. With this in mind, the instructional team and PD leadership decided that they did not want teachers to be online for eight hours per day. They also considered the breadth of personal challenges and needs that teachers brought to the PD sessions.

QUESTIONS TO CONSIDER

- Which duration and format works best for your PD's goals: close and compact or spaced out over time?

- What time constraints affect your facilitators and participants?

- Are there district/school restrictions on scheduling?

- If you choose to hold your PD over several days or weeks:
  - How do you plan to support your facilitators and prevent their burnout?
  - Will you need a plan to keep teachers engaged during the "off" days/weeks?
  - How can you help teachers protect PD time from being double booked by administrators?
  - How will you minimize teacher attrition?

- Can you develop a schedule that permits flexibility for teachers and facilitators to accommodate their other commitments?

- What are the expectations for participation? For example, can teachers have their children nearby, or do they need dedicated time and space to participate?
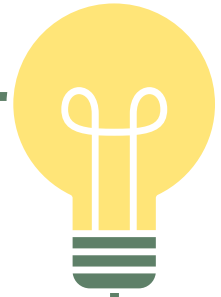
SYNCHRONOUS AND ASYNCHRONOUS MEETINGS

One benefit of synchronous meetings (i.e., meetings in which everyone joins at the same time and in the same space) is that they are more likely to lead toward a sense of community as facilitators and participants interact. Asynchronous activities (that is, tasks or activities that may be completed independently) allow for flexibility, support PD providers in perfecting the content and avoiding technical problems, and permit participants to proceed at their own pace through the materials. Asynchronous sessions may be difficult for participants to complete, however, because of pressing demands on their time and schedule distractions. While a mix of synchronous meetings and asynchronous activities can attempt to harness the advantages of both approaches, without a clear PD agenda and participation expectations it may result in a schedule that is complicated or confusing to participants, especially if multiple time zones are involved.

We recommend that PD providers be aware that adding asynchronous time may complicate record keeping in situations where attendance needs to be monitored (such as, for example, where continuing education credits are awarded). While face-to-face PDs can monitor attendance with, for example, a simple sign-in sheet, virtual PD with asynchronous components requires a more complicated system. One provider indicated that this was one of the most complicated aspects of managing their summer 2020 PD, as it can be difficult to truly measure the time spent by participants on asynchronous activities.

INSIGHTS

Balancing synchronous and asynchronous learning. Most virtual PDs incorporated both synchronous and asynchronous, self-guided learning and practice. PD providers spent significant time examining the PD content and identifying what elements could be done independently. Many programs also incorporated "office hours," where participants worked independently but could check in with facilitators via a chat or video platform if they needed assistance. Learning Management Systems (LMS), such as Canvas, Moodle, and Google Classroom, which allow participants to upload and share their work, can provide accountability.

Insights from case study #1:
One teacher described a surprising benefit of online PD: "In the physical space participants take time to talk to other groups and learn from what they were doing. There's a social aspect of comparing themselves to others that occurs in the classroom setting. And often due to the lack of confidence, participants begin to create similar designs, not meaning to, but to see what others do and copying and building from them. But in the virtual environment, they lack this opportunity. But teachers we felt were more creative. They worked really hard and they concentrated on the design process."

Insights from case study #2:
The PD provider explained that they had to consider how much asynchronous versus synchronous time each PD session would include. While typical programming would have included five consecutive days of in-person instruction, the team understood that instruction had to be adjusted so that teachers would not experience burnout from being online for long periods of time. One of the approaches that PD providers took was subdividing some of these courses into smaller components and using pedagogical approaches that allowed for more group discussion and interaction.
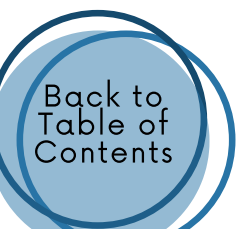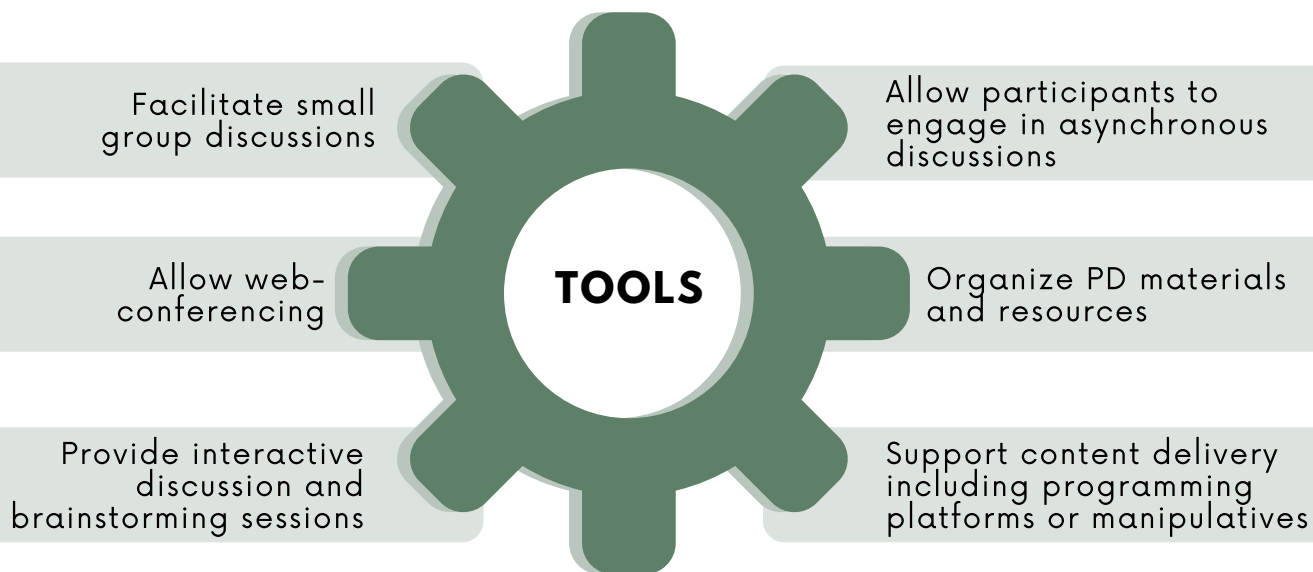
QUESTIONS TO CONSIDER

- Given your curriculum and teacher population, what is the right balance between synchronous meetings and asynchronous activities?

- How can (a)synchronous activities advance the goals of your PD?

- What elements of the PD require a collaborative environment and what may be possible to offer asynchronously, via video, print, or other materials?

- How will you create a culture of accountability for completing asynchronous work?

- How will you help participants keep track of PD elements such as the agenda, links, and tools?

SELECTING TOOLS FOR PD

There are many tools that can support virtual learning, many with similar functionality. It is important to consider how the tools will be used to support PD before settling on a particular tool.

Facilitate small group discussions

Allow participants to engage in asynchronous discussions

Allow web-conferencing

TOOLS

Organize PD materials and resources

Provide interactive discussion and brainstorming sessions

Support content delivery including programming platforms or manipulatives

Some constraints on tool choices can be the instructional curriculum, which may require the use of a proprietary platform. In other cases, local policy influences tool choice; e.g., if a district uses a specific LMS or web-conferencing platform, or if teachers are accessing materials from a school network, some sites may be blocked.

Providers also noted that they spent a great deal of time thinking about whether and how the tools could work across a range of devices - including mobile phones and tablets - to both support PD participants and model tools and strategies for using them that teachers could then employ with their students.

With a rapid pivot to virtual, accessibility was not always a consideration. There are several organizations that provide guidance on putting together virtual meeting accessibility tools and information that may be applicable to your PD.
For example, AccessSIGCHI has three useful guides:
🔗 Guide for accessible meetings
🔗 Guide for virtual conferences
🔗 Guide for remote work

Of note, not all K-12 curriculum is accessible.
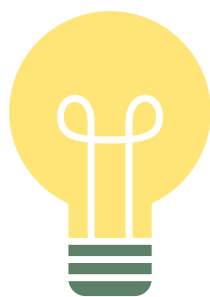
Incorporating tools into the PD. Providers noted several ways to incorporate tools into the PD.

- Some opted to mail participants manipulatives, like robots, micro:bits, or other materials.

- Other providers tried to simulate the experience of a face-to-face activity.

- One PD provider surveyed teachers prior to the PD to see what technologies they had access to and then provided it for those teachers who lacked access (e.g., hot spots).

- Providers mentioned not only tools for instruction but also for organization.

Insights from case study #3:
The PD provider discussed the challenges of material distribution. Although the PD course was online, there was a demand for physical copies of the curriculum and books. The PD team had to decide how they would safely pick up the materials, mail the materials to teachers, and what to do if a teacher signed up for the PD after materials had been sent. This was a time-consuming challenge as the PD provider had to plan and coordinate logistics in a dynamic environment in addition to the more substantive planning of the 2020 PD.

QUESTIONS TO CONSIDER

- Does your PD require physical manipulatives or specific tools?
  - Can these elements be accommodated in virtual PD and/or virtual classrooms?
  - Does your budget permit mailing materials to participants in advance?

- Will facilitators need any additional tools, such as support for back-channel communication?

- How might you use technology to mirror in-person pedagogical techniques, such as pair programming?

- How and where will physical and digital materials related to the PD be hosted and organized?

- Will facilitators and/or participants be able to add to and/or comment on digital materials?

- Will you also host discussions, peer support, links to external resources, etc.?

- Which tools are participants already familiar with?

- Which tools do participants already have access to?

- Which tools are or are not allowed by district policy?
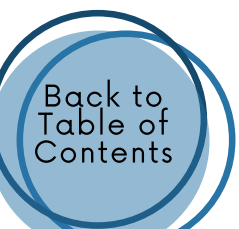
SUPPORTING TOOL USE DURING PD

Once you have made your decision about which tools to incorporate into your PD, you can begin to think about how to build in support for teachers to use the tools.
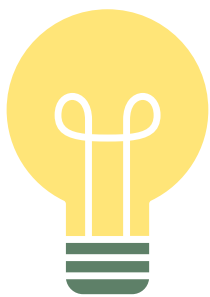
INSIGHTS

Smoothing the use of third party tools. Providers noted several best practices that helped to smooth the use of third-party tools. One strategy included having a dedicated technical support facilitator during the PD. This person was able to respond to technical help questions, while the other facilitators focused on delivery of PD content and modeling pedagogical approaches. Additionally, several providers held pre-PD tool orientation sessions. These were designed to free PD time for instructional content by working with teachers to set up accounts, install software, and become familiar with the tool before the PD began.

QUESTIONS TO CONSIDER

- How will you train PD facilitators and PD participants on the tools you plan to use in the PD?

- Will your budget permit a technology facilitator?

- Will your schedule permit a short tool orientation session?

INCENTIVES

What types of incentives did providers offer to teachers to encourage and support participation? Participation in CS PD is a significant investment of time. Many providers offer incentives to teachers to encourage and support participation.

INSIGHTS

Reallocating travel costs. Since 2020 programs did not involve housing or travel costs, many providers were able to re-allocate their budget. Some programs chose to reduce or eliminate registration fees associated with the PD. Of the 23 programs reporting their incentive strategies, 76% of them offered some kind of credential to teachers in 2020. One provider noted in a follow-up conversation that they used some of the funding that they had set aside for travel and housing to purchase technology, which they mailed to teachers to support their instruction.
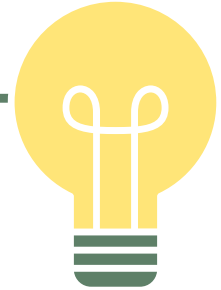
QUESTIONS TO CONSIDER

- If your PD usually charges a fee, are you able to reduce or eliminate that fee?

- If you have previously set aside funds to cover travel and housing for PD participants, can you reallocate those funds toward other uses (e.g., additional facilitators, distributing materials, and even delivering meals if funders allow)?

- Given your PD population, what incentives are likely to be of value to them: continuing education credits, micro-credentialing, a stipend, and/or recognition and leadership opportunities?

FACILITATOR TRAINING

The role of the facilitator is to deliver the PD to the teachers. In some cases, the facilitators also design the PD and may have helped design the curriculum. This section focuses on preparing facilitators to deliver the PD content and providing ongoing support. Typically, preparing facilitators involves ensuring familiarity with the curricular content, delivery mechanisms, and sensitivity to teachers' ongoing experience.
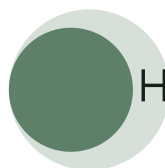
FACILITATOR PREPARATION

Prior to the summer 2020 PD, most programs had a training period for their facilitators. Most 2020 facilitator preparation focused on:
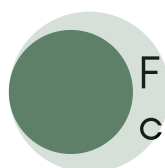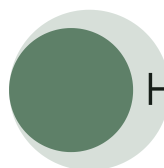
- Familiarity with the curriculum
- How to combat video call fatigue
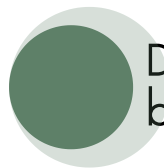- How to use online tools
- How to address equity
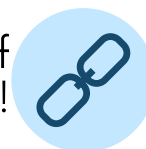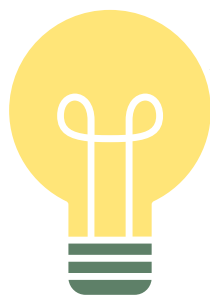- Effective pedagogical practices
- Developing team-building skills
- How to support online participation from all participants

Don't forget there are lots of resources at your disposal!

Preparing facilitators depends on their prior engagement. Some facilitators were part of the core programmatic team that developed the summer 2020 PD and therefore did not require separate facilitator training. Many facilitators are themselves CS teachers who may have been trained through the PD program in past years. Projects training new facilitators focused on techniques for virtual PD, such as how to combat video call fatigue and how to use technology, including navigating the platform and organizing materials in the LMS.

Other examples of changes to PD implementation included creating videos of difficult concepts for teachers to watch multiple times, reviewing modules to ensure they would work remotely, and having facilitators script their content delivery. There were multiple providers who reported that facilitators wanted more preparation for best practices in online instruction and that facilitators would have preferred more practice with the tools. Other providers realized that they needed more facilitators; for example, one facilitator was needed to monitor the chat during synchronous meetings while the other presented the content.
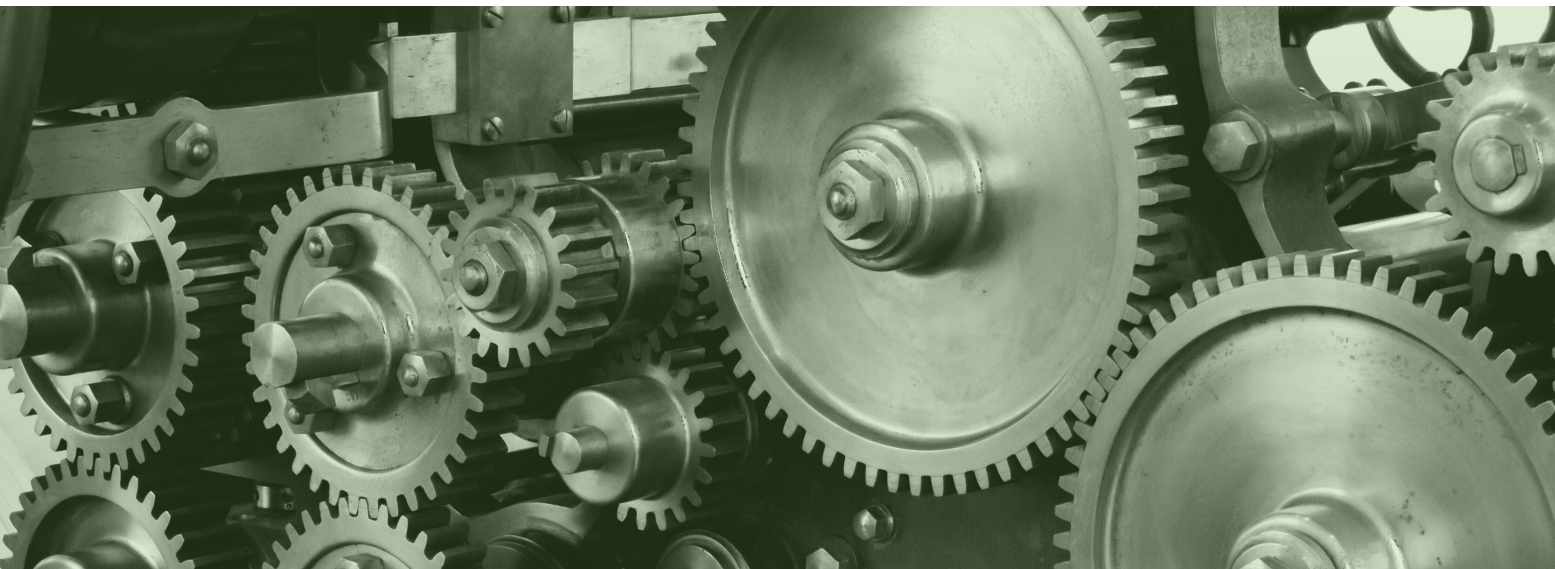
QUESTIONS TO CONSIDER

- Are facilitators involved in creating the PD content and/or delivery?

- How familiar are the facilitators with the PD content?

- How familiar are the facilitators with the virtual PD delivery mechanisms, including virtual tools and platforms?

- Are the facilitators responsible for creating or nurturing an online community among teachers? What skills are needed for these responsibilities?

- For returning facilitators, what changes have been made to the PD since the last sessions?
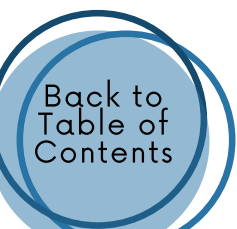
ONGOING FACILITATOR SUPPORT

Facilitators need ongoing support during the PD implementation to reflect and improve upon their practice, particularly as many were navigating virtual PD facilitation for the first time.

INSIGHTS
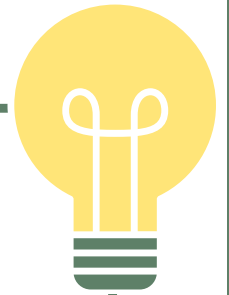
Supporting Facilitators. The challenges of virtual PD were mitigated by high levels of collaboration and support between facilitators. In some cases, the facilitators were also classroom teachers who had been teaching remotely during the spring; their expertise and experience were valued and incorporated into the design of the PD. Nearly two-thirds of providers offered debriefing sessions after the training, while about half used a private online space for facilitators to share ideas and challenges and/or to host regularly scheduled facilitator support meetings.

QUESTIONS TO CONSIDER

- What expertise do the facilitators bring?
- What role(s) do the facilitators play during the PD? For example, who will manage the technology? Who will present the content?
- Are facilitators expected to provide technical support for participants in addition to delivering content? If so, who will train them?
- Is feedback from participants being collected regularly? How will facilitators use this feedback to improve the PD?
- Will the teachers be grouped by skill and/or comfort level? If so, how will this impact the work of the facilitators?
- How can you support facilitators during the training? Can you build in debrief sessions, technology support sessions, or the opportunity to shadow an experienced facilitator?

MODIFYING PD PEDAGOGY

PD delivery is dependent on the choices made prior to PD around scheduling, LMS tools, and facilitator training. It is also contingent upon the goals and objectives for the PD, as they relate to teacher knowledge and skills.

PD Pedagogy depends on the goals and objectives of the PD

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INSIGHTS

Providers modeled pedagogy for offering CS instruction online in anticipation of a virtual or hybrid academic year. To support teachers going into an uncertain year, PD providers used a variety of strategies, including:

Facilitating Discussions

- "Stirring the pot" a bit by asking questions such as, "But if you do that, wouldn't it lead to [a negative outcome]?" in order to promote engagement, conversation, and discussion.
- Asking everyone to write a comment in the chat in response to a question - but not to post it until they were asked to; this technique permitted everyone to focus on their own, distinct response instead of other comments at first.

On Going Assessment

- Providing teachers with more formative assessment opportunities to account for the lack of face-to-face check-ins.
- Using short, end-of-day surveys in order to expand on anything PD participants found difficult or confusing.
- Ensuring that the PD facilitators represented diverse backgrounds in order to better connect with the teachers participating in the PD.

Modeling and Resource Support for Teachers

- Applying social and emotional learning principles not only to model for teachers what they can do with their own students but also as a genuine attempt to support the teachers themselves.
- Giving teachers guidance on best practices for teaching online and pacing the content.
- Offering more resources to teachers, allowing them to approximate a real-world lesson in a virtual format. For example, PD providers created tutorials and videos to augment instruction, identified interactive sites (such as an online LEGO building tool instead of physical LEGO blocks), and demonstrated methods for pair programming in virtual breakouts
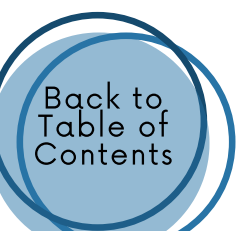
Insights from case study #1:
The instructional team for the PD provider not only gave teachers opportunities to learn about one another through small-group exercises and time allotted for introductions but also made time to learn about teachers directly through focus groups. To better understand the needs of their teachers, PD facilitators held focus groups to learn about teachers' experiences and to garner feedback related to what teachers found challenging about the PD, how they were translating what they learned in the PD session into classroom practice, and the challenges teachers may face while teaching in a virtual learning environment. With this information, PD providers were able to tailor the PD to teachers' needs and strengths to create an equitable environment in which all teachers could learn and succeed.

QUESTIONS TO CONSIDER

- How will you gauge teachers' comfort level with the content and pedagogy?

- What materials might teachers need to effectively engage in the PD?

- What resources are needed to approximate hands-on activities for the PD and for when teachers return to the classroom (whether virtual, hybrid, or remote)?

- What is lost in the virtual content delivery for which teachers may need additional support over the academic year?

ADDRESSING STUDENT EQUITY

PD incorporated discussions of student-focused equity and access, especially in light of the pandemic, as many teachers were still uncertain as to whether school would be in-person, virtual, or hybrid during the 2020-2021 academic year. Equity concerns were related to student access to synchronous instruction, educational technology, and engagement. Supporting students with IEPs or those on 504 plans was also considered.
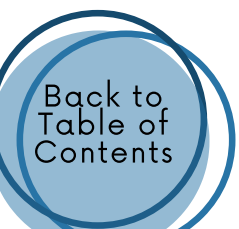
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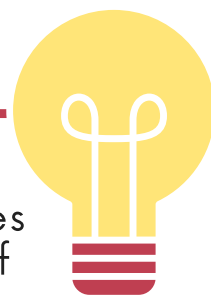
Being mindful of technical access. Several providers focused on access in the sense of not relying on activities requiring broadband internet, not presuming the kinds of technology available to students at home, and not assuming access to physical materials, like robots. These providers focused on incorporating unplugged lessons into the curricula, as well as on brainstorming with teachers to find common household items that students could use in their activities. Additionally, providers recognized that students learning remotely may face different challenges, from the need to care for younger siblings to the distraction of games or movies on another monitor.

Incorporating learner needs. Other providers focused on differentiation for students with IEPs, Section 504 plans, and other specialized learning needs. Programs worked with teachers to think through how lessons could be tailored to students with differing levels of experience with computing, different reading and mathematics backgrounds, and different learning needs.

Modeling strategies. Several programs mentioned that they used the PD sessions to model instructional approaches, the use of online resources and tools, and virtual engagement strategies. Teachers were encouraged to reflect on the PD experience as their own personal learning environment and to take away strategies that might work in their own classrooms. Beyond modeling technical platforms or specific tools, some PD providers also drew from the theory of social emotional learning (SEL) to demonstrate strategies for increasing students' sense of belonging and personal connection, even while remote learning.
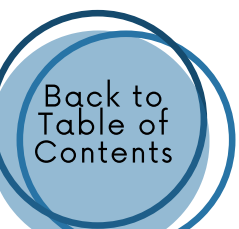
- What physical and digital materials will students need to participate in class?

- In what ways can lessons be modified if they need to be "unplugged"?

- If the decision is made to teach the course remotely, what aspects need to be revised for the virtual space? Can it be revised, or should it be postponed until in-person learning can occur?

- How can teachers support students with diverse needs and learning preferences?

- How can teachers support students with disabilities if instruction is remote?

- How will a sense of community, similar to a K-12 classroom, be developed in the virtual space?

Don't forget there are lots of resources at your disposal!
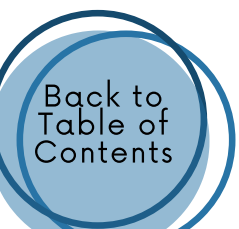
TEACHER COMMUNITY

One aim of many PD offerings is to foster a sense of collaboration and camaraderie among participants. This community can in turn serve as a support network not only during the PD but also when participants implement what they have learned in their own classrooms. Creating a supportive community can be especially important for individuals who are new to CS -- especially if they are the only CS teacher on their campus.

Programs reported using a variety of strategies to build community, such as having breakout sessions during webinars/meetings, icebreaker/team-building activities, and regular discussion posts. One provider noted that teachers were more likely to engage in a small breakout room than in a large webinar. Roughly half required some level of participation in an online community platform to complete the PD tasks and/or had facilitators to promote virtual dialogue on discussion posts.

In our work, we explored two broad aspects of community among participating teachers:

- tools to foster community through ongoing discussions and interactions

- ways PD providers worked to develop a sense of community.

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INSIGHTS
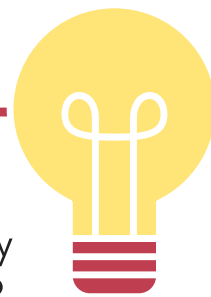
Building Community. While providers recognized that participants missed opportunities to interact in person, they also highlighted ways they worked virtually to build community among participants. As one provider noted during a follow-up conversation, "We found that creating community ahead of our PD was important! We began hosting Coffee and CS Ed Zoom check-in calls weekly on Fridays when the pandemic began and feel that the network from those calls and the structure of coming together for conversation, collaboration and troubleshooting helped to set the stage for success in our virtual summer PD sessions."

Similarly, another program began each day with an informal coffee and book study meeting to discuss a chapter of a book related to equity in CS Ed, and they found that it helped to build their community. The coffee hour was also used to allow facilitators and participants to test their microphones, share their screens, and use other technical tools. One provider indicated that using humor, particularly memes, helped to build community. Another strategy was to maintain a spreadsheet to track teacher participation to ensure that each teacher participated each day.

Insights from case study #2:
One of the challenges the PD provider faced in the beginning of PD programming was boosting the morale of teachers who were experiencing Zoom fatigue and were disappointed that they would not be able to meet in person. Yet while the PD year began on a low point, PD providers shared that the PD sessions soon became a "welcome distraction." To make sure that they did not have teachers disengage, the instructional team increased their communication efforts and hired assistants who could regularly keep in touch with participants and send reminders to ensure teachers were engaged in all facets of the PD. The PD providers also hired additional facilitators to be able to keep teachers connected to programming both during and after PD sessions. PD providers noted, however, that many more facilitators were needed because there was a breadth of needs, particularly related to urban and rural teachers' access to the internet.
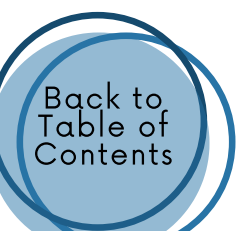
Insights from case study #3:
The PD provider discussed how they established a sense of community among teachers by building on previously established relationships. While the PD provider continued to offer opportunities for teachers to work collaboratively, they noted they were in a unique position because many teachers had already spent time together in the previous summer session and knew each other, as well as the facilitators and PD leadership team, when starting the 2020 PD. Nevertheless, to keep the sense of community strong, PD providers discussed embedding humor into instructional materials to build rapport and creating optional Zoom happy hours for teachers to connect with their colleagues about topics of their choice.

QUESTIONS TO CONSIDER

- Think of various communities to which you are connected (e.g., work, neighborhood, school, faith, etc.). What are ways that other community members make you feel welcome, included, and safe to try something new?

- What role does collaboration and community play in your PD design? In particular, what will effective collaboration and community among PD participants look like for the PD?

- Are there ways to build camaraderie or extend a warm welcome before the PD begins?

- Do some participants already know one another? Consider how group work is structured so that individuals do not cluster exclusively with existing colleagues to allow for more interaction and relationship-building in the larger group.

- Will PD provide a way for participants to connect with one another during and after the PD (e.g., sharing contact information with participants' permission, a Google group, etc.)? If you host a discussion board or virtual platform, how (and who) will help to facilitate such conversations and keep them going?

EVALUATING PD

PD EFFECTIVENESS

Determining whether the PD is effective in meeting its planned goals can enable providers to make meaningful improvements. This follows the continuous improvement model's Plan-Do-Check-Act (PDCA) method, where evaluation is the "Check" and making changes to your PD is the "Act."

> **How do PD providers know if and how teachers are learning from their PD experiences and growing in their ability to teach their students?**

OUTCOMES DATA - ALL PD PROVIDERS

Category	Value
Program Satisfaction	55%
Assessed PCK	3%
Self-reported PCK	41%
Assessed CK	14%
Self-reported CK	34%
Self-Efficacy	28%
Interest Teaching CS	17%
No collection of data	31%

Examples from the Hindsight 2020 study:
PD providers varied in what they used in 2019 and 2020 to measure teacher learning and PD effectiveness varied. Beyond program satisfaction, there was a wide variety of data collected, including self-efficacy, self-reported pedagogical content knowledge (PCK), and self-reported content knowledge (CK).

QUESTIONS TO CONSIDER

- What are the values of the district and school communities in which participants belong?

- What are factors that impact student learning that are most important to the participants?

- What key data points are needed to improve PD offerings?

- What constructs around equity will be measured to better understand if the PD affects teachers' beliefs about each student's ability to learn CS?

- From which other constructs that might impact student learning will data be collected?

- How do you collect data from teachers with an emphasis on improving your PD, not on rating the teachers?

RECOMMENDED EVALUATION MEASURES

PD providers can collect meaningful, formative feedback that will lead to an improved PD experience for teachers. We recommend collecting three types of data:
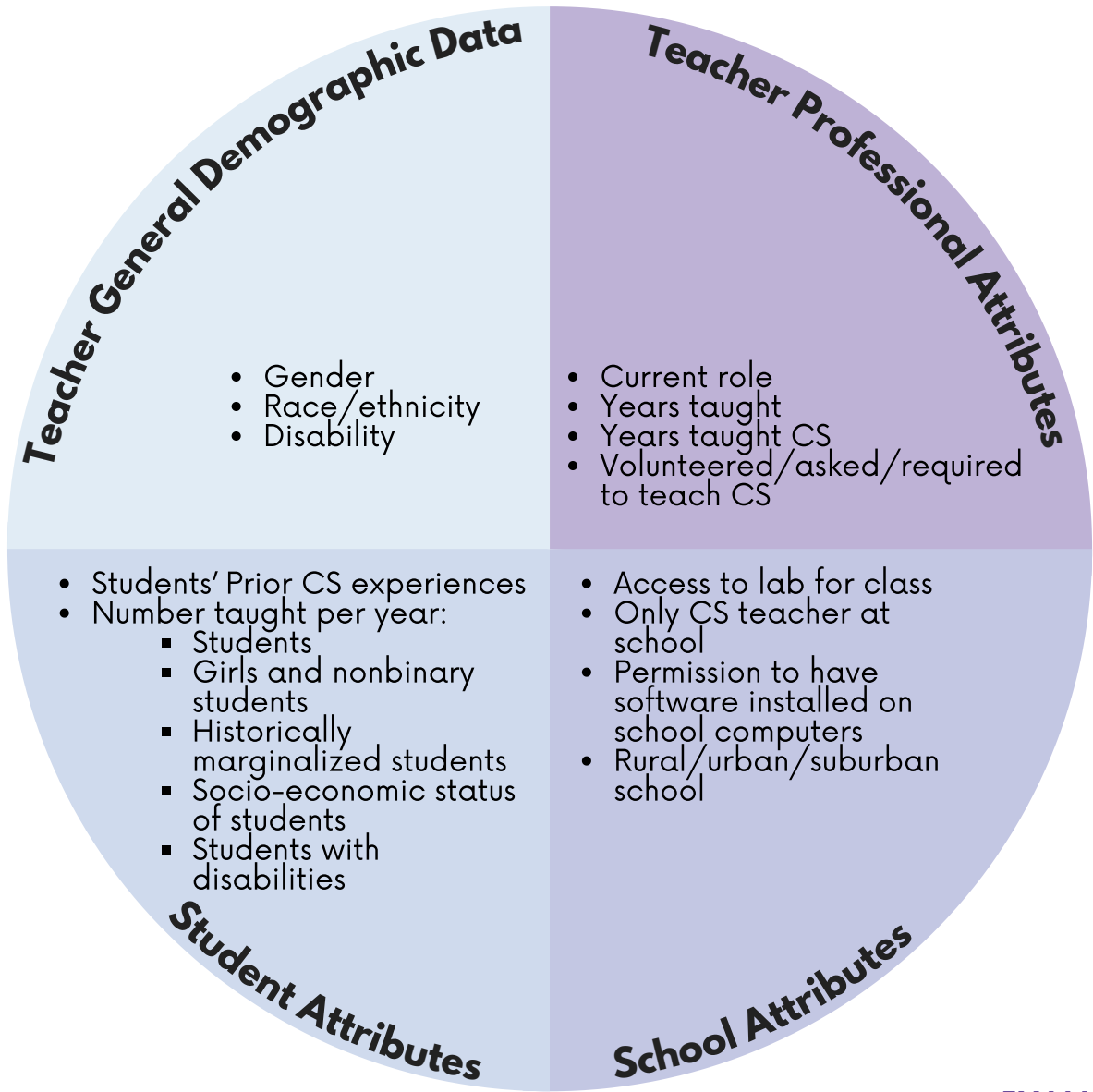
- Demographic data
- PD satisfaction
- Data related to constructs (e.g., self-efficacy, interest in teaching CS, growth mindset)

DEMOGRAPHIC DATA

As a standard practice for CS PD providers, we recommend the following demographic data is collected:

Teacher General Demographic Data

- Gender
- Race/ethnicity
- Disability

Teacher Professional Attributes

- Current role
- Years taught
- Years taught CS
- Volunteered/asked/required to teach CS

Student Attributes

- Students' Prior CS experiences
- Number taught per year:
  - Students
  - Girls and nonbinary students
  - Historically marginalized students
  - Socio-economic status of students
  - Students with disabilities

School Attributes

- Access to lab for class
- Only CS teacher at school
- Permission to have software installed on school computers
- Rural/urban/suburban school

UTILIZING DEMOGRAPHIC DATA

Asking participants whether they volunteered to teach CS, asked to teach, or were required to teach can provide insight into a participant's perspective of their participation experience. Likewise, school attributes help PD providers understand teachers' access to PD and whether or not the participant is the sole CS teacher in their school. This can provide insight on issues related to community, resources, and support for the participant.

Asking about participants' access to a teaching lab or other questions related to their teaching environment as well as their school's ability to install software on computers for teaching CS can help providers shape their PD. Both may affect the software they choose to use to teach computer science.

Knowledge about student attributes can be instrumental in understanding the composition of the participants' classrooms and unique challenges participants may face in creating an equitable environment for learning CS. If the PD is targeting interventions or curricula focused on any particular subgroup, members of that subgroup or attributes related to the group can be collected. For example, if the PD uses games to motivate engagement with the content, identifying whether students play video games, seek out opportunities to play games, or find them motivating would be good influencing factors.

PROGRAM SATISFACTION

What are good measures of program satisfaction to collect? PD providers collected a variety of data related to program satisfaction (e.g., registration, communications, etc.). We recommend logistical information, information on their virtual learning environment, course engagement, and pace of the course.

INSIGHTS
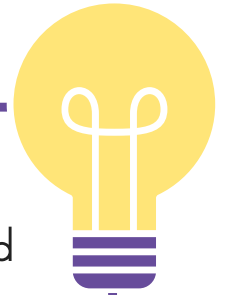
Program satisfaction and virtual PD. When offering PD virtually, outside pressures may influence learning (e.g., care-taking responsibilities, Internet access, hardware and software needed for the course). Asking participants what their perceived level of engagement was during the course is recommended, since a virtual delivery of PD takes away some of the ability for providers to observe the classroom. In-person and virtual course offerings have their own pace, and pace of instruction is an important aspect of learning. We recommend asking participants for their perceptions of the course pace.

Similar to demographic data, some of these questions may vary with the program goals, particularly with respect to logistics. For example, if pair programming is a key aspect of the PD, then the logistics and tools required for engaging in pair programming virtually, directions from the facilitator, feedback on the interaction, and overall connection between need to implement the aspect and the value derived by the activities can also be measured.

Measuring satisfaction levels of participants is often unique to the PDs structure, registration process, pedagogy, and more. We recommend asking questions about participants' logistical information, information on their virtual learning environment, course engagement, and pace of the course.
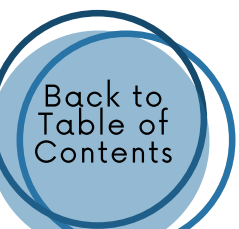
MEASURING TEACHER GROWTH

Content knowledge, pedagogical content knowledge, and growth and equity mindset are key pillars for PD providers to target if all students are to learn CS. As a standard practice, we recommend that providers consider collecting content knowledge, pedagogical content knowledge, and beliefs.

Growth mindset requires teachers to operate under the assumption that a student's talents and aptitude can change over time [7].

Equity mindset "...refers to the perspective or mode of thinking exhibited by practitioners who call attention to patterns of inequity in student outcomes. These practitioners are willing to take personal and institutional responsibility for the success of their students, and critically reassess their own practices." [22].
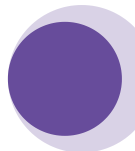
Key teacher impacts on student learning:

- **Content knowledge**

- **Pedagogical content knowledge**

- **Growth and equity mindset**

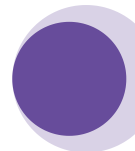**How does your PD measure teacher growth?**

CONTENT KNOWLEDGE

PD providers can measure self-reported or assessed content knowledge, though assessed is usually more accurate than self-reported. If collecting only data after the PD (post) and using self-reported measures, PD providers can measure growth (with an appropriate 5- to 7-point scale) with questions like:

How much did you know about [topic] prior to the workshop?

How much do you know now about [topic]?

Posing both questions can help PD providers gauge whether participants are learning about the content topic to the degree that the providers had planned. However, exercise caution with this method, since pre-surveys of content knowledge can be influenced by the Dunning-Kruger effect [6], resulting in teachers overstating what they know in the pre-survey.

A content knowledge assessment (such as a quiz) can be brief. Four to five key content questions, perhaps one for each topic in the PD, can suffice. We caution that overburdensome or challenging assessments can negatively impact teacher self-efficacy.

To avoid issues in collecting actual and/or self-reported data pre- and post-data, providers may opt to review submitted course artifacts, such as one or two key assignments, to understand if the PD learning goals are being met.

PEDAGOGICAL CONTENT KNOWLEDGE

Pedagogical content knowledge is as important as content knowledge [19]. What aspects of pedagogy are most important to the PD? Asking teachers pre- and post-PD if they understand key aspects of pedagogy that your PD offering is targeting (e.g., pair programming, teaching computational thinking through storytelling, etc.), then measuring the change provides insight into teachers' PCK growth. Similar to measuring content knowledge, the Dunning-Kruger effect might cause pre- data means to be higher than post-data means. Measuring post-PD only is acceptable and may be adequate for your needs.
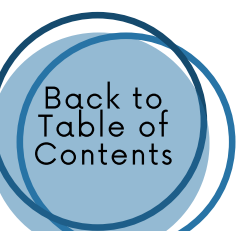
BELIEFS

Measuring beliefs both pre- and post-PD is likely to be prone to overstating their beliefs in the pre-data, and, therefore, is less likely to be subject to the Dunning-Kruger effect. What types of beliefs do we recommend collecting? Each PD is different and there are several to choose from. Choosing those that most align with PD goals will ensure that the evaluation is meaningful. We recommend PD providers consider collecting data related to interest in teaching CS, mindset, self-efficacy, their support network, and their beliefs about the benefits of students learning CS.

INTEREST IN TEACHING CS	Many teachers have been told they will be teaching CS and there may be some that have anxieties about doing so. Having an interest in the topic being taught can impact student learning [10]. It is important to know whether PD offerings are successfully promoting interest among PD participants, particularly those who have not chosen to teach CS.
SELF-EFFICACY	Since self-efficacy has been shown to impact student learning [21, 23, 20], it is important to gauge what type (positive or negative) and how much impact the PD had on teachers.
MINDSET	Two mindsets can be evaluated: growth and equity. Growth mindset and equity mindset share similar qualities and require teachers to understand that each student has the capacity to learn, regardless of their personal characteristics, upbringing, or family's economic status.
BENEFITS OF STUDENTS LEARNING CS	Teachers' understanding of how CS is relevant to students and the important benefits of students learning CS can increase their interest in teaching CS.
SUPPORT NETWORK	Isolated teachers, including being the only CS teacher in the school, can have a negative impact on self-efficacy, and teachers' support networks are important and have a relationship to academic achievement [9, 21]. Being supported promotes a sense of belonging, which is important for teacher self-efficacy.
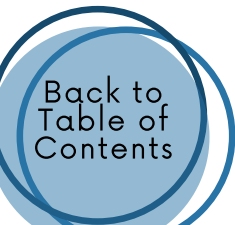
- What data should be collected pre- and post-intervention versus post-intervention only?

- How will PD providers ensure that even the least engaged in their PD offering provide data?

- For surveys, how long will the survey be? What trade-offs are there in time to take and complete the survey versus amount and type of data collected?

- How can participants be reassured that their data will be used to inform PD rather than to evaluate them or their teaching?
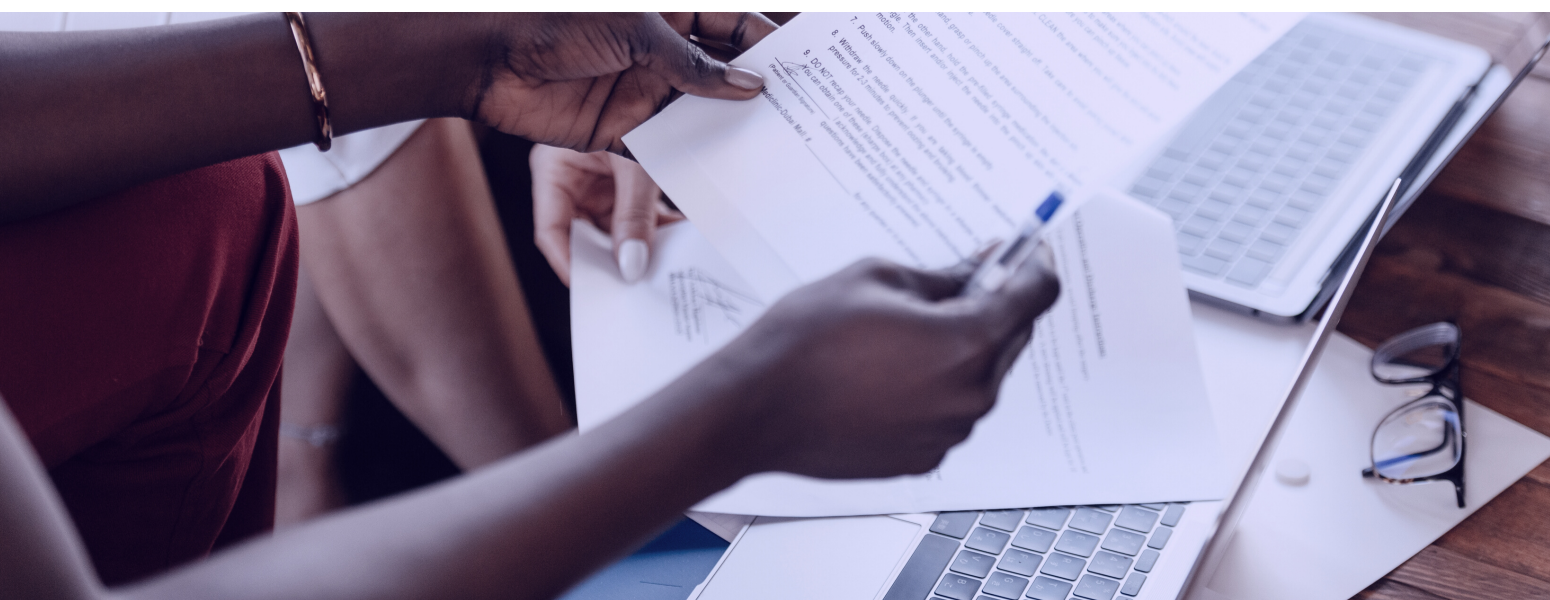
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RESOURCES

Here are some helpful resources - listed in order of appearance within the guidebook:

- **Case Study #1**
- **Case Study #2**
- **Case Study #3**
- **Teachers Know Best: Teachers' Views on Professional Development.** Bill and Melinda Gates Foundation https://usprogram.gatesfoundation.org/-/media/dataimport/resources/pdf/2016/11/gates-pdmarketresearch-dec5.pdf
- **Considerations for Delivering Online PD.** Dianne O'Grady-Cunniff
- **I Felt Like We Were Actually Going Somewhere** - SIGCSE '21: Proceedings of the 52nd ACM Technical Symposium on Computer Science EducationMarch 2021 Pages 739–745https://doi.org/10.1145/3408877.3432482
- **The Virtual Pivot: Transitioning Computational Thinking PD for Middle and High School Content Area Teachers** - SIGCSE '21, March 13–20, 2021, Virtual Event, USA. © 2021 Association of Computing Machinery. ACM ISBN 978-1-4503-8062-1/21/03...S15.00. https://doi.org/10.1145/3408877.3432558
- **Research-based design recommendations for transitioning a computational thinking summer professional development to a virtual format** - Ferdig, R.E., Baumgartner, E., Hartshorne, R., Kaplan-Rakowski, R. & Mouza, C. (2020). Teaching, Technology, and Teacher Education during the COVID-19 Pandemic: Stories from the Field. Association for the Advancement of Computing in Education (AACE). Retrieved June 18, 2021 from https://www.learntechlib.org/p/216903/.
- **AccessSIGCHI** <u>Guide for accessible meetings</u> https://www.sigaccess.org/welcome-to-sigaccess/resources/accessible-conference-guide/
- **AccessSIGCHI** <u>Guide for virtual conferences</u> https://www.sigaccess.org/accessible-virtual-conferences/
- **AccessSIGCHI** <u>Guide for remote work</u> https://accesssigchi.com/2020/03/13/accessible-remote-work-and-covid-19/
- <u>**What is AccessCSforAll**</u>? University of Washington. https://www.washington.edu/accesscomputing/accesscsforall.
- **Open Source** <u>LEGO building tool</u> https://opensource.com/article/20/6/open-source-virtual-lego
- <u>**Plan-Do-Check-Act (PDCA) method**</u> https://asq.org/quality-resources/pdca-cycle

Videos the Hindsight 2020 Team found helpful:
- <u>**Tough as Nails:**</u> https://stemforall2021.videohall.com/presentations/1915
- <u>**Mobile CSP**</u>: https://stemforall2021.videohall.com/presentations/2201
- <u>**CodeVA**</u>: https://stemforall2021.videohall.com/presentations/2002

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