An Immersive Virtual Experience to Drive Change in Computer Science Education

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Abstract—Striking inequities in computer science education (CSE) present educators, researchers, and the broader community of stakeholders with the challenge of broadening participation of underrepresented groups. In response, through our work with the Rutgers University Computer Science Teaching & Learning Collaboratory, a researcher-practitioner partnership (RPP) funded by the National Science Foundation, we held the 2020 Summer Institute, an intensive 3-day virtual workshop for high school teachers, administrators, and school counselors from over 15 districts across NJ and PA.

The workshop included 12 unique and purposeful professional learning opportunities focused on increasing the capacity of district teams to provide inclusive, rigorous, and equitable CSE at the high school level. Sessions included panels with teachers and students nationwide, demonstrations on the use of CS tools for teaching remotely, and strategic planning opportunities to coordinate long-term goals and systemic change relating to CSE. This report summarizes the program, expresses the experience of participants measured through daily evaluations, and reflects on lessons learned to inform future work.

Index Terms—computer science education, broadening participation, professional learning, researcher-practitioner partnership, high school teachers, school administrators

I. BACKGROUND

In 2018, with funding from the National Science Foundation, the Center for Effective School Practices (CESP), a unit of the Rutgers University Graduate School of Education, established the Rutgers University Computer Science Teaching & Learning Collaboratory (CS-TLC), a researcher-practitioner partnership (RPP) that embraces meaningful connections between high school teachers, school administrators and leadership, higher education faculty and staff, industry experts, and research evidence with the shared mission of strengthening rigor and inclusion in CSE and increasing the recruitment, retention, and engagement of historically underrepresented students in the field. Since then, we are proud to have worked with over 70 CS and non-CS teachers, administrators, and school counselors from NJ and PA school districts that serve student populations of varying racial and ethnic compositions, socioeconomic statuses, and community interests.

One of the key activities of our project has been annual Summer Institutes, week-long events held on the main campus of Rutgers University - New Brunswick. During these 5-day gatherings, members of the RPP community attended multiple professional learning opportunities during the day, hearing from experts in CS content-pedagogical knowledge, equitable classroom practices, and facilitators to broadening participation efforts. These sessions, roughly 4 each day, took place in one of Rutgers' *active learning spaces*, which allowed members to sit in small pods, each with access to a microphone, whiteboard walls, and screen-share capabilities, which could be broadcasted on larger central screens to share out with the broader group.

Of equal, or potentially greater, importance outside the learning spaces, members from across districts had a chance to share, establish connections and networks, collaborate during spontaneous work sessions, and strengthen relationships with colleagues within their districts. It is through these moments, over meals, walking back to dorms, or at the bowling alley, that the strength and added benefit of the RPP's collaborative structure came to light, when coupled with relevant, sustained support. Our Summer Institutes went beyond providing professional development by creating spaces for knowledge-transfer, planning for implementation, and relationship building. Existing literature on best-practices in professional development supports our approach, confirming the importance of involving administrators as key change-drivers [1] as well as providing spaces for planning, debriefing, and discussion [2].

For our 2020 Institute, the pandemic presented us with the unique challenge of replicating this experience virtually. Although it would be easy to present predominately didactic professional development on a virtual platform, this did not feel true to our RPP's mission, which is centered around leveraging partnerships and collaboration. Rather than settling, we developed a rigorous, inclusive virtual experience to invite progress in CSE.

II. INSTITUTE GOALS

We sought to develop a program that would respect the novel constraints on teachers' and administrators' time brought

on by the pandemic, establishing communication channels with students, transitioning materials to Learning Management Systems [3], and coordinating student support [4]. We also wanted to provide an experience that was meaningful and relevant, employing our RPP structure, all while avoiding the potential pitfalls of virtual gatherings, like "Zoom fatigue" or lack of participant engagement [5].

In terms of content, we aimed to provide guidance and support in response to the disruptions associated with the sudden transition to virtual learning, which is especially relevant considering underrepresented minority students were particularly impacted by this shift, but still share information which would be useful in larger contexts and have a lasting impact.

Our goals for the development and execution of the 2020 Virtual Summer Institute were to:

- Address current challenges faced by teachers during the pandemic
- Conduct meaningful professional learning tailored to HS teachers, administrators, and school counselors with varying CSE experience , avoiding information-overload [6]
- Provide uncompromising virtual substitutes for in-person networking, relationship-building, and collaboration spaces
- Facilitate strategic planning to spark initiatives that reach underrepresented students

III. PARTICIPANTS

Registration for the 2020 Summer Institute was circulated via email, announcements on our Canvas page, and posts on our social media platform (Mobilize) to all RPP members. A total of 39 members attended the event, representing 17 school districts. Combined, these districts house over 20,000 high school students, most with no racial majority.

Given that educators have additional responsibilities and time constraints, we allowed participants to register for individual sessions, rather than the entire 3-day event. In the registration email sent to administrators, we suggested specific sessions we believed would be most impactful for them. Teachers were also afforded flexible scheduling and the option to select their choices from concurrent sessions.

IV. INSTITUTE HIGHLIGHTS

In the end, we decided to hold the 2020 Summer Institute as a 3-day event from 9am-3pm, with a 30-minute working lunch each day. We held 12 total sessions; all 30 HS teachers, 2 school counselors, and 7 administrators that RSVP'd (over 90% of RPP membership; a similar rate as past years) attended at least 80% of the sessions they signed up for. Table 1 details attendance by session; note that "B" sessions occurred simultaneously.

It was important to us that this event include a significant social component, since many teachers were facing "covid isolation" around this time [7]. Before beginning each day, we had a themed breakfast open for anyone to join - our themes included a "breakfast at the beach" and a "winter wonderland;"

winners were selected each day and each received an hour of individual consulting time with one of the presenters. Additional contest winners were selected based on online engagement, "Best Tweeter" and received coaching time with our team. During breakfast and following the institute each day, we held optional "office hour" sessions that focused on strategies to prepare students virtually for AP CS courses, as well as changes to their curricula. We also held lunch breaks together to give everyone a chance to catch up, continue conversations, and network.

Table 1. Session Attendance by Role

Session	Teachers	Administrators	Counselors
1A: Who are We?	30	7	2
1Ba: Teacher Panel	10	2	2
1Bb: Using Real-World Data	20	2	2
1C: Projects in CS	30	2	2
2A: Integrating State Standards	29	6	2
2Ba: Online IDE's	19	0	2
2Bb: Utilizing Scratch	10	2	0
2C: Curriculum Roadmaps	28	5	2
3A: CS Distance Education	30	6	2
3Ba: Student Panel	18	0	2
3Bb: CS Best-Practices	11	3	0
3C: Building CS Culture	27	3	2

A. Technology Use

When considering the suite of tools to carry out the Institute, we needed to find platforms that allowed us to replicate the collaborative nature of previous years while being mindful of ease of use, teacher's familiarity with the programs, and price. During the institute, we leveraged technology in the following ways:

1) Zoom: Based on teacher feedback, our institutional licenses available, and the ability to use breakout rooms, we elected to use Zoom web conferencing for the main platform to conduct sessions. Zoom allowed us to pre-assign participants to breakout rooms to pre-group district teams or individual members based on geographic/socioeconomic areas, courses taught, or other demographics for collaborative sessions. We could also actively monitor and save chat, and record sessions for later viewing, with transcription. Participants were also encouraged to keep their webcams and microphones on whenever possible and to rename themselves during meetings to include their school, pronouns, and preferred name for easy identification.

2) Google Classroom: The Google Classroom platform was familiar to almost all RPP members, so we utilized it for all event-related communications outside of Zoom. For each session, we created a post in the feed that contained the Zoom meeting link, the speaker, a brief description, and a guiding question that members were encouraged to respond to in the comments. For sessions that had additional resources or worksheets, their links were posted in the announcement as well. Links to the recording and relevant follow up files were posted as an addendum following each session.

3) Google Drive: One of the benefits of our RPP is the ability to openly exchange resources, ideas, and experiences

among members of the group. For sessions that had "work-sheets" (templates to guide discussions and record important themes), sessions with resources, or planning tools, all members posted their work in a centrally located, protected shared drive. This afforded district teams the ability to view work from other groups for ideas or items to consider, as well as provide a safe, consistent location for all files. This drive was archived following the event and made available on our online engagement platform, *Mobilize*.

B. Professional Learning

Throughout the institute, we offered a total of six sessions dedicated specifically to providing professional learning to educators teaching (or coordinating the instruction) of varying levels of CS courses. These sessions were designed to build on existing, ongoing professional development modules offered to RPP members and took into consideration the results of the pre-survey administered before planning the institute. Professional learning sessions were facilitated by key RPP partners, our team of subject-area experts, including representatives from the Rutgers University Computer Science Department and industry partners. Key learning outcomes from these sessions included:

- Integrating real-world datasets into CS instruction, demonstrations, and assignments - including navigating to online resources for accessing data, importing data into various IDE's across languages, and scaffolding and differentiating these types of assignments
- Responding to the publication of new state student learning standards in computer science and design thinking by incorporating new concepts into classroom instruction, both in CS and subject areas
- Using online IDE's with distance education to allow students without access to school computer labs the ability to write, compile, and execute code, especially when unable to install programs on school laptops due to restrictions or operating system
- Engaging non-programming students through the use of the Scratch drag-and-drop coding environment to tackle novel, exciting, and creative problem-solving exercises
- Adopting best practices for teaching CS via distance education, inclusive of virtual alternatives to pair programming and other student-collaboration techniques, grading assignments, and promoting student choice

C. Panel Discussions

One advantage of hosting our conference remotely was the ability to select speakers in a geographically unrestricted way. We were able to hold two panel discussions during our summit. Our first panel consisted of four teachers from around the country. Two of the speakers were from New Jersey (one from a magnet STEM academy and the other from a high-needs, ethnically diverse, and socioeconomically disadvantaged district). To broaden the perspectives of our panel, and to offer specific insights to those teaching Latinx students (four of the attending districts are comprised of over

50% Latinx students), we invited a teacher from California who teaches AP CS courses in Sweetwater Union High School to a population of over 80% Latinx students, as well as a teacher from a border town in south Texas who teaches 6 sections of varying levels of CS courses at a mid-sized school to a student population of over 97% Latinx students. Panelist teachers were asked to share insights and experience on topics of student recruitment, retention, engagement, and their thoughts on going remote. Each educator also shared a personal account of a meaningful, impactful, or powerful experience with CSE.

We were fortunate enough to also be able to hold a panel discussion with a diverse group of computer science students at varying stages in their academic careers. This session, entitled "Diverse Learning Experiences in Computer Science," featured three female CS students of color from NJ. Two students were at the high school level (one freshman, and one rising senior) and the third was a computational cognitive science major from Rutgers University. Each panelist spoke about the makeup of their schools, prior CS classes, experiences joining CS courses as a minority, their confidence, and challenges they have faced. Panelists also shared what they thought were effective strategies for recruiting and retaining minority students and their opinions on culturally relevant curricula.

D. Strategic Planning

Literature emphasizes the importance of "debrief" time following professional learning to ensure the adoption and use of the content presented [8]. Each afternoon, working in district teams, participants worked together during a three-hour strategic planning session focusing on a specific aspect of CSE. These sessions began with a brief presentation and discussion on the topic to present relevant ideas and practices from research, then participants were divided into breakout rooms to work with their districts to develop plans to incorporate concepts from the discussion. After an hour of development time, each district shared their ideas and plans with the larger group; following this think-tank, districts dispersed to breakout rooms again to make any revisions to their work.

The first strategic planning session focused on teaching CS utilizing a more project-based approach. This session presented (a) different types of project assignments including ones that introduce a concept, ones that afford students the opportunity to learn as they complete a project, and ones that allow students to demonstrate mastery of a previously taught concept; (b) how to design, scaffold, and differentiate projects in ways that allow student voice and choice; (c) strategies to ensure projects are successful in engaging students from historically underrepresented groups, and; (d) how to grade assignments mindfully and purposefully. During planning time, teachers were grouped based on the courses they were teaching to complete a Project Design Journal; these were aggregated and made available to the community for classroom use.

The second, Curriculum Roadmap session, focused on building high school CS course pathways that considered course sequencing, elective courses, the necessity of prereq-

uisites, alignment of courses with state standards, curriculum articulation, and pedagogies. Districts worked in groups based on their size and scope of existing CS pathways and were provided with a sheet of prompts with items to consider when designing their pathways. During the third session, the same groups added to their pathways, strengthening them with extra-curricular elements and outreach events.

V. Reflections

A. Participant Takeaways

In coordination with our external evaluation team, we conducted a systematic evaluation of the Summer Institute with the goals of reflecting on our work, informing future endeavours within our project and current research on what works with virtual professional development events. Evaluation surveys were administered daily and asked about attendees' satisfaction with the day overall, their main takeaways, most impactful sessions, and suggested changes. On the whole, responses were overwhelmingly positive. Below are representative quotes from the evaluations that illustrate main participant takeaways:

- "CS is more than coding"
- "All people can code; they just need a reason to do it"
- "Focusing on success in relation to the digital divide"
- "The importance of coherence across our district"
- "The prerequisites we impose hold some students back"
- "The importance of the culture surrounding CS classes"
- "Creating relevancy in the classroom"
- "Need more people solving more problems - bottom line"

Based on teacher post-survey response data (with total of 27 respondents, a 90% response rate), 92% of teachers were "satisfied" or "very satisfied" with the overall professional development experience from the 2020 Summer Institute. Additionally, all were "confident" in their ability to integrate material from the institute into their classroom practice, with 79% indicating they are "very confident" or "extremely confident."

B. Lessons Learned

In the development and execution of and reflection on the 2020 Summer Institute, we identified contributors to success that are of use to professional learning providers and the education and research communities writ large.

1) Go Thoughtfully Virtual: Despite the global circumstances, we found that hosting our Institute virtually, rather than postponing it, was the right choice. However, based on personal experiences in long Zoom meetings and being at home, we needed to modify our agenda to a manageable schedule each day (6 hours, versus the past year's 8) and event duration (3 days, versus the past year's 5) to maximize our time together without losing people's attention. Based on participant feedback, the only change we would make is to have a 60 minute break each day, rather than 30.

2) Flexible Scheduling: Allowing participants to RSVP to individual sessions, rather than the entire Institute, ultimately increased the number of attendees, as people who were unable to join on certain days or at specific times could still attend other sessions. This was especially useful to administrators and school counselors, who were able to RSVP to recommended sessions that would benefit from their contributions.

3) Utilize Breakout Rooms: Moving away from a didactic model increases engagement of teachers during professional learning [9], which is especially important for a virtual session. We found that breakout rooms divided longer sessions and invited more active participation. By having participants supply their Zoom emails at registration, we were able to pre-assign breakout rooms that best fit the session's theme, such as grouping teams from similar geographic regions or those serving similar student populations.

4) Structure Conversations: Based on previous meetings, we noticed that in breakout groups, teachers' conversations tend to shift towards discussing common problems of practice or issues they are currently facing. Although this is an important aspect of our RPP structure, efforts during certain sessions should focus on the topic at hand. Providing semi-structured templates and loose deliverables to guide discussions kept conversations on task and resulted in documentation that could be used for research analysis and be shared with the broader group for later reference.

5) Mediate Knowledge-Transfer: The most impactful part of each session, especially strategic planning sessions, was the dedicated time for representatives from each team to share the work and highlights from their discussions in breakout rooms. This allowed members from other groups to consider different and new ideas, ask questions of each other, and engage in discussions that spawned from certain themes. We were also intentional in providing a shorter, additional breakout period to incorporate ideas from these "share-outs." For an hour of working time with 6 groups, we have found that *at least* 45 minutes of sharing out is needed.

6) Think Bigger (Geographically): Moving our conference to a virtual platform allowed us to bring in speakers and guests from beyond our geographic area, expanding our pool of potential speakers. By simply emailing educators around the country, we found people were willing, and even eager, to share their experiences.

VI. Conclusion

The CS-TLC 2020 Virtual Summer Institute proved to be an effective professional learning and strategic planning event for educators across NJ and PA. It was successful in both preparing educators to respond quickly and confidently to challenges presented by the pandemic and equipping them with knowledge and skills with long-term implications for high school CS. Conducting this event provided useful insights for the broader educational and research communities in terms of flexible scheduling, incorporating social components to learning events, and leveraging technologies as uncompromising alternatives for face-to-face learning and collaboration.

REFERENCES

[1] Postholm, M. B.. (2019). The school leader's role in school-based development. *Educational Research, 61*(4), 437–450. https://doi.org/10.1080/00131881.2019.1677171

[2] Shernoff, D. J., Sinha, S., Bressler, D. M., Ginsburg, L.. (2017). Assessing teacher education and professional development needs for the implementation of integrated approaches to STEM education. *International Journal of STEM Education, 4*(1). https://doi.org/10.1186/s40594-017-0068-1

[3] Lapada, A., Miguel, F., Robledo, D. A., Roldan, A., & Alam, Z. (2020). Teachers' Covid-19 Awareness, Distance Learning Education Experiences and Perceptions towards Institutional Readiness and Challenges. *International Journal of Learning, Teaching and Educational Research, 19*(6), 127-144.

[4] Ferri, F., Grifoni, P., & Guzzo, T. (2020). Online learning and emergency remote teaching: Opportunities and challenges in emergency situations. *Societies, 10*(4). https://doi.org/10.3390/soc10040086

[5] Nadler, R.. (2020). Understanding "Zoom fatigue": Theorizing spatial dynamics as third skins in computer-mediated communication. *Computers and Composition, 58*, 102613. https://doi.org/10.1016/j.compcom.2020.102613

[6] Blitz, C. (2019, February). Information overload: navigating existing CS resources without reinventing the wheel. Poster presented at 4th international conference on Research in Equity and Sustained Participation in Engineering, Computing, and Technology (RESPECT), Minneapolis, MN.

[7] Diliberti, M. K., & Kaufman, J. H. (2020). *Will this school year be another casualty of the pandemic? Key findings from the American Educator Panels fall 2020 COVID-19 surveys* (Report No. RRA168-4). RAND Corporation. https://doi.org/10.7249/RRA168-4

[8] Sprott, R. A.. (2019). Factors that foster and deter advanced teachers' professional development. *Teaching and Teacher Education, 77*, 321–331. https://doi.org/10.1016/j.tate.2018.11.001

[9] Darling-Hammond, L., Hyler, M. E., Gardner, M. (2017). *Effective teacher professional development*. Palo Alto, CA: Learning Policy Institute.