Reflections on Launching a Networked Improvement Community with Computer Science Educators

Carol L. Fletcher
Texas Advanced Computing Center
The University of Texas at Austin
Austin, TX
cfletcher@tacc.utexas.edu

Ryan Torbey
Texas Advanced Computing Center
The University of Texas at Austin
Austin, TX
rtorbey@tacc.utexas.edu

Joshua Childs
Educational Policy and Planning
The University of Texas at Austin
Austin, Texas
joshuachilds@austin.utexas.edu

Rebecca Zarch
SageFox Consulting Group
Amherst, MA
rzarch@sagefoxgroup.com

***Abstract*—This experience report details the lessons learned while launching a Networked Improvement Community (NIC) with 23 teachers in Texas as part of the NSF-funded Accelerating Women's Success and Mastery in Computer Science (AWSM in CS) project. Conceived to address the persistent gender inequities in computer science (CS) education, the NIC was designed to bring together researchers and practitioners to collaboratively develop and implement solutions with the goal of increasing female participation in CS courses. This experience report explores the lessons learned, such as the importance of building a sense of community, trust, and collaboration, before jumping into problem solving as a NIC. Additionally, the report addresses considerations for sustaining the NIC virtually given the logistical constraints placed on teacher collaboration during the school year.**

Keywords—CS for All, RPP, NIC

I. Introduction

Accelerating Women's Success and Mastery in Computer Science (AWSM in CS) is a project focused on improving the enrollment and experience of young women in secondary computer science classes in Texas. While the bulk of this experience report will examine the lessons learned in launching the AWSM in CS (pronounced "Awesome in CS") project's Networked Improvement Community (NIC), it is important to understand the context of the overarching goal of the project, addressing the persistent disparities in computer science course enrollment between male and female students in Texas, in order to fully appreciate our approach.

The project was conceived as a response to the trends in enrollment in high school CS courses seen since 2011. The lack of female representation in high school computing has been well documented with females seen as a subset of students who are traditionally underrepresented in CS along with students of color, students from low socio-economic backgrounds, students with disabilities, and students from rural communities [1,2]. Since our research team began tracking CS enrollment in 2011, notable improvement has been documented in several of these traditionally under-represented subpopulations. As noted in Figure 1, overall enrollment in high school CS courses has more than doubled since 2011 (124% increase) [3]. Even more encouraging is that the enrollment of underrepresented minorities (URM), defined in this study as Black and Hispanic students, has increased by 154% and the enrollment of economically disadvantaged students (EcoDis), defined here as eligible for free or reduced lunch, has increased by 156%. Upon first glance, it would appear that improvements in female representation have also been promising, with a doubling of female enrollment (104% increase).

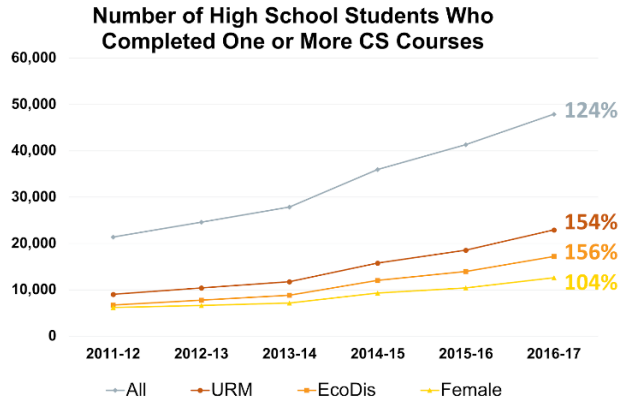

Fig. 1. Number of high school students who completed one or more CS courses

A deeper examination of these data in the context of overall improvement, however, shows that as a percent of the overall enrollment of students in high school CS, young women have seen a decline since 2011, going from 29% in 2011-12 to 26% in 2016-17. In short, the gap is widening between young men and young women in CS in Texas. In fact, when we examine traditionally underrepresented subpopulation's enrollment in CS courses compared to their representation in the high school student population, we find that the gap is most acute for young women (Figure 2) [3].

To address this persistent underrepresentation, The University of Texas at Austin, in collaboration with Austin Independent School District and 10 other Texas school districts, launched the AWSM in CS project in 2018 with funding through the Computer Science for All Researcher Practitioner Partnerships (CSforAll:RPP) program of NSF (Award #1837602). This project was planned as a Networked Improvement Community (NIC) consisting of 23 secondary CS teachers all committed to recruiting, supporting, and retaining more young women in their CS courses. A NIC is one approach to engaging the diverse parties of an RPP. This experience report

978-1-7281-7172-2/20/$31.00 ©2020 IEEE

will highlight some of the strategies deployed to design and support the NIC, some lessons learned in launching our NIC, and, based on the initial launch, considerations for sustaining the NIC.

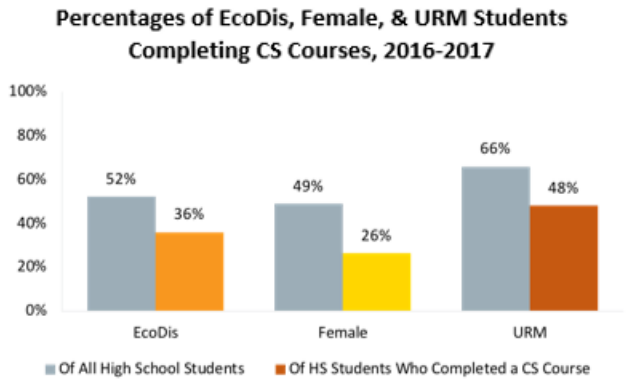

Fig. 2. CS course completetion percentages of underrepresented groups

II. Improvement Science as a Tool for Addressing BPC

In Texas, educators have long been engaged in efforts to improve teaching methods and student outcomes around high school computing courses. As mentioned earlier, CS course completion for underrepresented students has increased over the past five years. However, more investment and engagement is necessary to have this improvement trend impact young women in CS education. In recent years, organizations like the National Science Foundation (NSF) and CSforAll have promoted the tools and frameworks of improvement science to advance efforts to broaden participation. From its onset, improvement science has been defined as seeking to discern what works for addressing a complex problem, for whom, and under what set of specific conditions [4]. Improvement science in education has focused on addressing gaps between the aspirations of educational systems and their capacity to deliver high-quality education to all students [5].

A key framework and tool within improvement science is the plan-do-study-act (PDSA) cycle. PDSAs serve as a process for rapid cycles of learning from practice, a way to maximize learning, and a method for introducing a change to a complex system [6, 7]. PDSAs include four steps: planning a small test of change; doing or implementing a practice that matches what was planned; studying by monitoring or measuring what was implemented; and finally acting by refining and adjusting to what happened in the previous phases of the PDSA cycle to improve in the next iteration. An important part of the PDSA cycle process is to learn from the data. This involves comparing what was anticipated or predicted to what actually happened and took place. Improvement science uses PDSAs to frame, discipline, and document the learning that happens in organizations [6]. It provides educators an opportunity to implement new ideas, processes, and practices, refine them based on identified needs, and then use the results of implementation to make changes and commit resources and expertise to where it best fits.

NICs serve as a one example of the potential of improvement science in education [4]. NICs were created to address problems of practice by linking diverse kinds of expertise from research, educational design and practice in a process that can lead to improved student and educator outcomes [8, 9]. Russell et al. (2016) situate NICs as operating as scientific learning communities around four key dimensions: 1) they are focused on a well-specified aim; 2) they are guided by a deep understanding of the problem, the system that produces it, and a shared working theory of how to improve it; 3) work is disciplined and oriented by the rigor of improvement science, and 4) NICs are coordinated to accelerate the development, testing, and refinement of interventions, their rapid diffusion out into the field, and their effective integration into varied educational contexts. Beyond just identifying problems, NICs leverage the expertise of both researchers and practitioners to engage in activities that purposely arrive at a collective and deep understanding of the problem to be solved [5]. Spreading and scaling improvements in NICs requires several functions that are facilitated by a "hub". These functions include improvement coaching, network initiation and development, data analytics, innovation design, knowledge management and collaborative technology to support collaborative action as well as spread knowledge, and that the network's capacity to reach its aim increases over the time of implementation [5].

III. AWSM in CS as a Networked Improvement Community

A. Guiding Research Questions

Several research questions guide the work of the AWSM in CS RPP, but this experience report will focus on addressing one question in particular:

What does the backbone organization learn about supporting practitioner change from participating as a hub or convener for the NIC?

This paper addresses some of the initial lessons learned by the backbone organizers from the NIC initiation and launch. We also discuss how these lessons learned will guide our work in sustaining the NIC through virtual meetings during the school year.

B. Structure of NIC

AWSM in CS is a three-year project that combines in-person summer institutes with a combination of virtual and in-person meetings during the school year to support and sustain the NIC. AWSM in CS kicked off with a 5-day institute in June 2019.The 5-day summer institute was intended to facilitate teachers' root cause analysis of the problem, jumpstart planning of individual PDSA cycles, and build lasting relationships among participants. The research team partnered with professional development specialists from the National Center for Women & Information Technology (NCWIT) to provide training specifically focused on supporting female participation in computer science.

Sustaining a NIC consisting of teachers from multiple schools and districts is a significant challenge to a backbone organization. Unlike other professionals, teachers lack the ability to meet with their colleagues from outside of their school during the workday, either in-person or virtually, due to the structure of the school day. This problem is compounded for CS teachers, who are often the only CS teacher in their school (this

is the case for 9 of the 11 schools represented in AWSM in CS). As such, it is vital that support during the school year be designed around the realities of the teacher workday. To maintain engagement throughout the school year, we chose to use monthly virtual meetings, conducted after school and facilitated through Zoom, as a vehicle for teachers to share the progress on their PDSAs and receive feedback from peers. NIC participants also committed to attending one in-person meeting each spring and fall.

IV. Lessons Learned in Launching our NIC

Several key themes emerged from the feedback from NIC participants in the summer institute. We believe these themes and the discussion surrounding them would be helpful to anyone planning to start a NIC.

A. Building Authentic Community

In reflecting on the launch of our NIC, the first lesson learned was the importance of building authentic community. The value of community cannot be underestimated when teachers are pushing themselves to learn something new and reflecting on their personal role in systemic inequities in CS. Nearly 80% of the teachers have more than 6 years of teaching experience, but less than 6 years of experience teaching CS. The teachers in our cohort needed the support of others to thrive. Just because you have people in the same space, doesn't mean that you have a community. Each teacher brings something different to the table. The group is diverse in terms of which courses they have taught, what endorsements they hold, and discipline in which they teach. You have to be purposeful in your design to build the types of collegial, trusting, collaborative, and reflective experiences, particularly when teachers are dealing with challenging and sensitive topics.

B. Co-Designing PD

One of the tenets of RPPs is to empower all of the participating partners. Prior to the institute most teachers had limited experience generating or using research (see Table 1). As novice researchers, and with the constraints of teacher work environments, empowering teachers as active partners can be challenging in the initial design phase. In AWSM in CS, this meant giving teachers control over the specific interventions they chose to select for their PDSA cycle, respecting and elevating the experience they bring to the table. This also meant utilizing feedback from teachers each day to modify the next day's agenda in response to their suggestions and needs. This feedback loop and the ability of teachers to customize their own PDSAs based on their personal interests or school contexts, built trust, buy-in and a sense of shared community that is often absent in traditional PD. One participant commented on a post-institute survey "The presenters mingled with teachers and got to know us. Each task we worked on pointed back to what we're doing next school year. Each step built on the previous until we finally had our plans."

C. Data Walk

One of our most popular activities of the summer institute was the data walk. This activity highlighted for us that even though teachers may be interested in a topic of equity, such as the lack of female participation in computer science, they may not be knowledgeable of the related statistics. Teachers' major focus is on their classrooms, with secondary focuses potentially on their schools and districts. In our data walk activity, we hung a variety charts around the room that highlighted different representations of the lack of female participation in CS. Many of the charts were at the regional, state or national level. As teachers walked around in small groups, they were able to simultaneously form a picture of the current state of equity in relation to female CS participation while also having meaningful conversations with their peers about potential causes for the lack of female representation in high school, college, and the workforce that laid the foundation for their root cause analysis. The data walk informed their root cause analysis and helped them to go beyond an exclusive focus on their own personal or anecdotal experiences when considering the root causes of underrepresentation.

TABLE I. EXPERIENCES USING RESEARCH

Since starting work at your school/district, how often have you done the following	Never	Occasionally	Often	All of the time	Count
Used research to mobilize support for important issues?	26%	44%	22%	9%	23
Used research to get others to agree with a point of view?	22%	65%	4%	9%	23
Selectively used research because it would support a decision?	26%	57%	13%	4%	23
Used research to discredit a policy or program?	52%	48%	0%	0%	23

D. Self-reflection

The systemic inequities in education are often uncomfortable for teachers to address. Examining the role that a teacher's personal actions may play in perpetuating inequities is an even more uncomfortable conversation. AWSM in CS was designed to create a welcoming and safe space to self-reflect. It is an immensely difficult task to assess one's own actions and how they may positively or negatively impact female participation in CS. One participant commented on a post-institute survey "It was a good opportunity to meet with other CS teachers and talk about our classes, which I never get to do. It brought up some things I had been doing poorly, and some things to be aware of." This depth of self-reflection is important to foster during the launch of a NIC, particularly one that focuses on PDSA cycles.

E. Time to Collaborate with Colleagues

Balancing the need to share research and information with teachers along with the time it takes for them to meaningfully process and consider how that research can impact their practice is a difficult task for RPP leaders. We purposefully designed the summer institute so that large chunks of time were devoted to true collaboration, giving teachers time to digest new material and think deeply about how it might impact their practice. NIC participants repeatedly cited this collaboration time as one of the most valuable aspects of the summer institute.

F. Building Trust by Honoring Teachers' Time and Expertise

Asking teachers to participate in a NIC means honoring their time and expertise by including them as co-designers, compensating their participation, and offering a high-quality experience in the project. The summer institute was the first engagement opportunity and the positive experience (see table 2) has laid the foundation for the next two years of the NIC.

TABLE II. TEACHERS' PERCEPTIONS OF THE INSTITUTE

Scale: Strongly agree (5); Agree (4); Neutral(3); Disagree (2); Strongly disagree (1)	Average
The goals of the AWSM in CS project are clear.	4.8
The orientation was supported by effective/appropriate use of technology.	4.8
The content of the orientation was relevant to my responsibilities	4.7
Expectations were thoroughly explained	4.7
The facilitator was knowledgeable and helpful.	4.7
The facilitator was well prepared.	4.7
This professional development opportunity will extend my knowledge, skills, and teaching performance	4.6
The orientation goals and objectives were clearly specified.	4.6
Time was used efficiently and effectively.	4.6
Sufficient time was provided for guided practice and tasks	4.5
The orientation activities were carefully planned and well organized.	4.5
The pre-meeting assignments were appropriate	4.4

V. Considerations for Sustaining our NIC

Intensive, in-person NIC meetings are valuable for laying the foundation for the work but not feasible for multi-district partnerships that must be sustained during the school year. Our challenge is to ensure that the positive aspects of the summer institute are reflected in the support provided during the school year. This support includes virtual monthly meetings along with one day in-person convenings each semester. As we move forward, the following considerations explore the more difficult work of continuing the NIC throughout the school year.

A. Supporting Teacher Agency

A large part of the philosophy of the RPP model is the empowerment of the practitioner. As we move into the school year, teachers are designing their own research-based interventions to test in their classrooms and schools. Our virtual calls include teachers sharing out updates on their PDSA cycles. At the time of this writing, we have had two rounds of calls with a total of six teachers who have shared their updates and gathered feedback from their peers and the project team. The ownership teachers have over their own interventions and iterations is an important part of sustaining the NIC as it moves into the school year. Milestones, such as the share out sessions on calls, allow for us to simultaneously nudge teachers into action while still allowing them ownership over their work. Supporting teacher agency is a core component of ensuring success as we move forward.

B. Continuing Engagement While Respecting Busy Schedules

Participating in a weeklong training during the summer is a lot different from a teacher perspective than engaging in a multi-year project. During the school year, teachers face an increased demand on their time. We have to achieve a delicate balance of respecting the time of teachers, while also putting structures in place that promote continued engagement. On the communication front, we have started a five-bullet weekly newsletter that allows us to both disseminate important information about the program as well as provide addition resources and food for thought for all teachers.

C. Creating Value

Finally, in order to sustain the NIC moving forward, we need to be focused on creating value for those involved. Part of our duty as the hub organization is to provide teachers with the skills and resources they need in order to best accomplish our shared goal of increasing the participation of females in middle and high school CS courses. With this in mind, we use the weekly emails and the monthly calls to connect teachers to relevant resources, such as short videos they can use in the classroom. In planning our first in-person meeting of the school year, we deliberately chose to bring in a guest speaker to address intersectionality, something we did not cover during the summer training but is highly relevant to the work we are doing. Moving forward, we aim to sustain our NIC by continuing to shape it into a valuable activity for those involved.

VI. Conclusion

Intensive NICs have a lot to offer the field of computer science education. The problems of equity in CS education are complex, and addressing them will take a concerted effort from all levels of our education system. Teachers, with their busy schedules and competing priorities, are often given marginalized roles to play in the efforts to enact transformational change. The backbone organization for AWSM in CS has learned valuable lessons about how to effectively initiate and sustain a NIC that both values the expertise of teachers and acknowledges the systemic constraints that educators face.

References

[1] Google Inc., and Gallup Inc. "Diversity Gaps in Computer Science: Exploring the Underrepresentation of Girls, Blacks and Hispanics." 2016.

[2] National Center for Women and Information Technology. "Women and Information Technology: By the Numbers." 2018.

[3] C.L. Fletcher, J. R. Warner, L. S. Garbrecht, and C. Ramsey. "Lessons Learned from Developing a Framework for Evaluating the Impact of Computer Science Teacher Professional Development on Csforall Outcomes." In American Educational Research Association Annual Meeting. New York, NY, 2018.

[4] D.M. Berwick, "The science of improvement" *Jama* 299, no. 10, 2008, 1182-1184.

[5] P.G. LeMahieu, A. Grunow, L. Baker, L.E. Nordstrum, and L.M. Gomez, "Networked improvement communities: The discipline of improvement science meets the power of networks." *Quality Assurance in Education* 25, no. 1, 2017, 5-15

[6] M. Hannan, J.L. Russell, S. Takahashi, and S. Park, "Using improvement science to better support beginning teachers: The case of the building a teaching effectiveness network." *Journal of Teaher Education* 66, no. 5, 2015, 595-508.

[7] C. Lewis. "What is improvement science? Do we need it in education?" *Educational Researcher* 44, no.1, 2015, 54-61

[8] A.S. Bryke, L.M. Gomez, and A. Grunow, "Getting ideas into action: Building networked improvement communities in education." *Frontiers in Sociology of Education*, 2011, 127-162.

[9] J.R. Dolle, L.M. Gomez, J.L. Russell, and A.S. Bryk, "More than a network: Building a professional community for educational improvement." *National Society for the Study of Education Yearbook* 112, no 2, 2013, 443-463.

[10] Code.org Advocacy Coalition, Computer Science Teachers Association, and Expanding Computing Education Pathways. "2019 State of Computer Science Education." 2019