

Making Research Practice Partnerships Work: An Assessment of The Maker Partnership

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Abstract—Strong, equitable research practice partnerships (RPPs) center both researcher and practitioner perspectives and priorities. These RPPs facilitate rigorous, relevant research that practitioners can use to improve program implementation. Our project, The Maker Partnership, is an RPP focused on building knowledge about how to help elementary level teachers integrate computer science (CS) and computational thinking (CT) into their regular science classes using maker pedagogy. In this experience report, we use the Henrich et al. framework to assess the Maker Partnership’s effectiveness along five dimensions and share practical advice and lessons learned. This paper contributes to the CS and RPP literature by providing insight into how an RPP can address critical problems of practice in computer science education.

Keywords—Research Practice Partnership, teacher capacity building, elementary level, CS/CT integration, maker pedagogy

I. INTRODUCTION

It is widely acknowledged that students benefit from opportunities to apply computer science/computational thinking (CS/CT) skills across subjects [1], [2]. Further, integration of CS/CT skills into core subjects taken by all students (such as science) ensures more equitable access and serves the goal of broadening participation in CS. Yet, at the elementary level, CS/CT instruction tends to be implemented sporadically, if at all. Two key barriers to widespread integration of CS/CT instruction are the lack of teacher capacity [3] and a paucity of research on exactly how to build such capacity [4].

The Maker Partnership is a research practice partnership (RPP) created to address the critical need for models of professional development (PD) and support that help elementary teachers integrate CS/CT into their science instruction. The partnership leverages Maker pedagogy and curriculum, which are based on the engineering design process, with students brainstorming and developing solutions, using technology to create prototypes, and then testing and refining those prototypes together. The hands-on, interdisciplinary nature of Maker activities makes them ideal for integrating CS/CT into science content and broadening CS participation of those who have historically been underrepresented [5]–[7].

RPPs are long-term collaborations between researchers and practitioners that coalesce around mutually defined “problems of practice” [8]. There are several different types of RPPs. The Maker Partnership is a design research partnership, in which

“researchers and practitioners...collaborate to design, study, improve, and scale innovations in teaching and learning” [9, p. 2]. Our aim was to equip teachers with the content knowledge and pedagogical skills to incorporate CS/CT into their science instruction and to contribute to the research on how to support teachers in such endeavors. RPPs also center equity [10], [11] by “explicitly addressing historical imbalances of power between the two communities [researchers and practitioners] and focusing on problems faced by practice organizations.” [12, p. 8]. In our case, we leveraged stakeholder experiences and perspectives (i.e., those of teachers, curriculum developers, trainers, and program providers) to inform research questions, methods, and sense-making, with an underlying aim of increasing equity in CS [13].

II. DESIGN OF THE MAKER PARTNERSHIP

Our RPP brings together the Research Alliance for New York City Schools—a research center at New York University; and two “practice-side” partners: MakerState—a curriculum developer, implementer and trainer; and Schools That Can—a school support organization. In addition to this core group, we worked with 16 teachers in eight New York City public elementary schools serving predominantly low-income Black and Latinx students. The teachers provided input into the curriculum developed, participated in PD, and integrated CS/CT into their afterschool programs in the first year of implementation (2018-19), and into their classroom science instruction in the second year (2019-20). Due to the COVID-19 pandemic, all instruction and PD was conducted virtually in the last few months of the project (March-July 2020).

As designed, teachers implemented the Maker Partnership curriculum in afterschool “makerspaces” first, then during the traditional school day. We used this scaffolded approach so that we could focus on developing teachers’ CS/CT skills in the first year and give them the opportunity to try out new skills and pedagogical strategies in an afterschool setting that was lower-stakes and more flexible than a classroom setting. During the first year (in the afterschool setting), teachers implemented a curriculum that was provided by the Partnership. In the second year, teachers adapted curricular materials from the Partnership and developed their own CS/CT activities, tailoring them to support their science curriculum. Our staged approach to implementation also allowed the RPP to test out and iterate different approaches to providing PD and support to teachers.

A. *Maker Partnership Professional Development and Supports*

Our practice-side partners designed and implemented eight full days of PD spread out over two years: five full days during the first school year and three full days in the second school year, followed by a half-day culminating event. The PD focused on maker pedagogy and practices (in particular, through the “design cycle”), essential CS/CT concepts, the integration of CS/CT and science content, and the technologies (such as programming languages and robotics equipment) that are used in the Maker Partnership curriculum activities. The PD was designed to provide teachers with multiple opportunities to engage in maker activities in order to develop familiarity and proficiency with the technologies and pedagogical approach.

During the summer between the first and second year of implementation, our practice-side partners facilitated a two-day lesson-planning retreat for teachers to refine and adapt the curricular units and lessons for their specific classroom contexts. In addition to these formal sessions, program staff coached and provided feedback to teachers through in-person visits to their afterschool programs and classrooms, and provided email or phone support on an as-needed basis. Teachers also had access to materials and resources for each lesson or activity through an online learning platform, where they could watch videos of programming tutorials, post modifications to lessons, and give feedback to—and receive feedback from—other teachers in the program.

B. *Research Questions, Data Collection, and Analysis*

The Maker Partnership explored a range of research questions such as: What type of PD and supports do teachers need to integrate CS/CT into their science instruction? What are the benefits and constraints of the Maker approach to integrating CS/CT into science and broadening participation of Black and Latinx students? How does experiencing CS/CT integration through a maker approach influence student outcomes such as interest in science and computer science, confidence, and development of computational thinking skills?

To answer these questions, we drew on multiple data sources over a two-year period, including:

- Seven online teacher surveys across both years of the study;
- Four teacher focus groups in the second year of the study;
- Pre/post online surveys of students’ attitudes and beliefs in both years of the study;
- Pre/post online assessments of students’ computational thinking skills (in the second year of the study);
- Annual interviews with STC and MakerState practice-side partners in both year;
- Case studies of four schools (including observations of instruction and interviews with teachers and administrators) in both years of the study.

In this experience report, we use Henrich et al.’s., framework [9] to assess the success of our RPP, provide practical advice, and highlight lessons that can inform other researchers and practitioners engaged in similar RPP efforts. The framework outlines five dimensions of successful RPPs: 1) building trust and cultivating partnership relationships, 2) conducting rigorous research to inform action, 3) supporting the practice-side partner organization in achieving its goals, 4) producing knowledge that can inform educational improvement efforts more broadly, and 5) building the capacity of participating researchers, practitioners, practice organizations, and research organizations to engage in partnership work.

Though the research we conducted as part of the Maker Partnership drew on a broad set of data collected over two years to address a variety of research questions, our assessment of the Maker Partnership as an RPP is informed by a specific subset of these data. Specifically, we use two rounds of in-depth interviews conducted with our practice-side partners (9 interviews total) and numerous discussions at team meetings where we reflected on our partnership’s successes, challenges, and areas for improvement. At each of these meetings, we collectively took detailed notes. Our practice-side partner interviews included questions such as: How has working in an RPP model changed your approach to working with schools? Has the research practice partnership model led to any key learnings or ‘a-ha’ moments for you? Were there any changes that you made to the Maker Partnership as a result of that learning? What about the RPP model has worked well for you so far? Do you have any recommendations for improving how we work together? Have you experienced any challenges associated with working in close partnership with researchers? What might you want to change about how we work together as a team next year (asked only in the first year)?

To analyze the interview data, three members of the research team read the transcripts and coded text segments using codes representing the five successful dimensions of RPPs from the Henrich, et al. framework. We did not formally code our meeting notes. Rather, we used the notes to document key decisions made and ideas and themes that emerged from our discussions. We referred back to these notes and the interview transcripts to flesh out illustrative examples of findings described in this experience report.

Once the data were coded, the research team discussed the evidence and examples we had from meeting notes and interviews that aligned with key indicators that Heinrich et al. identify for each of their five dimensions. We also discussed areas where our RPP met challenges and had more room to grow. We then drafted outlines of the findings related to each dimension. Members of the research team reviewed and commented on the outlines, which the lead authors then used to draft the paper. We shared a draft of the paper with our practice-side partners to make sure that we accurately represented their perspectives and experiences. Following a discussion and consensus on our conclusions, we incorporated their feedback in the final version of this paper.

III. ASSESSMENT ALONG FIVE DIMENSIONS

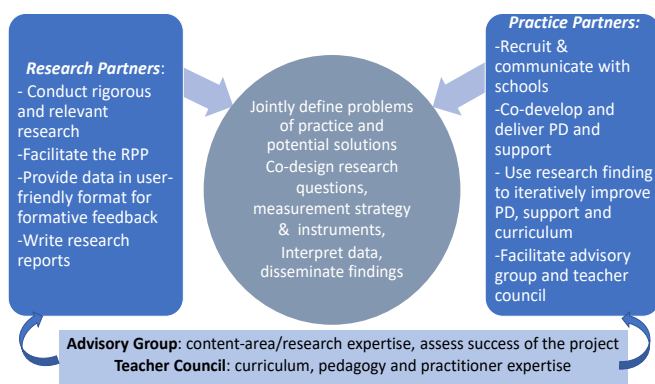
A. Dimension 1: Building Trust and Cultivating Partnership Relationships

Trust and relationship building is the cornerstone of effective and equitable RPPs. We developed trust by establishing routines for working together and making decisions collaboratively. This included articulating clear roles and responsibilities, developing communication routines, and engaging in culture-building activities that helped maintain a balance of power and enabled us to draw on each other's varied forms of expertise.

When writing our first proposal together, we recognized that it was important to jointly establish which components of work would be led by one organization or the other, and which components would be done collaboratively. In reflecting on the health of the partnership in an interview, one of our practice-side partners highlighted the importance of this effort to define roles and responsibilities: "I think the two important considerations [especially] when there are multiple practitioners are, what are the roles and perspectives that the practitioners are playing, and then, what structures do they need for effective collaboration, and how does that fit into the overall RPP?"

As shown in Figure 1, the Maker Partnership's practice-side partners had primary responsibility for leading recruitment of and communication with schools and teachers, developing curricular materials and resources, and designing and facilitating PD and coaching for teachers. The research partners had primary responsibility for collecting, analyzing, and sharing formative and summative feedback with our practice-side partners, and took the lead in organizing the RPP meetings. Both partners contributed to identifying problems of practice and possible solutions, developing our research questions and measurement strategy, interpreting data, and disseminating findings and resources from the project.

Figure 1: Maker Partnership Roles and Responsibilities



Setting up routines and procedures that allowed for clear and consistent communication was essential to aligning program objectives, research objectives, and instrumentation. Regular meetings (e.g., twice per month), jointly set agendas, and rotated facilitation and notetaking responsibilities promoted distributed leadership and power across research- and practice-side partners. Though frequent meetings took a lot of time and effort, they ensured all partners contributed in meaningful ways and were involved in substantive decision making. As one of our practice-side partners shared, "The

regular meetings with all the partners [meant] there was a chance to exchange ideas, knowledge, and updates... That was very supportive to everyone involved and kept us focused on: What were the key things that needed support within the Maker Partnership? What were we learning?"

As the partnership evolved, we learned which agenda items were best addressed through live interaction in a face-to-face or video meeting (such as reviewing and interpreting findings from data and making strategic decisions about the direction of the work), which could be addressed via email (such as administrative tasks/routine updates), and which were best addressed through subcommittee meetings (such as planning a specific PD agenda). This allowed us to make the most efficient use of everyone's time. We also maintained key project files on a shared platform (Google Drive), which helped foster transparency and collaboration, because we all had access to relevant information.

Finally, an important factor for building trust and relationships was the attention we paid to bonding as a team. Through celebrations and social gatherings, we established a strong personal rapport with one another. Examples include shared potluck meals, a jointly created slideshow of photos and memories from our work over the years, and celebrations of personal milestones such as weddings and births.

B. Dimension 2: Conducting Rigorous Research to Inform Action

At the heart of our RPP was a commitment to research that addressed problems faced by the practice-side organizations and by participating teachers. Before writing our first proposal for funding, we worked closely with our practice-side partners to identify and develop a deeper understanding of the problem of practice we wanted to address. This included a structured exercise to explicate root causes of the problem and drawing on existing research to develop a theory of change. With an agreed-upon focus for our research, we then collaboratively selected research methods that balanced rigor with feasibility, and we planned for the sharing of findings in ways that took the needs of our practice-side partners into account.

From the earliest stages of the partnership, we shared ideas and feedback on the overall study design as well as individual data collection instruments. For instance, after developing a draft student survey, we asked our practice-side partners to weigh in on both the substance of the survey instrument and on the process for administering the survey to students. We recognized that our practice-side partners could advise us on the most appropriate outcomes to expect, the most student-friendly language to use, and how to ensure that research activities led to minimal intrusions on student learning. Our practice-side partners also helped with data collection by reminding teachers to complete surveys, dropping off or picking student surveys at schools that could not administer them online, and making time during PD sessions for us to conduct teacher focus groups.

C. Dimension 3: Supporting the Partner Practice Organization in Achieving Its Goals

Our practice-side partners' primary goal was to build a PD model that could enhance teachers' capacity to integrate CS/CT into their science instruction, ultimately improving student

outcomes. The RPP supported this effort by explicitly and consistently focusing on gathering evidence to evaluate and inform progress toward this goal.

To ensure that our research was useful for project implementation, we presented formative findings to our practice-side partners in a timely and user-friendly manner. For instance, after most PD sessions, we surveyed teachers about the content and format of the session. Within days, we shared findings from these surveys with the practice-side partners. We learned that presenting this material in a visually appealing way made for a more productive conversation.

This cycle of continuous data collection and analysis enabled our practice-side partners to improve the support they were providing to teachers in two key ways. First, it allowed them to identify strategies that were working and worth continuing. Our research revealed, for instance, that teachers found the explicit modeling of lessons to be useful—it enabled them to better understand the curricular activities from a student’s perspective and incorporate that understanding into their own teaching practice. Second, our research helped our practice-side partners refine their implementation by providing valuable information about the kinds of additional support teachers needed (e.g., help with the logistics of using technology) and how to structure future training sessions (e.g., building in time for teachers to plan together).

As noted by one of our practice-side partners, “[Frequent formative data] gives us an ability to turn and pivot with interventions and adjustments on the program that allow us to achieve more reliable and immediate success... the closer the research and practice can be integrated... the faster we can move with the teachers and students and the more nimble we can be in pivoting and intervening where needed.” In other words, our practice-side colleagues were able to use the data we were collecting to keep improving the content they provided to teachers and the ways in which they organized each PD session. Survey data from teachers after their last training suggest that this approach largely worked: Teachers overwhelmingly reported that their understanding of CT had improved since they began participating in the program.

Our practice-side partners also noted that working within an RPP structure brought more accountability to their work. As one explained in an interview, “I felt that participating in the RPP matured us as practitioners because ...in previous programs years ago, I would just be like, ‘It’s coding. Let’s make it fun. The kids are gonna love it’ Participation in the RPP challenged us to go beyond, ‘Just try it. It’s fun. They’ll love it and just trust us.’ We had to ratchet it up many levels above where we were to say, ‘This is why it’s impactful. This is our approach. This is the pedagogy of it. This is how it integrates with existing academic learning objectives, and this is how we’re going to measure it.’ It sobered us up as far as what we need to actually do to get [CS/CT] integrated into K-12. For us, that’s our mission. That, to me, was probably the chief value of the RPP. We had to grow up a little bit...a lot.”

We were less successful in collecting frequent, direct measures of students’ CS/CT competencies. Our practice-side partners noted that doing so would “tighten the loop between formative assessment and practice adjustments,” helping them

address their longer-term goals related to student outcomes. Though we had planned to assess student mastery of CS/CT skills throughout the school year, the data collection proved to be too burdensome for teachers. Our pre/post student assessments painted a picture of overall progress, but did not allow for feedback that could inform mid-course corrections to teacher supports provided during the school year.

D. Dimension 4: Producing Knowledge That Can Inform Educational Improvement Efforts More Broadly

Our project has yielded important knowledge about how to build elementary teacher capacity to integrate CS/CT into science instruction. Throughout the project, we have presented lessons from our work to research and practice audiences through informal brown bag sessions as well as formal conference presentations and videos. We are now working to compile tools and resources we developed for the Maker Partnership into formats that can be easily adopted by others in the field. For example, we plan to submit our surveys and assessments to an instrument repository (e.g., CSedresearch.org) and have shared teaching artifacts (e.g., standards crosswalks, lesson plans, science and CS/CT content resources, examples of student work) through our websites (see for example <https://maker-state.org/for-teachers/>) and networks.

We are also in the process of drafting practitioner- and research-facing briefs and peer reviewed journal articles to share key findings and lessons from our RPP. Knowing that practice-side partners can connect more authentically with practitioners than researchers, we collaborated to create a short video for educators describing the Maker Partnership. We also plan to co-author future publications, with an emphasis on practitioner voice and experience. Among the benefits of co-authoring and co-presenting our findings is that it helps keep practitioners engaged and excited about the work and sharing what we are learning. As one of our practice-side partners noted: “The chance to present together or at least in the same conference was an exciting way to share the knowledge beyond the program. [It]... kept staff excited about the work—and interested and engaged in the program... which is important.”

Additionally, we are aiming to expand the scope and membership of our RPP. Thus far, our RPP has focused on designing and researching approaches for building the capacity of *individual* teachers to incorporate CS/CT into their instruction. To better understand the problems of practice *schools* face when integrating CS/CT into elementary instruction, we surveyed school leaders and educators, asking about their CS/CT priorities, plans, practices, and challenges. We then conducted an in-person session with interested schools to further explore CS/CT problems of practice and possible solutions. Two central problems emerged from this work: CS/CT instruction is not schoolwide and therefore not reaching all students, leading to disparities, especially for Black and Latinx students; and teachers lack instructional materials that support culturally relevant CS/CT. Building on what we have learned through the Maker Partnership—for example, the need to have school leader buy-in and support—we are planning to design and test a schoolwide approach to sustainably integrate CS/CT. This work will continue to inform educational improvement efforts, addressing the pressing need for models

that effectively engage underrepresented populations in CS and further the knowledge base on CS/CT integration more broadly.

E. Dimension 5: Building the Capacity of Participating Researchers, Practitioners, Practice Organizations, and Research Organizations to Engage in Partnership Work.

To build capacity to engage in partnership work of this kind, both research-side partners and practice-side partners must commit to narrowing the distance between research and practice activities; this allows partners to develop an in-depth understanding of the considerations that are “top of mind” for their collaborators. Our team was able to accomplish this through intensive, collaborative work that required us to engage in new and unfamiliar tasks as well as structured team reflection that allowed us to assess and improve upon our work together as an RPP.

From the very start, our full team engaged in substantive collaboration. During the proposal stage, we developed a plan for rigorous research that would be relevant and useful for our partners and for the field. Throughout the project, both researchers and practitioners took on new and unfamiliar roles. As one of our practice-side partners articulated, “It’s not the researchers doing all the research parts, and then us doing all the implementation parts. We’re all engaged in the learning process.” On the research side, this included working with practice-side partners to develop assessments of students’ CS/CT skills, determine the focus of upcoming PD sessions for teachers, and facilitating teacher reflection on their classroom practice. Likewise, our practice-side partners engaged in activities typically associated with research, such as developing a research plan and designing interview protocols and survey instruments. In an interview, one practice-side partner put it this way: “I do feel like [the RPP] really improved my capacity to think like a researcher... I really appreciated the opportunities to talk through [survey] questions and really think about—how do we ask this question?... Hearing the perspective of you all as researchers definitely shed some light on how to think about those kinds of questions moving forward.”

Another way we ensured our partnership led to capacity building was through collaborative sense-making of the data. At the project’s midway point, for instance, we jointly analyzed interview and observation data. After sharing excerpts of field notes and interviews that focused on teachers’ use of maker pedagogy, team members used post-it notes to respond to the following questions: What is surprising to you? What questions does this raise for you? What are the implications for practice? After everyone had posted their responses to the questions on chart paper, we did a gallery walk to read one another’s reflections on the data. This activity resulted in a shared understanding that teachers needed more support to incorporate maker pedagogy into their in-school instruction, and we concluded the meeting with a discussion about how to provide such support. In interviews, our partners agreed the activity was very useful, and noted that the RPP would benefit from even more frequent (e.g., quarterly) deep dives into data.

Our team also incorporated multiple mechanisms for group reflection, which strengthened our capacity to engage in partnership work. For example, we engaged an advisory group, made up of expert researchers and practitioners in the field, who

acted as “critical friends” for the Maker Partnership and, as one of our practice-side partners reflected, “raised the intellectual level of the project.” Semi-annual advisory group meetings provided an opportunity to think deeply about the big questions raised by our project, such as: What does/should CT look like at the elementary level? How will we recognize successful integration of CS and science? Thinking about one of our advisory meetings, one practice-side partner stated, “That felt like a really rich place of learning for all of us, being able to engage with that learning and the back-and-forth dialogue that we had, some of the brainstorming we did with thinking about different models of the Maker Partnership and the integration of CS/CT, and how all the pieces fit together.” Our advisory group also evaluated our progress toward meeting project objectives and provided recommendations and questions for our team to consider as we planned for upcoming program and research activities.

In addition, our team scheduled regular opportunities for intra-group reflection. These opportunities took the form of extended team meetings, held over a potluck lunch, in which we acknowledged our team’s accomplishments, expressed appreciation for individual contributions, and used a structured protocol to reflect on the overall functioning of our RPP. The main questions our group regularly reflected on were: What challenges are we currently facing with our partnership? What needs to be done to address those challenges? What about the RPP model has worked well for you (and your organization) so far? And how could the work of our RPP be strengthened? These meetings allowed us to build camaraderie among our team members and to brainstorm solutions to emerging challenges before they became barriers to the success of our project. As one of our practice-side partners noted, “I really loved the [reflection meetings]... to take a step back and reflect on, how are we doing as an RPP? I think those were helpful.”

IV. CONCLUSIONS

RPPs are designed to support equitable research that leads to more useful evidence. In this experience report, we highlight several strategies and routines that helped us to develop an equitable partnership and as a result, conduct research that was grounded in local context, addressed the questions and needs of our practice-side partners, and informed program improvement and knowledge building in the field. Perhaps not surprisingly, given that we are a relatively young RPP, we have made more progress on some dimensions than others. Our success in building trust, conducting rigorous research, and building partnership capacity has provided a strong foundation upon which our partnership can grow. As our RPP continues to evolve, we aim to tackle new problems of practice, continuing to support our practice-side partners in achieving their goals and producing knowledge that advances the field of CS education.

One of our key learnings from this experience was that forming an equitable RPP requires explicit attention to building an infrastructure to support the work. This includes continuous care and nurturing to develop and maintain relationships and trust, establishing routines that foster strong communication and transparency, and ensuring that partners have equal voice in determining the project’s shape and direction. However, such efforts have tradeoffs. As other scholars have noted, working in

the context of an RPP can be more time consuming and complex, and therefore, more costly than traditional research [14]. We are exceedingly fortunate that all members of our RPP are interested in and committed to undertaking this type of work.

Another key lesson is the importance of reflecting on and assessing the success of the partnership. We found Henrich et al.'s dimensions of success [9], as well as the tools and guidance in Penuel and Gallagher's book [15], to be a useful framework to guide our partnership's self-assessment. Through our use of these tools, we developed an awareness of the important features and characteristics of RPPs. It gave us a concrete way to structure conversations about how we were doing and how we might improve our work together. It also helped us understand and envision a healthy progression of growth for our partnership, starting with writing our first grant proposal together, and continuing to produce and disseminate knowledge and tackle new problems of practice.

Going forward, an area where we hope to deepen our RPP work is to more explicitly incorporate "mechanisms for recognizing systemic racism" [16]. Calabrese et al. note that though RPPs have always had a focus on addressing inequalities, recognizing and combatting systemic racism have received less explicit attention. As we work on new funding proposals to expand our RPP, we are shifting our focus to more explicitly address the underrepresentation of Black and Latinx students in CS by combining the Maker approach with Culturally Responsive Sustainable Education.

The widespread call for providing all students with opportunities and access to high-quality CS education and addressing longstanding disparities has driven demand for rapid implementation and scaling. However, there are many gaps in our knowledge about the most effective ways to do this. Our experience with the Maker Partnership suggests that RPPs are well positioned to address these gaps through research and practice that are tightly coupled and equitably prioritize the insights and priorities of practice-side and research-side partners.

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