



# Early Findings on the Impacts of Developing Evidence-Based Practice Briefs on Middle School Computer Science Teachers

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**Problem.** K-12 teachers face many challenges when teaching a new subject like computer science (CS). They are often far removed from the research being conducted to identify evidence-driven solutions to these challenges. Likewise, researchers are also often removed from the challenges of classroom practices that teachers face when teaching CS.

**Research Questions.** To create a collaborative process for teachers and researchers *outside* of a research practice partnership, we piloted a facilitated process in which CS middle school teachers and CS education researchers collaboratively created CS teacher practice briefs. Our research question for this study was: *In what ways are teachers impacted by the process of creating teacher practice briefs in collaboration with researchers?*

**Methodology.** We conducted a qualitative study, using a semi-structured interview protocol to interview five teachers and three researchers to gain an understanding of how this process impacted the participants. We used thematic content analysis to identify several subthemes across our pre-established themes: motivation for teachers to participate, impacts on teachers, perceived impacts on students, and impacts on researchers.

**Findings.** We found that the impact on teachers mirrored impacts found on teachers who engage in Research Practice Partnerships, including increased self-efficacy, expanded professional networks, and changed classroom practices.

**Implications.** By bringing researchers and educators together with a clear focus on equity-based problems of practice in CS education, the results display a multitude of positive impacts. Teachers indicate that they are positively impacted, researchers develop a clear understanding of realistic practices, and students are peripherally impacted through changed practices in the classroom. Therefore, the most significant contribution to advance the disciplinary understanding is the potential for this new process to decrease the gap between research and practice.

CCS Concepts: • **Social and professional topics** → **Computing education; Computing education programs; Computer science education;**

Additional Key Words and Phrases: Qualitative, teacher practice briefs, middle school, teachers, challenges, computer science, computational thinking, researchers, research and practice, practice, impacts

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## 1 INTRODUCTION

Although practitioners (e.g., teachers, counselors, administrators) and researchers are both outcome focused and interested in increasing academic achievement among students, the gulf between the two has often been (and still is) very wide [66]. Typically, when research concludes, the findings are disseminated to other researchers and are often out of practitioners' reach. Further, research is often conducted in silos—it may not meet the critical problems and challenges that practitioners face or adequately consider the context of the practitioners' work [34, 52].

Collaborations between researchers and practitioners (including K-12 teachers) is a rapidly growing way to bridge the gap between classroom reality and research studies or theory. One practice to connect teachers and researchers is known as **Research Practice Partnerships (RPPs)**. In the past, RPPs have primarily focused on bridging the research and practice gap in K-12 **computer science (CS)** education by connecting CS teachers and CS researchers. Although the term *practitioner* in RPPs implies an array of practice-organization roles [38], in the context of partnerships, teachers are often regarded as a special population because they occupy a dual space as both the recipient of project interventions and a critical voice within the project. Teachers invested in RPPs can participate in the design of classroom materials or take on leadership roles within the RPP, acting as conduits to their colleagues and representing the classroom perspective.

Previous research has shown that collaboration between researchers and practitioners (such as RPPs) can have specific impacts, including positive changes in teachers' self-efficacy and a sense of ownership by asking and answering questions that matter to their immediate and long-term practice as an educator [36, 44]. Additionally, outcomes of RPPs have been shown to improve the quality of teaching, including improvement of student engagement and learning, have replicability to scale new teaching approaches, expand **professional learning communities/networks (PLC/N)**, and build bi-directional knowledge between researchers and practitioners [13, 63]. Finally, researchers' ability to expand their knowledge of current practices is essential to future researchers; therefore, in RPPs researchers are able to gain a deeper understanding of school contexts, including policies and procedures [38, 56].

Although RPPs have been shown to have positive impacts, RPPs are multi-year projects that can require significant resources and time commitments from all involved parties. Even when RPPs are able to receive appropriate levels of funding, the intensity and longevity of RPPs can be a barrier for practitioners to participate. Thus, the meaningful process of researchers collaborating with teachers to achieve a shared goal of improving classroom practices (as well as the benefits from such participation) are limited to only a small percentage of teachers.

To share research with teachers in an RPP, [Bell and Rhinehart](#) created a framework to engage both researchers and practitioners in collaboratively creating *practice briefs* [7]. Defined as a condensed document designed to support teachers with research-based information, practice briefs are often focused on teachers' problems of practice, particularly as they relate to equity [7]. As further defined by [Hatch-Tocaimaza and Hu](#), a practice brief "...is an article that provides empirically based, conceptually coherent recommendations and guidance using the best and most current research to tackle a specific, urgent challenge in everyday language that practitioners can use in immediate, real-world scenarios they face every day" [27].

Given the impacts of RPPs on teachers, our overarching research question for our pilot study was: *In what ways are teachers impacted by the process of creating teacher practice briefs in collaboration with researchers?* Our goal was to use the [Bell and Rhinehart](#) framework outside of an RPP to facilitate teacher-researcher collaborations and then to determine if there are similar or different impacts on teachers as those found in RPPs. We primarily focused specifically on the impact that the development of Teacher Practice Briefs (TPBs) has on teachers, but also the tangential

impact on researchers and students. We engaged in a qualitative study that used a thematic content analysis of data obtained through semi-structured interviews.

In this article, we provide a description of the research literature in Section 2. We provide an overview of our research design and methodology in Section 3. We present our results in Section 4, followed by a Discussion in Section 5.

## 2 BACKGROUND AND CONTEXT

In this section, we provide the background and context for our study, including collaborative activities to bridge the researcher-teacher divide, impacts of researcher+practitioner collaborations, general challenges of these collaborations, practitioner motivation to collaborate with researchers, and the importance of practitioner self-efficacy. We also dedicate a section to equity, since this is a primary goal of the practice briefs.

### 2.1 Collaborative Activities to Bridge the Researcher-Teacher Divide

Research shows multiple ways this problem of division has been addressed, specifically through school-university partnerships, teacher researcher communities, researcher-teacher roles, and coaching.

*2.1.1 School-University Partnerships.* Partnerships between schools and universities are one way to connect practitioner and researchers to reach a common goal of researching and then disseminating best practices. This collaborative work needs to focus on full participation of practitioners. Their full participation can mitigate the chasm and ensure that practitioners' voices, contexts, and experiences are considered. Additionally, researchers sharing their knowledge of reading and leveraging research with practitioners could impact future instructional decisions within a particular context [14, 42, 51, 54, 64]. As a way to mitigate the problem of connecting research to practice, School-University Partnerships, similar to **Professional Development Schools (PDSs)**, were established over 40 years ago to solve problems that arise from the deep separation between research and practice [10, 12, 24, 57].

In one study, researchers utilized a PDS model to "effectively support teacher preparation, teacher professional development, and research to meet the needs of at-risk students" [67, web]. Through these partnerships between a school and university, teachers are able to take ownership of their learning and growth, while also engaging with researchers to provide evidence-based information for future use in school settings. The National Association for Professional Development Schools identifies five Essential Elements of a PDS [11]. The five elements are as follows:

- A comprehensive mission that is broader in its outreach and scope than the mission of any partner and that furthers the education profession and its responsibility to advance equity within schools and, by potential extension, the broader community.
- A school-university culture committed to the preparation of future educators that embraces their active engagement in the school community.
- Ongoing and reciprocal professional development for all participants guided by need.
- A shared commitment to innovative and reflective practice by all participants.
- Engagement in and public sharing of the results of deliberate investigations of practice by respective participants.

*2.1.2 Teacher-Researcher Communities.* Teacher-researcher communities have been used by several researchers as a way to create interdisciplinary curricula, investigate student learning, and overall develop **professional learning networks (PLNs)** [25, 33, 35, 46, 61]. One way to conceptualize teacher-researcher communities is through the implementation of **communities of**

**research practices (CoRPs).** A community of practice, within the context of a teacher–researcher community, is based on the community of practices that are often embedded into the professional practice of scientists. Essentially, it is a “small group of scientists who meet regularly to help each other and promote good practices” [62, p. 1]. In the context of education, a teacher–researcher community, or community of research practices, is a group of teachers working with researchers to investigate and eventually implement best practices.

More recently, teacher–researcher partnerships have been studied as a way to foster teachers’ professional learning. The goal of this type of partnership is to foster “autonomous and expert professional learning among teachers in order to implement change” [37, p. 625]. In one specific study, researchers and teachers focused on researching a change in science classroom practices, specifically implementing practice-based learning. As part of this process, researchers acknowledged that “teacher and researchers should trust that all ideas and concerns will be acknowledged and that there will be room for the free generation of ideas and positive feedback on all ideas” [37, web]. While this research did not focus specifically on researching the partnership, but rather the impact on students, the concepts shared in the research are important for this collaborative work to continually grow.

**2.1.3 Teacher as Researcher Role.** Not only is there the teacher and researcher model, but there is also the researcher teacher role in which one person serves in both capacities simultaneously [4, 33]. Ideally, the person filling this dual role uses their classroom experiences as a teacher to conduct research around topics that may be of importance to other teachers and researchers. Typically, an individual filling this role has “. . . a primary appointment in a university context and use their university teaching (Duckworth, 1987) or seek out experiences teaching in PK-12 schools (Lampert, 2001) to use as primary data for their work.” [33, p. 77] This type of work, where a teacher takes on the role of a researcher in their classroom, mirrors what is known as action research and can be very beneficial. In general, action research is the process where participants (i.e., teachers) “examine their own educational practice systematically and carefully” [21].

**2.1.4 Coaching.** Finally, coaching is another form of teacher–researcher collaboration and can take many forms. However, in literature, coaching is presented as mostly uni-directional with (1) researchers coaching teachers on instructional practices involving new curricula and pedagogical practices and (2) other more experienced teachers coaching teachers with less experience [6, 48]. In the coaching process, teachers identify their own goals for improving their practice. Then, teachers often fill the role of researcher/evaluator in their own classrooms while coached by researchers and other teachers to help them achieve their self-identified goals.

## 2.2 Factors that Influence Collaborations’ Success

While there are positive impacts of partnerships between researchers and practitioners, there are also challenges that can influence the process and end goal. Some of the challenges focus on differing priorities, conflicting visions and approaches, and power imbalances [8–10, 17, 23, 32, 41, 60, 66]. Being aware of these challenges, as both the researcher and practitioner, are important in moving forward with collaborations of this nature.

**2.2.1 Differing Priorities.** When researchers and practitioners collaborate there are often different, sometimes conflicting, priorities, which can impact the overall end goals. Researchers are often focused on addressing gaps in existing theory or research, while teachers are more focused on immediate problems of practice in the classroom [14]. However, as teacher–researcher partnerships continue to become more prevalent, it has been found there are shared priorities with sometimes different paths to that end goal [37].

**2.2.2 Power Imbalances.** Another challenge for researcher and practitioner collaborations are power imbalances, which often occur based on an implicit perception of a hierarchy between researchers and practitioners. This imbalance is often referred to as a power hierarchy and can inhibit reaching overall project goals [8, 9, 17, 23, 30, 32, 41]. This is further complicated by the complexities of communication between researchers and practitioners [66], including issues of shared language or content-specific jargon [56].

Knowledge sharing between researchers and practitioners is often difficult, including sharing knowledge that is gained from experiences and sharing knowledge that connects research findings to lessons learned [55, 56]. Equitable knowledge sharing that includes the practitioner voice in the overall partnership is often blocked. The difficulty of equitably sharing both the researcher and teacher voice is focused on the equitable dissemination for future use in practice and research. The artifacts from the partnership are often shared at academic conferences. However, due to lack of time and monetary resources, practitioners are often unable to commit or attend such dissemination platforms [23].

**2.2.3 Trust.** Positive impacts often rest on the firm foundation of trust—a key element of a successful collaboration. Building and maintaining trust among and between practitioners and researchers can require significant time and commitment [10, 17, 31, 32, 66], which can be difficult when time is a known burden [47]. Reliance on roles and responsibilities that are established upfront help ensure that proper boundaries are set and trust is maintained. This trust is built upon the discourse around the problems of practice, which the parties within the partnership seek to solve mutually and for similar interests [34].

In the context of RPP-specific collaborations, once trust is established, other important tenets need to be developed. These include establishing equitable norms to follow while engaging in the group process [15, 68], creating rules of engagement to help lay the groundwork of expectations, establishing clear roles and responsibilities [41], collaboratively identifying the pressing problems of practice [68], establishing shared language [22, 56], and developing ways to ensure the work is shared equitably [34, 47].

Developing trust and the other norms, as well as paying close attention to the components of a successful collaborative researcher–practitioner experience, is important because researchers and practitioners often have diverse roles. Researchers can provide research plans, take a leadership role in structuring the shared learning, establish roles and responsibilities, support teachers' development of pedagogical content knowledge through balancing researcher and practitioner needs, collaborate with district leaders, put effort into being of service to practitioners, and provide evidence to support a strong model [19, 31, 58]. Additionally, researchers may act as knowledge brokers, connecting practitioners to other knowledge in real time as needed [16]. Researchers also often bring connections to external supports for implementation, evaluation, and dissemination of findings [15, 20, 63].

### 2.3 Known Impacts of Researcher and Teacher Collaborations

By the very nature of collaborative relationships, the researchers and practitioners work is a more equitable and ethical way since they leverage ideas, assets, and "...community stakeholder experiences and perspectives to inform research questions, methods, and meaning-making" [9, p. 1], [8, 31]. Engaging in equitable and ethical ways of working together, the group has the potential to discover interventions that have a higher adoption rate due to their usability and relevance in the local context [9, 13, 31, 34, 63, 69] since the rigorous research often provides better assurance that the new practices solve the targeted problem and are institutionalized [9, 15, 63]. This

Table 1. Known Impacts of RPPs on Teachers and Researchers as Indicated in Previously Published RPP Literature

Group	Impacts
Teachers	Confidence [20, 36, 63] Knowledge and awareness of important advances in scholarship [13, 20, 63] Creating opportunities to develop and apply new knowledge [13] Access to usable research [63] Self-efficacy [36] Classroom practices [63] Leadership capability related to STEM improvement [63] Engagement in professional learning [63] Sense of ownership [36] Personal Identity [22] Professional Renewal [22] Affirmation for long-term collaboration [22] Expanded professional communities [63]
Researchers	Deepen their understanding of realities of school contexts and practices [38, 63] Expanded professional communities [63] Increased confidence in the value of their work [63] Increased confidence in the outcome of their research [38] Personal Identity [22] Receipt of yearly feedback to support improvement [31] Professional Renewal [22]

collaborative partnership also provides the platform for participants to “. . . self-reflect about how their own expectations influenced the RPP [which] has resulted in an honest description of the challenges that must be negotiated” [17, p. 10], including the challenges that district leaders face “. . . when attempting to make system wide improvements in complex education settings, particularly in high-needs priority schools” [31, p. 26].

The outcomes from all of these positive impacts include improved academic achievement among students [13, 58, 63], improved student engagement [63], and improved metrics for other social-emotional factors that impact learning [63]. The improved academic impact is primarily attributed to the networked community of the RPP accessing research and interpreting the data, which inevitably impacts decision making in the learning community [10, 13, 31]. Further, tools and resources for improving curriculum can be provided and shared more widely [63] and this generalized knowledge can extend beyond those involved in the RPP [38, 53]. The adaption of the continuous improvement model, as a whole, helps to ensure the continued use of “social resources” via continued networking as well as the continued sharing of ideas, processes, materials, and tools [13, 38].

In addition to the overall general benefits, researcher and practitioner partnerships have been shown to have a positive impact on individual researchers and teachers (see Table 1). Benefits to teachers include increased confidence and self-efficacy [20, 36, 63], improved classroom practices [63], increased sense of ownership of research [36], and more awareness of advances in scholarship to improve teaching [13, 20, 63]. Researchers also share in benefits, including a deeper understanding of the realities of school contexts and practices [38, 63] and an increased confidence in the value of their work [63].



## 2.4 Practitioner Motivation to Understand Research

It has been found that, overall, researchers are motivated by decreasing or closing gaps in existing research and theory [14], while practitioners' motivation is twofold: knowledge sharing to future generations of the teaching profession and personal professional growth.

Teachers' motivation to engage in research or collaborative work is often centered in the knowledge sharing of best practices. This can occur through collaborative endeavors such as RPPs or it can be accomplished through practitioners mentoring a pre-service teaching during student teaching [65]. Overall, there is a research-based goal to provide knowledge and expertise to the next generation of educators [43, 65].

Personal professional growth also motivates teachers to participate in research. Built into the fabric of the teaching profession is the valued process of continual reflection toward growth. Therefore, participating in professional growth activities, such as practitioner and researcher collaborations, is sought out by educators due to the identity most practitioners claim of life-long learners [18, 28, 40]. Overall, teachers engaging in researcher and practitioner collaborations focused on research and future professional impact is often motivated by their own desire for professional growth [3].

## 2.5 Practitioner Self-Efficacy

Engaging in professional learning has also been attributed to developing a teacher's self-efficacy, which is a term coined by Bandura [5]. Self-efficacy, in the context of educators, describes a teacher's confidence in their ability to complete a task or achieve a goal. It has been found that teacher self-efficacy is not linear, but rather develops over time with ebbs and flows depending on the availability of resources and collegiate relationships. Additionally, vicarious experiences can impact a practitioner's self-efficacy [70]. Vicarious experiences can be anything observed, heard, or read, such as collaboration while developing research practice briefs.

In one research study, researchers investigated the relationships between teacher self-efficacy and teacher effectiveness [59]. In this study, the researchers found that teacher self-efficacy has a positive association to teacher's delivery of content, teacher's role in facilitating peer learning, and teacher's role in regulating students' learning [59]. The researchers also found that collaboration is positively related to a teachers' self-efficacy.

## 2.6 Equity

As previously stated, the goals for RPPs, TPBs, CoRPs, and other similar practices focused on researcher and practitioner collaboration often lead to power imbalances between researchers and practitioners. These power imbalances can often result in the silencing of individuals. Therefore, the concept of equity within the partnership is not only a matter of ensuring everyone is able to share their voice, but it can also impact partnership goals focused on equity and inclusivity. Additionally, these partnerships introduce a multi-party problem, which is amplified when the practitioners and researchers have no or only a limited history of interactions [32] and have not been trained to work together [66].

One study [26] focused on defining equity in the context of RPPs. In a collaborative effort between K-12 administrators and university researchers across the state of California, equity was defined in the context of CS and RPPs. The definition developed by the group of professionals is as follows:

Equity is accomplished when every student is provided with what they individually require to learn and succeed in fulfilling their personal, academic, and social advancement, and when success and achievement is not predicted by any demographic factor.

This requires continually interrupting inequitable practices, examining biases, and creating inclusive environments for all, while discovering and cultivating the unique gifts, talents, and interests that every student possesses. Equitable practices are based in the belief that every child's educational experience should be rigorous and relevant, and that everyone is capable of learning. These beliefs require providing a learning environment that is safe and respects every student [26, p. 1].

Grounding the collaborative work in this shared definition can impact the current and future progress of the partnership and research.

Finally, entering the research and partnership with an open mindset is important because the research may bring to the forefront cultural gaps and differences, including those practices and policies that are inflexible, yet detrimental to the overall being of those impacted. Policies and practices that can be changed as a way to create an equitable environment for all individuals in a learning context may also be recognized through this process [17, 29, 32]. Overall, equity within various aspects of the research, including the students, can be addressed through research practitioner partnerships. However, as noted, there are often "...complex and interrelated problems of practice" [39, p. 6].

### 3 METHODOLOGY

#### 3.1 Research Design Overview

To answer our research question, *In what ways are teachers impacted by the process of creating teacher practice briefs in collaboration with researchers?*, we first conducted a literature review to determine if any published studies examined impacts of teachers engaging in the creation of teacher practice briefs. While there were several studies that were adjacent to this work, none of the evidence was clearly connected. Therefore, it was important for us to choose a research method that was centered on our inquiry-focused research question. We chose a qualitative approach to explore potential impacts based on a semi-structured interview (see Appendix A) and artifacts from the process. Specifically, we chose a utilization-focused qualitative research approach, which focuses on the process, from beginning to end, and the impact of the process on the intended users [50]. In the case of this study, the intended users are researchers and teachers.

Additionally, we used the [Bell and Rhinehart Framework for Creating Teacher Practice Briefs](#), which is a stepwise method that provided structure for implementation. The framework defines important elements of the process, including:

- *Integrate a focus on equity throughout each tool.*
- *Focus on a specific, broadly felt problem of educational practice.*
- *Gather the best knowledge from both research and practice to help readers more fully understand each issue.*
- *Highlight what people in different roles can do to address this problem of practice, providing context, actionable advice, strategies, and tools, all of which should connect to educators' everyday work.*
- *Suggest ways to take action with respect to the problem of practice by linking off to other tools, articles, websites, and resources.*
- *Prompt further reflection and support discussion among colleagues [7].*

The framework documentation<sup>1</sup> provides three parts: a description of how to launch a brief development initiative, a description of how to research and write the brief, and an example of a brief.

<sup>1</sup><http://stemteachingtools.org/assets/landscapes/How-to-Develop-Practice-Brief-Initiative.pdf>.



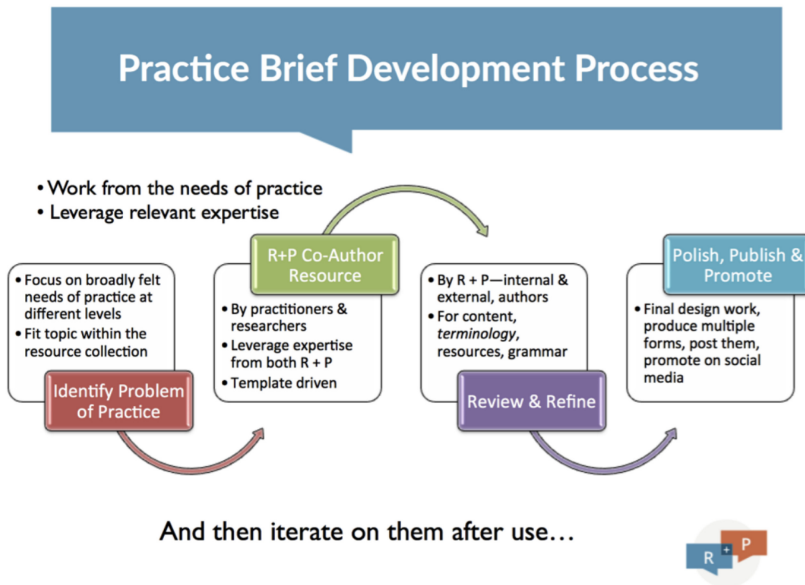


Fig. 1. The Bell and Rhinehart Framework for developing teacher practice briefs. The framework was developed for disseminating knowledge gained within an RPP. This work is provided for educational use under Creative Commons Attribution NonCommercial ShareAlike 4.0 International license by the Research+Practice Collaboratory 2016.

Launching a brief development initiative has several steps to prepare for the design, development, and dissemination of the brief, including the identification of teachers and researchers who will participate and of an editorial team for polishing the final product.

The process engages both teachers and researchers working together to create the briefs. The Practice Brief Development Process is shown in Figure 1.

While the process does not define who is engaged in the first step (Identify Problem of Practice), we chose to let the teachers define the problem in order to ensure their voice was heard early and remained prominent throughout the development process.

### 3.2 Study Participants or Data Sources

In this section, we describe the researchers' backgrounds that inform their approach to this study, the participants involved, and the researcher-participant relationship.

### 3.3 Researchers' (Authors') Reflexivity Statements

Using the [Bell and Rhinehart](#) Framework, one of the authors of this article created the research design and multi-week plan for piloting this process and served as its facilitator. The author has a strong CS education research background with a particular focus on K-12 and pathways for broadening participation in computing. They have received formal training in and has conducted several qualitative studies. They particularly appreciate the nuances of qualitative studies and how they reveal underlying attitudes, behaviors, and impacts. The author is familiar with the impacts of researcher-practitioner initiatives, particularly with how they impact teachers. However, this was the first time they implemented this process, and they relied on their understanding of the literature and the [Bell and Rhinehart](#) Framework to guide her in the creation and implementation of the pilot. They were unsure how the process would be perceived by the researchers and teachers

and whether or not the practice briefs would be meaningful to other teachers while also being based on the evidence. They were equally interested in learning about the impacts of the process on teachers, what they thought about the process, and how they thought the process could be improved in future iterations. Further, the author is a white woman who has teaching experience in post-secondary and adult education institutions and in industry and has conducted research across a broad range of diversity interventions.

The other author was brought in during the data analysis phase of the study. They have a strong background in qualitative research. Supporting the work of the first author, they analyzed the data without having knowledge of or interacting with the participants. Supporting the experience of the first author, they have experience as an elementary classroom teacher, education professor in higher education, and action researcher embedding herself in the work of teachers in the field. Finally, the author is a white woman who has focused her work on equity practices and transforming PK-12 classroom environments to be fully inclusive of all identities and intersectionalities.

To help mitigate researcher limitations in data interpretation, data analysis was conducted by both researchers. More details are provided below in Section 3.6.

### 3.4 Participant Recruitment

The study, including the recruitment process, received **institutional review board (IRB)** approval from the facilitator's institution. In addition to learning more about research, incentives for the study included a \$1,000 stipend for participating teachers who completed the initiative and \$850 for the researchers who engaged in the process.

In this section, we describe the recruitment and participation selection processes.

**3.4.1 Recruitment Process.** To recruit participants, we worked with the **Computer Science Teachers Association (CSTA)** to create a screening questionnaire that informed teachers about the study and asked for key information, including the following:

- Teachers' demographic characteristics, years teaching middle school teaching, years teaching computer science in middle school, and the name and location of the school where the teacher currently teaches.
- Three most important problems of practice that the teachers face in their classrooms when teaching computer science in our classroom.
- Whether or not they had engaged in any research studies before
- Whether or not they would be available to meet at a preset time each week for up to 4 consecutive months (January through April).

The screening questionnaire was emailed (December 2020) to all middle school teachers in the United States who taught CS or Computational Thinking (CT) and were CSTA members, with responses requested within 2 weeks of receiving the email. From the initial emailed call, we received 83 entries in total. Given that this was a pilot study that would be conducted virtually, we wanted to scope appropriately and therefore limited the number of problems of practice to three areas and decided to form three teams of two teachers and one researcher, each focused on one problem of practice.

**3.4.2 Participant Selection.** To choose the teachers who would participate in the study, and to identify the overarching problems of practice for each of the teacher groups, we first narrowed the list of teachers by removing those who had or potentially had conducted research in the past. We wanted to include teachers that were new to formal education research in order to study the impact of closing the gap between classroom educators and researchers. This left 43 teachers. Then, one entry was removed from a teacher who was not located in the United States, one duplicate entry,

and two entries in which teachers indicated involvement with an RPP in computer science. This left 38 teachers from which to select for this study.

Using the school name and location for each entry, the researcher identified the school demographics for each teacher's school, including whether or not it was a Title I school<sup>2</sup> and composition of the student body race/ethnicity. This information was added to the overall data spreadsheet. Included on the spreadsheet were the applicants' identified problems of practice from the initial call for participation.

The researcher shared the information with two staff members at CSTA to determine what problems of practice to target and which of the teachers expressed interest in these problems of practice. We carefully considered the phrasing of the problems of practice as posed by the teachers, which provided some indication as to their understanding of the problem and their interest in seeking a solution. Additionally, we considered our interest and goal in developing teacher practice briefs heavily rooted in equity. Through this process, we narrowed the applicant pool down to nine.

Through discussions with CSTA, we chose the following three broad problems of practice as the focus of this work:

- Meeting the needs of emergent bilingual/multilingual students learning English.
- Recruiting for and retaining girls in CS classes.
- Teaching in ways which attract and retain students identifying as members of marginalized groups.

Of the remaining nine teachers, four were interested in addressing gender equity, three in equity of marginalized students, and three in instruction of English language learners.<sup>3</sup> From these, we chose six based on their personal demographic and their school's demographic information with an effort made to have a diverse set of teachers (location, race/ethnicity, gender, and Title I status). Of the six, only five could participate in the month-long activity and, despite our efforts reaching out to additional teachers, a replacement for the sixth participant could not be found.

For the emergent language group, only one of the teachers was available to join the study. The five selected teachers consented to this study, including researchers' review of artifacts from the study and an interview scheduled at the project's conclusion.

### 3.5 Our TPB Implementation Process

Our process first involved gaining a better understanding of the overall process by considering the guiding principles as well as the infrastructure needed to deliver it. Once we gained a better understanding, we planned our 4-month schedule (see Table 2), estimating 2–3 hours per week for participants.

Since we were not working within an RPP (for which the process was originally designed), we changed the beginning of the process by interacting with only the teachers in the first 5 weeks. This gave the teachers time to establish rapport, gain an understanding of what a research article contains, and carve out the specific problems of practice they wanted to focus on for their brief. This also ensured that the teachers and their problems of practice were uniquely centered within this process and that their voices were integrated into the draft sections of the practice brief. During this time, the teachers worked in pairs and started tackling sections of the brief, including what the topic for the brief entailed and why it was important.

<sup>2</sup>In the United States, "Title I, Part A (Title I) of the Elementary and Secondary Education Act, as amended by the **Every Student Succeeds Act (ESEA)** provides financial assistance to local educational agencies for children from low-income families to help ensure that all children meet challenging state academic standards" (<https://nces.ed.gov/fastfacts/display.asp?id=158>).

<sup>3</sup>One teacher was interested in more than one topic.

Table 2. Schedule for the Practice Brief Development

Week 1 (T)	Kick-off and icebreakers Discuss the reason for this project Reflect on problems of practice the teachers experience in their classrooms (Jamboard exercise)
Week 2 (T)	Discuss the structure of a K-12 CS education research article Teachers define the following in their groups: the focus of their problem of practice within their student groups; the primary issue; why it matters
Week 3 (T)	Teachers refine answers to questions from week 2 Facilitator reviews the structure of an education research article Action item for next week: Read research article assigned and add findings to the spreadsheet
Week 4 (T)	Review what you learned from the articles as a whole group Reconsider the problems of practice you focused on Action item for next week: Read assigned research articles and add findings to spreadsheet
Week 5 (T)	Review what you learned from the articles within your groups Reconsider the problems of practice you focused on Action item for next week: Read assigned research article assigned and add findings to the spreadsheet
Week 6 (T&R)	Meet the teachers icebreaker Review the TPB development process Teachers discuss their problem of practice and what they have learned so far with researchers Researchers provide feedback to the title, problem of practice, and why it matters Action item for next week: Researchers provide one article for teachers to read
Week 7 (T&R)	Next five sections (overview): Things to Consider, Reflection Questions, Attending to Equity, Specific Guidance, Links to Related Resources Things to Consider (breakout): Create a list of five to seven things to consider Reflection questions (if time or if they surface from discussion on things to consider) Action item for next week: Researchers provide two articles for teachers to read
Week 8 (T&R)	Discuss articles read (breakout) Refine and finalize: Things to Consider and Reflection Questions (breakout) If time, work on Specific Guidance Action item for next week: Researchers provide two articles for teachers to read
Week 9 (T&R)	Share out of Things to Consider and Reflection Questions (all) Work on Specific Guidance, Links to related articles, and Equity (breakout) Action item for next week: Researchers provide two articles for teachers to read
Week 10 (T&R)	Refine and finalize the following sections: Specific Guidance, Links to related articles, and Equity
Week 11 (T&R)	Share out of entire brief with all teachers Facilitator sends briefs for internal and external researcher review
Week 12 (T&R)	Refine materials based on reviewer feedback Action item for next week: Facilitator sends modified briefs to external teachers for review
Week 13 (T&R)	Refine materials based on reviewer feedback Cover next steps of the publication

We identified the three external researchers in week three by searching through literature to determine who is conducting the research that teachers were interested in. Once the researchers agreed to participate, we briefed the researchers on what the teachers have done so far and shared the materials that they developed with the researchers. We then introduced the researchers in week six, starting with an icebreaker and having the teachers share what they had learned so far. From there, the researchers and teachers worked together, guided by the facilitator, to refine and complete each section of the brief.

**3.5.1 Participants.** Five teachers and three researchers engaged in the pilot initiative, with all five teachers participating in the study (100% participation rate) and all three researchers as well. The teacher demographics were two Black women, two white women, and one Latino/Hispanic man. One teacher had 1–2 years of experience teaching CS, two had 3–6 years, one had 7–10 years, and one had over 10 years (see Table 3). Teachers were from across the country with varying state standards for teaching CS (Colorado, Maryland, New York, Tennessee, Virginia). School demographic information is provided in Table 4.

The three researchers were all women. One researcher identified as white and Jewish with 20 years of researching experience and 12 years of CS-specific research experience. The second researcher self-identified as white/non-Hispanic with 12 years of researching overall, which all

Table 3. Middle School Teaching Experience Across the Five Teacher Participants

Experience Teaching	Experience Teaching CS
1–2 years	1–2 years
3–6 years	1–2 years
7–10 years	3–6 years
Over 10 years	3–6 years
Over 10 years	Over 10 years

Table 4. Demographics of Schools where the Teacher Participants Teach

Title I	School Demographics
Yes	22% Black, 19% Hispanic, 51% White
Unknown	13% Black, 6% Hispanic, 74% White
No	1% Black, 14% Hispanic, 77% White
Unknown	81% Black, 11% Hispanic, 2% White
Unknown	94% Black, 6% Hispanic, 1% White

(In the United States, “Title I, Part A (Title I) of the Elementary and Secondary Education Act, as amended by the Every Student Succeeds Act (ESEA) provides financial assistance to local educational agencies for children from low-income families to help ensure that all children meet challenging state academic standards” (<https://nces.ed.gov/fastfacts/display.asp?id=158>).

has focused on CS. Finally, the third researcher is a self-identified white with 5 years of total research experience all of which has focused on CS.

**3.5.2 Researcher–Participant Relationship.** During the pilot initiative, the author-facilitator was in regular contact with the participants, guiding them through the brief creation process. Although the researcher had great interest in the impacts of this process on teachers, they were focused on walking the teachers through the brief creation process with the end goal of having three shareable practice briefs. The facilitator did not know any of the teachers prior to the start of this pilot. The other author did not have any relationships with the participants and did not engage in any of the pilot project meetings with the teachers.

3.6 Data Collection and Analysis

Data collection took place throughout the initiative (January–May 2021), including artifacts (i.e., collaborative virtual brainstorming boards and virtually shared note taking documents) produced by the teachers during the project and semi-structured interviews after the initiative concluded. The interview protocol was developed by one researcher and reviewed by an experienced external researcher who conducted the interviews. We audio recorded the interviews, then transcribed them using a transcription service.

For data analysis, the researchers are formally trained in coding and generating themes from the codes and have conducted qualitative data analysis. Using a process described by [49], the external researcher was brought in to ensure a greater measure of objectivity so that the researcher/facilitator did not present unknown biases into the interview process. Each interview averaged 47 minutes in length, with a range from 29 to 72 minutes. The semi-structured interview questions

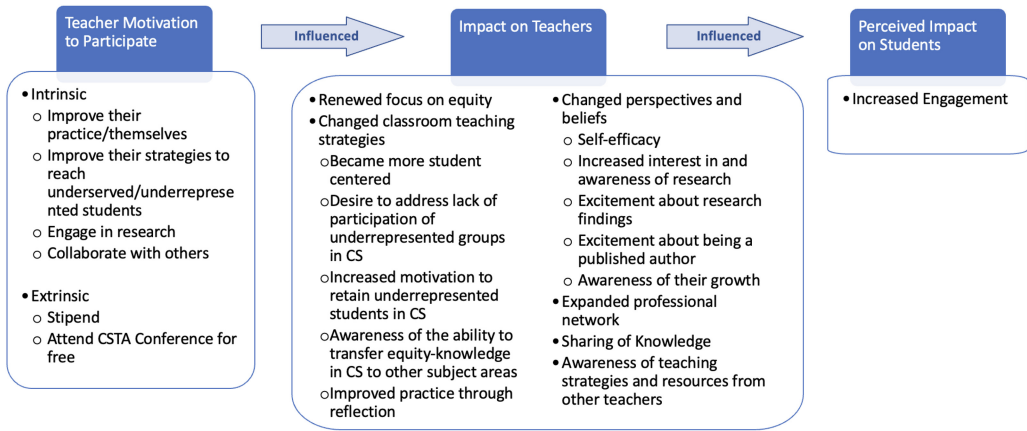


Fig. 2. Major themes and emergent subthemes from the teacher interviews.

can be found in Appendix A. To understand the participants' thoughts about impacts and about the initiative, we let coding categories emerge from the analysis.

We engaged in the data analysis process by independently conducting three passes of a traditional open coding process across all five interview transcripts using Dedoose software. We coded sentences and/or phrases that indicated impacts on the participant, their state of mind, their thought process, and their motivations for participating in the study. Once completed, rather than compare and only accept those where we had identical codes, we intentionally merged our codes to identify overlaps and differences using the rationale that we would likely find different codes given our backgrounds and experiences with the project. We then created themes from these codes, the findings of which are presented in the next section. Data from the artifacts was used to cross-check the interview findings and support the manner in which we interpreted the interview findings. For example, we could see through the historical capture of the writing of the briefs that teachers started to write, and the researchers reframed the writing to be better situated in research findings.

While we asked questions about the implementation of the brief development process, those findings are not included in this specific article. Rather, process-specific findings and recommendations for future implementation are outlined in [45].

## 4 FINDINGS

The major themes embedded into the interviews included motivation for teachers to participate, impacts on teachers, perceived impact on students, and impacts on researchers (Figure 2).

### 4.1 Teacher Motivation to Participate

As a way to provide context around teachers' motivation to participate in this initiative, we asked them why they signed up to participate. Teachers mentioned both intrinsic and extrinsic motivations in their responses.

**4.1.1 Intrinsic Motivation.** Within the subtheme of Intrinsic Motivation, four categories emerged: a desire to (1) improve their practice (and themselves), (2) improve strategies to reach underserved/underrepresented students, (3) engage in research, and (4) collaborate with others.

*Improve their practice (and themselves).* With respect to intrinsic motivation, the teachers had various reasons for participating. One teacher stated three times in the interview their desire to



grow as a teacher and as a person, stating “I’ll sign up for anything that’s going to make me better as a teacher, as a person.”

*Improve their strategies to reach underserved/underrepresented students.* Three of the teachers stated that they wanted to participate due to reasons related to the lack of equity that they have seen in their classrooms. Two teachers wanted to recruit more underrepresented students in their CS classes, with one stating that in “one class right now I have 27 boys and two girls. It is really a problem and that’s why when I saw [the invitation to participate] in an email I was super interested.”

Another has seen a significant shift in their student population and has felt ill-prepared to be able to teach the students effectively, stating that “I felt like it was important that I needed to address all of those children’s needs. I see my classes, computer science as one of the breakaway classes for the kids, that if they can learn this information, that gives them job opportunities, and it’s a life-changer.”

*Engage in research.* One of the teachers stated that “I was looking to possibly do an [Doctorate of Education] in the next year or two. I wanted to make sure that I was. . . capable of participating and writing and being okay, academically.” Another teacher stated that “I started the tech program at my school and [this study] seemed a really cool opportunity to get a chance to do some supported guided work. It’s been a while since anybody has helped me do research. That takes a lot of time, finding quality articles, and a lot of the stuff.” Both comments are closely related to them wanting to improve their practice, but these particular comments showed a specific interest in engaging with research for different reasons.

*Collaborate with others.* One teacher stated that they signed up, because “this type of opportunity, I thought, was a great chance to learn from others that’s already been way more experienced and still be able to give my experiences as well.” As a novice teacher, they wanted to spend time in collaboration with other teachers.

**4.1.2 Extrinsic Motivation.** With respect to extrinsic motivation, two categories emerged: the stipend and the potential to attend the CSTA conference for free. One of the teachers mentioned the \$1,000 stipend for participation, stating that “I thought that [the process] was going to be great. Of course, there was the mention that we would get paid the stipend of the \$1,000 stipend, and that was, I was like, sure, I will do work that’s important to me and get paid for it. That sounds awesome. That’s a great deal.” The same teacher also mentioned the potential for attending the CSTA conference for free, since they had never been and had always wanted to go.

## 4.2 Perceived Impacts on Teachers

As we considered the codes related to the process’s impacts on teachers, five subthemes emerged: Renewed focus on equity, changed classroom teaching strategies, changed perspectives/beliefs, expanded professional networks, awareness of resources, and sharing the knowledge gained.

**4.2.1 Renewed Focus on Equity.** In the teacher interviews, the focus on equity was evident, specifically when teachers reflect on their own process of discussing their mindsets regarding historically absent populations from CS. “The whole goal of the teacher brief was to find equity and really identify what those challenges are as we focused on the black and brown community and the Latino with the X. We wanted to make sure that we identified what were some of the issues, and we wanted to make sure we highlighted some of the strengths and really pushed forward.”

Most of the teachers were also aware of the practice of creating an equitable and transformative environment for students often marginalized in CS education. For example, one participant noted that equity is more than “just throwing some couple of posters of Black people who have contributed, and then talking about them like one-off situation in the midst of teaching tech. . .

kids need to feel connected to the content” regardless of their culture, which is more than race. In essence, one participant reiterated the importance of truly understanding the term “culture” throughout their interview. “I have some kids who come from different family structures and different economic backgrounds. There are so many different things that are culturally contributing to how they identify and how they interact.” Additionally, it was stated, “It’s really important that if we’re making sure to demonstrate and commit to valuing a woman’s voice in the development of technology or valuing all the contributions that brown and Black people have contributed to, it should not only be in the (under-served schools)—White kids should also see the importance of this.”

Finally, throughout the interviews, it was communicated that many of the strategies provided in the teacher briefs are also “just good teaching,” but usually it is mindsets that need to change. Overall, educators need to “actively work against White dominant culture within my (their) classroom because I (many) always went to school with a White dominant. That’s how all schools at this point have been structured.” “I have to deprogram myself and it’s very hard to do that if you’re only getting information from this one source (white dominant culture).”

**4.2.2 Changed Classroom Teaching Strategies.** The process of working with researchers to develop briefs had an immediate impact on the teachers. Specifically, one participant stated, “Oh yes, using [what I’ve learned] with my students” in answer to a question about how the TPB development process impacted their classroom practices. We found four primary areas of change, becoming more student centered, sharing more about the lack of representation in the field and the importance of changing that, the recognition that their changed Pedagogical Content Knowledge (PCK) transferred to other subject areas that they teach, and a continued reflection on their classroom practice through the lens of equity.

*Became more Student-Centered.* Through this process, participants reflected on increasing their understanding of needed factors to be more student centered. One participant stated that “I have more of an understanding of [students] needing that encouragement from family. . . maybe the families need more information about why this would maybe be a good field to encourage your daughter to go into.”

Not only did the participants reflect on including families as a way to be more student centered, but they also reflected on implementation practices. For example, one participant stated, “Instead of telling them what they’re going to do, I listen to them, I give them a voice and ask them [questions]. Just mainly giving them a voice and a choice because that’s what the research says.” Furthermore, participants reflected on evaluating if the curriculum is engaging or not to students. Through reading the research and interacting with partners, one participant stated that this experience was helpful because it made them “aware of how unengaging the curriculum was. . . I was just following the letter, I want to make sure I get it right.”

Additionally, participants discussed checking in with students more as a way to become more student centered. For example, one participant reflected that since engaging in this process they are more likely to check in with their students by asking, “What can I do to help you? Do you need anything?” Diving even further into this check-in, one participant stated that since reading the research during this project, “I do pay closer attention to my girls [in class] and I listen to them.”

These concepts under the larger theme of becoming more student centered also go hand in hand with the theme of integrating more culturally relevant activities for students of all backgrounds to be more engaged. One participant made the point that checking in and understanding the curriculum at a deeper level has wider impacts. “This [TPB] is not for people who want to teach Black kids. This is for people who are teaching, period. If we’re only using a culturally responsive and culturally relevant and inclusive curriculum for girls and minoritized students, then. . . [we’re] perpetuating the issues. We’re missing the bigger picture here is that is the whole group of people

who are in control and are very comfortable and confident that things are how they're supposed to be." Essentially, motivating and engaging *all* students in culturally rich CS instruction will improve learning experiences.

Through the process of putting into practice what they learned through reading and learning about student-centered practices, one participant reflected that the students reacted positively to changed teaching practices. Specifically, the teacher reported the students saying, "Oh, okay, now this makes sense" after implementing a [particular activity] learned about through this process."

*Increased motivation to retain underrepresented students into CS.* It became apparent that participants were able to focus on how to retain students not only through motivation and engagement, but also through the specificity of relationship building. "When they're in my class, I can show more about how this would be something good in your future. Not just teaching them the concepts in my class and not just working on having projects where girls might like them better or not, or anybody might like them. I think getting to understand more of that why, is going to help me more with the how or the what I can do. Building those relationships."

*Desire to address the lack of participation of underrepresented groups in CS.* The lack of representation and participation of underrepresented populations in the field of CS was recognized and discussed throughout the process of developing the TPBs. One participant reflected on speaking with their students about who is a role model in CS for underrepresented populations. After talking with their students, "I just broke down the numbers, how it's not that diverse and the reason for being is, how many people do you know that work in tech? You don't see any role models, you don't see people that's push forward. When you ask anybody else where they want to be, they'll see something in sports because that's what they see. It's basically talking about that exposure to them."

One participant also discussed her motivation to get more women into CS fields. "After doing this research, I was feeling I'm so motivated. I want to get [more people from underrepresented populations] in CS fields to come into my classroom and show and talk. I have talked to my administrator, my evaluator about my desire to do all these things. She was like, 'Yes, we're so hoping for next year'."

*Knowledge in CS equity transferred.* One participant expressed that they were applying new strategies that they learned to engage a particular group of marginalized students to a different group of marginalized students. When the interview asked, "Do you think some of the things you learned about—The strategies you got [for working with a group of marginalized students], do you think some of them will transfer?", to which one of the teachers responded "Absolutely. Especially being that [one particular student from marginalized group] enrolled this late in the school year, just basically trying to communicate with [student] and giving [student] a voice and a choice and things that [student] can do with the short time we have left, so absolutely."

*Improved practice through ongoing reflection.* Acquiring resources (e.g., Telenova activities, using Scratch) and reflecting on current practices influenced teachers' classroom implementation. Aside from already shared quotes, one of the teachers who taught inner-city students at a school attended by predominantly Black students discussed how reflecting and intentionally changing their classroom practice during this process influenced them to "integrat[e] things a little bit more, whether it being music, using items such as Flipgrid, having students act out certain movie scenes that they like. Just making it more hip, but still, helping them move somewhere that's lucrative because what this does is prepare you. Maybe they want to go ahead and make a YouTube channel because all of these things are lucrative."

**4.2.3 Changed Perspectives/Beliefs.** The impact on teachers' changes in perspectives and beliefs was immediate and, according to participants' statements, may be long-lasting. This can be summarized by one participant who stated that this project "changed my teaching perspectives

in the world of technologies, I want to say, 1000%.” Another participant stated, “we want to make sure that we just continue to work on the engagement, that’s why I’m saying this practice has just helped me just open my eyes more on how important that engagement is.”

*Self-efficacy.* Self-efficacy, or an individual’s confidence in their ability to complete a task or achieve a goal, was evident in statements made by all of the teachers. As stated by one participant, “It [the TPB process] has improved my confidence dramatically. The main thing, like I said, I went and really had to look myself in the mirror. I was like, ‘You’ve got to teach to style to your children.’” Other participants also reflected their increased confidence due to the TPB process, including one that stated “I think just the more you know. The more you know about everything, the more confident you are. I’ve always focused on what I need to teach these students to get them to be successful. Now I’ve seen through research and through collaborating with others, in my same field of why this is so important, or how can we make it even better? Not just teaching in the moment of in the class of, oh, we’re learning these concepts or whatever but just getting to, I think making me more educated and more well rounded. . . is huge.” And, “I think it gave me some more confidence that I was doing what I needed to do for the kids because some of the things that we looked at were things that I was already doing and using. It reinforced for me because I don’t have peers in my county to fall back on, so I’m an isolated island. Sometimes I question, ‘Am I getting too cocky in thinking I’m doing the right thing and I’m totally off on the left field, or am I going in a direction that’s good for the students?’ It gave me the feeling that yes, I was doing the right thing with my kids.”

Another participant stated, “It has actually increased my confidence because I actually feel like I know a little bit about what I’m trying to do. I know what the goal is, and now I feel more confident in pursuing the goal.”

It increased other participants’ confidence writing more academically. “When you don’t write academically all of the time, it’s hard to put things that don’t have the incorrect nuance sometimes. [Researcher] was able to help me hone that and tweak it so that it made more sense for a broader audience than me looking at it from a narrow focus of being here.” Another participant stated, “it’s [TPB process has] given me confidence to step out there and write a little bit more.”

Participants also felt more confident in reading research for future practice. One participant stated, “It’s also helped me expand my research a little bit as well because one of the things that I’ve noticed while I’m reading articles for this research project, I started reading other articles of interest.” Another participant stated, “would love to almost take a sabbatical and really focus on this and get to use all my brainpower and maybe pop into the classroom once a quarter to do a project just to inform my research but. . . I would love to yes, work on other projects but I also would love to find somebody who’s I guess, looking to add—Google wants to add more resources so that teachers have someplace to go to.”

*Increased interest in and awareness of research.* Participants becoming more aware of research and the impact research can have in policy development and implementation was clear in the findings. For example, one participant stated, “I’m now aware of some resources that I’ll be able to look at as I’m trying to continue to design. I’m only three years into writing curriculum, and I’m doing it for the most part from scratch.” Overall, it can be summarized by one participant, “it [this process] has made me want to learn more.”

*Excited about research findings.* The participants reflected on their excitement about their research findings. They were sharing their knowledge with others and were able to share their excitement with others. One participant stated, “I need to start watching what I say because I’m going to lose some friends if I keep saying, ‘The research says.’ They’re tired. I can tell a few of them are tired of hearing me say that but oh well, I was excited about it.”

*Excited about being a published author.* The participants shared the the common reflection that they were excited to be a published author, which is providing knowledge sharing to the future of

the profession. One participant stated that “Just looking back at the whole thing, every step that we did, and now I’m a published author, like, ‘What?’ I never thought I would say that. I’ve always just read other people’s things.”

*Awareness of their growth.* Participants were aware of their immediate and continued growth. One participant stated, “I’m a better teacher. I’m a better person. I looked at this experience as personal growth as well as professional growth. I’m at a point in life where I just I’m still trying to grow, and so this is something that I will continue to work on.” As is evident in other themes, participants also grew in writing skills and gleaning information from research.

**4.2.4 Expanded Professional Network.** By the end of the process, teachers felt connected to their partner. This was evident through teacher statements such as “We just had a lot of really good conversations where we got to just really bounce off each other’s energy.” Additionally, one of the teachers stated that they felt as if they were part of “a powerhouse team.”

Bonding not only took place between the teachers, but also expanded to their broader **professional learning network (PLN)**. Not only were the teachers able to bond and connect, they were also able to collaborate with like-minded colleagues. This was especially important for CS educators who are the lone CS teacher in their school and/or district. When discussing the expansion of their PLN and collaboration, one teacher stated “I don’t have peers in my county to fall back on, so I’m an isolated island.” This process enabled the teachers to be able to brainstorm, research, and develop resources for other teachers who are in similar settings.

**4.2.5 Sharing of Knowledge.** Once knowledge was gained through this process, participants began sharing this new knowledge with colleagues, expanding their PLNs, and providing resources to individuals in and out of their school districts. The noted places our participants shared their knowledge was with professional development groups or at their local professional development days with colleagues, through CSTA professional learning, and at Girls Who Code, where at least two participants volunteered. One participant stated that their network did not change at all. However, this participant then went on to say how much they learned from their new colleague.

Connecting with professionals from all over the country through the TPBs also created personal connections for future networking. One participant stated, “[The researcher] has just a huge plethora of resources. [Researcher] was telling us that [researcher] could connect us with people.”

**4.2.6 Awareness of Teaching Strategies and Resources from other Teachers.** Becoming more student centered, as outlined in an earlier theme, supports this theme of learning new strategies by gaining access and knowledge of resources. For example, Telenova activities and videos on YouTube and TikTok focused on best practices. One participant reflected on their use of social media as a way to connect but also learn new teaching strategies. “I read a lot. I follow things on Twitter and Instagram, TikTok wherever I can find.” Further, the direct connections with team members provided ideas around new teaching strategies. “[Researcher] just has the wealth of knowledge and resources. That has definitely expanded my learning community [and resources].”

### 4.3 Perceived Impact on Researchers

Although not a primary focus of our study, we also interviewed the researchers in a focus group setting to ascertain some of the impacts on them. The focus group interview protocol primarily focused on the overall process implementation and ways to improve it in the future. However, one question focused on their impacts of this collaborative process. The three researchers agreed that the overall engagement, learning, and process was “super grounding.” While the TPB implementation process did not have a direct impact on their future research, the researchers saw this collaboration “impact[ing] future teaching” and “professional development design.” Importantly,



this process reminded the researchers of the “varying teacher perspectives, mindsets, and locales” around the country.

#### 4.4 Perceived Impact on Students

While the students were not interviewed or part of this project overall, the participants did reflect on some peripheral impact on students from this project. For example, when a teacher participant immediately changed classroom practice based on their engagement in the process, students reacted in a positive way. One participant said, “Oh yes, (I’m already) using (learned practices) with my students.” Some of the concepts or lessons implemented immediately included making students more aware of representation, or lack thereof, in the technology field for historically marginalized individuals and women. Another participant stated, this process has “changed my teaching perspectives in the world of technologies, I want to say, 1000%.”

#### 4.5 Overall Process

Participants reported challenges and positive feedback about the overall process [45]. Challenges included participants’ fears and anxieties around the unknown nature of the work and time or scheduling constraints, while other feedback centered on the organized structure of the process and the ability to work directly with researchers. Since these findings are reported in more detail in [45], we summarize them briefly here.

*4.5.1 Challenges.* One challenge was the teachers’ initial feelings of fear and anxiety, which was shared by nearly every teacher participant. There was a reported fear around writing, the misconception that teachers would need to find the research to review, and the overall fear of the unknown. Anxieties about writing were stated by three of the five teachers. One teacher stated, “I told my partner I am not a strong writer, but I’m going to do everything that I have to do in order to prepare.” Another teacher stated, “I was always thinking about the writing process. It was a fear of the unknown.”

A fear of the unknown supported the specific theme of time commitments and scheduling. When the teachers were asked to participate, they were told it would take approximately 20–25 hours in total, including weekly meetings. However, most teachers invested a total of 25–30 hours across the 4 months, averaging 2.5 hours per week. Teachers reflected that at points during the process they did not have enough time to read and take notes on one pre-selected article prior to the meeting. One teacher stated in the interview, “For me, it’s just a time balance. There was no challenge in the work we had to do. I enjoyed coming together and meeting with my team. We met once a week every Thursday, then we would have to read the article in between. It wouldn’t seem like just to have to read a 20-page article or a 10-page article in a week’s time would be hard or something that you should be able to expect from a person, but sometimes it was.”

*4.5.2 Positive Feedback.* While there may have been some challenges, the teachers also noted positive feedback to the whole process. These experiences may in part have been due to the facilitated process, which teachers described as well-structured and organized. This includes how the facilitator set up readings of current research, created time for engagement with their teams, and enabled the writing of the briefs. As one teacher noted, “This has been a very wonderful experience for me. Like I said, very, very organized. [Facilitator] facilitated very well.” This concept of the entire process being well-structured can be summarized by one teacher who simply stated, “It was all planned out.”

Not only was the researching and writing process planned out, but there was intentionality of adding researchers into the groups later in the process, which gave teachers an opportunity to reflect on their problems of practice. One of the teachers noted that the researchers entry was



## Teacher Practice Briefs Development Process

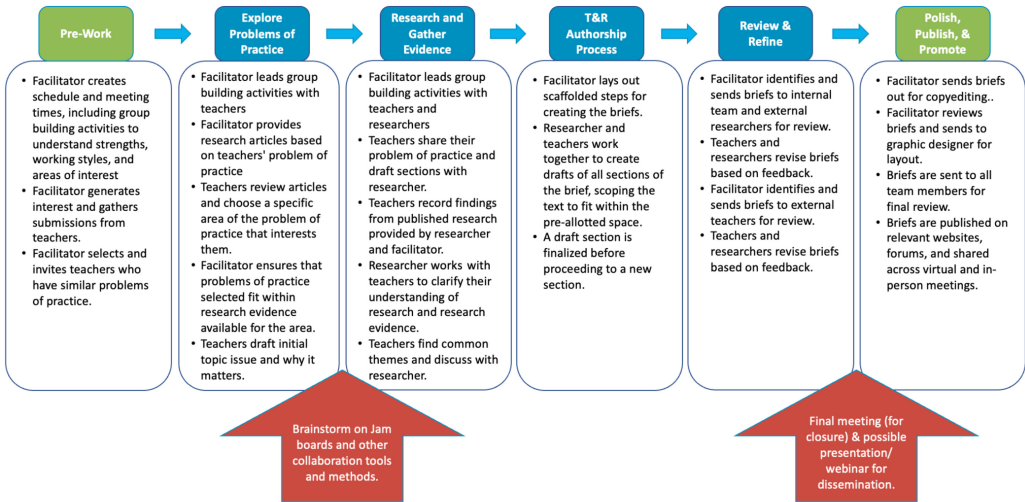


Fig. 3. Edited teacher practice brief cycle.

perfectly timed, stating that “[Researcher] just came in at the right time and everything came full circle.” They further clarified that the teachers somewhat struggled to interpret the research through their teacher lens, since research articles were so new to them. They were unsure how to parse through the various content that they were reading. When the researcher joined, the researcher brought the clarity and shaping that the teachers needed to connect the various findings.

## 5 DISCUSSION

### 5.1 Comparing Prior Theories and Research Findings

Overall, the basis for this project focused on the need to improve equity-focused teaching practices. As found in other research focused on impacts of RPPs on teachers, we also found positive impacts based on mutual knowledge building and the development of professional networks to potentially continue the collaborative learning process past the constraints of the project [56]. Similar findings around self-efficacy were also found and expanded upon through this study, including teachers’ confidence in their classroom practices. This increased self-efficacy increased teacher effectiveness through self-reported interviews, which supports other previous work [59, 70].

While many of the comparisons were similar, the one main difference was the edited process for developing the TPB. While it was based on previous work [7], the framework in this study was expanded (see Figure 3).

**5.1.1 Motivation.** We investigated teacher motivation to participate in the study to understand how we can motivate teachers to participate in creating teacher practice briefs in the future. Though we specifically built into the project a \$1,000 stipend for teachers who completed the study, teachers’ motivation to participate were found to be both internally and externally focused. Teacher participants were interested in their own personal growth, aligning with previous research [3, 18, 28, 40]. Impacting the profession on the common good is also a motivating factor and aligns with previous research [43, 65, 65], and this was further confirmed in the teacher participants’ sharing of the knowledge they gained during the TPB process.

The external value of monetary stipends was also a motivation. Historically teachers in the United States are a low-paid profession [1], therefore participation in work that simultaneously benefits personal professional practice and provides monetary benefits may be an appreciated activity for teachers.

**5.1.2 Equity.** Ensuring that equity is at the forefront of a collaboration process is arguably the bedrock of this work. This includes grounding the work in teachers and researchers studying equitable practices within a program or learning environment, ensuring equitable practices are embedded into the partnership itself by engaging with an open mind, and finally sharing the findings through an equity-focused lens. This was completed through the RPPs and the TPBs developed and disseminated.

The goal of the three TPBs was to focus on creating more equitable environments for the three identity groups that were selected for this project: **historically marginalized students (HMGs)**, bi/multilingual students, and girls. In research it shows that oftentimes girls, HMG students, and bi/multilingual students are absent from CS classes due to a variety of reasons, one of which stems from the microaggressive language often used, such as “boys are more natural at math and science than girls.” While this statement does not have any scientific backing, it is said in schools around the world. This then decreases populations of students from entering the CS classroom. However, when students do enter CS classrooms, it is important that the deficit jargon and mindsets are absent from the learning environment.

Although the TPBs were developed and disseminated successfully, the process of developing a singular and clear topic was discussed at length due to the “complex and interrelated problems of practice” [39, p. 6]. These interrelated problems of practice, with the focus of equity, were decided before the researchers entered the partnership. This led to some disconnections between the teacher-decided focus and the need that researchers saw in the research. However, collaborating to find a common definition and understanding of the problem of practice was completed and beneficial for setting trust, ownership, and belonging within the group dynamic.

**5.1.3 Impacts.** Four of the five major impacts on teachers of the TPB process align with previous research on the impacts of research and practice collaborations (see Table 5).

- All five teachers expressed that they changed their classroom teaching strategies, including more awareness about reflecting on their CS teaching practices to teach their students more effectively. This aligns with [63], which found that RPPs led to classroom practice changes. Finding this larger theme was not surprising—baked into the profession of teaching is the process of constant reflection and growth. Each year teachers around the United States are evaluated, which includes an embedded course of action for reflection to improve their practice [2].
- Teachers expressed changed perspectives and beliefs, which included increased self-efficacy teaching CS, increased confidence engaging with research, increased interest in and awareness of research, excitement about research findings and being a published author, and self-awareness of their growth in this process. With the exception of increased interest in research, which was not found in the literature we reviewed, our findings supported or partially supported results from the impacts of RPPs.
- Teachers expressed that they had expanded their professional network, both with researchers and with other teachers, again aligning with findings reported in [63].
- Teachers expressed their excitement in sharing of knowledge with others and, though they shared their knowledge at a conference, this additional knowledge-sharing was not built into the TPB process. It appears that they shared this knowledge because they believed that it

Table 5. Known Teachers Impacts of Teachers who are Engaged in RPPs Compared to our Findings

Impacts	RPPs	Our Study
Access to usable research	[63]	Supported
Affirmation for long-term collaboration	[22]	Not supported
Awareness of their own growth through the process	Unknown	Supported
Changed classroom practices	[63]	Supported
Creating opportunities to develop/apply new knowledge	[13]	Partially supported
Engagement in professional learning	[63]	Partially supported
Excitement about being a published author	Unknown	Supported
Expanded professional communities	[63]	Supported
Increased confidence	[20, 36, 63]	Supported
Increased interest in research	Unknown	Supported
Knowledge and awareness of important advances in scholarship	[13, 20, 63]	Supported
Leadership capability related to STEM improvement	[63]	Partially supported
Personal Identity	[22]	Partially supported
Professional Renewal	[22]	Partially supported
Renewed focus on equity	Unknown	Supported
Self-efficacy	[36]	Supported
Sense of ownership	[36]	Supported
Sharing of knowledge learned (voluntary)	Unknown	Supported
Transfer of new equity-practices knowledge	Unknown	Supported

was rooted in evidence and could help other teachers improve their classroom practices—and thereby reach more students.

A somewhat pleasant and surprising finding is teachers' statements reflecting a renewed focus on equity and the ability to see connections for transferring their new equity-focused practices (e.g., culturally relevant practices) to other subjects that they teach. Though we have not found this in our literature review of the impact of RPPs on teachers, we can imagine that this might be an area of interest for RPPs to investigate further.

Through the embedded, natural, and continual reflection process in which teachers are trained to engage, teachers in our study realized how their engagement with the TPB process will benefit and be used in their future learning environments. This includes immediate implementation, reevaluating their CS curriculum, and sharing their newly gained knowledge and resources with colleagues.

## 5.2 Alternative Explanations of Findings

As with any qualitative research, the findings are based on the backgrounds and experiences of the researchers who undertook this study. Therefore, alternative explanations for the findings could be the impact of COVID-19 on the teaching field. This project took place at the start of the pandemic, which could have greatly impacted the challenges outlined in the findings. Additionally, the positive impacts from this study could be attributed to the constant structure of collaboration during a time of high uncertainty.

Further, the teachers who engaged in this study self-selected by sharing their equity-focused problems of practice in their screening questionnaire. On the one hand, the teachers already have a predilection for solving problems of practice related to equity and this may partially explain why they were engaged so highly throughout the entire activity—which in turn could explain why the activity had the impact that it did on the teachers. On the other hand, our team specifically selected researchers that were engaged in research that teachers were interested in. In this case, we focused

on equity; however, in the future, we could find researchers that study any topics that teachers are interested in.

### 5.3 Central Contributions to the Discipline

The most significant contribution to advance the disciplinary understanding is the focus on decreasing the gap between research and practice through a new collaborative practice that engages researchers and teachers. Through the process of bringing researchers and educators together, with a clear focus on equity-based problems of practice in CS education, the results indicate that there is early evidence for a multitude of positive impacts. In essence, the central contribution of this work to advancing researcher-teacher collaborations, as well as impacting the future of CS education, is clear in the data. Teachers are positively impacted, researchers develop a clear understanding of realistic practices, and students are peripherally impacted through changed practices in the classroom.

A second contribution is the process itself, which we have defined in Figure 3. This process can now be used with a larger group of teachers and researchers to vet it further and more clearly understand impacts on a variety of teachers.

### 5.4 Types of Contributions Made by Findings

Previous research has shown numerous positive impacts through the collaborations between researchers and educators, particularly participants involved in RPPs. Our findings display some of the same impacts, while also addressing previous challenges.

One of the challenges addressed in this research study, as compared to RPPs, is the decrease in time spent on the project. RPPs are designed in a way that often spans multiple years. However, time barriers often impact the overall projects. Therefore, we designed this partnership to span one semester, which therefore decreased, however did not eradicate, the time commitment barrier. The findings from this study can be utilized in future collaborative efforts between researchers and educators.

### 5.5 Strengths and Limitations

The overall process and collaboration between and among participants was one of the strengths in the study design and overall project. Additionally, beginning the project with only teachers ensured that their voices were heard and that their problems of practice were leading the way when researchers entered for the TPB development.

As with most research projects, participation attrition was a limitation. Out of the eight educators who were invited to participate, only five were able to commit to the project. This created a one teacher–one researcher partnership in one of the groups, which led to input from only one teacher in that group (compared to two in the others) and likely a less rich experience for the teacher and for our resulting set of data. Likewise, we sought teachers with an interest in equitable CS education, which also may have biased the impacts. Future research that includes teachers with various interests could help define more generalized impacts.

The quality of the materials was solely based on qualitative data, which provides a story of the project overall. However, in future studies adding in reflective journaling from the facilitator and/or researchers and teachers would add to the overall data. This information would also provide context for the development process rather than focusing solely on the end reflection of the entire process. Regardless of the perceived limited amount of data from the one-on-one interviews, the analysis process was thoughtful by bringing in outside researchers to provide validity to the process.

It should be noted that this project was completed in the United States with middle school teachers and is context sensitive [49]. Outside of this population, problems of practice may look different; however, the process to discover, investigate, and eventually write the TPBs are highly transferable to anywhere in the world with any grade level teacher. This is evident from our replicating previous work based on the RPPs designed by [Bell and Rhinehart](#).

Further, the TPB process was a catalyst for these impacts; however, what remains unclear is whether the researcher-teacher collaborative meetings led to these impacts or whether the creation of the TPBs did—or a combination of both. However, we note that none of the RPP studies that discuss impacts differentiate whether or not it was due to being part of the collaboration or the actual RPP that had those impacts. The end result, however, increased teachers' self-efficacy, which is a desirable outcome regardless of what was the specific or combined catalyst. These are early findings, and future research would enable researchers to differentiate this.

One of the ethical dilemmas and challenges of this project was the publication of the teacher briefs with participants' named as authors. Therefore, we were limited to general indications from this study to help maintain some level of confidentiality. Future researchers can conduct a different style of study that includes a larger number of participants or uses a different methodology (e.g., quantitative) to capture impacts on teachers that further protects their identity while also identifying more specific challenges for each group.

## 5.6 Future Research

This is a pilot study with early indications that the teacher-researcher TPB creation process has an impact on teachers that is similar to those found in teachers that participate in RPPs. Future research requires more teachers involved in this process and greater datasets (both quantitative and qualitative) collected to see if the impacts align with these early findings. Our future research work also includes having teachers participate in action research to explore the impact of this process on teachers and on their students.

Further, there is ample room for investigating the impact on researchers, since that was not a focus of this particular study.

## 6 CONCLUSION

Connecting educators and researchers is a known need in the field of education and more specifically in the field of CS education research. Piloting the process of teachers and researchers collaboratively developing TPBs has wide-reaching implications for future research, policy changes based on the collaborative future research, and overall practice both in research and the classroom. It can even provide a way for stakeholders to leverage this process to achieve similar teacher and researcher impacts (e.g., increased self-efficacy) and close the teacher-researcher gap. This project demonstrates the implications for future research practice to engage with and involve educators who are in the classrooms daily and know the ins and outs of their problems of practice. Additionally, collaborating with CS teachers also provides a foundation for teachers to conduct their own research, understand how to address problems of practice, and implement classroom practices based on their findings. While this work was conducted in the United States, the implications for future research and practice around the globe is evident.

This is just one study in the small pool of studies focused on the impact these collaborative relationships can have for researchers, educators, and students. The implications for this study are wide-reaching because the process of developing publicly available TPBs not only impacts those participants involved, but can impact students around the world. Empowering teachers through this work and helping researchers to understand the realistic problems of practice is essential and integral to the future of CS education research.

## APPENDIX

### A SEMI-STRUCTURED INTERVIEW PROTOCOL

- (1) In late 2020, you received an invitation to submit your information to participate in this study. Reflecting back to that time, to the best of your recollection, why did you choose to sign up to be a part of this study?
- (2) Which problem of practice did you focus on for your brief? How did you decide on the focus for your practice brief? (probe: What was your thought process?)
- (3) How much have you used research to guide your teaching practices in the past? How have you used it?
- (4) Reflect upon the process that you went through in creating the practice briefs.
  - What were the best parts of the process for you?
  - What were the most challenging parts?
  - During the process, how did you keep a focus on equity? Tell me more.
- (5) In what ways has going through this experience impacted your teaching? (or you think will impact your teaching in the future?)
- (6) How has going through this experience impacted you?
  - Do you feel more or less confident in teaching CS to your students? Explain.
  - What do you think about CS education research and researchers after this experience?
  - How has your professional community expanded, if at all?
  - Did you share your experiences in this process with others? If so, what did you share?
  - In what ways, if any, can you see yourself participating in a similar project in the future?
  - In what ways, if any, can you see yourself engaging with research in the future? Would you consider being involved in a research project in the future?
- (7) Looking back, are you glad you signed up for this study? If so, why? If not, why not?

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