Exploring Research Practice Partnerships for Use in K-12 Computer Science Education

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Since 2017, over $100 million in U.S. National Science Foundation grants have been awarded to establish new and extend existing Research Practice Partnerships (RPPs) focused on K-12 computer science (CS) education. Given this investment, what are RPPs and why is so much faith being placed in them? Their unique promise for CS K-12 education is, in part, their intentional design for bridging the gap between researchers and practitioners. In this article, we provide an overview of RPPs, their benefits and challenges, methods for assessing RPPs, and additional resources for those who want to dig deeper.

INTRODUCTION

Research Practice Partnerships (RPPs) have been increasingly used in the U.S. over the last couple of decades to address general problems of practice found in K-12 education. These unique partnerships involve the collaboration of researchers and practitioners who are committed to designing and implementing solutions to problems that practitioners (e.g., K-12 administrators, teachers, staff) face. In the context of K-12 computing education, RPPs have been relatively rare.

In 2017, the U.S. National Science Foundation (NSF) issued its first call for proposals for growing Research Practice Partnerships (RPPs) focused on equitable Computer Science (CS) education [38]. This K-12 "for all" initiative seeks to foster research into problems of practice practitioners face based on mutual partnerships between researchers and practitioners. From 2017–2020, 120 unique projects were supported by this initiative, many of which have been for existing or new RPPs for CS in various stages of progress (Figures 1 and 2). Projects have ranged from seeking to address such problems as the lack of computational thinking (CT) and CS education in middle school [20] to the lack of equitable access of Advanced Placement (AP) Computer Science Principles (CSP) courses for all students [6,34] (Figures 3 and 4).

Adopting RPPs while K-12 computing education is still in its infancy, particularly with respect to primary education, has the potential of having meaningful and lasting impact given the known impacts of RPPs in other fields. To shed light on the potential reasons why the NSF is investing so heavily in RPPs for CS, we provide an overview of RPPs in general, discuss their benefits and challenges, and highlight ways to measure their health and success. We also provide a set of resources for those interested in learning more.

Figure 1: NSF-funded CSforAll RPPforCS Awardees, 2017–2020. Of the 120 unique projects, 33 of these are collaborative submissions to the NSF rather than a single submission (which may or may not have multiple organizations).

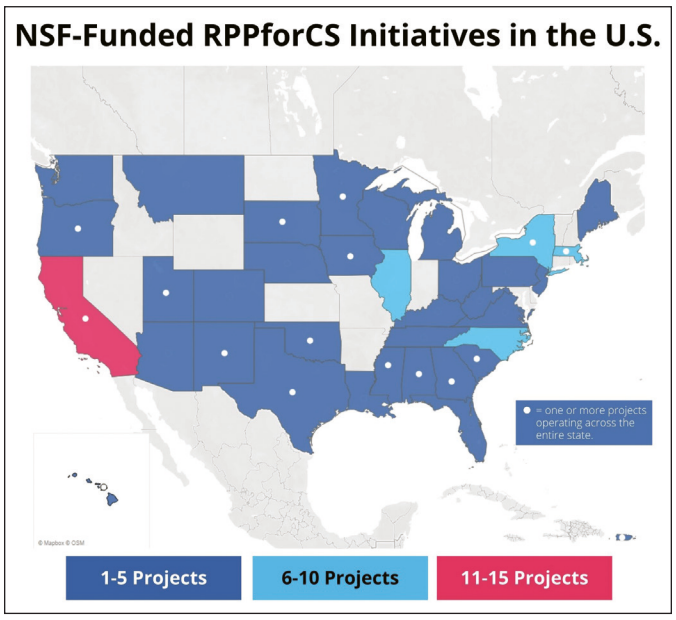

Figure 2: Figure 2. NSF-funded RPPforCS projects across the U.S, 2017–2020.

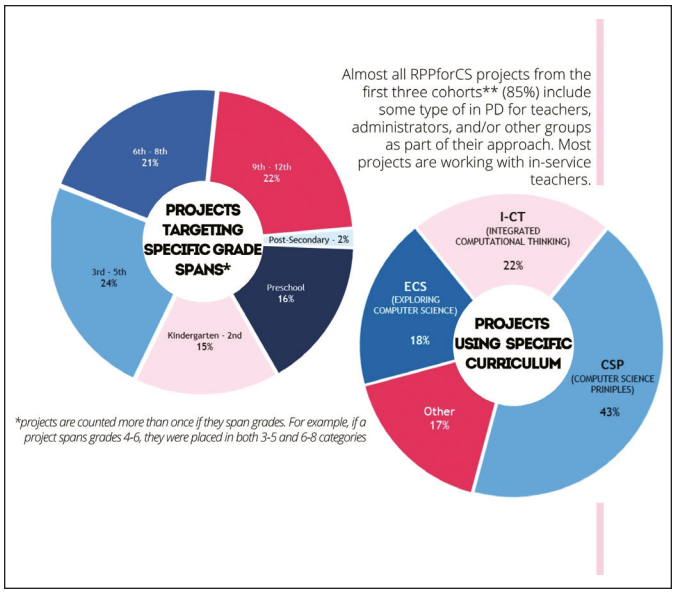

Figure 3: NSF-funded RPPforCS project details, 2017–2020.

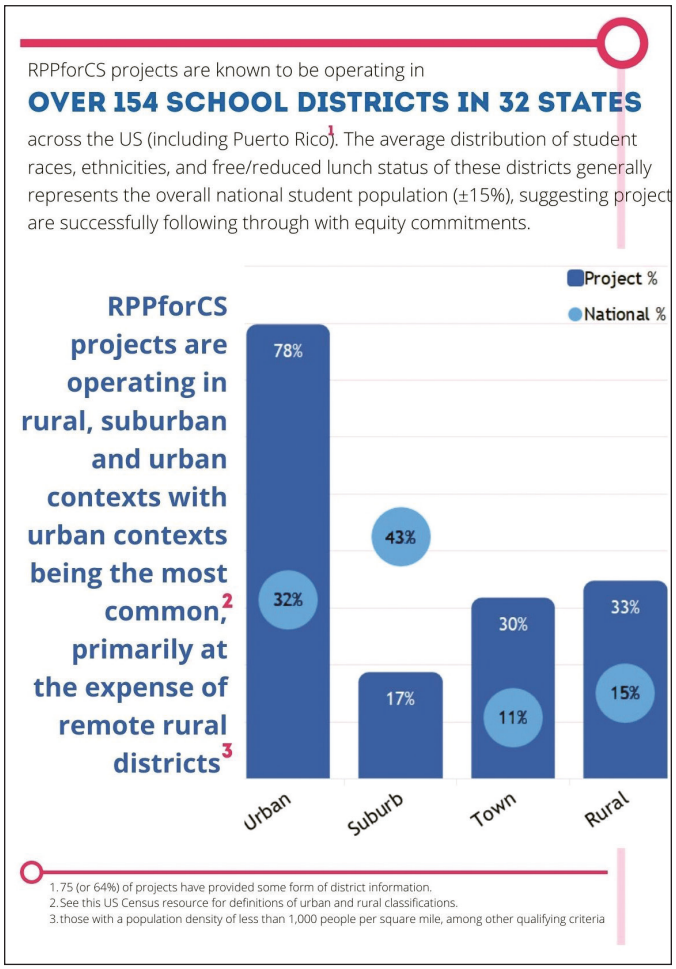

Figure 4: NSF-funded RPPforCS school district demographic data, 2017–2020.

DEFINITION AND KEY COMPONENTS

Though practitioners and researchers both are outcome focused and are interested in increasing academic achievement among students, the gulf between the two has often been very wide [48]. In the past, school-university partnerships [4,20,48] were established for many of the same reasons that RPPs are today—to solve the problems that arose from the deep separation of research from practice. The traditional silo-ed research pipeline has typically consisted of disseminating findings to practitioners once the research has concluded. The hand-off from researcher to practitioner may not meet the critical needs that practitioners face or adequately consider the context of their work [28,39].

Coburn et al. have defined RPPs as "...long-term collaborations between practitioners and researchers that are organized to investigate problems of practice and solutions for improving schools and districts." [8,p.48] RPPs are intentionally organized and can be focused within a single school, but typically they involve several schools, a single school district, multiple school districts and even supporting agencies. They can be formed across distributed networks (e.g., special education providers across a state) [7,8].

Full participation by practitioners in the course of conducting research, as designed in RPPs, can ensure that practitioners' voices, contexts, and experiences are considered. Practitioners also benefit from research, building the knowledge needed to leverage research in their decision-making within a particular context [8,33,40,43]. Ghiso et al. points out nuances in the formation of RPPs.

> [RPPs] call on forms of professional knowledge that may have traditionally been less visible or valued in the academy. Collaborative research teams are engaged in deeply relational intellectual and emotional labor: They have to develop methodological sensibilities and skills that are attentive to issues of power and have to negotiate social and institutional boundaries. [19,p.1]

An RPP's long-term structural approach and intent are paramount to their success. This approach allows for the time and space needed to institute a continuous improvement paradigm [50], including the Plan, Do, Study, Act (PDSA) cycle that can be continually repeated to identify promising practices and bring them to scale.

Basic tenets of RPPs are that they are long-term collaborations, mutualistic, and consist of efforts to build and maintain trust among their participants [26,53]. Mutualism equalizes the power structure between researchers and practitioners and elevates the concept of joint work to design and implement solutions, study their impact, and redesign and refine their solutions [38]. Trust becomes a key element of a successful partnership—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 which they seek to mutually solve [28].

RPPs also involve original analysis of data, a practice that involves the collection of data within the context of the problems being solved, the district(s) or school(s), and/or the specific intervention, program, or reform strategy [8]. This enables the district leaders to be able to analyze and interpret the data in a way that considers their unique district's frameworks.

There are similar and shared functions among different ways in which RPPs are implemented. Connolly notes that even with RPPs "everything grows from a strong foundation" [9]. Part of this requires recognizing that the ecosystem of connected academic enterprises and institutions can result in positive change that impact student learners [9,56].

RPP FRAMEWORKS

There are similar and shared functions among different ways in which RPPs are implemented. Connolly notes that even with RPPs "everything grows from a strong foundation" [9,p.1]. Part of this requires recognizing that the ecosystem of connected academic enterprises and institutions can result in positive change that impact student learners [9,56].

To facilitate the partnership, rules of engagement can help lay the groundwork of expectations, roles, and responsibilities for the RPP [32]. Partnership models include the following.

- RPP Research Alliances—Typically focused on a specific district, region, or state for ongoing problems of similar interest [5,27]
- RPP Design/Co-Design models— Typically focused on the fully collaborative model of designing, studying, improving, and then scaling classroom practices based on empirical evidence [5,26,27,45]
- Networked Improvement Communities (NICs)—often short-cycle improvement efforts, these communities engage education professionals, researchers, and designers to use a continuous improvement model for exploring the usage and refinement of promising practices that address shared problems [5,27]
- Hybrid—Two or three of these methods combined [27]

Collaboration strengthens the RPP, demonstrates its value, and can help institutionalize the work [9]. It can also ensure that the right problems of practice are being addressed [54]. Identifying and decomposing the pressing problems can be aided by the use of the Edelson's design methodology [14] and other step wise processes that include grounding the decom-

position in practice through the RPP team members' vision, by function, and in relation to the contexts to which it applies [31,36,40,52]. This requires a range of perspectives and can further identify relevant stakeholders who should be included in the RPP [40].

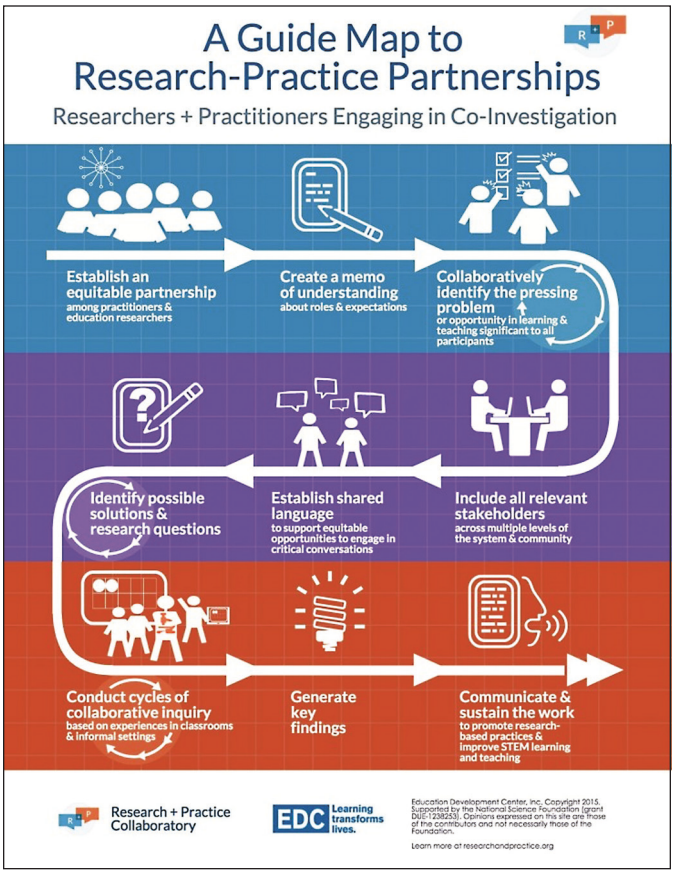

Figure 5: The various steps of how RPPs function and the important key processes within them [32,42]. Used with permission by Education Development Center and the Research+Practice Collaboratory.

A critical step of an RPP is to identify and implement solutions [36] as well as formalizing the research questions that are to be addressed (Figure 5). Ecosystems help in this process by offering a "...powerful lens for researchers and stakeholders as they can answer the key problems of practice." [56,p.1] Inter-organizational practices for an RPP can ensure better communication and understanding across the research and partnership communities, including meeting routines to encourage communication and professional support [18,42].

Collaborative inquiry can be performed through a variety of methodological approaches that are iterative in nature and test and refine the new educational approaches [36,42,44]. A collaboratively developed research agenda is necessary for identifying how findings will be discovered [3,7,14]. Findings are often generated using shared tools and common practical measurements [18,48], some of which may need to be developed for the RPP. Collaboration is key in conducting the research within schools and school districts to collect the data needed for the findings. It is important to find meaningful ways to share findings as well as recommendations for change and action [36].

ROLES AND RESPONSIBILITIES

The impact of meaningful partnerships has been shown to include positive changes in teachers' self-efficacy and sense of ownership in the research, researchers' deeper understanding of school contexts, and improvement in students' engagement and learning [29,42,51,56]. Researchers and practitioners can collaborate in many ways in RPPs, several of which share common attributes for achieving success [26,29,47]. In successful partnerships, both parties know and fulfill their negotiated roles and responsibilities throughout the project to enable high-quality relationships [9,48]. Their partnership should be honest, transparent, and trusting [9,23,47].

Researchers and practitioners often have diverse roles. Researchers can provide the research plan, take a leadership role in structuring the shared learning, establish roles and responsibilities, support teachers' development of pedagogical content knowledge, collaborate with district leaders, and provide evidence to support a strong model [14,26,48]. They act as knowledge brokers, connecting practitioners to other knowledge in real time as needed [10] and often bring connections to external supports for implementation and evaluation and disseminate findings [9,16,47].

While the term practitioner implies an array of practice-organization roles [30], teachers are often regarded as a unique population. They occupy a dual space as both the recipient of project interventions and a critical voice within the project. Teachers may participate in design work to create classroom materials or take on leadership roles within the RPP, acting as conduits to their colleagues and representing the classroom perspective [1,3]. Roles and responsibilities of researchers and practitioners depend on the RPP type. In Research Alliances, their roles are distinct, and collaboration between them happens at the start and end of the project. The main responsibility of practitioners is designing and implementing the policies and programs, while researchers' responsibility is to evaluate the policies and programs [41].

The Design Research model shares elements with, but is distinct from, the Research Alliances model. This model uses a co-design approach, and researchers and leaders work together in an iterative process in identifying challenges, test strategies, and finding solutions over the long term [39]. Kali et al. notes that these tasks require Design Centric (DC) RPP participants to take on more than the traditional roles and often share responsibilities of consultant/facilitator, designer, and researcher [30].

In a NIC, there is no clear delineation between researcher and practitioner [39,40]. Researchers can take on the work of facilitating and guiding members through the improvement process, while practitioners can take on responsibilities for developing measures, gathering, and analyzing data [48]. In other words, in NICs it is assumed researchers' and practitioners' roles can be counter-normative to their routine responsibilities [8,39].

GENERAL RPP BENEFITS

Benefits of RPPs are multi-faceted and researchers and practitioners can both be positively impacted due to the participatory knowledge building process [46]. RPPs can result in higher quality research that builds capacity among researchers, practitioners, and their institutions that is more likely to have a positive, timely impact [26,36,47]. By their nature, they are more equitable and ethical since they leverage ideas, assets, and "...community stakeholder experiences and perspectives to inform research questions, methods, and meaning-making" [1;2,p.1;26]. RPPs have the potential to discover interventions that have a higher adoption rate due to their usability and relevance in the local context [2,7,26,28], since the rigorous research often provides better assurance that the new practices solve the targeted problem and are institutionalized [2,9,47].

The outcomes of these many benefits include improved academic achievement among students [7,44], student engagement, and other social-emotional factors that have been shown to affect learning [47]. An RPPs networked community enable access to the research and its interpretation, and decision making can then be based on the interpretation of this research [3,7,26]. Tools and resources for improving curriculum can be provided and shared more widely, and this generalized knowledge can extend beyond the RPP [30].

The adoption of the continuous improvement model helps ensure continued use of "social resources" through networking as well as the continued sharing of ideas, processes, materials, and tools [7,30]. Their long-term nature and open-ended commitment lead to the acceptance and use of the continuous improvement model dedicated to addressing persistent problems of practice [7,13,46] and results in a significant amount of original data that is produced over time [3]. Districts and statewide policymakers then build "...their own capacity to use and generate research effectively" [3,p.6].

RPPs have been shown to have a positive impact on its participants (Figure 6). Benefits to participating K-12 teachers include increased confidence and self-efficacy, improved classroom practices, and more awareness of advances in scholarship on improved teaching [7,16,29,47]. Researchers also share in benefits, including a deeper understanding of the realities of school contexts and practices and an increased confidence in the value of their work [30,47].

There potentially may be another class of benefits that have yet to be documented by others or otherwise might go unstated, particularly at the macro level (e.g., policy, procedure, culture of the participating organizations). These may include partnerships extending to new challenges and opportunities, development of trust allowing difficult conversations to occur, and acknowledgement and open discussion of power dynamics/power relationships by participants.

GENERAL CHALLENGES

The first two hurdles that RPP initiators face are the ability to form the collaboration and infrastructure that can sustain change and decompose the problem of practice that considers the holistic needs of learners [30,40,41,46,54]. Partnerships can face organizational and knowledge management issues that plague any institution—finding and potentially hiring qualified researchers, long-term funding, employee and leadership turnover, complexities of institutional and RPP hierarchies, the needs of external special interest, lack of focus on the guiding goals and political influences [1,3,5,7,13,26,27,42]. Partnerships are also faced with decisions about choosing whether the benefits of the RPP outweigh the resources to conduct the research [36]. Differing priorities, shifting goals, differing visions and approaches can all contribute to tensions among RPP members [3,12,27,49]. Maintaining a local context on the partnership work can be a challenge, particularly when there are other forces at play [27].

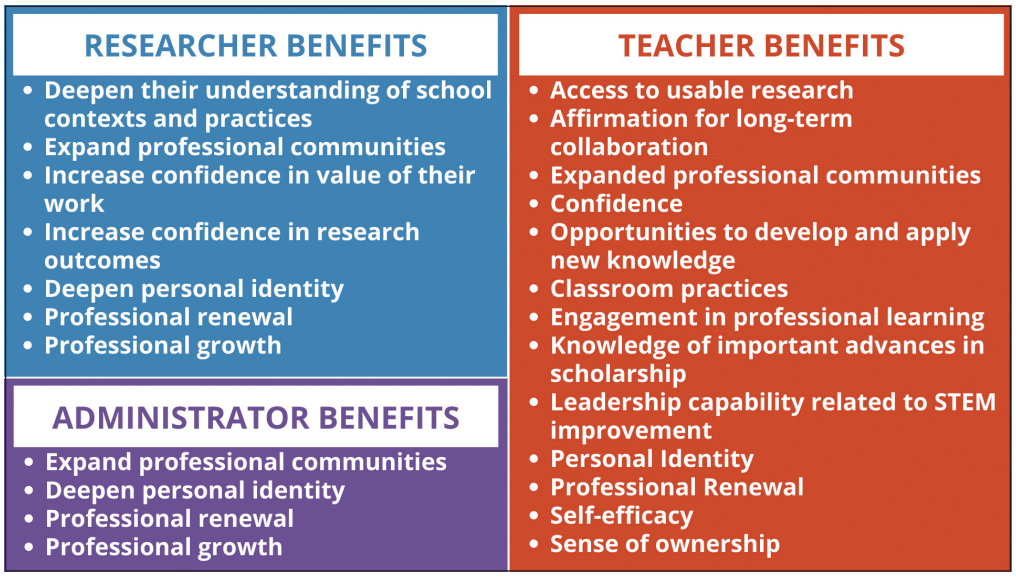

Figure 6: Impacts of RPPs on practitioners and researchers based on previously gathered evidence [7,16,26,29,48].

RPPs often highlight cultural gaps and differences, including inflexible practices and policies [12,24,27]. Likewise, they introduce a multi-party problem, which is amplified when the practitioners and researchers have a limited history of interactions and have not been trained to work together [27,48]. Many of these organizational complexities multiply as more members are added to the RPP [48].

Power imbalances can inhibit the goals for equity and inclusivity and inhibit the building of trust among the team [1,2,12,19,27,32]. This is further complicated by the complexities of communication, including issues of shared language and communication about the partnership itself [30,46]. Equity within various aspects of research, including students, can be addressed in RPPs, but often there are "...complex and interrelated problems of practice associated with the creation and scale of new practices that aim to position educators as techquity designers and brokers" [31,p.6]. In this regard, working towards justice also means that challenges can arise when considering if and when research should be conducted [12].

Building and maintaining trust among the RPP members can require significant time and commitment [3,12,26,27,48], which can be difficult when staff time may be limited [36]. Teams must also be flexible and adaptable, since at times the focus of the work may shift [42]. An example of this is the shifting required to address the impact of COVID-19 on the RPP team, the RPP's goals, and the impact on students.

Sharing knowledge from the original data produced and lessons learned throughout the team can be challenging [41,45]. Ensuring that practitioners understand the research methods and processes requires adeptness at meeting practitioners where they are [12,27,29,44]. Findings are often presented at academic conferences and practitioners may not have the time or resources to commit to attending [19].

Research findings may challenge the practitioners' fundamental beliefs and institutional obstacles and require that teachers take the time to shift their teaching to include practices related to findings [3,7,27]. It may also be difficult to build teacher capacity to engage in the RPP and the implementation [13].

ASSESSING RPPS AND THEIR VALUE

Assessment of RPPs is important in ensuring that the key components and the value of RPPs are being continually addressed. In this section we highlight several assessment methods that enable formative assessment to grow the RPP and summative to describe the progression of the RPP against a framework for benchmarking purposes.

THE FIVE DIMENSIONS OF EFFECTIVENESS MODEL

Although relatively new and not specifically designed for RPPs in CS, the Five Dimensions of Effectiveness assessment model [27] has already been used and referenced across a variety of projects [9,25,29,31] and has evidence of validity. In this model, RPP progress is measured across the following five dimensions, including building trust and cultivating partnership relationships and producing knowledge that can inform educational improvement efforts more broadly. Various indicators are used across these dimensions to actually provide assessment measures. This model, which is carefully aligned to best practices in establishing and implementing RPPs, provides a strong sense of how RPPs can be structured to support and embrace the equal partnership RPPs seek to achieve.

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THE WILDER COLLABORATION FACTORS INVENTORY

The Wilder Collaboration Factors Inventory can be used to assess the collaboration and partnership qualities among groups involved in an RPP [9,35]. This instrument has 44 questions across 23 factors that groups utilize. Factors include the history of collaboration/cooperation, flexibility, ability to compromise, open and frequent communication, and shared vision.

THE RPPFORCS HEALTH ASSESSMENT

Healthy partnerships will be proactive in giving their partnership attention. Based on the Five Dimensions of Effectiveness model, the RPPforCS Health Assessment Tool offers a matrix for evaluators to evaluate the RPP design process over time to assess the maturity of the RPP [59]. The Tool can help facilitate the design of the RPP and reflection among partners as a part of the trust building process. For RPPs that are struggling to function as healthy partnerships, it may facilitate difficult conversations needed to improve partner dynamics.

THE WENTWORTH ET AL. SURVEY

The assessment framework provided by Wentworth et al. can be used to examine the impact of RPPs on behaviors, "such as educators' evidence-based decision-making, in the context of school and district improvement efforts." [55,p.251] Wentworth et al. developed a survey instrument to measure several key components of RPPs that accompanies the framework.

SWOT ANALYSIS

A Strengths, Weaknesses, Opportunities, and Threats (SWOT) analysis is a well-known assessment measure used in businesses to help identify the strengths, mitigate weaknesses, seize on opportunities and identify threats, all in an effort to improve the processes and functions of an organization. A SWOT analysis is another method for evaluating an RPP's health [22,24]. The concept of SWOT as an indication of each component at a particular point of time could potentially be useful for principal investigators/directors of RPPs in order to improve the processes.

STUDENT OUTCOMES ASSESSMENT MODEL

The Student Outcomes Assessment Model measures outcomes of an RPP's interventions. This model uses a "difference-in-differences estimation strategy" to "...compare student outcomes among the innovations schools to the remaining schools in the district." [5,p. 5] Outcome measures are defined collaboratively with stakeholders (e.g., district leaders) based on jointly desired outcomes. This can include a mixture of quantitative and qualitative measures and should take the context of partnership participants into account.

RESOURCES

Though it will take time to understand their short- and long-term impacts on building equitable CS education ecosystems in K-12, research on RPPs in general indicate that RPPs for CS hold great promise. If you or your team are interested in forming an RPP for building and/or improving your equitable CS education ecosystem, consider investigating these resources:

- RPPforCS [10]
- National Network of Education Research Practice Partnerships [37]
- NSF RPPforCS Call for Proposals [38]
- Research+Practice Collaboratory [42]
- Searchable Database of existing NSF-funded RPPforCS [44]
- WT Grant Foundation supported projects [57] ❖

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