Assessing the Effectiveness of Computer Science RPPs: The Case of CAFÉCS

Erin Henrick
Partnerships for Improvement in Education
Franklin, TN, USA
erin.henrick@partnertoimprove.com

Steven McGee
The Learning Partnership
Chicago, IL, USA
mcgee@lponline.net

Ronald I. Greenberg
Department of Computer Science
Loyola University Chicago
Chicago, IL, USA
rig@cs.luc.edu

Lucia Dettori
Office of Computer Science
Chicago Public Schools
Chicago, IL, USA
ldettori@cps.edu

Andrew M. Rasmussen
Office of Computer Science
Chicago Public Schools
Chicago, IL, USA
arasmussen@cps.edu

Don Yanek
Office of Computer Science
Chicago Public Schools
Chicago, IL, USA
dgyanek@cps.edu

Dale F. Reed
Department of Computer Science
University of Illinois at Chicago
Chicago, IL, USA
reed@cs.uic.edu

***Abstract*—Research Practice Partnerships (RPPs) are a relatively recent development as a potential strategy to address the complex challenges in computer science education. Consequently, there is little guidance available for assessing the effectiveness of RPPs. This paper describes the formative evaluation approach used to assess the progress of the first year of the formalized RPP, Chicago Alliance for Equity in Computer Science (CAFÉCS). This paper contributes to the RPP literature by providing a case study of how an RPP effectiveness framework can be adapted and used to inform partnership improvement efforts in computer science education.**

***Index Terms*—computer science, research practice partnerships, evaluation**

I. Introduction

Research Practice Partnerships (RPPs) are a relatively recent development as a potential strategy to address the complex challenges in education, particularly in the field of computer science education. Defined as "long-term, mutualistic collaborations between practitioners and researchers," RPPs are "intentionally organized to investigate problems of practice and solutions for improving district outcomes" [1, p. 2]. Currently, there is limited research focused on evaluating RPP effectiveness. This paper describes the formative evaluation approach used to gather baseline information to assess a newly formalized RPP along the five dimensions outlined in the RPP effectiveness framework developed by Henrick, Cobb, Penuel, Jackson, and Clark [2].

The Chicago Alliance for Equity in Computer Science (CAFÉCS) RPP seeks to address the challenges associated with providing every high school student in Chicago Public Schools (CPS) with a high-quality, introductory computer science education course [3]. CAFÉCS was established to provide CPS schools with the necessary supports to deliver equitable access to CS and hold them accountable for the quality of the program. Currently, CAFÉCS aims to empower at least 20,000 students annually with the foundational practices of CS.

Although this assessment of CAFÉCS took place during the first year that the team formalized into an RPP, it is important to note that the team had been collaborating for almost a decade. Because of this, this initial RPP assessment was designed to understand the history of CAFÉCS and document how and in what ways the partnership was operating as an RPP. This analysis contributes to the RPP literature by providing a case study of how the RPP framework can be adapted and used to inform partnership efforts in computer science education.

II. Origins of CAFÉCS

By 2007, declining college enrollments in computing subjects and consequent threats to economic security were being widely recognized as constituting a crisis [4]. At the SIGCSE '08 meeting, a number of computer science teachers at CPS and area universities came together to discuss problems they were seeing in their area and to begin taking concerted action. They noted that access to high school computer science courses was only through AP classes for the top students in the district or through the Information Technology track of the Career and Technical Education program available in a limited number of schools. The vast majority of CPS students had no access to computer science courses. Additionally, there were racial disparities among those CPS students taking the AP class, with a higher concentration of Asian and Caucasian students and a lower concentration of African-American and Hispanic students in comparison to the CPS population as a whole. These Chicago educators (including Don Yanek and Dale Reed) resolved to form a Chicago chapter of the Computer Science Teachers Association and to work together

The authors are supported in part by National Science Foundation grants CNS-1738572, CNS-1738776, CNS-1738691, CNS-1738515 DRL-1640215, CNS-1543217, and CNS-1542971.

978-1-7281-0821-6/19/$31.00 © 2019 IEEE

to improve access to computer science for all high school students in Chicago.

In parallel, computer science faculty members from Loyola University Chicago (Ronald Greenberg) and University of Illinois Chicago (Dale Reed) had been conducting high school outreach for their departments. With support from the National Science Foundation (and with educational researcher Steven McGee as the external evaluator), they conducted hundreds of classroom visits to area high schools to promote interest in college-level study of computer science [5]. These visits resulted in increased interest in computer science, regardless of race or gender, but many of these students lacked access to a computer science course in their high school.

Through an NSF PI meeting the following year, members of the informal Chicago working group learned about the Exploring Computer Science (ECS) curriculum developed jointly by Gail Chapman and Joanna Goode (and since updated a number of times) [6]. The ECS curriculum and professional development program was developed with the goal of broadening participation of women and minorities and increasing equity in the field of computer science [7]. The Chicago team felt that ECS would be valuable for broadening access to computer science in CPS, and in the summer of 2010, Reed and Yanek went to Los Angeles and participated in the ECS professional development program.

The following year, with an additional university faculty member at the lead (Lucia Dettori of DePaul University), further NSF funding was procured to adopt and adapt the ECS program for Chicago. During the 2012–2013 school year, CPS became the first district outside of Los Angeles to successfully implement ECS [8]. Particularly important to this effort was the identification of an internal CPS administrative champion (Brenda Wilkerson) heading the Information Technology Career and Technical Education track. Wilkerson (who has since transitioned to heading AnitaB.org) established the CPS Office of Computer Science, and pioneered the term CS4All which went on to be used nationally. The Office of Computer Science included Andrew Rasmussen as an early key member.

In 2016, CPS made computer science (CS) a high school graduation requirement (starting with students beginning high school in Fall 2016). ECS is the most widespread course through which students satisfy the requirement. Since 2012, 45,762 students have gone through the ECS course, 85 of 115 high school schools have begun offering ECS, and there are 181 active ECS teachers. Still, substantial work remains to ensure that every CPS high school graduate experiences a high-quality computer science course. The total high school population of CPS (the 3rd largest school district in the US) is 107,352 students, including 78% receiving free or reduced lunch, 18% English-language learner (ELL) students, 47% Hispanic, 37% African-American, 10.2% Caucasian, and 4% Asian.

The ongoing effort to provide every CPS student with a relevant and compelling CS experience, has benefited over the years through support from Code.org, Microsoft, The Chicago Mercantile Exchange Foundation, Apple, City of Chicago, Google, Social Works, and especially steadily from the National Science Foundation.

In 2017, key Chicago collaborators joined together to formally create CAFÉCS as an RPP under the NSF Computer Science for All Researcher Practitioner Partnerships program, with Erin Henrick as the external evaluator.

III. RPP Framework

The RPP effectiveness framework [2] is comprised of five broad dimensions of effectiveness that represent objectives shared across different types of RPPs. The first two dimensions pertain to the quality of the partnership. The first dimension focuses on the RPP goal of building trust and cultivating partnership relationships. The second dimension relates to the RPP goal of conducting rigorous research to inform action. Significant progress on these two dimensions appears to be critical if an RPP is to make progress on the remaining three dimensions, which pertain to the results achieved by the partnership. The third dimension concerns the RPP objective of supporting the partner practice organization in achieving its goals. The fourth dimension relates to the RPP goal of producing knowledge that can inform educational improvement efforts more broadly. Finally, the fifth dimension focuses on the RPP goal of building the capacity of participating researchers, practitioners, practice organizations, and research organizations to engage in partnership work. For each dimension there are indicators of progress that partnerships might use to assess their progress in accomplishing each objective.

IV. Methods

When designing an evaluation of a specific RPP it is important to take into account the goals of the RPP and the RPP's improvement plan (the hypothesized mechanisms or processes by which the intended improvements will be produced), as well as the purpose of the evaluation. The purpose of this initial assessment for CAFÉCS was to provide baseline data on each dimension of the RPP effectiveness framework for the CAFÉCS leadership team to use for improvement purposes. In addition, a secondary goal of this initial work was to inform the ongoing evaluation design by beginning to identify the indicators for each dimension of effectiveness that are relevant to CAFÉCS and to inform customization of the indicators in the effectiveness framework to the goals of CAFÉCS.

Because the initial assessment was intended to be formative in nature, the study design employs program-based evaluation design [9] and uses qualitative methods to synthesize information across multiple information sources in order to document progress along each dimension of the RPP framework.

A. Data sources

Evidence for each indicator was gleaned from the following data sources: written meeting logs of weekly leadership team meetings, one-hour audio-recorded interviews with leadership team members in November 2017, and monthly evaluator meetings between Erin Henrick (external evaluator) and Steven

McGee (educational researcher) that took place via video-conference between November and April to discuss further developments in the RPP after the initial November interviews. As a part of these evaluator meetings, Erin Henrick and Steven McGee also completed an RPPforCS health assessment that informed this analysis.

B. Interview protocol

The initial interview protocol was designed to gather baseline information about the CAFÉCS partnership, including the history of the partnership, the goals of the partnership, and anticipated challenges of the partnership. In addition, it aimed to document the different roles and organizational structures within the partnership, the types of activities within the partnership, and the different expertise individuals brought to the partnership. The protocol specifically asked about each of the RPP effectiveness dimensions, and asked interviewees whether or not each dimension reflected a goal for CAFÉCS. Finally, the interview aimed to better understand what kind of data would be useful to document partnership success, and to evaluate improvement over time.

V. Findings

1. Building trust and cultivating partnership relationships.

CAFÉCS is an established partnership between CPS, CS faculty from DePaul, Loyola, and University of Illinois Chicago, and education researchers from the Learning Partnership. The CAFÉCS Leadership team includes a diverse team of experts — computer science professors, educational researchers and CPS district leaders. There is significant evidence of trust and strong partnership relationships. When asked if it was a specific goal of CAFÉCS to build trust and cultivate partnership relationships, all members of the leadership team reported that it was a strength of the CAFÉCS team. There is significant evidence of strong working relationships between members of the leadership team, despite the fact that the partnership includes people from five institutions across Chicago. The leadership team meets weekly for an hour and a half, usually via video-conference, and has been meeting regularly for the last three years. Outside of the weekly meeting, smaller subgroups typically work on tasks and report out at the weekly meetings. In addition, the team members described spending time with one another socially and getting to know one another personally as well as professionally.

In addition to meeting regularly, findings indicate that CAFÉCS has shared partnership values. All interviewees reported a strong desire to impact CS education in Chicago, and this common goal fueled the desire to continue working together over time. In addition, there was also evidence of shared norms of working together. For example, all interviewees reported that collaborative decision making was a hallmark of the weekly meeting. One interviewee described the importance of shared partnership values when considering expanding the partnership to include new members.

Another highly important indicator of institutional trust is the relationship between CAFÉCS and the CPS Office of Research. The Office of Research reviews all research conducted in CPS. Approval for CAFÉCS to conduct research in CPS signifies the value that is placed on contributions that the research is making to CPS. In addition, the Office of Research has approved a data-sharing agreement with CAFÉCS. This approval is only granted to select partners that play a central role in CPS. CAFÉCS has already published several reports based on these data [10]–[15].

While this initial assessment clearly showed evidence of trust and deep partnership relationships, this dimension continues to be an important area of focus. Because of the growth of the partnership, the leadership team is working on hiring additional team members and reworking the organizational structure of CAFÉCS. In addition, team members' roles are changing within the partnership as new members join the team. These changes warrant continued focus on maintaining the CAFÉCS partnership ethos while growing and evolving.

2. Conducting rigorous research to inform action.

The Learning Partnership has structures in place to conduct research that informs action effectively. The Learning Partnership research advisory board is comprised of quantitative researchers and practitioners to balance rigor and feasibility. This initial assessment indicates that both rigor and feasibility inform research design. For example, these considerations impacted decisions related to research measures CAFÉCS decided to use (e.g., student CS assessments, attitude surveys).

Since becoming an RPP, CAFÉCS has conducted several analyses to inform action. Examples include analyses to understand the failure rate for ECS [11], and to better understand why teachers are not using the journaling component as part of the think-pair-share routine. CAFÉCS has several routines that support this objective. One strategy has been to ask CPS team members for hypotheses related to the problem of practice and then share findings and data representations at project meetings and through written reports and presentations.

3. Supporting the partner practice organization in achieving its goals.

How a partnership begins may impact how the partnership is organized to accomplish this goal. The CAFÉCS partnership began with the practice side of the partnership as the driver, rather than the research side of the partnership being the initial driver of the work. The interviews reflected this focus on supporting CPS in achieving its goals.

All members of the leadership team articulated that the primary goal of the CAFÉCS partnership is to support CPS in achieving its CS goals. Members of the RPP described wanting to help high schools implement high quality computer science as a graduation requirement by 2020 and support CS implementation across all grade levels. Other notable goals included supporting teachers who are new to the ECS curriculum, helping students understand how CS fits into their lives, creating supplemental materials and professional

development (PD) for ECS, and informing state policy for CS.

Interviewees reported wanting to achieve a variety of outcomes, most of which were geared towards supporting CPS to achieve its goals. Outcomes included: attainment of the 2020 graduation requirement, increase of staff to support CS implementation, increase in number of schools implementing CS at a high level, increase in the number of CS after school activities, decrease in teacher-reported frustration over CS, and an increase in the number of classrooms engaging in exciting, open discussions in CS classes.

All interviews indicated that the CAFÉCS partnership provided significant expertise and professional knowledge that informs decision-making and provides guidance across all areas of CS implementation in CPS. For example, CAFÉCS analyzed teacher survey data in order to make informed decisions related to changing the PD model. CAFÉCS supports partnership goals by immediately sharing relevant findings with the district (e.g., sharing at principal PD that the number of years a teacher has taught CS predicts learning outcomes [13]). Another example is the plan to create talking points to share with principals and schools related to the findings that attendance at ECS PD reduces the failure rate [11].

A focus of the upcoming work will be conducting cycles of identifying a problem of practice and systematically trying out and measuring the impact of solutions to the problem of practice. The partnership team identified the need to better leverage the expertise of practitioners by giving them a greater voice in clarifying the problems and proposing solutions.

4. Producing knowledge that can inform educational improvement efforts more broadly.

CAFÉCS is viewed as a pioneer in the CSforAll arena, and therefore is well positioned to impact the field in a variety of ways. CAFÉCS has written research publications and presents at both research and practitioner conferences. For example, recent publications focus on ECS effects on student attitudes and computational thinking skills [10], [12], [13] and build on earlier research [5], [14], [15]. Members of CAFÉCS have also shared their experiences at CS4All RPP workshops (e.g., [16], [17]) and have provided periodic updates to congressional representatives from local districts. CAFÉCS has developed and shared teacher and student surveys [18] and has contributed to the development of student assessments that can be used broadly in the field [19].

5. Building the capacity of participating researchers, practitioners, practice organizations, and research organizations to engage in partnership work.

There is significant evidence of partnership impact on organizational and individual capacity to engage in partnership work. The work is supported through grants and through the CPS operational budget, signifying the importance of the work. All of the team members have taken on new roles and responsibilities professionally because of this work. What began as CS outreach has now turned into supporting organizational change across the system. All leadership team members have engaged in research paper writing, presenting at conferences, and participating in evaluation advisory meetings. In addition, the new Office of Computer Science at CPS is designed to integrate the partnership work into the day-to-day operations.

In addition, team members from two universities reported increased appreciation from their institutions for partnership work. For example, CAFÉCS-related research work contributed towards the shift of one university faculty member from the lecturer faculty track, which involves only teaching, to the clinical faculty track, which involves both teaching and research. In addition, a university Dean was granted a modified leave to work in an official capacity within CPS.

VI. Next Steps

As described earlier, the purpose of this initial assessment for CAFÉCS was to provide baseline data on each dimension of the RPP effectiveness framework for the CAFÉCS leadership team to use for improvement purposes. In addition, a secondary goal of this initial work was to inform the ongoing evaluation design by beginning to identify the indicators for each dimension of effectiveness that are relevant to CAFÉCS, to inform customization of the indicators in the effectiveness framework to the goals and improvement plan of CAFÉCS.

Findings from the initial assessment were shared with the leadership team at a meeting in April 2018, which was audio-recorded and transcribed. Feedback on the initial draft was integrated into a final document shared with the leadership team during a team meeting to get feedback on whether or not the initial assessment resonated with the shared experience of the RPP team members. Members of the CAFÉCS team expressed value in this initial work, mainly because it provided an opportunity to think broadly about how the RPP was designing partnership work in order to achieve maximum positive results. This formative assessment will be used to design measures (both proximal and distal) that can be used to inform ongoing work within the partnership.

Based on the initial assessment, the leadership team decided to focus on several areas: 1)maintaining the ethos of the partnership while expanding to include additional research team members and additional members of the CPS CS office by holding monthly CAFÉCS meetings as well as adding quarterly strategic planning leadership retreats, 2) developing a dissemination plan for sharing findings within CPS, and 3) continuing to develop and prioritize a research agenda to provide CPS with data to support decision-making.

Using the RPP effectiveness framework for formative assessment purposes worked well for CAFÉCS, in part because the five dimensions aligned well with the goals and aspirations of CAFÉCS before it officially ”became” an RPP. Because the dimensions capture the goals that longstanding and well respected RPPs aspired to achieve, the framework gave CAFÉCS helpful guideposts to use when planning and organizing their collective efforts to accomplish the challenging and critical goal of providing quality CS education for all students in CPS.

References

[1] C. E. Coburn, W. R. Penuel, and K. E. Geil, "Research-practice partnerships: A strategy for leveraging research for educational improvement in school districts," A white paper prepared for the William T. Grant Foundation. http://rpp.wtgrantfoundation.org/library/uploads/2016/01/R-P-Partnerships-White-Paper-Jan-2013-Coburn-Penuel-Geil.pdf, Jan. 2013.

[2] E. C. Henrick, P. Cobb, W. R. Penuel, K. Jackson, and T. Clark, "Assessing research-practice partnerships: Five dimensions of effectiveness," William T. Grant Foundation. http://rpp.wtgrantfoundation.org/library/uploads/2017/10/Assessing-Research-Practice-Partnerships.pdf, Oct. 2017.

[3] L. Dettori, R. I. Greenberg, S. McGee, D. Reed, B. Wilkerson, and D. Yanek, "CS as a graduation requirement: Catalyst for systemic change," in *SIGCSE '18*. Association for Computing Machinery, 2018, pp. 406–407, https://doi.org/10.1145/3159450.3159646.

[4] L. B. Cassel, A. McGettrick, M. Guzdial, and E. Roberts, "The current crisis in computing: What are the real issues?" in *SIGCSE '07*, 2007, doi: 10.1145/1227310.1227426.

[5] S. McGee, R. I. Greenberg, D. F. Reed, and J. Duck, "Evaluation of the IMPACTS computer science presentations," *The Journal for Computing Teachers*, pp. 26–40, Summer 2013, International Society for Technology in Education, http://www.iste.org/resources/product?id=2853.

[6] J. Goode and G. Chapman, "Exploring Computer Science (version 8)," Retrieved October 1, 2018 from http://www.exploringcs.org/curriculum, 2018.

[7] J. Margolis, J. J. Ryoo, C. D. M. Sandoval, C. Lee, J. Goode, and G. Chapman, "Beyond access: Broadening participation in high school computer science," *ACM Inroads*, vol. 3, no. 4, pp. 72–78, Dec. 2012, doi: 10.1145/2381083.2381102.

[8] J. Margolis, G. Chapman, J. Goode, L. Dettori, and D. Lewis, "A tale of three ECS partnerships and why scalability $\neq$ sustainability," ECS Working Paper #1 http://www.exploringcs.org/wp-content/uploads/2014/04/A-Tale-of-Three-ECS-Partnerships.pdf, Nov. 2013.

[9] C. H. Weiss, "Theory-based evaluation: Past, present, and future," *New Directions for Evaluation*, vol. 1997, no. 76, pp. 41–55, Winter 1997, https://doi.org/10.1002/ev.1086.

[10] S. Mcgee, R. I. Greenberg, R. McGee-Tekula, J. Duck, A. M. Rassmussen, L. Dettori, and D. F. Reed, "An examination of the correlation of Exploring Computer Science course performance and the development of programming expertise," in *SIGCSE '19*. Association for Computing Machinery, 2019, to appear.

[11] S. McGee, R. Greenberg, L. Dettori, A. M. Rasmussen, R. McGee-Tekula, J. Duck, and E. Wheeler, "An examination of factors correlating with course failure in a high school computer science course," The Learning Partnership, Tech. Rep. 5, Aug. 2018, https://ecommons.luc.edu/cs_facpubs/205.

[12] S. McGee, R. McGee-Tekula, J. Duck, L. Dettori, D. Yanek, A. Rasmussen, R. I. Greenberg, and D. F. Reed, "Does Exploring Computer Science increase computer science enrollment?" in *American Educational Research Association (AERA) Annual Meeting*, Apr. 2018, https://www.academia.edu/36446926.

[13] S. McGee, R. McGee-Tekula, J. Duck, C. McGee, L. Dettori, R. I. Greenberg, E. Snow, D. Rutstein, D. Reed, B. Wilkerson, D. Yanek, A. M. Rasmussen, and D. Brylow, "Equal outcomes 4 all: A study of student learning in ECS," in *SIGCSE '18*. Association for Computing Machinery, 2018, pp. 50–55, https://doi.org/10.1145/3159450.3159529.

[14] S. McGee, R. McGee-Tekula, J. Duck, R. I. Greenberg, L. Dettori, D. F. Reed, B. Wilkerson, D. Yanek, A. M. Rasmussen, and G. Chapman, "Does a Taste of Computing increase computer science enrollment?" *Computing in Science & Engineering (Special Issue: Best of RESPECT 2016)*, vol. 19, no. 3, pp. 8–18, April 2017, https://doi.org/10.1109/MCSE.2017.50.

[15] L. Dettori, R. I. Greenberg, S. McGee, and D. Reed, "The impact of the Exploring Computer Science instructional model in Chicago Public Schools," *Computing in Science & Engineering (Special Issue: Best of RESPECT 2015)*, vol. 18, no. 2, pp. 10–17, March/April 2016, https://doi.org/10.1109/MCSE.2016.39.

[16] L. Dettori, D. Reed, S. McGee, D. Yanek, A. Rasmussen, and R. Greenberg, "History of CAFÉCS," National Science Foundation Computer Science For All Research-Practice Partnerships workshop, Mar. 2018, https://ecommons.luc.edu/cs_facpubs/196.

[17] B. Bevan, S. McGee, E. Henrick, and L. Dettori, "RPPs love 'em or leave 'em: Voices from the field," in *2019 Research in Equity and Sustained Participation in Engineering, Computing, and Technology (RESPECT)*, 2019, to appear.

[18] R. I. Greenberg and S. McGee, "ECS evaluation survey instruments," http://ecommons.luc.edu/cs_facpubs/93, Oct. 2014, Compilation of multiple surveys: ECS student preSurvey pp. 1–2, ECS student postSurvey pp. 3–4, teacher background survey pp. 5–11, teacher ECS workshop feedback form pp. 12–13, teacher ECS implementation survey pp. 14–24.

[19] SRI International and Principled Assessment of Computational Thinking (PACT), "Pact | resources," https://pact.sri.com/ecs-assessments.html, 2018, last accessed 12/1/2018.