

Leveraging Collective Impact to Promote Systemic Change in CS Education

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ABSTRACT

Collective impact is an approach for solving complex social problems at scale. The challenge of broadening participation in computing (BPC) is one such problem. The complexity of BPC is compounded by the decentralized nature of public education, where decisions are made primarily at the state level and subject to interpretation at the district level. As such, diversifying computer science (CS) pathways across the nation requires a systemic approach such as collective impact to engage all of the stakeholders who influence CS education and whose decisions can either facilitate or hinder BPC efforts. This experience report discusses how the collective impact framework has been used to advance the work of the Expanding Computing Education Pathways (ECEP) Alliance, an NSF funded BPC Alliance focused on states and state policy as the unit of change. We discuss how the five essential features of collective impact (common agenda, shared measurement, mutually reinforcing activities, continuous communication, and backbone support) coalesce to facilitate ECEP's theory of change. The report highlights specific policy changes that ECEP states have addressed to promote BPC, the flipped accountability that results from a non-hierarchical leadership model, and the challenges of measuring systemic changes as an intermediary to BPC.

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CCS CONCEPTS

• **Social and professional topics~Computing education** • **Social and professional topics~K-12 education** • **Social and professional topics~Race and ethnicity** • **Social and professional topics~Gender** • **Social and professional topics~Computing / technology policy**

KEYWORDS

Collective impact; equity; computer science education; broadening participation in computing

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1 Introduction

Since the 1970s, the National Science Foundation (NSF) has invested more money in STEM education than any other government agency [1]. For over 15 years, broadening participation in computing (BPC) has been a goal of NSF's Computer and Information Science and Engineering (CISE) Directorate in response to the lack of diversity in computing graduates and the computing profession [2]. NSF programs such as CS10K, STEM+C, CSforAll: Research and RPPs, RPPforCS, and the BPC Alliances have all tackled inclusion at various levels of computing education including K-12, undergraduate, and graduate programs; all with the goal of increasing access, participation, and persistence in computing by students historically underrepresented in the field. Underrepresented populations in

computer science (CS) are defined by NSF as women, ethnic minorities (African Americans/Blacks, Hispanic Americans, American Indians, Alaska Natives, Native Hawaiians, and Native Pacific Islanders), persons from economically disadvantaged backgrounds, and persons with disabilities [3]. More recently, students from rural communities have also been recognized as underserved in CS education. The BPC Alliance program, established initially in 2006, was created specifically to “increase the number and diversity of college graduates in computing and computationally-intensive disciplines” [4]. BPC Alliances have a unique focus on multi-sector collaborations that advocate for increased access, inclusion and engagement of all students in computing. This networked approach to solving what is essentially a social and cultural challenge, rather than a technical challenge, requires an organizational framework that is specifically designed to address complex social problems at scale. This experience report will discuss how one BPC Alliance, the Expanding Computing Education Pathways (ECEP) Alliance, has leveraged the collective impact model to address BPC and share lessons learned from the collective impact approach that could be applicable to others also working to increase equity and inclusion at scale in K-20 computing education.

2 Background

Collective impact is a model for addressing complex social change at scale [5]. It is designed to facilitate systems change, rather than focusing on targeted interventions toward one or two components of a system. Because the challenges of uncovering, understanding, and addressing the systemic barriers that have contributed to the inequitable outcomes we see in computing education, collective impact is particularly well suited to ECEP, which is focused on systems change at the state level.

When the BPC Alliance program was launched there were 11 funded alliances working to address the lack of diversity at multiple levels of computing from K-12 to higher education and industry. Each Alliance focused on a specific underrepresented group or theme within broadening participation that served to direct their effort. Within 5 years of the BPC launch, project evaluations were showing a direct impact on systems, national network engagement, and a new structure for connecting change agents [6]. ECEP’s work began when two of the original Alliances working on state level education reform combined their projects with the goal of scaling to additional states. In many ways this project growth was a natural extension for projects specifically focused on state reforms.

As ECEP has expanded from 2 states to 7 states to 17 states and finally to 22 states and the territory of Puerto Rico, the mission and goals have continuously adapted to address the most pressing issues in CS education pathways through state level advocacy and policy efforts. ECEP functions as a connector, a resource broker, a resource creator and a guiding collaborator. While the leaders who serve in the backbone role provide overall structure and resources, it is ECEP as a whole that works to address BPC. The backbone can only function with all of the

knowledge, resources and strategies being developed, tested and shared at the state level and across the ECEP Alliance.

The other Alliances also support and engage with the work of ECEP, forming an ecosystem of BPC tools and resources. The National Center for Women & Information Technology, the STARS Alliance, and AccessComputing have each served as partners on projects, providing specific areas of expertise to the ECEP Alliance.

2.1 ECEP’s 5-Stage Model of Change

Building a high-functioning collective impact model that engages all levels of stakeholders requires finding common methods to ensure that the mission and vision of the community remains constant. ECEP’s 5-stage model of change (fig. 1) acts as a guide from which state leaders develop state-specific solutions to BPC, while providing a common language across the community of projects and state leaders. The 5-stage model is simultaneously a top-down model, having been developed by the backbone leaders and shared across the member states, and a bottom-up model, in that it allows for states to adjust and adapt the model to suit the unique BPC strategies required to make change in their state.

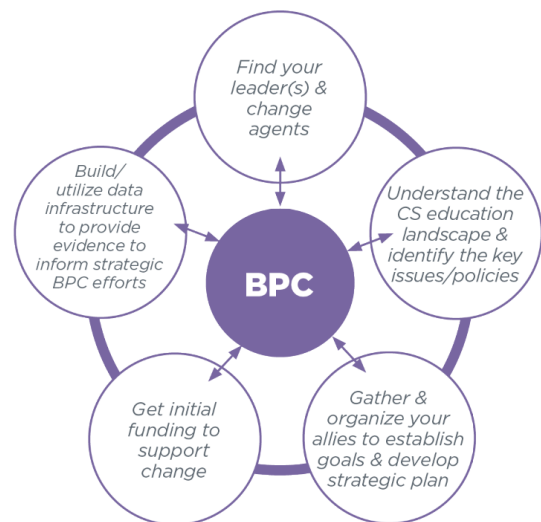


Figure 1: ECEP’s 5-Stage Model of Change

3 Results: Applying Collective Impact to ECEP

ECEP’s theory of change is predicated on leveraging the structures and resources of collective impact at both the Alliance-wide and state levels to broaden participation in CS. ECEP supports the work of diverse intra-state leadership teams focused on BPC and connects state teams to each other to facilitate inter-state collaboration. The work of state teams leads to outputs such as data systems improvements to identify BPC gaps and track BPC outcomes, the creation of strategic plans for BPC, and enactment of policy changes that address systemic barriers to BPC. The eventual outcome of this work is increased participation of marginalized students in computing pathways. The

comprehensive, multi-sector approach employed by ECEP goes beyond merely collaboration or networking. Collective impact organizations exhibit five core conditions for success: a common agenda, shared measurement systems, continuous communication, mutually reinforcing activities, and a backbone organization that coordinates all of these efforts [5]. The following sections outline how ECEP reflects these five conditions and applies them to the shared vision of broadening participation in computing.

3.1 Common Agenda

ECEP's theory of change is predicated on leveraging the structures and resources of collective impact at both the Alliance-wide and state levels to broaden participation in CS. ECEP supports the work of diverse intra-state leadership teams focused on BPC and connects state teams to each other to facilitate inter-state collaboration. The work of state teams leads to outputs such as data systems improvements to identify BPC gaps and track BPC outcomes, the creation of strategic plans for BPC, and enactment of policy changes that address systemic barriers to BPC. The eventual outcome of this work is increased participation of marginalized students in computing pathways. The comprehensive, multi-sector approach employed by ECEP goes beyond merely collaboration or networking. Collective impact organizations exhibit five core conditions for success: a common agenda, shared measurement systems, continuous communication, mutually reinforcing activities, and a backbone organization that coordinates all of these efforts. The following sections outline how ECEP reflects these five conditions and applies them to the shared vision of broadening participation in computing.

ECEP state leaders report that the consistent focus on keeping BPC front and center as states expand CS education, advocacy and policy efforts is vital to centering their work around equity. These results align with the findings of Kania & Kramer (2015).

"If participants in collective impact initiatives are to make the lasting change they seek, they must pay explicit attention to policies, practices, and culture that are reinforcing patterns of inequity in the community. They must develop targeted strategies that specifically and differentially take into account any underlying advantages that some people have, as well as the disadvantages that other groups face. And throughout every aspect of the collective impact process, they must bring to the table those whose lives are affected by the results of the work. Without vigilant attention to equity, efforts to align and coordinate resources can inadvertently reinforce institutional patterns that promote disparities and constrain progress for our most vulnerable community members" [7]

Specific examples of how the ECEP common agenda around BPC influenced state actions include Arkansas where the Department of Education has employed ECEP resources to continually assess their CS education initiative and ensure that it aligns with principles of BPC and Rhode Island where the CS4RI

team reported an increased focus on BPC tools introduced by ECEP, including the CAPE framework.

3.2 Continuous Communication

A successful collective impact model relies on continuous communication in order to facilitate learning both vertically from ECEP leadership to individuals/institutions and horizontally between partner organizations. Continuous communication in the form of monthly virtual meetings, email, and an open 'virtual door' policy are features of ECEP and have been reported to be a highly valuable aspect of Alliance membership. According to the 2019 ECEP Community Survey, annually facilitated by our external evaluator, when state leaders were asked to rank the services and resources offered by ECEP, five of the top six selections were focused on communication.

The monthly virtual meetings are open to all state leaders and follow an agenda that offers guest presenters time to share relevant resources. Time is also allocated to state leaders to share highlights of their initiatives, advocacy priorities, data collection/analysis efforts, and challenges. These presentations give an opportunity for states to learn from each other and provide feedback or additional resources that could overcome the challenges. State status reports focus on six key questions:

1. What are your state's specific BPC goals?
2. What underserved group is the primary target population for BPC in your state and what data have you used to identify the needs of that population?
3. What metrics is your state planning to use to track BPC progress?
4. What state policies are you focused on to support BPC?
5. How are you defining "what counts" as CS in your state?
6. What other challenges are you facing in establishing and tracking state BPC goals and metrics?

Speakers with external expertise on topics such as Career & Technology Education (CTE), equity in CS research, and policy advocacy are invited to monthly meetings to address ongoing research projects for the ECEP members, such as documenting CS teacher certification pathways in every state. Additionally, the ECEP Annual Convening has been held in collaboration with events spearheaded by other national organizations focused on equity in CS education, CSforALL Summit and CSEdCon, so that ECEP state leaders can learn from and contribute to the broader CSed community at large.

Monthly ECEP calls provide a space for state leaders to connect and learn. Agendas include state updates, which often surface new ideas and allow for sharing of best practices. Calls also allow for the maintenance of connections, collaborations and relationships that have formed within ECEP. It is this social network that allows a national network of leaders to continuously engage, test new ideas and share strategies. The monthly calls also create a space for accountability, as do on-going coaching sessions. Without consistent redirection towards equity-focused work and

measurement systems, the pursuit of BPC easily becomes a discussion about access alone.

3.3 Mutually Reinforcing Activities

Collective impact is built by leveraging stakeholders who each bring different perspectives and assets to the table to advance the goals of the organization. In ECEP, CS education researchers work in partnership with state departments of education and K-12 experts to collect and analyze data about access and participation of various student populations in CS. Experts in teacher certification and professional development partner with CS content experts to develop viable pathways to build teacher capacity and authorization to teach CS, thus increasing the capacity to serve students who have historically been denied the opportunity to take CS courses. Individuals with policy expertise and industry experience use their legislative advocacy skills to help ECEP teams to identify and advocate for policy solutions that can address the disparities that CS landscape reports reveal. Finally, K-12 educators themselves ground the work of all partners and help both advocate for CS for all students in K-12 schools as well as provide instruction in CS that will close opportunity gaps for historically underserved students. All of these entities work together in ECEP states to change policies and practices at multiple levels of the CS education system. Activities such as developing CS Landscape Reports, coordinating CS Summits, convening CS Task Forces, developing Strategic Plans for CS, and designing Data Systems that can track progress toward BPC outcomes require broad and diverse teams which coordinate their efforts strategically for success.

Mutually reinforcing activities are supported by ECEP grant funding and by leveraging the expertise and resources of state teams from across the network. Two examples of how state activities have been influenced by ECEP include:

- California: This team received an ECEP co-sponsorship to support the implementation of their CS Equity Guide, as well as key pieces of feedback from other state teams.
- Alabama: Illustrating the vast web of connections that ECEP membership brings, this team invited leaders from Arkansas and Virginia to their first statewide CS education summit. These leaders served as panelists, sharing the BPC coordination efforts in their states, and with ECEP leadership, co-led a strategic planning session.

Mutually reinforcing activities also include numerous strategies, policy changes, and institutional reforms that have been developed and implemented in ECEP states to address the systemic barriers that have made inequities in CS education so persistent. Examples include:

- Development of state standards for CS courses to provide consistency and quality assurance for teachers, administrators, students, and parents. State standards aligned to course codes reduce the likelihood that historically marginalized students will take a course that is deemed CS in name only and provide structure for new or inexperienced CS teachers who are more likely to work in schools serving larger numbers of low income or minority students.

- Rubrics for evaluating professional development or curriculum to ensure they address equity in CS along with state funding for curriculum training (like ECS or AP CS Principles) that has equity at its core.
- Creation or modification of CS teacher preparation and certification pathways to provide quality assurance and build the capacity of new teachers.
 - State policy that every school must offer CS coursework.
 - Funding models that institutionalize support for CS education in K-12 schools.
- Deeper examination of state data tracking systems to ensure CS enrollment is disaggregated by subpopulation and can be made public.
- State CS Strategic Plans and Task Force Reports that specifically call out equity and diversity goals.

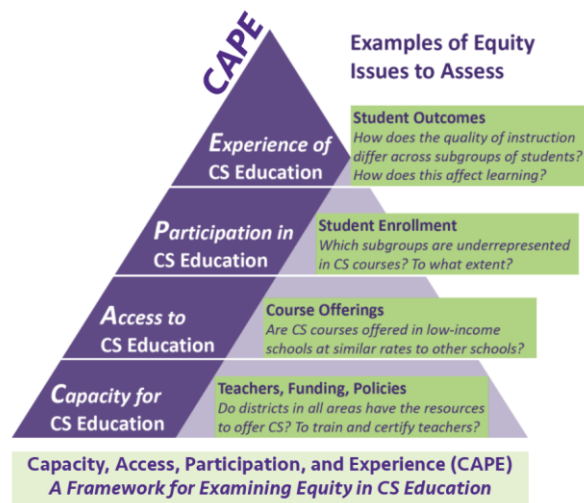


Figure 2: CAPE Framework

3.4 Shared Measurement Systems

When all partners in ECEP are contributing to a collective goal, measurement systems for assessing progress toward that goal must also be aligned. Using consistent measures of progress facilitates assessment toward progress at both a local or regional level as well as at an aggregate level. ECEP is tackling this challenge by using the CAPE Framework (fig. 2) to help state leadership teams focus their interventions and measurement on a set of consistent outcomes related to equity in CS: Capacity for Equitable CS, Access to Equitable CS, Participation in Equitable CS, and Experiences of Equitable CS [8]. While this is still a work in progress, each ECEP state is developing metrics and systems to measure CS education at these four levels in a consistent and scalable manner.

One example of how ECEP has facilitated shared measurement systems occurred when the Texas team shared their state and regional CS Profiles. These one page documents, updated annually, focus on state and regional trends in CS teacher capacity (tracking the number of CS certified teachers), access (tracking the percentage of high schools that offer CS courses), participation

(tracking student completion of CS courses by sub population) and experience (tracking student passing rates for CS courses by subpopulation). After this was shared, other states such as Georgia and Virginia began working on similar dashboard-type tools to measure equity and disparities across their states. This conversation has continued with additional states working together to explore technical tools for creating similar data visualization tools.

Capitalizing on interest from other states, ECEP applied for and received a supplemental grant to work with the six New England states on a common metrics project. The goal of working with a small group of states was to develop and test an effective system for building common measures with the aim of future national scaling. This project has already shown modest success, due in a large part to the collective impact model and pre-existing backbone structure of ECEP.

3.5 Backbone Organization

Collective impact projects require a dedicated group of individuals to coordinate the work, support the communications infrastructure, and lead organization-wide data collection and reporting. ECEP as a backbone organization serves as a knowledge broker connecting state leaders with specific needs to others within and outside the network through an Experts Bureau, manages co-sponsorship applications from ECEP states to provide seed funding for activities such as landscape reports and summits, and provides coaching and support to build the capacity of state leadership teams in all aspects of their work toward equitable CS educational opportunities and outcomes.

Because ECEP formed when efforts in two states were combined, significant time and effort has been put into a distributed content management system. The combination of shared digital resources and continuous communication allows ECEP to coordinate activities that drive BPC efforts and sustain the community. ECEP hosts a public facing website, an internal collaboration site and two digital filing systems, one housing all digital resources and accessible by all ECEP members, the other housing all administrative and strategic program documents, accessible only to the leadership team. The collaboration site serves as a project repository, with all resources and materials relevant to the mission and vision of ECEP. The site also contains links to programs, projects and research that ECEP state leaders can access for their on-going work. ECEP state leaders are invited to upload and share resources they create, or that they have found useful. Curating these resources is a vital contribution of the backbone organization.

4 Discussion

Our experience indicates that applying a collective impact approach to the complex problem of BPC can lead to the systemic changes that are needed to make scalable improvements for students in the K-12 CS education pipeline. Collective impact requires a paradigm shift for how research projects are coordinated and an adjustment in the types of outcome data that

are most reflective of success. ECEP continues to grapple with these shifts as we seek to address the complexities of achieving BPC.

4.1 Flipping Accountability for ECEP Partners

By its very nature, collective impact is a non-hierarchical organizing model for change. In ECEP, state team participation is primarily voluntary and uncompensated. State leadership involvement is predicated on commitment to the common agenda and finding value in engaging in the activities of the network that they believe advance their own local goals and mission as well as those of the ECEP. As a result, accountability is flipped to some degree as compared to a traditional model in which a prime entity holds the various network members accountable for actions and outcomes. In contrast, the ECEP members collectively hold the backbone organization and other members accountable for producing value for their participation. One benefit of this flipped accountability is that it continuously grounds the work of ECEP in the practical needs of its membership. It also opens up greater opportunity for distributed leadership from numerous diverse partners who may not be official PIs or Senior Personnel but who are making significant contributions to the organizational learning around BPC by sharing their own initiatives and experiences. One measure of accountability is the authentic and continuous engagement of state leaders in the ECEP and their consistent willingness to contribute to tackling shared challenges as a network. On average 45 individuals from the 23 ECEP teams participate each month in virtual meetings and every single team has either shared resources, strategies, or state highlights over the past two years. The active participation and contributions of state teams in ECEP indicates that flipped accountability is effective and has resulted in authentic participation and value add for the majority of members.

One drawback to this distributed leadership model is that voluntary participation, even when coupled with a clear commitment to the common agenda, can make it difficult to move partners forward when they have competing priorities for their time which are tied to other specific funded projects. One way ECEP has evolved to address this tension is to develop a more formal application for membership for new states and a memorandum of understanding outlining what is required for state team commitment. Both of these have proven useful for clearly defining the contributions that members of the ECEP are asked to make. As ECEP continues to mature, we are also developing a more robust Executive Committee, made up of state leaders as well as external advisors, to elevate more diverse voices through a formal feedback structure and to distribute opportunities for leading initiatives of ECEP beyond PIs.

4.2 Measuring Systemic Change

One of the biggest challenges to the systems change work in which ECEP is engaged is that of measuring consistent network-wide outcomes. The systems change work that is needed to ensure historically marginalized students have access to, participate in, and have positive learning experiences of CS education is not

amenable to simple quantitative measures. While the ultimate goal of ECEP is to diversify the computing education pathways, the systemic change that will serve as the lever for those improved outcomes must be in place to scale efforts beyond grant funded teacher professional development projects or interventions with individual districts. In addition, public education policy is largely determined by state and local entities. This is even more true with the recent elevation of CS education as a formal component of state or district policies in many ECEP states. With 22 states and the territory of Puerto Rico actively participating in the ECEP community, the variety of topics to address, including educational policy, funding levers, state vs. local authority, and CS specific policies is enormous. States have struggled with questions such as a) what counts as a CS course? b) what does it mean to be a qualified or certified CS teacher? c) what counts as a high school? (necessary for determining the percentage of high schools that offer access to CS), and d) how do we measure access and participation for marginalized populations if our state doesn't collect disaggregated data on enrollment?

States are at very different stages in their ability to collect the type of disaggregated data necessary to measure BPC outcomes. Helping states to make the systemic changes necessary to facilitate and measure BPC in the long run has thus been a goal of the ECEP. For example, in states where no state standards existed to define what constitutes a CS course, it was extremely difficult to determine if the specific experiences students were having in courses was truly focused on CS and computational thinking, versus generalized technology literacy. This impacts BPC efforts because without the consensus that course standards provide, the potential for historically marginalized students to experience less rigorous technology courses simply branded as CS is high. As such, before collecting data on diversity of access and participation in CS courses, several ECEP states have invested considerable time and energy into developing new state policy around CS standards, consistent course codes, and other policy level changes that lay the foundation for measuring BPC outcomes.

While this variety can prove challenging to aggregate outcome measures across ECEP and demonstrate gains in BPC outcomes which often take several years to materialize as a result of policy change, we have found that the benefit of struggling to address these questions together as a collective impact organization has

been tremendously valuable to our state teams. The New England CS Metrics project is one example where the ECEP was able to test and incubate a model for addressing these challenges regionally that is now being shared across the entire ECEP Alliance.

5 Conclusion

There are no simple solutions to BPC. If we hope to institutionalize the gains we are making while there is political will from policy makers and support from industry advocates, we must address the structural barriers and challenges that have made large scale access to and participation in computing education an impossibility for millions of historically marginalized students in American schools for decades. The collective impact model, when applied to BPC Alliances such as ECEP, has shown promise as a framework for coordinating the systemic change that is necessary to dismantle structural barriers to CS education and create new on-ramps to CS pathways for all students.

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