Through the Looking Glass: Computer Science Education and the Unintended Consequences of Broadening Participation Policy Efforts

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***Abstract*—This experience report provides insights into the unintended consequences of five states efforts to make computer science education policy changes in an effort to broaden participation in computing (BPC). At the 2019 Expanding Computing Education Pathways (ECEP) meeting, several member-states were invited to share about the unintended consequences of computer science education policy reform in their states. Due to the nature of policy making and implementation, marginalized communities including students, practitioners, and under resourced schools are most impacted by education policy reform efforts. As computer science education gains traction as an education policy priority in states and districts, it is important to learn the lessons of past education policy failures and successes, specifically how these policies could trigger unintended consequences that will impact the broadening of participation within K-12 computer science education. The examples put forth by the states include unintended consequences of policies such as making CS count as a graduation requirement, defining computer science, developing CS standards, and teacher certification. These experienced unintended consequences may be relevant to other states seeking to make CS policy changes. This paper concludes with a reflection on the ECEP model as a tool for mitigating these unintended consequences as part of the BPC efforts.**

Keywords—broadening participation; policy; experience report

I. Introduction

The Expanding Computing Education Pathways (ECEP) is an alliance network of states focused on equity in computer (CS) education. Funded by the National Science Foundation since 2012, ECEP has grown from an initiative serving 2 states, to a network of state teams, local stakeholders, and national partners collaborating on systemic CS educational reform. Based on these collaborative efforts, we identified a model for state change. The model was intended to serve as a framework for advancing BPC goals within a state. State leaders build strategic, data driven, efforts furthering CS educational reform utilizing the model as a framework. The ECEP model for state change utilizes 5 key concepts: (1) Identify a diverse set of stakeholders, (2) Understand the landscape, (3) Organize stakeholders, (4) Seek funding, and (5) Develop an infrastructure and process to monitor BPC progress. The model is intended to scaffold state education reform and advocacy efforts while maintaining a BPC focus

Any policy effort designed to make wide scale change is complex and may result in unintended consequences (e.g., Lubienski, 2005). This seems even more prevalent in CS education policy reform efforts, potentially due to the multifaceted and novel nature of the work (Ericson, Adrion, Fall, & Guzdial, 2016). CS education advocates are attempting to build pathways to CS education for what the National Science Foundation has described as the missing 70%. This missing 70% refers to the percent of women, African Americans/Blacks, Hispanic Americans, American Indians, Alaska Natives, Native Hawaiians, Native Pacific Islanders, and persons from economically disadvantaged backgrounds, and persons with disabilities who are not currently enrolling in and being retained in K-20 CS education (Kurose, 2017) ECEP states often have similar focus areas within the model yielding lessons learned about making systemic change within their states.

Often, American education policy is created by stakeholders who are not responsible for implementing the broad policy changes that usually go beyond their original intent (e.g., Madsen, 2002). Legislation that is aimed at addressing one issue in society may have effects or unintended consequences elsewhere that dampen or even reverse the gains the policy sought to acquire in the first place. These unintended consequences of policy (both positive and negative) have been found at all levels of educational policy: federal, state, and local (Brady, Duffy, Hazelkorn, & Bucholz, 2014). Unintended consequences are the result of policies created at every level of the educational system, leading to practices, actions, beliefs that were inadvertent and caused more unforeseen issues. For example, zero tolerance policies were implemented over the past thirty years in an effort to curb the perceived increase in violence and discipline infractions in schools. This zero tolerance policies have shown to have had a negative impact on Black girls (Lindsey, 2018), lead to the proliferation of the school-to-prison pipeline (Love, 2016), and have not made our schools any safer (Martinez, 2009).

Frequently, stakeholders charged with proposing, writing, or passing the policy or law do not consider what the unintended consequences of a policy may be, even though the power of unintended consequences has been well documented (Ganapati & Frank, 2008). However, working through all the possible outcomes of a given policy or law can be an impossible task for stakeholders who usually operate within constrained timeframes, pressure from relevant constituents, the influence of money, or not being able to fund a proposed policy or law (Hyatt & Filler, 2011). Due to the nature of policy making and

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implementation, marginalized communities and students, practitioners, and under resourced schools are most impacted by unintended consequences in education (Stechter et al, 2001). As CS education gains traction as an education priority, it is important to learn the lessons of past policy failures and successes, specifically how these policies relate to unintended consequences that will impact the broadening of participation CS education.

In September 2019 ECEP members gathered for an annual summit in which state teams had the opportunity to share the unintended consequences of local CS education policy efforts. This report highlights a collection of state stories that serve as a cautionary tale for other state leadership teams currently engaged in CS education reform efforts. These stories are designed to create a roadmap by defining the policy, highlighting what happened when the policy was implemented, what lessons were learned when obstacles appeared in the implementation phase, and how leaders may have mitigated these problems prior to the policy being adopted.

II. Lessons Learned

A. California

California and its CSforCA campaign has long been advocating for CS to "count" toward college eligibility in its higher education system. Research has demonstrated that when CS "counts" toward high school graduation and college eligibility, students are more incentivized to take it and prioritize CS in their already demanding high school schedules. When the CalState university system announced a proposal to increase the quantitative reasoning requirement from three to four years, and accept CS toward the additional quantitative reasoning requirement, it seemed like a "win" for our multi-stakeholder coalition.

However, as the CSforCA coalition's equity advocate partners discussed the possible unintended consequences, we learned that the proposed change could disproportionately decrease eligibility for African American, Latinx, and low-income students, who currently lack access to advanced level CS courses in their high schools. Moreover, since these students have historically struggled to meet university admissions standards because they often attend under-resourced schools that don't offer access to these courses, this change is seen as further disadvantaging students in an existing unequal system of education. The CSforCA coalition is working closely with equity advocates to develop an implementation timeline that would increase expectations and opportunities for all students, while ensuring a solid infrastructure is in place to so that all students have equal access to high quality and advanced level instruction, while also having the scaffolding in place to be successful in a college-preparatory pathway.

We learned that equity in CS must mean being an advocate for equity in education overall. It is necessary for CS education advocates to explore unintended consequences of well-intentioned policy proposals and recognize that we are operating in an existing unequal system of education. It is our collective responsibility to use CS education as an opportunity to disrupt these inequalities, rather than contribute to them.

B. Utah

Prior to 2013, Utah had a Computer Technology graduation requirement, which could only be fulfilled by a basic computer literacy course. When Exploring Computer Science (ECS) was introduced as an alternative method for completing this graduation requirement, the number of Utah high school students enrolled in CS courses grew dramatically. In 2016, the Utah Board of Education responded to this success by replacing the "Computer Technology" graduation requirement with an updated "Digital Studies" graduation requirement. Six courses were accepted for this graduation requirement, including ECS three other CS courses, and two business courses. On paper, this policy change appeared to be a win, with more advanced CS offerings that might appeal to students with some programming backgrounds.

In practice, Utah has seen a drop in CS enrollments since this policy change has been enacted. Allowing for more CS courses to fulfill this graduation requirement has not led to more CS section offerings at local schools, perhaps because most Utah schools do not have more than one CS teacher. Furthermore, the more advanced CS courses often require a higher level of CS endorsement. The school's one CS teacher may not yet be endorsed to teach anything beyond ECS. In contrast, the business teachers who used to teach "Computer Technology" were already endorsed to teach the two more advanced business courses. The Utah ECEP team has heard anecdotal stories of students who have expressed an interest in enrolling in CS classes being registered in business classes instead, with only those students with vocal parents as advocates being enrolled in CS classes. To identify struggling schools and the underlying causes for lower CS enrollments, the Utah ECEP team is conducting a report on enrollment trends by schools and districts. We are also working on a CS for Utah campaign to help administrators, guidance counselors, teachers, parents and students better understand the value of CS for all students.

C. Georgia

In 2015, the GA governor created a task force on computing education that resulted in the expansion of high school course offerings and the creation of a position dedicated to CS at the DOE. In addition, the State Board of Ed approved certain courses to count for graduation credit (science, math, and foreign language). Since then, attention around the state has been focused on CS teacher professional development. Private, non-profit, and government organizations, working in concert under the umbrella of CS4GA, offered a plethora of diverse CS professional development (PD) opportunities. In 2016, the Georgia Professional Standards Commission required that CS be taught by a teacher with an approved credential (an add-on certification for in-service teachers or an endorsement). The CS teachers, many of whom lacked this credential, protested and the credential requirement date was pushed back two consecutive years and is now being enacted in 2019. Due to poor communications and test burdens, the state lost some CS teachers when they left CS for their prior field of instruction. Many CS teachers that were near retirement described being unmotivated to take the required CS test to obtain the credential. Recently the professional standards commission agreed to allow teachers with other certifications (Business, Math, Engineering, Science) to teach the Middle School Courses until the legislation is fully enacted in 2025 and districts had enough time to train their teachers.

Support for CS continued to grow with legislative commitments to teacher training, equipment purchases, and curriculum development. In 2019, Senate Bill 108 was passed nearly unanimously to require all high schools and middle schools to offer CS by 2025. This bill was accompanied by an appropriation of $750,000, with 85% dedicated to teacher training. These requirements brought out the question "What counts as CS?." The State Council which is made up of 30% industry, 30% higher ed, as well as government and K-12 representatives, lacked consensus over what counted as CS. For example, the programming courses were voted in by an easy majority, but cyber security, IT support, Web Design, and Networking were a mixed result. Despite having defined what CS is as a state when we created our K-8 standards, our definitions of what constitutes CS remains amorphous. Without a clear definition, it is difficult to identify what needs to be covered in a certification process. CS is more than programming, as once was the case, and includes foundational knowledge, awareness, and skills like digital citizenship and computational thinking. Expanding the understanding of what constitutes CS is currently underway in Georgia.

D. Indiana

One example of an unintended consequence in Indiana of CS education policy and implementation is the passage of the 2018, Senate Bill 172. The bill included one policy that by 2021, all high schools will be required to offer at least 1 CS class. Rural school districts in particular report difficulties associated with offering CS at the high school level with their limited teaching staff. By 2018-2019, approximately 50% of public high schools had students who completed a CS course and only 14 counties still had no students that completed a CS course during that school year. Although we are seeing an upward trend, smaller school districts have expressed the difficulties in offering so many required diverse courses, and have attempted to come up with solutions to address this problem through online courses and shared career center courses. The Executive Director of The Indiana Small and Rural Schools Association stated that "We acknowledge that larger school districts can offer more diverse course offerings...The logistics of transporting either students or teachers...will take time and extra support. It is tough to add an advanced course in one district without adding enough students to fill the course from both systems" (Lagoni, 2017).

Although the Indiana Department of Education has been working to support school districts to achieve these instantiations, there is still little known about how this policy will be enforced. Many partners throughout Indiana are working hard to support rural and small schools. Through summit meetings, we have been able to host sessions directly related to providing PD support for K-8 teachers and focusing on supporting rural schools. Also, due to landscape reporting, we have been able to identify which districts do not have any students who have completed a CS course yet. Therefore, we have been able to target those specific school districts and work with them to offer CS.

E. Virginia

In 2016, Virginia law mandated CS standards for all students be integrated into K-8 classrooms, and also created mandatory standards for four standalone elective courses at the middle and high school level. Prior to the clarity provided by the General Assembly through the funding allocation, CodeVA was largely viewed by the Virginia Board of Education (VDOE) as a vendor, rather than a partner. The initial independence of CodeVA afforded Virginia with some very significant advantages. CodeVA's independent advocacy led to all of Virginia's early adoption of CS policy and legislation. However, the lack of a defined relationship and partnership wasted time. For example, although the VDOE adopted Virginia's CS standards in November of 2017, it was not until early summer 2019 that the VDOE assigned course codes to those classes, allowing school divisions to officially offer the classes.

Heading into summer 2019, CodeVA offered its free, state-funded summer professional development institutes with heavily enrolled sessions. Yet there was unexpectedly low PD attendance for high school level courses. Many of the classes had been cancelled by their school divisions at the last minute. The issue turned out to be related to Carl D. Perkins Career and Technical Education grant funding restrictions. The VDOE had issued CS elective course codes, but had not assigned CTE Virginia's Educational Resource System Online codes. Thus, division grant compliance officers flagged these classes as problematic, and due to the problematic flagging, divisions simply cancelled the courses. In many cases, these classes still could have been offered by the school division had they known to contact CodeVA for advice on alternative course codes. The same CTE course that many Virginia divisions had used since CodeVA began its work would have satisfied the Perkins funding requirements until the following year when the VDOE could have worked out the problem. The VDOE is now working on planning to assist in clarifying and in developing implementation plans for divisions.

III. Discussion

Engaging a diverse group of stakeholders is an essential component of making educational policy change at the state level in an effort to minimize the unintended consequences on students, teachers, district leaders, and industry. The ECEP framework can be used by any state to mitigate the potential for unintended consequences, especially as they relate to BPC:

1) Build a diverse leadership structure.. Having a leadership team that represents a diverse set of voices ensures that all students, teachers, district leadership, and other stakeholders in computing education are considered when advocating for policy reform. If specific stakeholders are not at the decision making table advocating for their systems and specific needs, policy can create unnecessary burdens, deepening the inequities in CS. ECEP recommends that states include stakeholders from departments of education, government offices, business and industry, K-12, higher education, community groups, national CS education and advocacy groups, non-profit organizations, informal education, students and parents. Demographic diversity should be a priority in leadership development to ensure a focus on BPC. For example, Georgia's case study showcased the importance of having more voices involved making decisions that could have predicted the unintended consequence of requiring current teachers to obtain certification.

2) Understand the data landscape. Using available state and national data to create a landscape report is critical for informing decision making and policy design. Policy development based on strong data allows for strategic planning, potentially alleviating the possibility for unintended consequences down the road. For example, Indiana used student enrollment data to focus efforts on rural schools that needed more training and support.

3) Organizing stakeholders. Developing and promoting a shared purpose and message of BPC when championing change efforts provides an opportunity to reach out to other vested communities such as literacy, math, informal education, and/or non-profits. By broadening the equity message, BPC efforts gain support while protecting against ripple effects that may negatively affect other communities and aligned initiatives. In Virginia's example, if VDOE had involved CodeVA in earlier conversations as a partner, there could have been a continutation or increase, of, CS growth

4) Work towards sustainability. Seek funding to develop an infrastructure that allows for BPC to remain at the heart of any CS educational process. A strong, well-funded infrastructure can help multiple groups align goals, organize technical assistance and PD with an equity focus and monitor the landscape, allowing efforts to adjust and adapt when appropriate. In Utah's example, it showed the importance of building a structure to support schools and teachers in being able to equitably extend beyond Exploring Computer Science.

5) Focus on data. A good data infrastructure allows for continuous monitoring of the landscape to ensure the BPC goals are being met, without any group being unintentionally left out or behind. Collecting outcome data is crucial to ensure that efforts are addressing inequities, not exacerbating existing discrepancies in access, enrollment, and retention in computing. As shared in many of these case studies, unintended consequences often impact the missing 70% that we critically need in CS. Therefore, it is important that continuous monitoring of our BPC goals are at the forefront.

Finally, just as states report that communication and collaboration are essential to all elements of the ECEP model, it is critical that these stories are shared. ECEP participants highly value the opportunity to learn from other members in the community. By sharing these stories state teams are able to reflect on their own work, draw upon strategies tried in other states, and learn from missteps. This cycle allows the BPC community to grow and reflect, with the goal of seeing more students from the missing 70% building confidence in CS and pursuing CS classes, degrees, and potentially careers.

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