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It takes a village: supporting inquiry- and equity-oriented computer science pedagogy through a professional learning community

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This article describes the importance that high school computer science teachers place on a teachers' professional learning community designed around an inquiry- and equity-oriented approach for broadening participation in computing. Using grounded theory to analyze four years of teacher surveys and interviews from the Exploring Computer Science (ECS) program in the Los Angeles Unified School District, this article describes how participating in professional development activities purposefully aimed at fostering a teachers' professional learning community helps ECS teachers make the transition to an inquiry-based classroom culture and break professional isolation. This professional learning community also provides experiences that challenge prevalent deficit notions and stereotypes about which students can or cannot excel in computer science.

Keywords: professional development; professional learning community; pedagogy; broadening participation in computing; teacher learning; exploring computer science

Introduction

The [ECS] PDs showed me that reflection and conversation with colleagues is one of the most important contributors to professional growth. (Exploring Computer Science (ECS) teacher)

Recently there has been a rush to provide teacher “training” as international awareness grows of the need to improve and increase access to Computer Science (CS) education. An increase in classes requires an increase in teachers. Yet, too often, these teacher “trainings” are one-shot events, often

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focusing on a particular topic or programming language. In contrast to this approach, the ECS program has developed an alternative teacher professional development (PD) model based on prior research about supporting teaching practice (Loucks-Horsley, Stiles, Mundry, Love, & Hewson, 2010; National Research Council, 2000). We have gathered data and analyzed ECS teachers' feedback about what they feel is important for supporting their teaching and preparation for the classroom. In this article, we will discuss the empirical impact of the ECS PD and implications for scaling up.

Background: the ECS program

The ECS program was developed in 2008 as a yearlong introductory high school CS course combined with teacher PD. The course and accompanying PD program were developed in response to the findings of a three-year research study showing disparities in CS learning opportunities based on race, gender, and socioeconomic status (Margolis, Estrella, Goode, Jellison Holme, & Nao, 2008). The ECS curriculum was designed to engage all students in the computational thinking at the heart of CS, with a special focus on underrepresented students in low-resourced schools (Goode & Chapman, 2015). The ECS course consists of six units: (1) Introduction to Human Computer Interaction, (2) Problem Solving, (3) Web Design, (4) Introduction to Programming (Scratch), (5) Computing and Data Analysis, and (6) Robotics. ECS was first piloted in the Los Angeles Unified School District (LAUSD) and since then has expanded nationwide through the support of the National Science Foundation and the non-profit organization code.org to 8 of the largest school districts in the nation.

ECS professional development

Recognizing that teachers who teach CS are often isolated within their schools without organized academic departments of colleagues, the ECS program purposefully supports development of a teachers' learning community. At the heart of this learning community is the PD program that includes a minimum 2-year commitment to an annual weeklong summer institute (one week before and after the first year of teaching ECS), quarterly PD meetings, teacher community meetings, in-classroom coaching program, and various collaboration and leadership opportunities for teachers. Additional opportunities for teacher collaboration occur through the in-classroom ECS coaching program. On average, teachers attend approximately 84 h of PD workshops for which their time is paid. Additional hours spent in the community meetings and coaching program vary between teachers and are unpaid and voluntary.

ECS PD involves key features directed at providing creative, active, participatory, and engaged learning spaces for teachers that model what should occur in ECS classrooms. The key features of ECS PD include:

(1) immersion into inquiry and equity-based practices; (2) a focus on teachers' instructional practice done through a teacher-learner-observer model, and (3) development of an *on-going* face-to-face professional learning community of practice (Goode, Margolis, & Chapman, 2014).

The first key feature – immersion into inquiry and equitable practices – involves purposefully structuring PD activities so that teachers personally experience inquiry-based learning. Educational researchers define inquiry as being based on the presumption that:

all students need opportunities to construct knowledge by solving real problems through asking and refining questions, designing and conducting investigations, gathering, analyzing, and interpreting information and data, drawing conclusions and reporting findings. (Blumenfeld, Fishman, Krajcik, & Marx, 2000)

In ECS PDs, all teachers work in collaborative groups, solve challenges together, reflect on their learning, and actively participate. Teachers have the experience of teaching a lesson in front of other teachers for immediate reflection and feedback. Modeling how students learn CS in ECS classrooms, these PDs support teachers learning-through-doing while allowing them to bring into the experience their outside and personal knowledge, skills, and perspectives. Equitable teaching practices are highlighted, along with facilitated discussions about the ways that structural disparities and belief systems have contributed to the underrepresentation of female, African-American, and Latino students in CS.

The second feature involves the teacher-learner-observer model focused on instructional practices. ECS PDs concentrate on teachers' experiences of inquiry and practicing the art of teaching. During the weeklong summer institute, teachers work in small groups, plan, and co-teach introductory ECS lessons to their fellow teachers who participate as "students." Following each lesson, co-teachers reflect on their experience and observers note what they saw happen during each sample lesson. Then the space is opened to a whole group discussion about the implications for teaching these lessons using inquiry-based methods for diverse students. Teachers who have not yet co-taught are then given time to use these reflection discussions to modify their own lessons as necessary, drawing on the experiences of their fellow teachers. The PD activity cycle is (re) planning → teaching → reflecting (Goode et al., 2014). This way of supporting teachers in demonstrating lessons with one another has been shown to increase content knowledge, allow educators to practice their skills, and support collaboration (Loucks-Horsley et al., 2010).

The third feature of ECS PD involves building an on-going professional learning community. This feature of ECS PD recognizes teachers as resources of professional experience and skill, and not just receptacles for

the PD facilitators' knowledge. The ECS learning community then extends as well beyond the weeklong summer institute and goes into teachers' classrooms throughout the school year. This is done not only with monthly meetings where teachers can regroup with their professional community and discuss their experiences, but also through an in-classroom coaching program where coaches extend the PD learning into the classroom, reflecting on classroom enactment of the curriculum. Coaches also help lead additional teacher gatherings throughout the school year as requested by teachers in the ECS community.

Professional learning community

Strong professional cultures are essential to supporting educators in changing norms of practice and pedagogy (McLaughlin & Talbert, 2001). This is why "professional learning communities" or "PLCs" are seen as invaluable to supporting educational change. PLCs have been understood differently in varying contexts with a wide range of definitions (Fulton, Doerr, & Britton, 2010). This study builds upon (Stoll, Bolam, McMahan, Wallace, & Thomas, 2006) review of PLC research defining PLCs as:

a group of people sharing and critically interrogating their practice in an ongoing, reflective, collaborative, inclusive, learning-oriented, growth-promoting way (Mitchell & Sackney, 2000; Toole & Louis, 2002); operating as a collective enterprise. (King & Newmann, 2001, p. 223)

The history of PLCs can be found in school reform efforts arguing for teachers to play active roles in curriculum development (Stenhouse, 1975) and for educators and schools to be self-reviewing or self-evaluating (McMahon, Bolam, Abbott, & Holly, 1984). Drawing on the belief that teachers' everyday experiences are an important source of knowledge best understood through critical reflection between teachers (Buysse, Sparkman, & Wesley, 2003), PLCs are meant to support school-wide reform through collaborative, inclusive, on-going examination of teacher practice geared toward improving student outcomes (Seashore, Anderson, & Riedel, 2003).

Since the 1990s, there has been a fair amount of research focused on PLCs for Science, Technology, Engineering, and Mathematics (STEM) educators. This STEM PLC research varies significantly in terms of the types of PLCs they describe, from PLCs focused on lesson study to university courses to collaborative action research or inquiry groups to grade level meetings or department meetings within schools to monthly discussion groups (Fulton et al., 2010). Others have studied a group of educators who met monthly to examine student work (Kazemi & Franke, 2004), and examined six school-based Critical Friends Groups (Curry, 2008). Of these studies, the PLC activities described that most closely reflect the kind of

PLC created among educators in ECS PD include research describing a university-based 3-week summer workshop with a follow-up research program for elementary teachers (Briscoe & Peters, 1997). Across these different study types, research findings reflect improved educator practice when PLCs support opportunities for teachers to collaborate and learn from one another.

Of course, ECS teachers from Los Angeles to Washington, D.C. do not belong to a single school. Rather, ECS teachers are often the only computer science educator at their specific sites who come together from numerous different schools in a region in order to attend ECS PDs. Thus far there have been no other studies of computer science educator PLCs involving teachers from different schools coming together for in-person PD. This paper illustrates the impacts of a PLC that, within the ECS context, refers to the collaborative and reflective community built among educators from different schools who came together during ECS PD events and meetings over multiple years.

Research question and methods

This paper discusses the following research question: How did the ECS PD model impact educators' professional growth?

Data sources included end-of-year and post-PD teacher surveys during the 2010–2011, 2011–2012, and 2012–2013 school years. Post-PD surveys were distributed on paper following every weeklong summer institute and were completed by 26 teachers in 2011, 17 teachers in 2012, and 28 teachers in 2013. End-of-year surveys were administered to ECS teachers via surveymonkey. A total of 81 end-of-year surveys completed by 38 different teachers were analyzed. Nine teachers took the survey all four years of data collection, 3 teachers took them three years consecutively, 10 teachers took them two years consecutively, and 16 teachers took them only once.

These surveys asked for ECS teachers' attitudes about and experiences with PD and teaching ECS lessons in Los Angeles high schools. Survey questions were co-developed by the authors and an external evaluator to ensure that there were no leading questions. Furthermore, questions were rephrased and asked in different ways throughout the surveys to confirm consistency across survey-takers' answers. From year to year, survey questions shifted slightly in an effort to improve the depth and detail of teacher responses. For example, in the 2011 end of year survey, teachers were asked an open-ended question to describe any ways that the ECS PD sessions impacted their teaching, whereas by the 2012 end of year survey, teachers were *also* provided likert-scale questions that allowed them to rate the impact of the ECS program (curriculum, PD, and coaching) on their teaching practices.

Employing a grounded theory approach (Glaser & Strauss, 1967), the authors systematically reviewed the data corpus for patterns (codes, themes, and categories). Emerging patterns were triangulated against key findings from a yearlong study of nine ECS classrooms that describes the CS content, inquiry-, and equity-focused teaching strategies of ECS teachers (Ryoo, Margolis, Goode, Lee, & Moreno Sandoval, 2014).

Research findings

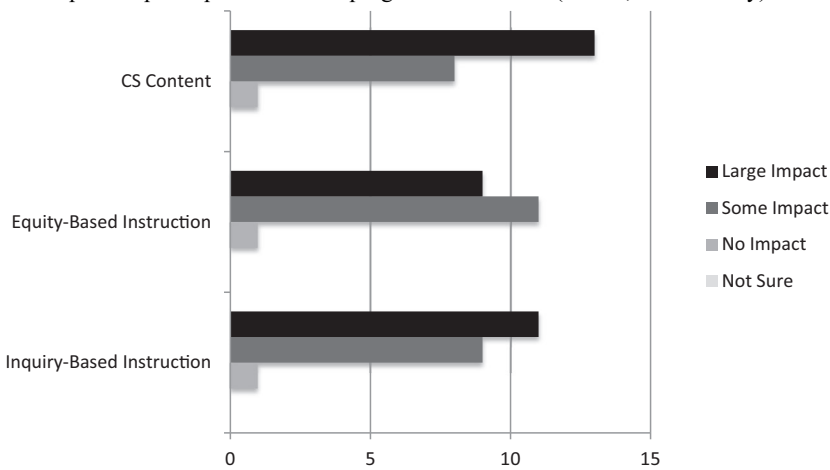
In contrast to many other types of PD that traditionally focus on content disembodied from instructional practices, the research evidence reveals that teachers placed high value on the time and space ECS PDs provided to build strong pedagogical skills with the support of colleagues in the community. In what follows, we will explain (1) how participation in the ECS professional learning community directly impacted teachers' inquiry- and equity-based pedagogy toward recognizing new ways of seeing the capacities of their students, challenging deficit ways of thinking and broadening participation in computing; (2) how building a professional learning community broke the isolation experienced by most CS teachers; and (3) how ECS educators valued the professional learning community of novice and expert ECS teachers beyond their first and second years of participation.

Finding 1: Teacher growth in pedagogy

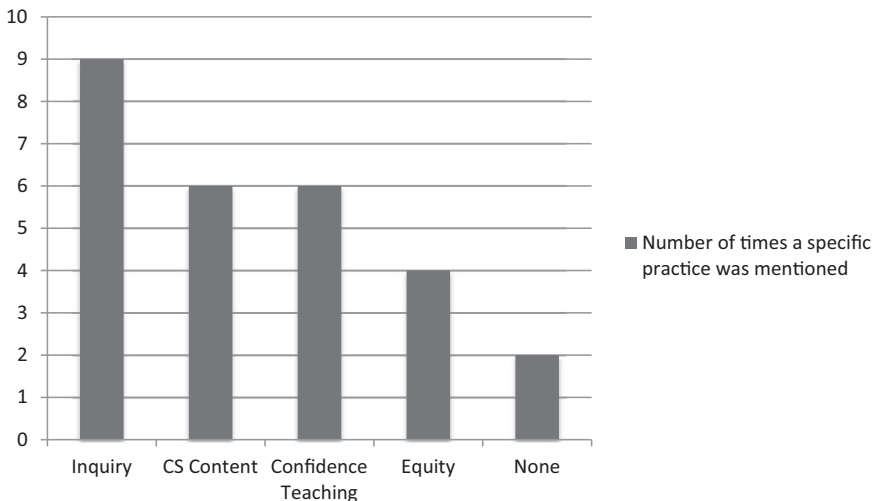
In this study, we examined all questions across the post-PD and end-of-year teacher surveys that specifically asked educators about their teaching practice or CS content knowledge. The following results reflect teachers' responses to these specific pedagogy and content knowledge-focused questions.

Across all end-of-year surveys (2010, 2011, 2012, and 2013), teachers described increased understanding, confidence, and application of inquiry and equity-based teaching practices as a result of their participation in the ECS professional learning community of practice.

In the 2013 surveys ($n = 23$), teachers were asked to rate the degree to which the ECS program (including curriculum, PD, and coaching) impacted their work as teachers. Twenty reported either "some" or "large impact" in relation to inquiry and equity-based teaching. Twenty-one reported either "some" or "large impact" on their CS content knowledge. One teacher reported no impact across all three areas, and two teachers skipped this question when rating inquiry and equity, while one teacher skipped this question when rating CS content impact. Details are shown in the graph below (Table 1):

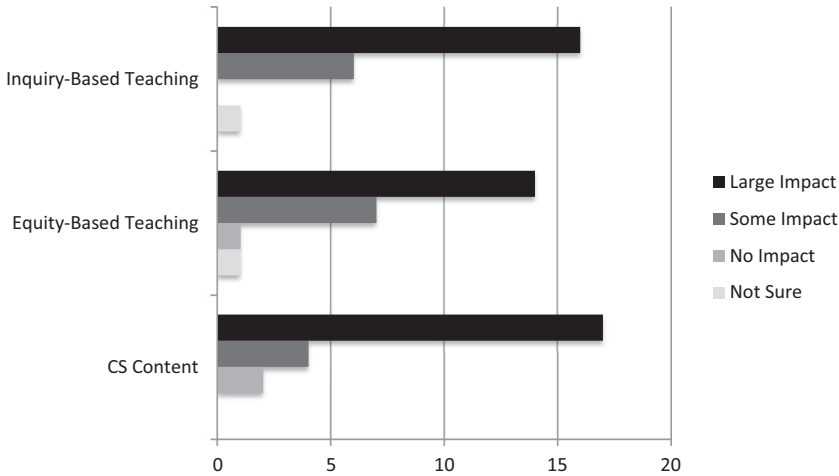
Table 1. Impact of participation in ECS program on teachers ($n = 23$; 2013 survey).

On this same 2013 survey, when asked the open-ended question, “How have you changed, if at all, in your practice? What comes to mind FIRST?” teachers primarily described changes related to pedagogy. A total of 21 teachers replied to this question. While 2 teachers noted no change, the rest described specific changes in inquiry- and equity-based pedagogy (see Table 1 above). For example, Aziz¹ (2013) described changes in his inquiry-based teaching such as “not volunteering the answer” as well as equity-focused pedagogy such as “empowering my students to trust their reasoning and unique way of solving problems.” Another teacher, Nestor (2013) described increased confidence teaching and improved CS content knowledge saying “I am now much more confident in my skills as a CS teacher.” Table 2 below illustrates the number of times key changes in practice were mentioned across all teacher responses.

Table 2. Changes in practice recognized by teachers ($n = 21$; 2013 survey).

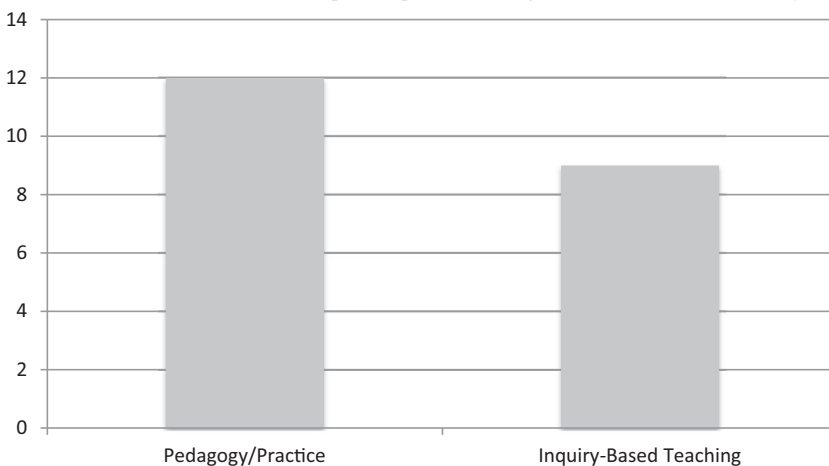
In the previous 2012 end-of-year teacher survey ($n = 23$), teachers were also asked to rate the impact of ECS curriculum, PD, and coaching on their practices related to inquiry, equity, and CS content. Across these three areas, the majority of teachers agreed they experienced “some” or “large impact” due to participation in the ECS professional learning community. The results of these questions are shown below.

Table 3. Impact of participation in ECS program on teachers ($n = 23$; 2012 survey).



In 2012, teachers were asked an open-ended question about changes in their teaching practices and professional growth, similar to the question asked in 2013 shared above (see Table 3). Over half of the teachers in 2012 also emphasized changes in pedagogy – with 9 teachers describing changes in inquiry-based teaching strategies specifically – as shown in Table 4. Statements included Kenneth (2012) mentioning, “My involvement has broadened my teaching practices” and Nina (2012) wrote, “ECS has stretched me

Table 4. How involvement in ECS impacted professional growth ($n = 23$; 2012 survey).



by having me teach topics that I have not taught before. It has also made me aware of alternative ways of teaching.”

In 2011, teachers were not asked the same likert-scale questions that were developed for the 2012 and 2013 surveys. However, open-ended questions asked educators how ECS impacted their teaching overall. Nine of 17 teachers described shifts in pedagogy and inquiry-based methods. More specifically, teachers expressed giving students more space to experience hands-on, inquiry-based learning. The focus on learning new inquiry-based teaching strategies that support cooperative learning was mentioned by several teachers who wrote, “My role has grown to be more of a facilitator and project manager. I have tried to foster self-motivation and team spirit” (Xavier, 2011) and “Teaching ECS has helped me improve my teaching as I collaboratively worked with ECS coaches to explore teamwork and how students [can] be active participants in their learning” (José, 2011).

Post-PD surveys across the 2011, 2012, and 2013 summers revealed similar results. In the 2011 post-PD survey, teachers reported valuing new pedagogical strategies for teaching CS and a deeper understanding of equity issues in the field. One teacher wrote, “I really enjoyed the diversity of approaches and pedagogy styles demonstrated in today’s lesson demos” (anonymous, 2011). Another educator explained “I learned about equity and creating an environment that meets the needs of all students” (anonymous, 2011). In the 2012 post-PD surveys, teachers were asked: “Did your understandings of inquiry-based pedagogy deepen in this session? Please explain and give examples.” All teachers reported increased understanding of inquiry-based teaching. Common statements included, “Yes. The lessons were great in providing examples of inquiry” (Elena, 2012). Similarly, teachers reported a deeper understanding of equity issues in CS as a result of the PD. Exemplary comments included, “Goodness yes ... I am very passionate about it” (Cory, 2012). Finally, 2013 post-PD surveys also reflected growing confidence with inquiry- and equity-oriented pedagogy across the majority of respondents. As one teacher explained,

I have always thought that I was teaching inquiry, but I now have a much better understanding of what that looks like and I realize that I was not even close. I now have a better protocol to follow. (Gary, 2013)

Similarly, another teacher wrote that she gained a new understanding of

Inquiry methods – otherwise I’d just be at the front of the room going ‘blah blah blah’ for an extra period each day and the same students who already ‘got it’ before I said anything will still be the ones who get it. (Courtney, 2013).

Yet another common statement was: “I am reinvigorated in my quest for inquiry and equity in CS” (Jared, 2013).

Overall, participation in the ECS community of practice helped teachers focus on what one teacher referred to as “*the art of teaching*” (Desmond, 2011). As explained by another teacher, he learned about “the importance of having students work on projects that are meaningful to them. Also, I became better at directing students to help each other rather than coming to me for the answers” (Ted, 2011). Similarly another teacher described gaining insight into how to make CS more meaningful: “I learned how to include more students and their talents by having so many different concepts. I learned how to make education more relevant to students’ lives” (Aziz, 2011). Another teacher described how these skills helped illuminate what learning “should look like”:

The one thing that I can say is that I have had to learn to deal more with “organized chaos” ... Students are up out of their seats, even out of the classroom and in the hallway, yet they all are working. This really is what a classroom should look like, so it is fun. (Clara, 2011)

Finally, working with other teachers who were also interested in broadening participation in computing led another teacher to feel “encouraged to make a link between social issues and computation: the social web, the impact of technology on communication” (Donald, 2011).

One of the most important themes to emerge from this research study is that the enactment of guided inquiry instruction led to new appreciations of students’ abilities to deeply engage with rigorous CS learning. The curriculum and accompanying inquiry- and equity-based instructional philosophy encourage student exploration, creativity, and ownership. Teachers’ appreciation of this and how it can work is captured in statements such as: “I have learned more about student collaborative work, inquiry-based projects and let the students be more creative” (José, 2012) and

I think that I am a much better informed educator as a result of my involvement with ECS ... my previous teaching involved only the use of applications. I now feel much more comfortable teaching students how to create their own. (Nestor, 2012).

Many teachers shifted their views of student agency in the classroom, explaining how they now believe in “let[ting] some of my students become the masters and then they can teach the other students” (Dennis, 2012) and “I have realized that I can turn over the learning process on some lessons to my students” (Stella, 2012).

The above teacher comments reflect new understandings of how to facilitate student creativity and self-expression through CS, and very importantly they challenge a more traditional top-down “banking method” of rote

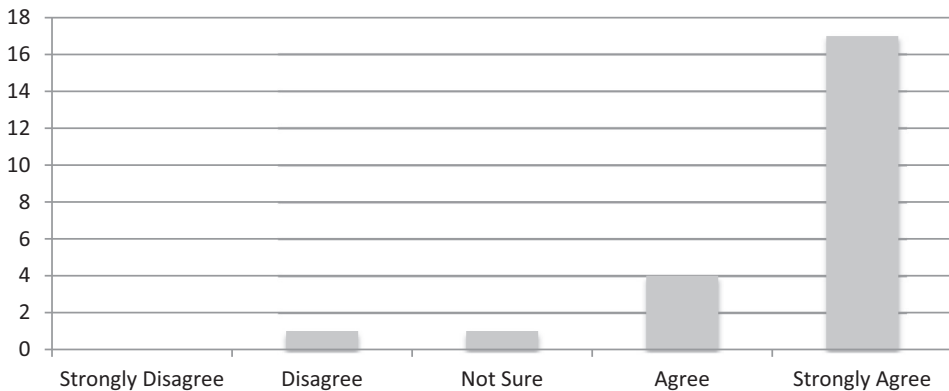
learning of coding. Rather than lecture at students or control their every action, ECS teachers' who expressed faith in their students' learning were offering a de facto challenge to a deficit-oriented perspective on students as incapable of handling rigorous CS learning either creatively or independently. Increasing the chances of this occurring is very important in a field with strong ethnic and gender biases and stereotypes that assume that only a narrow stratum are good at CS.

Of course, this is not to say that the teacher plays no role in understanding or knowing CS content or guiding student learning. Rather, ECS inquiry instruction is teacher "guided" with teachers intentionally asking thought-provoking questions and challenging students to re-examine the evidence or conclusions. The intention is for students to take charge of their own learning, get excited about new CS content and experiences, be producers rather than merely consumers of technology, and gain the confidence to be experts in the classroom who can also teach and assist their peers.

Finding 2: Breaking teacher isolation by establishing a professional learning community with a common curriculum

Across all end-of-year ECS surveys, teachers regularly mentioned the value of being part of a professional learning community, working with colleagues around a common curriculum, and exchanging ideas within the ECS teaching community. The most recent end-of-year 2013 surveys revealed that a strong sense of community developed among ECS teachers through PD opportunities. The majority of teachers indicated that they felt a sense of "belonging" to the "ECS community" as shown in Table 5 below:

Table 5. Teachers indicate how much they agree/disagree with the statement: "I feel like I belong in the ECS community." ($n = 23$; 2013 survey).



The reason why this sense of “belonging” to the ECS community was important becomes clear when examining the frequency with which teachers mentioned *community and collaboration as main influences on their professional growth*. When asked in the 2013 post-PD survey: “What do you think are the two most important things you have gotten out of participating in this PD?” 15 of the 28 teachers emphasized that belonging to a community of teacher colleagues had the greatest impact on their professional growth. As shown below, many described learning equity- and inquiry-based teaching strategies as well as new confidence in teaching ECS, often citing colleagues as a key source of new knowledge in pedagogy. As stated by Gary (2013): “I have gained a great deal of confidence with the curriculum by working with colleagues.”

When asked to elaborate with the open-ended question, “How has the ECS Professional Development impacted your growth as a teacher?” teachers’ comments focused on the network of teachers and sharing of ideas. For example, one teacher noted, “The network of teachers was the best because we had the same curriculum and some of the teachers provided different approaches and tools to teach a concept which was helpful” (Jenny, 2013). Another teacher explained:

The ECS PD sessions have helped me review and learn CS concepts while sharing ideas with other colleagues to modify my teaching...It is great to hear how others think or have an opinion about the same thing we are analyzing or talking about and how we would teach it. (José, 2013)

The opportunity to meet regularly with other educators was important because:

I had a point of reference that may have experienced similar issues in the classroom and they would be able to share how they went about resolving these issues. The members of the ECS community are always willing to share resources to help me be as effective of an instructor that I can be which ultimately impacts the lives of my students. (Desmond, 2013)

In fact, when asked in this same survey “What was the biggest influence on your growth in ECS?” most teachers mentioned the importance of colleagues and in-person PDs where they met with their colleagues.

In the earlier 2012 end-of-year survey distributed to 23 teachers, 9 discussed the value of collaborating with colleagues when asked the open-ended question, “Overall, how has your involvement with ECS (curriculum, PD, coaching) contributed to your professional growth? Please give examples.” As noted by one teacher, “Meeting with colleagues and sharing practices is extremely fruitful specially in a dynamic field such as computing, data analysis, and robotics” (Aziz, 2012). The impact of this supportive

community of practice stayed with teachers beyond PD, as one teacher explained:

Every day, I feel the presence of my colleagues and my grant members. I always know that they have my back. I always feel that I can get help. I have a positive outlook on any challenges I might face. I am not afraid to try a new approach or stick to my guns on an old one. I am part of a very small department at my school, but my ECS group makes me feel like I have the support and resources of a national department, and the support of the NSF for our work makes me feel honored and humble to be responsible for such an important path in our nation's future. (Mitzy, 2012)

Beyond valuing community for access to resources and exchanging ideas, teachers also reported the importance of this teaching community for breaking the isolation they felt in their schools. The majority of ECS teachers are the only CS educators at their schools as reflected in recent research regarding how CS educators lack the support of a CS community that other teachers may find in their English, Science, or History departments, for example (Century et al., 2013). ECS provides a space for educators to find instructional and emotional support when they need it. For example, in the 2013 post-PD survey, 16 of the 28 teachers who completed the survey described that one of the most important things gained was the teacher community. Comments included things such as: "I really appreciated knowing that I'm not out there by myself and having to create the wheel on my own" (Tony, 2013). Similarly, in the 2012 end-of-year surveys, teachers commented:

Their support made all the difference!!!! LAUSD is going through crises daily, and the impact of the financial doom and gloom makes going into the classroom seem futile. Knowing that this groups was here, to help, and that they truly care about what we do makes the news less painful, and makes me focus on my students and their success. In other words, the bombing seems farther away. (Mitzy, 2012)

I enjoyed socializing and meeting other ECS teachers who are doing the same things in their classroom as me. For an elective teacher, it is sometimes very isolating because we don't teach classes that other teachers teach at our schools. I loved the community that ECS provides. (Dennis, 2012)

In the 2011 end-of-year survey, Aziz explained that despite having weekly non-ECS PDs at his school, where "there is no growth, nothing is learned and taken back to class," the ECS PD experience is a contrast, as he stated:

ECS Professional Development sessions empowered me [to] be a better problem solver, teacher, and coach. My colleagues shared fantastic experiences, helped me get through difficulties, and ECS group provided so much support inside and outside of the classroom...I feel that I am not alone, I have help, I can ask questions about computers, programming, problem solving, and etc.

... ECS has truly supported me and helped me to become a better teacher.
(Aziz, 2011)

Of particular note are the ideas that this teacher emphasized about having colleagues who “share fantastic experiences” and “help him get through difficulties” and “provide support inside and outside of the classroom.” With the professional learning community developed through ECS PDs, this teacher did not feel “alone” and could find assistance with his teaching and CS content needs.

Finding 3: Teacher growth takes time

The ECS PD program is designed so that the first year of teaching is preceded by a weeklong summer institute, followed by four PDs throughout the year, and concluded with another weeklong summer institute where new teachers learn alongside teachers who are concluding their first year of teaching and deepening their understanding. Teachers attending these PDs vary in experience with the ECS curriculum, including both first-year and multi-year ECS educators. Despite this two-year model, we have found that teachers desire continued participation in ECS PDs and find them useful beyond a third or even fourth year of attendance.

Teachers who were in their third, fourth, and even fifth year teaching ECS report that meeting with colleagues and attending these PDs continues to be both useful and impactful beyond their first and second years of participation.

For example, when asked “Please describe any ways this year’s ECS Professional Development sessions have impacted your teaching. Please be as specific as possible,” a fifth-year ECS teacher replied, “It get[s] better every year...but I still have lots to learn” (Eduardo, 2013). Another fifth-year ECS teacher wrote, “I am still changing, trying to more effectively deliver the ECS concepts. It’s been the same for all the years that I have been involved with ECS. Trying to be more effective with inquiry-based strategies” (Joe, 2013). Beyond their first and second years teaching ECS, these teachers recognized that they still had more to learn.

Similarly the majority of fourth and fifth year teachers reported continuing to value ECS PDs because of the access to a professional learning community that these PDs provided. The important *continued* facilitation of teacher collaboration through PDs was noted in statements such as, “I have learned the value of collaboration and sharing ideas with other educators and support people ... I learned the value of reflecting on the successes (and failures) in my classes, and using what I learned to improve future instruction” (Ted, 2012, fourth-year ECS teacher). A fifth-year ECS teacher wrote: “the overall collaboration with colleagues in ECS has been extremely helpful ... The members of the ECS community are always willing to share

resources to help me be as effective of an instructor” (Desmond, 2013). Yet another fifth-year ECS teacher wrote that the most valuable impact on her teaching was “Our group here at UCLA. It’s like having mentors and family and students to practice on, all at once” (Mitzy, 2013).

Veteran ECS teachers’ reactions to the value of continued attendance at ECS PDs highlight how teacher growth through community support is ongoing. A fourth-year ECS educator similarly explained that the professional learning community of practice continued to impact his teaching: “Since this was my fourth year, the sessions did not have as great an impact as they did the first and second years. However, the opportunity to dialog with other teachers still proved to be very valuable” (Nestor, 2013). This has implications for our efforts to sustain a growing program. How long are we able to provide support? When is support most needed beyond the first and second year?

Discussion

Implications for growth and scaling up

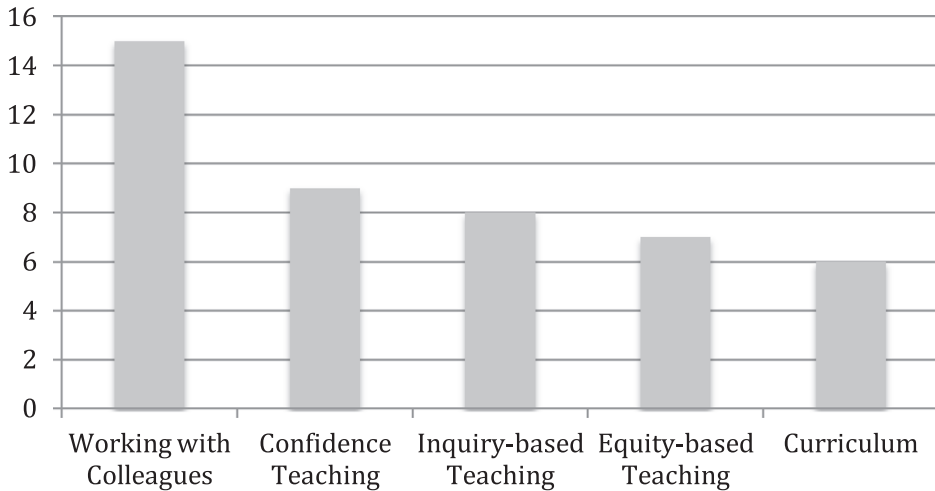
At a time when computer science is getting much attention and rapidly expanding in our schools, the hope for a national CS teacher learning community is that it will help break isolation, providing resources and a space for teachers to improve and reflect upon their best teaching practices. Because of the rapid expansion, there is mounting pressure to scale up CS teacher PD, to do it quickly, putting teachers’ “training” on the fast-track even putting at risk unintended consequences of less community-building between teacher cohorts because of less face-to-face interaction time.

Every educational reform program faces the same dilemma – with limited resources, what are the top priorities at this time? What are the unintended consequences of each decision? Our research provides the empirical evidence of how important teacher professional community building is. Teachers are rarely given the time or place to confer, reflect, and share with fellow teachers. This is part of the de-professionalization of the field. The contrast between the culture of schooling (where there is too little collaboration between teachers) and the culture of new creative spaces designed to foster innovation (where offices are often open architecture, with everyone sitting at a common table, designed to encourage collaboration and creativity) is not lost on us.

Part of the fast tracking of teachers’ PD is a big push to leverage the power of technology to supplement face-to-face interaction between teachers. This may be as difficult as fitting a three-dimensional world into a two-dimensional space. During one ECS PD, an LAUSD teacher leader commented on how “learning is a very emotional experience.” The emotion of learning – the dialog, the struggle, the reflection, the trust building, the misunderstandings, the vulnerability, the resistances, the breakthroughs, the

“ah ha” learning moments – are all catalysts for growth in teaching practice. For this reason, in ECS we continue to build in as much face-to-face professional time and space as we can, but also realize the importance of collaborating with the larger community to help figure out if and how to leverage technology to increase authentic connections and communities of learning as our community grows nationwide (see Table 6).

Table 6. Teachers respond to “What do you think are the two most important things you have gotten out of participating in this Professional Development?” ($n = 28$; 2013 post-PD survey).



Yet throughout all of these considerations looms the following question: in the near future, will there be a need or a place for the kind of professional learning community built through ECS as described in this paper? Especially with online CS teacher certification ramping up and as CS educators become less isolated in their schools with the development of campus CS departments?

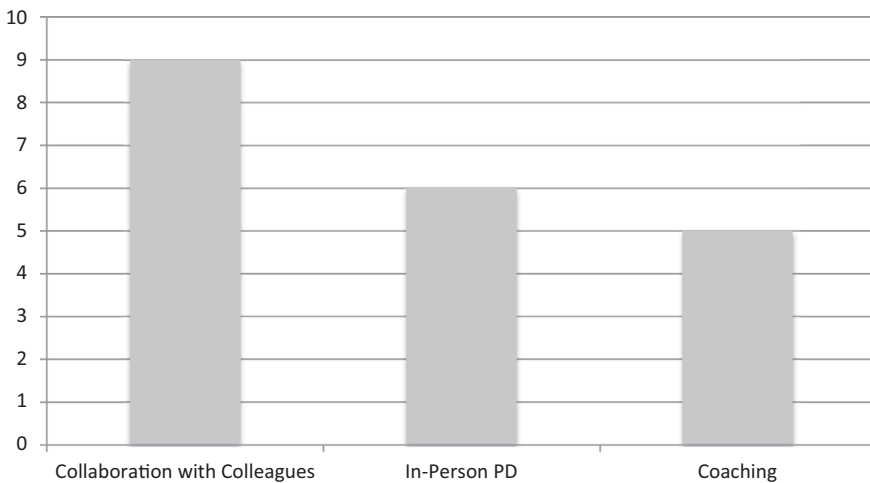
Our immediate response is *yes*. The majority of ECS teachers clearly value the professional learning community built through face-to-face time as evidenced by the research findings presented in this paper. However, what is particularly notable is that while the majority of ECS educators used our shared Ning website by the 2011–12 school year (but did not in all previous years), only a minority actually regularly posted or shared comments. Most educators only used the Ning to download resources posted by that minority of teachers. Furthermore, when asked in the end-of-year surveys “Please share any ideas you may have for building more community among ECS teachers,” nearly half of all teachers every year requested including even *more* face-to-face meeting opportunities through school visits, more numerous PDs, and social events. While incorporating virtual opportunities to connect will continue to be important for professional learning communities

across distance, today’s educators continue to appreciate the time spent in-person and, based on our research findings, teachers do not want to completely replace face-to-face time with online interactions.

Expanding the village

Computers don’t create cultural change within schools; rather, it is the teachers and administrators who do. Teachers require the space to think big and be bold with their teaching transitions. For this to happen, it is not just teachers who must change, it is the entire school culture and administration. For teachers to be supported in the mission of broadening participation in computing, administrators (technology coordinators, principals, counselors, and school board members as well) must understand this mission and the pedagogical changes that must occur. Teachers who are creating active learning classrooms should not be reprimanded for having collaborative-learning “noisy” classrooms. Likewise, principals who see students individually mindlessly cutting and pasting coding instructions, without thinking critically or working collaboratively, must realize that this is not the type of computer science education that is important for students. Furthermore, principals must understand that ECS pro-actively works for classrooms that reflect the demographics of the school, including an equal gender balance of students. When that is not the case, the full village must be mobilized to turn the situation around (see Table 7).

Table 7. Teachers respond to, “What was the biggest influence on your growth in ECS?” ($n = 23$; 2013 survey).



For these reasons, we encourage computer science education projects to make sure that all administrators in schools and in the administrative

leadership are provided with the right material necessary to understand how broadening participation requires changes at the classroom level (curriculum, pedagogy, course availability) to the macro level (including national policy) assuring quality computer science education for all students. We have found out this is a mission that needs constant monitoring, relationship building, and advocacy, along with big shifts in teaching practices.

While awareness around the need for computer science education has certainly increased in the last several years, the movement to bring more CS learning opportunities into schools must recognize that for change to be quality instead of just quantity, it must occur on multiple dimensions simultaneously. Getting more computer science into the schools needs infrastructure to keep the quality high and sustained. This is why the village must contain a strong professional learning community of CS teachers at its core, while also including administrators, policy-makers, educational researchers, computer scientists, students, and parents.

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Note

1. All names have been changed to protect teacher confidentiality.

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