



Exploring Computer Science Working Papers

A Tale of Three ECS Partnerships and Why Scalability \neq Sustainability

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Exploring Computer Science (ECS) is an NSF-sponsored educational reform program built to address the historical lack of computer science curriculum, engaging pedagogy, and institutional support available for schools serving high numbers of students of color [refs]. ECS lessons are designed to promote an inquiry-based approach to teaching and learning foundational concepts in computer science. The core of the ECS curriculum highlights the computational practices and problem solving associated with doing computer science, rather than narrowly focusing only on particular syntax or tools. A key component of the *Exploring Computer Science* program is the extensive and ongoing professional development support, which helps foster a teacher professional learning community that focuses on issues of effective pedagogy and inclusive practices.

In the five years since this course was first offered in LAUSD, enrollment statistics point to a marked success in reaching a highly diverse student population. Girls comprise 45% of ECS students. The success of this course and the instructional design of the program for broadening participation in computing can serve as a model for other districts and local regions looking to expand computer science education. Since 2011, the Exploring Computer Science program has been implemented in multiple areas of the US. Current partners include the Chicago Public Schools, San Jose California area, Oregon, Utah, and DC Public Schools. Several other sites, including Massachusetts and the upper Midwest, are on the near horizon, with many others having expressed interest for future adoption.

In this paper, "A Tale of Three ECS Partnerships," we summarize a panel that took place at the January 2013 NSF CE21 conference on lessons learned from ECS expansion. The three panelists were the PIs of Exploring Computer Science projects in Los Angeles, Chicago, and San Jose (Silicon Valley). As the moderator of the session, Joanna Goode asked each panelist to prepare comments in advance around four guiding questions:

1. How did you initially begin building the foundation for ECS in your community? How did you build key relationships between universities, districts, and teachers?
2. What have been the ingredients for ECS success at your local site? How do you know?
3. What have been some "teachable moments" for you in this journey of introducing ECS to local schools? What have you learned along the way?
4. How do you see ECS addressing equity issues in computer science education?

In response, each panelist spoke to the issues of introducing ECS into the respective districts, ingredients for success, teachable moments, and equity.

Several critical themes emerged across the three sites that are important information for new ECS projects and the CS10K campaign:

1. Scalability should not be confused with sustainability; despite external pressures to scale initial successes, we have found that the important work of sustaining these initial efforts within bureaucratic school systems cannot be rushed or cast aside in efforts to scale too quickly.
2. Partnerships with the local school districts are vital to both scalability and sustainability.
3. Teacher professional development and fostering of a professional learning community is a critical component of maintaining the rigor and equitable practices of the ECS program.

Los Angeles: The Birthplace of ECS

PI: Jane Margolis

Question: How did you initially begin to build a foundation for ECS in LA?

The foundation of ECS began in 2000, when our UCLA research team began a four-year research project about the state of CS education in the Los Angeles Unified School District (LAUSD) schools. Our larger overarching question was why are so few African American, Latino, and female students learning computer science? After doing several years of observations and ethnographic research in three LA high schools, we found large disparities of computer science classes between schools, with high numbers of African American and Latino students being denied access to CS learning. Another major finding was that throughout the district, educators were unclear as to what computer science was, often confusing computer literacy with computer science. Many courses that were classified as computer science, especially in schools with high numbers of African American and Latino students, were limited to Introduction to Computers, a course focused on computer literacy. The only college preparatory class in the District was AP Computer Science (AP CS), and this class did not exist in many schools. Further, we observed how AP CS was not successful in recruiting and retaining students who did not already have much exposure to CS. These research results can now be found in *Stuck in the Shallow End: Education, Race, and Computing* (MIT Press, 2008).

During these years our team was having regular conversations with the LAUSD Director of Science, Dr. Todd Ullah. Fortunately, we shared a common language, understandings, and commitment to social justice around educational reform.. Further, he had experience leading district efforts that involved developing inquiry-based science curriculum and accompanying professional development for high school science teachers. Through the exploration dialogue, Ullah committed to partnering with us in finding a solution to the scarcity of computer science classes in

the district. Ullah became our internal school district champion---which we learned was an important ingredient for success.

Question: What were your ingredients for success?

Several key ingredients for success we have found:

Building District Partnership with Internal Champions

The most important ingredient for success for us, from inception to implementation, has been an authentic, trusting university-K-12 partnership through which mutual expertise and experience is contributed to the project, and where our broadening participation in computing mission lines up with and contributes to the district priorities of providing all students with a college preparatory and career ready education. Our partnership with LAUSD is now in the 12th year, with Dr. Todd Ullah being co-PI on all of our work. Ullah has also been instrumental in increasing familiarity with ECS throughout the District leadership. While having a committed champion is key, we also learned that, due to turn over and reshuffling of District leaders, it is just as critical to eventually develop a network of internal champions.

Get Official Commitments to Offer ECS

In collaboration with our internal District champion, we contacted principals about offering ECS in their school and identifying a teacher to teach the class. We required principals to sign a commitment statement, which included a pledge to put ECS on the school master schedule, and a commitment to identify a teacher who would attend the summer PD week and the follow up PDs during the year. This official statement and linking the course to a teacher attending the PD is critical.

Teachers are Key

A vital, engaged and committed teaching community is critical to the vibrancy of our program. Our ECS *program* is not just a curriculum but is also a professional learning community of teachers—curriculum and PD/learning model together. The PD program focuses on content learning as well as pedagogical practice and growth. We have found that our program is at a minimum a 2-year program as it takes time and practice for teachers to learn both new content and transition from traditional CS classroom instruction (ie. commonly focused on programming with a teacher “delivery” model rather than guided exploration) to the inquiry mode. We also have an in-classroom coaching program and provide opportunities for teachers to visit other ECS classrooms and reflect. For the latter to occur, reflective teaching practices are critically important, and trust and respect are necessary. Developing and supporting teacher leadership and professional growth is a priority for our program.

Interdisciplinary Collaboration

Our team contains a critical mix of perspectives--- Our facilitators have both educational theory and social justice knowledge along with computer science and high school teaching knowledge. Instead of having the PDs and other ECS initiatives

planned by computer science experts alone (as has been common in the past), the shaping of ECS PDs has really been done by experts in education.

Question: What are some “Teachable Moments”?

Fidelity to Curriculum

Since LAUSD was the first place that ECS was introduced, we asked teachers to pilot the first version and provide feedback that we incorporated into subsequent curriculum revisions and the final version. This iterative feedback loop was very important for the first version of the curriculum, but it also created long-term challenges.

While we value and wanted to allow room for teachers’ creativity to flower, it is also true that curriculum development is a science that requires professional expertise. In the case with ECS, the curriculum was specifically designed to scaffold learning from unit to unit. The first two units focus on problem solving and are at the heart of ECS and at the same time often offer the most challenge for teachers in terms of inquiry pedagogy. In their reaction to the new pedagogy and focus on problem-solving and computational practice, teachers in our first cohorts of ECS often experienced or perceived that the first two units were either too difficult or too “easy”. These experiences often led to “feedback suggestions” to drop certain challenging activities that the ECS authors knew were critical to the purposeful scaffolding. Even changing the order of the units (which was suggested by several teachers) was problematic from a pedagogical and scaffolding perspective because they were really needed upfront. So we learned a lot about fidelity to the curriculum and as a result are now much more clear in our expectations with new teachers about the structure, the benefits of the curriculum as presented, and the need to adhere to the order and objectives of lessons.

ECS PD: Monday is rocky, Wednesday the light bulbs go on, and Friday is good

We have learned that ECS PD can begin a little rocky. Because many ECS teachers have had years of passive PDs where teachers are talked at, they are often taken by surprise by the expectations of full active participation during PD. Further, many teachers hold the same misconception that students do, that computer science is really about being squirreled away behind the computer. When the PD on the first and second day are generally “computer free zones” and the CS activities center around problem-solving, teachers can be both exhilarated and confused. By Wednesday, the connections between inquiry strategies, equity practices and CS content that happens in the PD and what can happen in the classroom are starting to be made--- and by Friday a true learning community is almost always formed and teachers are very amazed by the ECS PD experience.

Coaches Need Coaching

Part of our ECS program in LA is an in-classroom coaching program where ECS coaches visit teachers and then reflect with them afterwards about their observations and help teachers in areas that need improvement. These coaches are

highly valued by the teachers. Yet, throughout this process, we learned how coaches also need coaching. They must be more than “content people” (such as CS undergraduate or graduate students), they must be good inquiry-based teachers, and must have experience working with adult learners---helping them reflect on their own practices, and challenge themselves to take risks and grow. This has been a critical finding for us, and really shapes our hesitation about all the programs that suggest sending professional volunteers into the classroom. It is not that easy.

Question: How do we address equity issues in CS education?

Equity Exists in Every Aspect of our Work

Equity is not a separate topic, but rather exists in every aspect of our work. It begins with our choice of the schools and the schools district we work in. We chose to partner with LAUSD, the second largest district in the country, with 75% Latino population, 12% African American, and most students on free or reduced lunch.

From the very first day of ECS professional development (PD) and all of our meetings with District administrators, we explain how ECS has an equity mission to democratize computer science learning. Our choice of schools is deliberate, working to have ECS in schools with high numbers of Latino and African-American students. Within those schools, we have outreach activities such as talking with counselors about making sure that they recruit girls into the class (and we do have 45% females). But, some of our most important work is around educators’ belief systems. Working with the case studies from *Stuck in the Shallow End*, we discuss how beliefs about which students can (and cannot) excel in computer science mediate learning opportunities in multiple ways. And, we discuss how our curriculum is specifically designed to engage the interests of a broad segment of the student population, among them students who have little hands-on experience with computing, who have felt marginalized by the stereotypes of the field, and who enter with little confidence. The curriculum is designed to scaffold their learning and their confidence. We work with teachers to assure that classroom instruction is equitable in that it engages all students, and builds upon students’ prior knowledge and interests.

Chicago’s Taste of Computing: The First ECS National Expansion

PI: Lucia Dettori

Question: How did you initially begin to build a foundation for ECS in Chicago?

Taste of Computing (ToC) is the Chicago version of ECS. The seed was planted at SIGCSE 2008 in Portland. At one of the panels, sponsored by the ACM’s Educational Policy Committee, comments were made on the (sad) state of computer science education in K-12, the lack of popularity of the discipline and the need to broaden

participation in CS to include more women and other underrepresented groups. There was a call for action. Several members of what is now the ToC group were in the audience. They stood up, identified themselves as being from Chicago and being willing to work to change the status quo. The nucleus included high school teachers and university faculty with a common goal. What started as a conversation over a few meals in Portland continued as a plan of action once back in Chicago. The group expanded through the Chicago chapter of Computer Science Teachers Association (CSTA), the inclusion of faculty from three universities (DePaul, Loyola, University of Illinois Chicago) and additional high school teachers determined to bring more and better CS courses into Chicago high schools and give ALL students a chance to experience it.

Members of the group were familiar with the ECS curriculum and thought it might be a good starting point for the change they wanted to bring about. The initial naïve approach was to just implement the curriculum. Once a handful of teachers experienced the transformational PD associated with ECS, it became very clear that the curriculum itself would not be enough and that we needed to bring to Chicago the combination of PD with the ECS curriculum. For true change to occur, the teachers would need to experience the same transformation and embrace not only the computer science content but also the guided-inquiry approach, and the importance of creating an equitable classroom. The group expanded to include Gail Chapman, ECS National Outreach Director, as a vital part of the team.

Question: What were your ingredients for success?

A first attempt to secure funding from NSF to support the project was unsuccessful primarily because of the lack of widespread support and commitment from school principals to offer the course. The missing ingredient was a partnership with school administrators to ensure that our efforts would have an impact in the district. We decided to use the Career and Technology Education – Information Technology Program (CTE-Infotech) as our way into a significant number of schools (35). We built a relationship with the director of CTE-Infotech, an inspired administrator who believes in the need for all students to be exposed to real CS. At the time, CTE-Infotech was being revamped and was in need of a new introductory course that would focus more on computational practice than on applications learning, that would attract a wider audience and be a foundation for the various strands of CTE-Infotech. The leadership of CTE-Infotech recognized that the ECS curriculum and pedagogy, along with the associated PD would be a perfect match. From our point of view, this would provide us a way to have a significant impact right away without having to work one school and one principal at a time. A second attempt at getting funding through NSF was successful thanks to the better defined partnership among teachers, university faculty, Chicago Public Schools administrators and members of the LA ECS team.

Local Shaping of the Partnership

At the same time that the project launched, the Chicago mayor created 5 new STEM early college schools. The CTE-Infotech leadership was involved in helping shape the curriculum for the new schools and together we were able to ensure that CS would be a fundamental part of the STEM school curriculum. More specifically, the Taste of Computing course became the required technology course for all incoming freshmen at those schools. And the teachers who were to teach the course were required to attend the ECS-ToC PD. In addition to serving as the foundation course for the CTE-Infotech program and the STEM schools, the course is being offered as a Math elective at some schools.

Question: What are some “Teachable Moments”?

I cannot stress enough the importance of having a strong partnership with key stakeholders. A trusting and supporting community is vital to the success and sustainability of this project. The community must include high school teachers, ECS leadership, university faculty, school administrators, principals, and industry leaders. It is important to cultivate this partnership in person and over time. Baker’s rule #2 – Socializing over meals and drinks helps. Certainly the success in getting Taste of Computing off the ground depended on the personal relationships we have created among people with the shared conviction and goals. Through the Chicago Chapter of CSTA the community is growing and extending to industry partners. They have a powerful message to share with school principals, parents and students and help us in our advocacy efforts.

One of the main challenges we faced was the sheer volume of activities at the very start of our project. We planned for a controlled roll out with just 8-10 hand-picked pilot teachers going through one week of PD the first summer and the course being taught in a handful of schools. Instead we ended up with ~70 teachers, which resulted in us having to run two one-week and one three-day PD sessions in the first summer, and the course being taught in almost 40 schools to a large number of students. Given our goal for systemic change in Chicago, this was an opportunity we could not pass up. One needs to seize the moment, especially since this was the result of school and district leadership being fully on board with the approach and plan. This is the first year the teachers are teaching the course and we are faced with the challenge of being able to provide appropriate support, as well as enough monitoring to ensure fidelity.

The rapid, almost instantaneous, expansion also meant that teachers from a wide array of backgrounds were recruited to teach the course (sometimes at the last minute). We had a mix of business teachers, used to covering applications and keyboarding, art and music teachers, math teachers etc., which found themselves learning a new pedagogy and new curriculum at the same time. Being able to support all these teachers again relied upon the creation of a strong sense of community and trust among the teachers so that they feel comfortable sharing their insecurities and asking for help from the more experience teachers when needed. The size of the community increases the need to maintain and support

communication among teachers between PDs. The infrastructure for this online community is still being built.

Don't be afraid of your success. If needed find other sources of funding, from requesting an NSF supplement, to partnering with local technology industries that share your goals and for which a small donation earmarked for broadening participation in CS is a feasible commitment.

Local District Teacher Leadership

In addition to what was mentioned above two key steps to ensure continuity and success for the project are: develop the ability of the leadership team to facilitate and run the professional development workshops and foster new leadership among the teachers. While having a national facilitator come to run the PDs is essential at the onset, it is unrealistic to expect one person to facilitate all PDs in Chicago. In our case it was also very important to make sure the new leadership reflected the diversity model ECS embraces. This can be a challenge since the teachers are already spending a lot of time learning the new pedagogy and concepts, and, occasionally doubting themselves. Include money in your budget to support sending selected teachers to conferences, leadership workshops and other similar opportunities that would help build the confidence and skills of the next group of community leaders.

Fitting into the District Organization and Priorities

It is easier to make inroads by piggy backing on an existing program like CTE that is cross-district and is present in a variety of schools with different levels of resources, and covers the socio-economic and ethnic spectrum. It would have been a lot harder to convince one principal at a time to offer the course and send the teachers to the appropriate PD. This approach is also a way to sustain the effort by hopefully being able to substitute the ECS PD for several of the program specific PDs planned throughout the year. In the long run, of course, a more systemic change will happen if CS methods courses are taught in Schools of Education where teachers are getting their credentials, and especially when a CS endorsement is created and recognized. This is not the case in most states today but it is something a comprehensive community of advocates could influence. We constantly work on both fronts: getting teachers ready to teach ToC through our PDs, teach it in as many schools as possible through programs like CTE and the STEM schools, and at the same time work on the larger political issue.

Question: How do we address equity issues in CS education?

Certainly ECS plays an important role in addressing equity issues by really "meeting the students, all students, where they are" through the concepts covered, the activities and the creation of an equitable classroom culture that is stressed so much in the PDs. This starts with the teachers themselves, through the reflections carried on during the PD and beyond. In addition to the above, one thing that we found compelling was the fact that the project involves such a diverse group of teachers (beyond racial and gender diversity) with very different backgrounds, and

who bring to the table many different voices. This enriches not just the conversations around the course, in the PDs and in the classrooms but the CS educators' community at large.

San Jose (Silicon Valley): Lessons Learned

PI: Dan Lewis

Question: How did you initially begin to build a foundation for ECS in Silicon Valley?

The dot-com bust and off-shoring scares caused enrollments in CS courses to decline – particularly in Silicon Valley where many parents who had been working in the computer industry were laid off. This caused the cancellation of many CS courses that were never restored due to California budget cuts to education. (E.g., only two of our 10 partner high schools still had a AP CS course, and less than half had an introductory programming class.)

We began by contacting district superintendents and their relevant curriculum leaders. They helped identify schools that would most benefit from introducing the ECS course. We established a liaison representative in each district who made introductions to principals and helped setup initial meetings with the principals, counselors and teachers to talk about ECS.

At meetings with superintendents, we found it is important to ask about credentialing requirements – i.e. who is allowed to teach ECS? (The Santa Clara County Office of Education later ruled that all ECS teachers must have a math credential, compared to LAUSD where this has not been a restriction.) Also, ask about any existing CS curriculum frameworks within each school and/or district. What other courses (CS or not) will ECS be competing against for enrollment? How will ECS fit within students' course sequences? At what grade level do students have the most elective freedom and the necessary prerequisites?

In, 2008, our first BPC proposal was declined because although we had letters of support from district superintendents and principals, we had not acquired such letters from teachers. In 2009 we revised our proposal and resubmitted with letters from teachers, principals and superintendents. The proposal was funded.

Question: What were your ingredients for success?

Some of our ingredients for success were:

- Provide principals, counselors and teachers with employment projections, Advanced Placement test taker trends, and high school CS enrollment trends (NCWIT "By the Numbers"). Counselors were given copies of NCWIT's

“Counselors for Computing” (C4C) package and asked to help schedule pizza talks and recruit students.

- Be inclusive of business teachers, media arts teachers, or teachers who have after-school robotics clubs who may not have been selected to teach ECS.
- Provide schools with flyers and course descriptions to advertise the course.
- Have undergraduates (especially students from underrepresented groups) give ECS recruiting presentations at each school and provide pizza. These presentations were based on NCWIT’s sample roadshow slides.
- We were able to acquire funding to provide CS graduate students who worked in the high school classrooms to provide curriculum and technical support to the teachers, give an occasional lecture, and talk about going to college and about career opportunities. We gave preference to female and Hispanic graduate students to provide role models for high school students from underrepresented groups.
- Success is most easily measured by looking for increased enrollment in other CS courses (if any) taken after ECS, and by pre/post surveys of students that ask about their interest in CS, their intent to take another course in CS, their intent to major in computing in college, or their intent to pursue a career in CS.

Question: What are some “Teachable Moments”?

- Be aware of the high school’s timelines for determining course offerings, student selection of courses, curriculum days and career days.
- Educate the counselors – particularly with regard to our commitment to underrepresented students.
- Get commitments to offer the course. (These will nevertheless be dependent on enrollment demand, so you have to recruit students.)
- Watch out for personnel changes – especially the principal. Commitments then get forgotten.
- Make certain you understand the importance of pedagogy in ECS – especially with regard to impact on underrepresented groups. Our project leaders were CS faculty with little or no training in pedagogy, so it was easier to fall back and focus on the technical content of ECS during the PD. The teachers came from technical backgrounds but had very little or no background in computing, so their personal objective during the PD was more focused on the technical content of the curriculum rather than the pedagogy. We later recognized the shortcoming and brought in Gail Chapman to talk about pedagogy during subsequent PD’s.

Question: How do we address equity issues in CS education?

This was the biggest challenge for our project, for many of the reasons stated above. We found that teachers will want to teach the technology, and are less inclined to focus on the inquiry-based pedagogy, so that must be addressed from the beginning. It is also important to work proactively with teachers to prevent subconscious bias

in the classroom. It is important to provide non-traditional role models, such as guest speakers who are members of underrepresented groups.

Summary of Lessons Learned

Respondent: Gail Chapman

From these three stories of implementation, we have learned several key lessons about district partnerships and the implementation of the ECS program across three contexts.

District Partnerships

Local Context Matters

The implementation of ECS is based on partnerships with local school districts. But, who the specific partners are within the district depends on the context, i.e. a large urban district or several small districts, any schools or a few schools? Within this context, where is the locus of leadership?

Multiple Entry Points

What are the right entry points for ECS in the particular district you are working in, i.e. where should it best be “housed” within the particular district? For instance, does it make sense for ECS to be part of the CTE program, and/or a program of electives? Within each district partnership there may be different and/or multiple entry points.

District Awareness and Multiple Advocates

Having multiple people in each stakeholder category, i.e. multiple advocates, is critically important because district leaders change all the time---leaving or getting promoted or changing jobs. Depending on the situation, can you find multiple advocates in the different entry points? Within each district it is important to think about who gets things done, and, how things get done. Making sure that multiple stakeholders (principals, school board members, teachers, counselors, parents) are aware of the program requires that a team member take on the task of district awareness.

Overlay of ECS with District Priorities

Which district initiatives does ECS best map onto? Which district priorities are enhanced with the introduction of ECS? Currently, with the adoption of the Common Core and the Next Generation Science Standards, both of which stress the importance of inquiry, critical thinking, and problem solving, there is a powerful connection with ECS.

Those Critical Details

It is the teachers and District partnership expertise that assures that projects recognize district timelines and plan accordingly, such as when do students choose

their schedules; how does that impact recruitment; what does it take to get new courses on the books; how do counselors assign students to courses etc.

Need for a Pathway of CS Courses for Sustainability

Even though CS is not at this time considered a core subject, principals of schools need programs of study (i.e. pathways of courses) to sustain a program. The program of study may vary from district to district depending on the current course offerings, the graduation requirements etc. While there is an important push to have CS learning begin in the middle school grades, ECS was designed as a high school course, preferably offered for 10th graders. The sequence of courses could begin with ECS and culminate in AP CS or the new CS Principles course. In between could be courses in subjects such as game design, robotics, computational media etc.

A Guiding Principle: Curriculum Fidelity

While the ECS curriculum purposefully makes room for teachers' adaptation of lessons to meet the needs of students (such as the Microsoft certification adaptation in Chicago), we stress the importance of following the curriculum content closely beginning with units 1 and 2. The ECS curriculum units are specifically ordered so as to scaffold the learning of all students, including novice students (since this is an introductory foundational course). When units 1-2 are taught out of order, or lightly skimmed, it waters down the curriculum. This may seem counterintuitive to teachers since units 1-2 are "computing light" and focus on problem-solving and computational practices (inquiry, collaboration, communication, algorithmic thinking) but they are critical to set the learning environment for the entire course. We have learned the importance of explicitly stressing this curriculum fidelity, as some teachers may avoid the challenges that come with the inquiry pedagogy in units 1-2 especially. The core curriculum that needs to follow a specific sequence is units 1-4. Units 5 and 6 can be taught in any order and other topics that cover the learning goals of these units can be substituted.

Pedagogy is Key

Curriculum is more than "notes on a page" and really depends on the teachers' pedagogy to bring the learning to life. The ECS curriculum depends on pedagogy based on three pillars: CS content, inquiry, and equity. These pillars and accompanying expectations for teachers must be made explicit from the beginning.

Equity

Equity is woven throughout everything we do in ECS---from the choice of districts we work with, schools we focus on, classroom environments and norms we advocate to engaging all students with the ECS learning content.

Importance of a Professional Community of Teachers

ECS is a program consisting of both the curriculum and the teachers' professional development. It is the teachers' pedagogy that really makes the learning

environment rigorous and engaging, and the PD program focuses on the CS content and the pedagogy. In addition the learning community provides:

- Ongoing opportunities for teachers to reflect on their practice and explore their belief systems and their impact on students.
- Leadership development ---opportunities for teachers to present, develop leadership locally and nationally, attendance at conferences etc.
- Opportunities for informal teacher community meetings in other settings.

Two Steps Forward, One Step Back: Surviving the Budget Cuts and Pink Slips

Just when you think you have a great core of teachers, and after you have invested much time and energy with teachers who you envision as ECS teacher leaders, you are likely to receive notice that several of your teachers have been laid off, and/or had their ECS sections reduced because the school needs more remedial math sections, and/or the teacher has been promoted to an out of classroom position. In fact, teacher retention may be one of the most serious issues facing all of education, and it is no different in ECS.

It is for this reason that we urge all projects to do the following:

- Have principals sign an agreement that if a teacher attends a summer PD, they have committed that teacher to teach ECS the following year
- Ideally, have several teachers in one school teaching ECS so that they can become a learning community and on-site support system for one another, and so they can take over a teacher's section if he/she is displaced or promoted. In this way the course, and the ECS investment in PD is protected.

It takes time

- Note that the first time Chicago and San Jose submitted proposals they were declined. In both cases this was largely because they did not have commitments from all the stakeholders – district superintendents, principals AND teachers.
- TRUST needs to be built—among the leadership team, between the leadership team and the principals, etc. What sorts of communication mechanisms work; who will handle what; how do you get schools to commit? These are important factors to consider.

Scaling is Not Sustainability

Scaling is not equal to sustaining. There is risk in expanding too fast; you want to seize opportunities where they exist, but recognize the tradeoff. The pace of expansion must allow the necessary time for developing teacher leadership and advocates among principals, etc. This provides a foundation that will help to ensure that as you scale, the program will continue with fidelity and will be less likely to be disbanded because of budget cuts, etc.

State and Local Policy

School projects to improve STEM learning come and go all the time. Often they exist in only a few schools and last as long as the funding cycle. Rarely is there much success in sustaining and institutionalizing the programs in the district. For a CS project to have maximum chance of a good launch and sustainability it needs the buy-in of the local district, as well as local and state educational policies that bolster the presence of CS education.

Conclusion

ECS has been expanding at a rate we did not imagine when we first drafted the curriculum five years ago. While every ECS partnership has its own history, we hope that with the publication of these working papers, lessons learned from one site will help benefit another. The overarching focus of this panel was the issues of scalability and sustainability---issues that will need to be addressed by every educational partnership and alliance committed to increasing access to computer science education.

The themes described in this paper offer a snapshot of the challenges associated with building and sustaining ECS programs in schools. As ECS and other computer science programs continue to expand nationally, the lessons learned from these early adopters can inform future implementations and research.