Deploying Exploring Computer Science Statewide

Helen H. Hu
Westminster College
Salt Lake City, UT 84105
hhu@westminstercollege.edu

Cecily Heiner
Southern Utah University
Cedar City, UT 84720
cecilyheiner@suu.edu

Jay McCarthy
University of Massachusetts Lowell
Lowell, MA 01854
jay.mccarthy@gmail.com

ABSTRACT
Exploring Computer Science (ECS) is a high school introductory computer science class designed to increase student interest in CS. Utah is the first state to offer ECS statewide and use it to meet a high school graduation requirement. Over the past four years, 150 teachers have been trained as Utah ECS teachers and over 10,000 Utah students have taken the class. The Utah initiative is unique because it is the first to deploy ECS in a non-urban environment and with a modified half-year curriculum that includes no additional equipment costs. This paper discusses how the Utah deployment was organized, reports its results and unique difficulties, and offers lessons for deployments with similar characteristics: statewide, rural, and limited resources.

1. INTRODUCTION
Through the Utah Exploring Computer Science (ECS) Initiative, Utah became the first state to offer ECS statewide, adopting a proven curriculum and professional development (PD) model. The original ECS curriculum is based on six units, whereas the Utah initiative pared the curriculum down to three units to create a half-year version of ECS. This modification streamlined adoption because existing Utah graduation requirements include only a half-year of computing.

Over the past four years, 150 Utah teachers have participated in the ECS PD workshops, more than tripling the number of CS teachers in Utah. These teachers prepared to teach ECS, developed their inquiry-based teaching strategies, questioned equity in high school computer science classes, and strengthened the high school CS teacher community. Since 2012, over 10,000 Utah students took ECS in over 100 public and private schools, including urban schools, rural schools, in-custody schools, online schools, non-traditional schools, and schools on Native American reservations. In 2015-16, the Utah ECS Initiative encompasses teachers in 27 of the 41 Utah school districts, including all of the 12 largest Utah school districts. These 27 districts teach 83% of all Utah students enrolled in public schools. Many of the districts that are not teaching ECS are tiny, *e.g.* a single secondary school serving approximately 100 rural students grades 7-12 simply lacks the students and resources for a new course.

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While ECS has been implemented in urban school districts prior to the Utah ECS Initiative, rolling out ECS statewide in Utah introduced several challenges not experienced elsewhere. Although Utah has some large urban high schools with racially diverse student populations, many Utah schools are predominantly white. The majority of the Utah teachers are white and from rural or suburban areas. The ECS PD curriculum is as much about culture as it is about CS; this created a very different environment for the ECS PD workshops than occurs elsewhere. For instance, when external PD facilitators spoke about a racial equity gap in high school, it was less effective for the local teacher population; but when we focused on a local message about the gender gap in CS, our teachers were more receptive to the equitable teaching practices that will benefit all minority groups in their classrooms. Section 6 develops these lessons for adaptation by others.

2. PRIOR WORK
The origins of ECS are detailed in [4]. In 2008-2009, seven schools in Los Angeles Unified School District (LAUSD) implemented the first ECS curriculum, which was organized around six modular curriculum units and three pillars: core computer science concepts, inquiry, and equity. The original professional development model lasts two years, starting with a five-day summer workshop, followed by four Saturday sessions during the school-year and ending with a five-day summer workshop. The curriculum aims for a “low floor and high ceiling” so any student can succeed and learn something valuable, and students that discover a passion can go much deeper and explore more computer science. ECS integrates a variety of introductory CS approaches, including CS Unplugged and Scratch [1, 6].

The success of ECS in LAUSD spurred its adoption in other areas, beginning with Santa Clara County in 2010 [5] and Chicago Public Schools in 2011[11]. Initially most of these projects were funded by the National Science Foundation, but Code.org has partnered with over 70 school districts, including all seven of the largest school districts in the country to dramatically scale-up ECS adoption [10]. These projects and partnerships have involved largely urban areas with high populations of minorities traditionally underrepresented in computer science. Many have shared their valuable lessons learned in implementing the course, including how equity is central to the ECS program and that ECS professional development is a continual learning process [7, 8]. Project leaders emphasized the importance of partnerships for scalability and sustainability, of engaging and supporting teachers with quality professional development and a learning community, and of aligning ECS into existing district priorities [8]. They also noted the need to look beyond enrollment numbers and to measure whether all students were being engaged and were learning computational thinking [7]. While many of these lessons are applicable to any educational setting, they do not address the specific challenges of deploying ECS statewide for students in all settings, including urban, suburban, and especially rural schools.

3. DEPLOYING ECS STATEWIDE

Utah schools have adopted ECS quickly in part because ECS was modified to solve a widely-recognized Utah problem and to fit within the existing Utah education structure. During Utah Computer Science Teachers Association (CSTA) chapter meetings, high school teachers identified the lack of CS course options for ninth and tenth graders. They also shared general dissatisfaction by parents, students, and guidance counselors with an existing computer literacy course that was required for high school graduation. Adopting a pre-existing curriculum, the Utah ECS Initiative ran its first ECS PD in 2012 on Utah State Office of Education funds, preparing two teachers to pilot ECS in 2012-13, only one year after ECS was first discussed in a Utah CSTA chapter meeting. The National Science Foundation provided the funds to roll-out the program statewide, and state-level champions at the Utah State Office of Education and the State Board of Education created a permanent ECS course and a new ECS endorsement for 2013-14.

Getting ECS approved as a permanent option for high school graduation (as an alternative to the computer literacy course) proved more of a marketing and political project, than a technical or educational one. One author became a regular participant in the local tech industry group's public policy meetings. This industry group's experience with the State School Board and the legislature were invaluable in getting ECS accepted as a high school graduation requirement and including ECS teachers in a salary supplement program. The week before the school board vote, leaders from the tech industry flooded School Board members with messages supporting the importance of computer science education, and a few prominent leaders spoke passionately for the issue at the meeting.

Key to making ECS a successful course was staying vigilant about any state legislation, state and district policy, and implementation changes that would affect ECS. For example, the State Office of Education created a task force in 2013 to consider removing the half-year computer literacy requirement for high school graduation. This task force became an opportunity to have ECS officially added to the graduation requirement. At another point, a large school district was requiring its students to take the original computer literacy course despite having completed ECS, thus disgruntling many parents and students until we reached out to clarify the graduation requirements. Project members presented regularly at state-level and district-level conferences for guidance counselors and high school CS teachers. We also worked with the CSTA state chapter to publicize the ECS course at regional Hour of Code events and with local media including the state newspapers and television news shows. The key lesson is that the success of the Utah ECS Initiative required regular communications with numerous stakeholders.

4. A HALF YEAR ECS CURRICULUM

The full Exploring Computer Science curriculum [3] has six units, which are broken down into 158 days of 55-minute lessons. While the full-year curriculum is preferable because it demonstrates more applications of computational thinking, Utah schools adopted ECS quickly because it could fulfill the existing half-year graduation requirement. Utah's half-year version of ECS includes:

- All 19 days of Unit 1 (Human Computer Interaction)
- All 21 days of Unit 2 (Problem Solving)
- All 30 days of Unit 4 (Programming with Scratch)
- 0-15 days from the 30 days of Unit 5 (Computing and Data Analysis)

Units 3 (Web Design) and 6 (Robotics) were completely cut from the curriculum, to avoid duplicating an existing web design program popular at many Utah schools and to avoid the expense of providing robotics hardware to schools statewide. The main downside of this cut is that the shortened course does not provide application for and emphasis of other ECS principles, and instead can only apply them in one environment (Programming with Scratch.) The Utah State Office of Education has created a second half-year ECS II course that would allow teachers to cover the remaining units, but thus far no public schools in Utah have adopted the full year course.

4.1 A Modified Data Analysis Unit

Initially, we designed a ten-day Unit 5 that was piloted by an experienced ECS teacher. Based on the piloting teacher's challenges and the wide range of classroom pacing across the state, we created three shortened versions of Unit 5: a five-day, ten-day, and 15-day, which are being piloted in multiple classrooms in 2015-2016.

The five-day option contains only the critical foundations of data analysis, such as plots, trends, statistics and data subsetting. Teachers can choose to follow up with either five or ten additional days if time permits. The longer option keeps the inquiry focused group project and much of the most applicable and engaging parts of the original data analysis lessons. The shorter option is based on the longer one, but replaces the group project with a simplified project analysis.

Although the current ECS curriculum allows teachers to select any software platform for Unit 5, the curriculum was originally written for Deducer (a GUI for R) [3], and many teachers found it difficult to teach with other tools. Our version replaces those lessons with lessons designed for online spreadsheet and mapping tools. The result is a shorter lesson module that can work without requiring additional software installation; the new module can be taught by teachers with existing expertise in business technology, a common expertise for our CS teachers.

5. ECS PROFESSIONAL DEVELOPMENT

Many Utah teachers learned about ECS through state-maintained e-mail lists. They registered for our program to meet the five requirements for a Utah ECS teaching endorsement: (1) completion of Code.org's 20-hour Code Studio course; (2) a five-day summer PD workshop; (3) monthly meetings with other first-time ECS teachers in their district; (4) a one-day workshop on Scratch programming; and (5) two additional state-level conferences. They were encouraged but not required to attend another five-day summer workshop in their second year. Stipends were provided to compensate them for their time ($1,500 for the first four requirements of ECS endorsement, and $400 for their second summer PD).

The five-day summer PD also served as a Teaching Methods course for CS endorsement (the state requirement for teaching Computer Programming and CS Principles). Our workshops filled a major gap in the statewide education system, since no Utah universities in the state offered CS teaching methods courses. Teachers seeking a CS endorsement (rather than ECS endorsement) received a $400 stipend for their participation. They immediately recognized that a successful ECS course would increase the enrollments in their other CS courses, and many were able to add ECS to their teaching schedules for the upcoming year.

5.1 Five Day Summer PD

Unlike many traditional textbook curricula, ECS is not a course that can be fully understood without attending a five-day workshop. When teachers read the curriculum alone they do not understand what teaching practices make ECS distinctive. Our project benefitted significantly from an invitation to visit Chicago and participate in one of their professional development workshops. To pay it forward, we hosted a teacher from Maryland and shared materials with Massachusetts.

The five-day summer PD designed by Goode and Chapman inculcates teachers on the three pillars of ECS: (1) computer science concepts; (2) inquiry-based teaching practices; and (3) equity in the classroom.

Nationwide, workshop facilitators first model a few ECS lessons, which all participants experience as if they were high school students. These lessons are followed by a reflective session on how the lesson went and what pedagogical choices were made by the instructors. Many teachers express surprise at how inquiry-based teaching practices can transform a classroom. Eight other ECS lessons are assigned to participants to deliver in groups (preferably groups of four teachers). Equity issues are introduced when participants read and discuss chapters from *Stuck in the Shallow End* [9].

The five-day ECS PD was well-received by Utah CS teachers (4.33 on a 5-point Likert scale by 2014-15 teachers), but could sometimes overwhelm teachers who were completely new to CS. By the last year of the project, we required Utah teachers to complete the 20-hour Code Studio before attending the five-day PD. This exposure to programming helped prepare new-to-CS teachers for the CS concepts covered in the five-day PD.

In response to negative feedback about how equity was discussed in the PD, we shifted the emphasis on equity from race to accessibility, gender, and socio-economic issues in the first half of the week. Recognizing that some Utah teachers had little diversity training or experience teaching racially diverse classrooms, we added short 15-minute sessions to the PD workshop explaining how equity differed from equality, how culture means more than race, how implicit bias is present in everyone, and how to react to micro-aggressions in the classroom. These sessions were designed in response to feedback that teachers wanted more concrete suggestions on equity. In the last iteration, we included too many of these sessions; survey responses suggested the teachers may have been better served by half that many sessions. We discuss this feedback in detail in Section 6.1.

Finally, we partnered with NCWIT's Counselors for Computing (C4C) to share more information about CS pathways and career opportunities. Teachers were especially excited to receive CSTA posters to highlight the multiple facets of computer science.

5.2 District Monthly Meetings

In addition to the five-day summer professional development that was designed primarily as a pre-service activity for new ECS teachers, we ran mandatory monthly meeting groups to provide in-service support for first-time ECS teachers. These groups offered teachers opportunities to discuss local logistics and receive additional training after obtaining some experience in teaching ECS. The monthly meeting groups were generally organized at the end of the workshop. Three to six new ECS teachers were assigned to a group led by either an ECS facilitator or an experienced ECS teacher. Groups met for approximately 90 minutes, followed an established agenda (available at http://www.tinyurl.com/ecs-agenda), and shared their progress by posting their minutes to the CS10K community site.

Our monthly meeting groups were initially organized to limit driving, with groups being assigned geographically based on residence. However, several of our teachers lived in one district and taught in another. As a result, many teachers in our first round of in-service training were attending mentoring groups with teachers who taught in different districts. This made scheduling the meeting times more challenging, and also made discussions regarding district wide issues difficult. In 2014, we changed the model so that teachers were grouped with other teachers who taught in the same district.

Another unique aspect of our monthly meeting groups is that some teachers in rural areas lived too far from other ECS teachers to make face-to-face meetings practical. We resolved this problem by offering online mentoring groups through Google Hangouts. Because district IT was not always friendly for video conferencing, we collected a variety of contact methods including phone numbers. When there were technical connection issues, we were able to fall back on phone conferencing to patch teachers into the meeting. We intentionally kept the maximum size of online groups smaller than in-person groups.

5.3 One Day Scratch PD

In place of the third monthly meeting, we held a full-day combined workshop for new teachers on the Scratch programming unit. Groups of teachers presented on Scratch similar to the practice during the summer. In 2012 and 2013, we did not cover Scratch as part of the summer workshop, and many of the teachers were not prepared to teach effectively during this follow-up. Teachers that were assigned lessons later in the Scratch unit found their assignments especially challenging. In 2014, the teachers received more instruction in Scratch as part of the summer workshop, and they were more prepared to teach Scratch. In 2015, we did even more preparation by having teachers complete 20 hours of coding before attending the summer workshop, and the discussion on programming was much stronger.

5.4 Creating Leaders from ECS Teachers

We identified a pipeline of ECS mentors and facilitators through this process. The second summer of ECS PD was not required, so teachers who attended a second ECS five-day PD were our more committed teachers. Other enthusiastic teachers chose to present at the state-level conferences about ECS. We also observed teachers' ECS classrooms if they were within an hour of Salt Lake City. We invited enthusiastic teachers who demonstrated a good understanding of the inquiry-based teaching practices and equity issues to serve as mentors and to lead the district monthly meetings. Mentors were also invited to observe a third ECS workshop, to prepare them to serve as workshop facilitators in their fourth workshops (following the national ECS model for developing ECS facilitators). Three Utah teachers are trained and experienced ECS workshop facilitators. Two of these teachers were new-to-CS teachers at their first ECS workshop, and two teachers are currently serving as President and Vice-President of our Utah CSTA Chapter.

6. RESULTS

ECS in Utah has experienced astonishing growth (see Table 1), beginning with 53 ECS students in 2012-2013, and reaching over 5000 students in 2015-2016. One downside of this rapid growth is that more than half the ECS schools each year have been new to the program, where the first-time ECS teachers have not yet attended the PD and learned about equity. Thus, the gender breakdown of Utah ECS students has not reached the high percentages achieved in other districts, but is more than double than for other CS courses in Utah (28% female in 2014-15, versus 43.7% female in LAUSD and 13% in other Utah CS courses). On the other hand, because we have targeted large, diverse urban high schools early in the project, the 2014-15 racial diversity of ECS students are higher than those for the state as a whole: 65% white (76% in Utah), 23% Hispanic (16%), 4% Asian (2%), 3% African American (1%), and 1% Native American (1%).

Table 1. ECS Adoption in Utah

	2012-13	2013-14	2014-15	2015-16
Workshops	1 workshop	1	2	3
New Teachers	2 teachers	21	49	78
Total Teachers Trained*	2 teachers in 2 districts	23 in 10	72 in 23	150 in 27
Schools Offering ECS*	2 schools in 2 districts	17 in 9	53 in 22	106 in 26
ECS Students Enrolled	53 students	1205	3461	5375
Total Students	53 students	1258	4719	10,094

* teacher and school counts include public, private and charter schools, but student and district counts only include Utah public school districts

ECS students completed a retrospective pre/post-survey in the last month of the course. On a Likert scale of 1-5 (1=not competent at all to 5=perfectly competent), 2014-15 students had statistically significant gains in their knowledge and problem solving skills in computational thinking (31% increase from 2.86 (σ=0.93) to 3.74 (σ=0.94), $p<0.05$). Similarly, they showed significant gains in their ability to apply abstractions to problems and to write computer programs (33% increase from 2.86 (σ=1.02) to 3.79 (σ=0.95), $p<0.05$), and a slight increase in interest in working in pairs or teams (41% to 48% prefer learning best with a peer or group). Students had a significant increase in their likelihood of enrolling in additional CS courses (3.06 (σ=1.25) to 3.71 (σ=1.21), $p<0.05$) and an increased interest in studying a CS related major in college (17% to 30% of the class population).

6.1 Lesson 1: The Equity Gap is Not Obvious To All Teachers

One of the three pillars of ECS and a motivating factor in the curriculum design is equity. We repeatedly received negative comments about this part of the workshop. We used the book *Stuck in the Shallow End,* which discusses computing, equity, and race in the LAUSD [9] to seed many of our equity discussions. Many of the negative comments were targeted at the book, claiming that it was "outdated" and irrelevant because it was published about LA over a decade ago. One 2015 teacher wrote, "I did not like that book. I understand that my classes need to be equitable without reading about outdated studies done in LA, which is not at all comparable to my school." Another 2015 teacher claimed: "I don't think things [in Utah] are as bad as depicted in this book."

Many teachers expected that they would spend every day learning more computer science lesson plans and practicing concrete technical skills. One teacher wrote, "I do want those students in my class and I will try to engage them, but is it my job to tell them that they should be in those classes when they suggest they are uninterested? Through manipulative tactics? Shouldn't I respect that they have different interests than I do?" Another said, "[Equity] was talked about TOO much. I needed more content information." When they were not asking for more technical content, they simply expressed their emotional exasperation: "I understand the importance of demystifying computer science and reaching more groups [girls/Latinos/etc]; however, I see no reason to beat the subject of Equity 'to death' day after day!" Most concerning, some teachers did not understand what they should do about it. One teacher said, "[I wish we had] more time talking about how we as teachers can address the things that we see in our own schools."

In hindsight, we did not anticipate this resistance (projects in areas with more cultural diversity had not experienced these challenges to this degree), and we did not include enough survey questions to assess change in teachers' viewpoints. We asked teachers to rate their "understanding of equity in the classroom" (2.74 (σ=1.03) to 3.95 (σ=0.77), $p<0.05$) and their "ability to teach for equity" (2.82 (σ=0.98) to 4.01 (σ=0.78), $p<0.05$), but these questions are not nuanced enough and assume that teachers believe equity issues exist in classrooms. We should have explicitly asked "Do equity issues exist in your classrooms and schools?" and "What kinds of equity gaps exist?".

Over time, we learned to tailor the presentation of equity to local issues, often starting with the less-threatening socioeconomic status and then branching into accessibility [12], gender and race. Our discussions were more effective when teachers could connect the issues to their own experiences.

Racial equity was especially difficult given Utah's relative racial homogeneity. Our teachers felt it difficult to extrapolate from the book's material to their own experience in their classrooms. One teacher said, "I felt the book and study itself were bias [sic] and not reflective of the nation as a whole, nor do I think it reflects the Utah culture. If you could find a study on gender, that would more appropriately reflect Utah's bias." Our teachers were more willing to confront inequities related to characteristics such as gender, socioeconomic status, religion, and even, in our reservation schools, different tribal affiliations. We were initially not prepared for the strong negative reaction many of our teachers had to the race issues addressed in *Stuck in the Shallow End*, and our surveys did not explore the reasons for these reactions. We hypothesize that some of these reactions may be explained by the dynamics of White Fragility [2].

The cultural challenges of the curriculum were especially clear with ECS lessons like the cornrow curves assignment and the Martin Luther King website analysis. Many of our teachers were extremely uncomfortable with these lessons. Some teachers refused to use the lessons. One teacher was especially candid and explained that they were "afraid to teach a lesson like that" to a classroom of only white students, some of whom may have never seen an African-American in person. They felt they were inadequately prepared to address the cultural issues that were likely to come up in teaching these lessons. In a multicultural setting, these lessons would be connecting CS concepts to pre-existing cultural knowledge for at least some of the students. In our less diverse setting, teachers and students had no relevant pre-existing cultural knowledge, and the curriculum and PD did not adequately scaffold this knowledge for our teachers.

We learned that equity, diversity, and cultural issues have a huge range of meaning across the States. The issues that were relevant and natural during ECS' birth in a racially diverse culture were a challenge to adapt to a middle-America setting with a racially homogeneous population. We needed to think critically about which issues were necessary to discuss (such as giving all students opportunity) and which lessons could be taught using less controversial materials (such as using the Pacific Northwest Tree Octopus website for content analysis). This was an instance where we needed to spend more time making local adaptations. Future deployments of ECS should also consider cultural context.

6.2 Lesson 2: The Professional Development Model of ECS Requires Continual Growth

ECS has its own culture: the foundational pillars are equity, inquiry, and CS concepts, but there is also a strong focus on continual professional development for students and teachers alike. Continual professional development means a continual upward spiral of progression. It also means recognizing that teaching may never be perfect, but it can get better. Even with a fairly specific curriculum, there are many variations on how a lesson can be taught and adaptations that can be made to improve the lesson for a teacher or a student.

Many questions in ECS lessons from the fundamental "What is a computer?" to the more abstract "How do culture and computing relate?" are left deliberately open ended, and often learning is less about arriving at a particular "right" answer than it is about learning how to approach the problem using tools of computation. Many first-time teachers arrived at the workshop wanting "the answer". The lack of direct information dissemination was overwhelming for some teachers as indicated by the comment "The project coordinator was more concerned with our comments rather than giving ideas to us. We had to come up with ideas like our students do, which sometimes is not enough direction to move forward." Another comment indicated "At first it was weird trying to figure out what they meant, but the process of figuring out helped me to really analyze my teaching." Teachers' self reported ratings of their role "to think reflectively about my teaching practices" increased (27% from 3.16 to 4.01, $p<0.01$).

Initially, many returning teachers indicated that they felt that they had learned what they needed to know and did not have anything new to learn. One teacher reported "I took this workshop last year and this [picture activity] was a repeat." Others were overzealous in their desires to tell new teachers how they had taught ECS and how to teach ECS; they wanted to give "the right answer" to the teachers who were asking for it. As we discussed the issue with other facilitators including Gail Chapman, our professional development process for returning teachers evolved. In 2015, we included a letter and additional debriefing sessions at the beginning and end of the workshop day to help them focus more on their own development as well as helping the new teachers develop. We specifically focused on the issue of asking better questions as opposed to providing better answers. In 2015, the 15 returning teachers rated these debriefing sessions 4.2 on a 5-point Likert scale.

6.3 Lesson 3: Local Facilitators Preferred

In our surveys and interactions with our teachers, we repeatedly heard complaints about any facilitator who was perceived as an outsider to Utah culture. Unlike a workshop about a new textbook or a new software tool, the content of an ECS workshop includes more emotional discussions focused on the social and cultural issues that arise in a classroom. Two of the pillars of ECS, equity and inquiry, are about these issues. During PD, facilitators seek to demonstrate inquiry-based learning by having lots of tight interactions with teachers; they seek to expose and confront equity issues directly by talking about them openly. Many of our teachers felt that this created a tense and draining environment where they were being judged by external facilitators for their classroom practices and their cultural background.

Participants would sometimes even question some of our local facilitators on how long they have been in the community and the extent to their involvement. Utah has a strong local custom for modest dress and hairstyles, which immediately brands many visitors and some long-time residents as outsiders. Once we identified this preference for local facilitators, we were able to plan our discussions and approaches differently and create a better connection with the teachers. One teacher commented after their second summer workshop, "I quickly noticed that having a Utah team lead the workshop seemed more inviting and supportive than with the UCLA presenter who facilitated this workshop last summer." One team member experienced this local preference from the opposite direction when she facilitated a workshop in another state and felt the same push-back for being an outsider in that state.

Teachers' ratings of facilitation increased when the facilitation was done by a local team (from 3.91 (σ=0.95) for an external facilitator to 4.37 (σ=0.69) for local facilitators, p=0.01). Our recommendation to future efforts is to pay strict heed to understanding and adapting the curriculum and PD to the dominant culture of teachers and using as many local facilitators as possible, especially for the most pressingly emotional and social issues, so that teachers will buy-in, rather than push-back.

6.4 Lesson 4: Account for Workshop Attrition

Our initial plan was to run a total of eight workshops over four years and train a total of 105 new ECS teachers, with each workshop accommodating approximately 10-20 teachers. Within one year of the project, we realized that we had failed to account for two major factors in our calculations. First, because we were deploying statewide and many teachers did not feel a high degree of accountability to workshop facilitators, many teachers signed up for a workshop but did not attend. Second, ECS workshops are ideally run with 24-32 participants (to allow for 3-4 teachers to present each of the eight lessons). To fix both of these problems, we ran fewer workshops in our second year and began overbooking workshops to account for no-shows. Teachers who provided administration letters committing to two years of ECS courses were offered priority registration, whereas other teachers were admitted on a space-available basis. Our 2014 and 2015 workshops had a 11-23% no-show rate. Asking for letters demonstrating administration support helped reduce the no-show rate, but failed to eliminate it. Even workshops filled exclusively with teachers with letters from their administration still had over 10% of the teachers drop out.

Our smallest workshop had 22 teachers (28 registered) and was offered in a rural area, in part to accommodate teachers from rural areas who might find cities intimidating. Quality discussions can be difficult for the smaller groups, with less opportunity for diversity of thought, controversy, debate, or serious discussion. Our largest workshop had 39 teachers, the result of registering 46 and not having as much attrition as we were expecting. Larger groups made it more difficult to maintain individual accountability in completing homework and participating in workshop discussions. Individual teachers were more likely to show up late, disappear to answer phone calls, and be distracted by their laptops. The quality of the discussion dragged, and teachers and facilitators alike found it much more difficult to emotionally invest in a larger group where sharing deeply personal feelings and potentially controversial ideas is more intimidating.

6.5 Lesson 5: Scaling to Statewide Brings a New Set of Logistical Challenges

Scaling to statewide brought extra logistical challenges. With teachers in rural areas, we had to be more strategic about supplies, help arrange hotels and carpools, and make compromises in the evaluation of their teaching since it was impractical to observe their classrooms.

Recruiting practices differed in effectiveness for different teacher populations. Teachers in Northern Utah and teachers in larger districts were more likely to attend state-level conferences and therefore easier to recruit. Their guidance counselors were similarly easier to reach. To reach out to the smaller districts, we contacted district-level Career and Technical Education (CTE) directors and asked them to help identify appropriate teachers and inform guidance counselors. However teachers sent by school or district administrators were more likely to complain about ECS. Experienced ECS teachers were our best recruiters; many would convince their colleagues from other schools and districts to attend.

School schedules and class schedules often varied tremendously within a single workshop, and we often had teachers on traditional schedules, trimester schedules, A/B day schedules, and project based schedules in the same workshop. When we tried to address scheduling concerns as part of the week long workshop, teachers complained "good but not practical for different schedules." We found that by moving more of the scheduling logistics to the monthly mentoring meetings and by organizing monthly mentoring meetings by district, we were able to provide ECS advice and schedule scaffolding that was relevant and tailored to the teachers' needs.

7. CONCLUSIONS

In conclusion, the Utah Exploring Computer Science Initiative has led the first statewide deployment of ECS. This deployment is unique due to its geographical breadth, diversity of population density, and half-year variation of the ECS curriculum.

This paper has described our experiences during the first four years of this deployment and our contributions of (section 4) a model for adapting the standard ECS curriculum into a half-year variation suitable for credit-hour- and resource-constrained schools; (section 5) a multi-year professional development plan that turns some teachers with no CS experience into instructors, mentors, and workshop facilitators; and (section 6) a set of concrete lessons for adapting ECS to new geographical and cultural settings.

We hope that our results and techniques will be replicated in other states and regions so that the computer science education community can better understand the benefits and challenges of deploying courses like ECS in areas like rural, middle America.

We have created a sustainable program for introductory computer science for all Utah students; our next goal is to use ECS to identify promising teachers who we can train to teach the AP CS Principles course.

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9. REFERENCES

[1] Tim Bell, Gwenda Bensemann, and Ian H Witten. 1995. Computer science unplugged: Capturing the interest of the uninterested. In Proceedings of the 14th New Zealand Computer Conference.

[2] Robin DiAngelo. 2011. White Fragility. *International Journal of Critical Pedagogy,* 3 (3) (2011), 54-70.

[3] Joanna Goode and Gail Chapman. 2015. Exploring Computer Science. Version 5.0. Downloaded on August 13, 2015 from http://www.exploringcs.org/curriculum

[4] Joanna Goode and Jane Margolis. 2011. Exploring Computer Science: A Case Study of School Reform. Trans. Comput. Educ. 11, 2, Article 12 (July 2011), 16 pages.

[5] Daniel W. Lewis, Lisa Kohne, Timothy Mechlinski, and Mariana Schmalstig. 2015. The Exploring Computer Science Course, Attendance and Math Achievement. In Proceedings of the 2015 ACM Conference on Innovation and Technology in Computer Science Education (ITiCSE '15). ACM, New York, NY, USA, 147-152.

[6] John Maloney, Mitchel Resnick, Natalie Rusk, Brian Silverman, and Evelyn Eastmond. 2010. The Scratch Programming Language and Environment. Trans. Comput. Educ. 10, 4, Article 16 (Nov 2010), 15 pages.

[7] Jane Margolis, Gail Chapman, Joanna Goode, Lucia Dettori, and Dan Lewis. 2013. A Tale of Three ECS Partnerships and Why Scalability ≠ Sustainability. Exploring Computer Science Working Paper #1. Retrieved from http://www.exploringcs.org/research/ecs-working-papers

[8] Jane Margolis, Joanna Goode, and Gail Chapman. 2015. An Equity Lens for Scaling: A Critical Juncture for Exploring Computer Science. In ACM Inroads, 6, 3 (Aug 2015), 58-66.

[9] Jane Margolis, Rachel Estrella, Joanna Goode, Jennifer Jellison Holme and Kim Nao. 2008. Stuck in the Shallow End: Education, Race, and Computing. The MIT Press.

[10] Hadi Partovi. A Comprehensive Effort to Expand Access and Diversity in Computer Science. In ACM Inroads, 6, 3 (Aug 2015), 67-72.

[11] Dale Reed, Brenda Wilkerson, Don Yanek, Lucia Dettori, Jeff Solin. 2015. How Exploring Computer Science (ECS) came to Chicago. In ACM Inroads, 6, 3 (Aug 2015), 75-77.

[12] Andreas Stefik and Richard E. Ladner. 2015. Introduction to AccessCS10K and Accessible Tools for Teaching Programming. In Proceedings of the 46th ACM Technical Symposium on Computer Science Education (SIGCSE '15). ACM, New York, NY, USA, 518-519.