

TEALS: Teacher Professional Development Using Industry Volunteers

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ABSTRACT

Rising demand for high school computer science courses in the United States has created pressure to increase the number of computer science(CS) teachers in a short amount of time[2]. In this experience report, we present the TEALS program as a unique, high-touch, professional development model, pairing computing industry professionals with classroom teachers. By combining the relative strengths of the team (content and pedagogy) TEALS has been able to successfully train new CS teachers. We present the history of the TEALS program, the volunteer and teacher recruitment process, the volunteer training program, data from a study of the pedagogical content knowledge of the TEALS volunteers, and program growth and efficacy data. Additionally, we offer achievement of students on the AP CS A exam as an externally valid measurement of learning outcomes in TEALS classrooms.

Keywords

TEALS, Professional Development, Teachers, K12

1. INTRODUCTION

There is an increasing demand for computer science (CS) courses in high schools. In 2012, approximately 2,000 of the 30,000 high schools in the US had AP CS courses. The increase in programs must, by necessity, be accompanied by an increase in teachers who have appropriate pedagogical and content knowledge to effectively teach CS courses at the high school level.

Programs focused on expanding access to CS recognize the need to rapidly increase the number of CS teachers in the country[2]. Ideally, CS teachers would be prepared through a rigorous teacher preparation program that included instruction in both CS content and pedagogical knowledge required to be a teacher[3]. Unfortunately, few pre-service programs for CS Education exist. Many programs attempt to broaden participation in computing by offering summer workshops for teachers[5, 7]. In these workshops, teachers

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with little or no CS experience learn both CS content and how to teach CS.

In this experience report, we discuss TEALS' (Technology Education And Literacy in Schools) model of teacher professional development(PD). The TEALS program, described in Section 3, places CS experts in the classroom alongside teachers. We will discuss current PD models, the TEALS model specifically, and share data about the growth of TEALS in the United States. We will present data showing the outcomes of TEALS partnerships in transitioning classrooms from volunteer-supported to independent teaching, and share observations from an educational research firm's external evaluation of the TEALS program.

2. TRADITIONAL MODELS OF TEACHER PROFESSIONAL DEVELOPMENT

Teacher preparation has two phases. Before teachers enter the classroom they are considered pre-service, and the ongoing professional development a teacher completes while employed in a school is considered in-service. This section discusses current models of teacher preparation in CS.

2.1 Pre-service Teacher Education Programs

Pre-service teacher education programs in the United States are often undergraduate or graduate programs that work with students who are not yet teachers. The pre-service programs include coursework in content and pedagogy. For graduate programs, mostly used by professionals seeking a teaching certificate as a secondary career option, there may be fewer content specific requirements as the student would already have significant coursework from a related undergraduate degree if applicable.

Pre-service teacher preparation is rigorous, and despite the debates around its efficacy[1], often requires multiple years to complete. Enacting pre-service teacher preparation for relatively rapid CS teacher training has many barriers. First, pre-service preparation programs require at least one year to complete all of their components. Secondly, pre-service educators are not guaranteed positions at schools, and therefore may not be hired to teach computer science, even after they complete the program. Finally, there are few existing pre-service computer science teacher programs and programs have had difficulty recruiting potential teachers[6].

2.2 In-service Professional Development

In-service teacher education builds the capacity of current teachers in a new subject area or methodology through learning experiences called professional development(PD).

There are many models of in-service education, and a wide variety of providers of such training[8]. TEALS considers itself to be an in-service model of teacher development.

In-service teacher development or professional development can have positive impact on teacher practice[9]. Traditional models of PD have a much shorter time frame between PD implementation and classroom implementation than pre-service options. Because, by definition, in-service teachers are already employed by schools, there is a direct connection between the teacher and a classroom, or school schedule. Many existing models of PD used by the computer science education community rely on spring and summer PD for implementation of new material or new courses the following fall[5, 7]. The length of the PD interventions varies widely by program, some as short as a few days and others requiring many hours of independent study coupled with in person instruction by a provider. Unlike pre-service programs, where prospective teachers study content and pedagogy separately, in-service programs require teachers to develop both at the same time.

3. THE TEALS MODEL OF TEACHER PROFESSIONAL DEVELOPMENT

3.1 History of TEALS

The TEALS program grew from the efforts of its founder, Kevin Wang. After completing a B.S. in CS from UC Berkeley, Kevin worked as a CS teacher for 3 years and earned a Masters degree in Education from Harvard. In 2006, Kevin transitioned to a position at Microsoft to work on a project in distance learning. Kevin began volunteering at an independent school in Seattle, teaching CS 1st period. Other Seattle-area high schools heard about the arrangement, and asked Kevin to teach CS at their schools as well. Not wanting to give up his full-time engineering position, he found other volunteers at Microsoft to serve the additional schools. In the 2010-2011 school year, he formalized this arrangement as TEALS.

In 2011, TEALS formed a partnership with Prof. Stuart Reges at the University of Washington to use Reges' AP CS curriculum. TEALS also partnered with Prof. Dan Garcia at UC Berkeley, and together they created a high school adaptation of Garcia's Beauty and Joy of Computing class using the SNAP! programming language. With a growing cohort of new volunteers, TEALS began a formalized summer training program, aimed at familiarizing volunteers with the curricula, and introducing them to the basics of classroom management and student-centered learning.

The supply of software engineers willing to take on an early-morning part-time job could never scale to provide instructors to each US high school. To address the sustainability of the co-teaching model, TEALS adjusted the program to focus on building teacher capacity in CS. The adjusted model aims to hand off instruction of each CS class to a classroom teacher after 2-3 years of partnership, and holds schools accountable to that goal.

With financial support from Microsoft, TEALS has continued to grow rapidly. In 2014-2015, TEALS served 131 schools in 18 states and Washington DC. Those included 8 private schools, 13 public charter schools, and 110 non-charter public schools. Forty-eight (48) of the schools qualified for Title 1 school-wide programs, indicating that over

40% of their students are eligible for federal free or reduced-price lunch programs.

3.2 The TEALS Model of In-service PD

The TEALS program aims to expand access to computer science in high school by building CS teacher capacity. Partner schools identify a teacher from any discipline who is willing to become a CS teacher, but does not have a CS background. TEALS helps to find and train computer science experts as volunteer instructors, and creates teaching teams of four volunteers plus the partner teacher. The school offers a single section of computer science during first period, early enough for the volunteers to visit before their workday begins. Each volunteer attends class 2-3 times per week. Schools choose to offer either Introduction to Computer Science Principles (a 1-semester subset of the Beauty and Joy of Computing AP CS Principles course) or AP Computer Science A. The TEALS program provides curriculum materials, volunteer training, a community of support, special events and opportunities for students and teachers, and ongoing feedback and observation of partner classrooms.

During two years of partnership, the classroom teacher gradually increases their role in the classroom from learner, to supporter, to primary instructor. At the same time, the volunteers reduce their role from primary instructor to supporter. The TEALS partnership is much longer than most traditional in-service PD models. Over the course of a standard 2-year partnership, a teacher participates in approximately 300 hours of co-teaching with students and subject-matter experts in the classroom. Other styles of PD often rely on teachers attending sessions outside the workday. TEALS partner teachers gain experience in programming and computer science during their normal teaching hours and in their classroom.

3.3 TEALS Volunteers

Volunteers power the TEALS model. TEALS attempts to place 4 volunteers into each CS classroom with a teacher, though this is sometimes limited by availability. A multi-volunteer team reduces the time-commitment, allows flexibility for volunteer travel, and provides redundancy in case of a volunteer withdrawal from the program.

The selection and training process helps to ensure the selection of reliable volunteers with deep content knowledge, and an appropriate classroom demeanor. TEALS regional managers review volunteer applications and conduct interviews with each applicant. Representatives from partner schools attend the interviews to meet the candidates and give input regarding selection. The interview focuses on several areas: the applicant's technical credentials; the program model and commitment; past teaching experience; and presentational style. After the interviews, TEALS regional managers, with input from school representatives, choose which applicants to accept into the program and where to place them.

Volunteers commit to TEALS for one year. TEALS estimates that the total volunteer commitment for a year includes 260 hours of participation. The commitment begins with a summer training program (discussed in the following section), and includes classroom time, commuting to and from the school, preparation for class, regular team meetings, and monthly TEALS events.

In the 2014-2015 school year, TEALS worked with approximately 475 volunteers. The 334 volunteers who specified a current employer represent 144 distinct organizations. 135 (28.4%) of the volunteers work at Microsoft. 107 (22.5%) volunteers are female. TEALS does not collect data on the race or ethnicity of its volunteers.

During their application interviews, volunteers explain their reasons for participating in the program. Many volunteers feel fortunate to have landed in a career they enjoy that supports them well, and they seek an opportunity to give back. Some express interest in helping students from underrepresented groups such as young women and people of color to gain exposure to Computer Science. Other volunteers cite a specific teacher or mentor who inspired them in computer science whom they want to emulate. A few share that they “stumbled onto” CS late in college or after another career and wish they found it sooner. They want to provide today’s students with the chance to get in the door earlier.

TEALS volunteers tend to loosely fit into one of three profiles: recent college graduates who don’t have many family commitments; mid-career veterans, often with children in high school; and retired former-engineers with lots of time on their hands looking for something worthwhile to do.

3.4 TEALS Volunteer Summer Training

An effective classroom requires an instructor with skill in classroom management and pedagogy, with knowledge of the relevant subject area, and with specific knowledge of how to teach that subject (pedagogical content knowledge or PCK) [4]. The TEALS classroom relies on collaboration between the classroom teacher, who brings skill and experience in managing a classroom and general pedagogy, and the volunteers, who bring a wealth of knowledge of the subject area.

TEALS’ summer training program aims to introduce volunteers to the ideas of classroom management and pedagogy, and to walk through parts of the curriculum, emphasizing key pieces of pedagogical content knowledge. Classroom teachers are encouraged, but not required, to attend. TEALS estimates approximately 30% of classroom teachers attended one or more summer training sessions in 2014-2015, but these data were not formally collected.

The format of the summer training program has evolved and changed each year. In 2014-2015, the program consisted of 5 in-person 2.5 hour sessions held every 2 weeks, interspersed with 7 hours of online interactive video modules. In addition to the formal content, volunteers completed the major programming projects for the course, and met with their teaching teams to devise a syllabus and classroom plan.

One set of online training modules focused on the theory behind pedagogy techniques. Other online modules introduced the major curriculum projects and highlighted areas likely to cause students trouble. In-person training sessions provided an opportunity to model good teaching practices like questioning techniques, pacing, and group activities. In a typical interaction, instructors would model an activity, have groups of attendees practice implementing that activity, and then reflect on it.

Table 1 illustrates the breakdown of topics presented in the 2014-2015 TEALS summer training and an approximation of how much time was spent in each major area.

Major Topic (% Time)	Details
Classroom Management (18%)	Creating and implementing classroom procedures; Student notetaking; Setting clear expectations; Use of bonus incentives; Distribution of labor between team members
Pedagogy (35%)	Bloom’s Taxonomy; Creating learning objectives (SWBAT); Formative Assessment; Lesson Pacing; Writing lessons; Grading; Homework; Questioning
CS PCK (20%)	Pair programming; Socratic questioning; Design/Problem solving; Group activities; Peer assistance; Encouraging persistence; Debugging; Moving from concrete to abstract; Procedural decomposition; Demo and tutorials; CS Unplugged activities;
Working with Schools (7%)	School roles and personnel; Expectations of staff; Teacher-student relationship; Setting up the classroom; Getting help
Curriculum (12%)	Set of topics; Major projects; Lab ideas; AP Test Prep;
Program Info. (8%)	Administrative topics; Deadlines; Program model

Table 1: TEALS Summer Training Topics

3.5 TEALS Teacher Selection

TEALS considers the selection of a teacher as the most critical component to a successful partnership. Most importantly, that teacher must have several years of classroom experience, and demonstrate personal investment in the successful outcome of the TEALS partnership. TEALS does not specify a required subject area for partner teachers.

TEALS requires schools to nominate a teacher for the partnership when they apply to the program. That teacher must attend the partnership interview and meet the TEALS regional manager. During the interview, TEALS staff inquire about the teacher’s educational background, experience, and reasons for participation. The TEALS Regional Manager reviews the model of the program and goal of teacher hand off, and confirms that the teacher wants to participate.

TEALS partner teachers have variable levels of background knowledge in CS. Many partner teachers have no prior CS experience. A few teachers studied CS in college (but have not taught it). Some fall in between these extremes. While the teachers come from many disciplines, Math and CTE (Career & Technical Education) are most common.

3.5.1 Teacher Profile 1: Ada

Ada has completed her 2nd year as a TEALS teacher for the Intro CS course. In 2015-16, she will continue teaching without TEALS support. Ada has 11 years of classroom experience, and taught social studies prior to TEALS. She says, “I feel pretty prepared to teach the course independently. I just need to ensure that I have all the resources we created this year in one place.” She likes that TEALS has an online community for volunteers and teachers. “The online forums are helpful for communicating ideas. It all helps me feel that I am not alone in my course issues.” Next year, Ada will continue teaching Intro CS independently, and begin a new AP CS class with a team of TEALS volunteers.

3.5.2 Teacher Profile 2: Jason

Jason has 7 years of experience teaching English and History. He worked with a team of 4 TEALS volunteers on an Intro CS class, and will continue teaching it on his own in 2015-16. “This year we created two sections of the intro class, which forced me to plan for teaching the later period independently. As a result, I have been able to take the lessons that the volunteers help me to teach, and execute them on my own each day.” Jason appreciates the completeness of the TEALS model. He says, “TEALS has helped me to develop and understand a full curriculum, which most other PD does not. Additionally, TEALS has given me multiple thought-partners in terms of implementing ideas in the classroom, whereas most other PD gives you a toolkit and leaves you to try it on your own.”

3.5.3 Teacher Profile 3: Doug

Doug is a veteran teacher with 35 years of experience in math. After 2 years working with TEALS, Doug will teach AP CS independently in the fall of 2015. “The TEALS [PD] experience ranks among the top 3 or 4 in my career. First, it provides in-the-classroom support. This also encourages conversations and collaboration around planning the instruction and making sense of what the students are producing. My experience was that the volunteers came into the first year with a respect for what I knew about teaching, organizing a classroom, and meeting the needs of students, while they brought content expertise that I lacked. This mutual respect was key to making my initial experience a positive one. I was actually quite skeptical going into the first version of the partnership. Another aspect of the TEALS experience is the long time frame that supported my own learning as a teacher, and the gradual handing over of instructional responsibility to me... It’s also been great to have the experience of professional practitioners, who not only bring content expertise to the classroom discussion but also offer insights into how things actually work, patterns of practice in the real world.”

4. INITIAL EVALUATION OF OUTCOMES

TEALS’ primary success metric is course “hand offs,” where the partner teacher takes over primary instruction of the course. TEALS aims to hand-off courses within 2 years of partnership.

In spring, TEALS regional managers hold a partnership review meeting with each school. The meeting must include the school principal, the partner teacher, and any other administrators involved in the program. During these meetings the group discusses the state of the course, and how students are doing. The teacher outlines their level of participation in the course, and how they feel they are progressing towards hand off, answering the key question: “Would you be comfortable doing this by yourself?” Regional managers report that teachers respond candidly, since overstating their comfort level might result in having to teach without assistance when they aren’t ready.

In 2014-2015, TEALS classified each of the 154 partner classrooms with one of these outcomes:

- *Continue Towards Hand Off:* The TEALS partnership will continue with the goal of handing off the course after the following year.
- *Hand Off: Start Additional Course:* The teacher will take over the course, and the school will start a new TEALS partnership with an additional curriculum.
- *Hand Off Course, Alumni Mode:* The partner teacher will take over primary instruction of the course, but continue to seek TEALS volunteers as TA’s only.
- *Hand Off Course, No Further Support:* The partner teacher will take over primary instruction of the course, with no additional volunteer support.
- *Withdraw:* The classroom teacher will not teach the CS course in the following year, and TEALS will not return to the school.
- *Replace Teacher:* The classroom teacher leaves the program, but TEALS will continue to engage with the school.

Table 2 shows a summary of the outcomes of TEALS classrooms from the 2014-15 school year. The AP CS column shows the outcomes from classrooms where the AP CS A course was taught. Overall, 80% of the classrooms are progressing through the expected TEALS model, moving either towards hand off, or engaging in a hand off that leaves the course being offered in the school. TEALS successfully executed hand offs in 58 classrooms (37.9%).

Outcome	1st Yr	2nd Yr	>2 Yrs	AP CS	All
Continue To Hand Off	32	3	2	16	37
Continue as Alumni/TA	7	9	12	9	28
Hand Off: Alumni	8	9	12	22	29
Hand Off: Start Additional	7	3	1	2	11
Hand Off: No Further	14	2	2	6	18
Withdraw	7	2	0	5	11
Replace Teacher	12	2	5	11	19
Totals	87	30	34	71	153

Table 2: TEALS Class Outcomes from 2014-15

4.1 TEALS Student AP CS A Performance

In 2014-2015, 72 TEALS classrooms (47%) taught the AP CS A course. TEALS collects the aggregated exam scores of students who take the AP Computer Science exam in each of its partner schools. These scores provide a benchmark to compare student outcomes in TEALS classrooms with those in other computer science classrooms. The aggregated AP test data is a limited proxy for assessing the quality of instruction in TEALS classrooms.

At the time of writing, TEALS was still collecting 2014-2015 AP exam data from its partners. In the 2013-2014 school year, TEALS had 1,281 students enrolled in AP classes at the beginning of the school year. With 2 out of 40 schools not reporting their data, 671 TEALS students took the AP CS exam (See Table 3). The exam is scored out of 5 points, with a 5 being the best possible score. TEALS students averaged 3.28 points, compared to the national AP average of 2.96. Only 19.37% of TEALS students received the lowest score of 1, compared to 31.1% of all AP CS test takers.

Student Scores	TEALS	TEALS %	National	National %
1	130	19.37	12216	31.1
2	65	9.69	3016	7.68
3	130	19.37	6588	16.77
4	179	26.68	9091	23.15
5	167	24.89	8367	21.3
# students	671		39278	
Mean Score	3.28		2.96	
% of scores 3 or higher		70.94		61.22

Table 3: TEALS & National 2013-14 AP Scores

4.2 Evaluation of TEALS Instruction

During the 2013-14 school year, TEALS engaged WestEd, an educational research organization, to perform a qualitative study of TEALS instructional classroom practices. For the study, 8 experienced CS teachers were recruited to serve as observers of 14 TEALS teams in 4 locations. The observers worked with teams in Massachusetts (3), Southern California (3), New York (3), and Northern California (5). Over the course of 6 months observers visited each class 4 times and were asked to complete a post-observation evaluation provided by WestEd. The 8 mentors each completed at least one observation report, yielding a total of 20 reports collected by WestEd.

The post-observation form contained questions from 5 domains (shown in Table 4) and included areas for observers to record challenges, successes and general comments. Table 4 shows the questions provided to observers to report findings. For each question, observers could mark observed, did not observe, or unsure. It is important to note that TEALS does not expect instructors to exhibit all of the described practices in every class session.

The observation form also included open-ended questions for the observers to comment on successes and challenges, and provide any other relevant feedback. Additionally, the WestEd team held a one-hour phone conference to debrief the mentors about logistics, variation in instructional styles and the team dynamic, and challenges. Overall, the observers felt that four observations were not enough to fully represent the classroom dynamic. In the final report submitted by WestEd, the following summary elements were highlighted for observers' comments related to instruction and learning: (1)Most volunteer teams seemed to work well together; (2)There was variation across teams in the roles each volunteer played in the classroom; (3)While instructional style varied, the lesson format was somewhat consistent across sites (i.e., start with lecture then do a problem); (4)Some high school teachers were present and involved in the class, others were not engaged or absent; (5)Observers had difficulty assessing how student learning was measured over time; (6)Information provided to volunteers during summer PD may have been useful, but not easily recalled.

Data from the WestEd observations, as well as from TEALS staff observations, and from volunteer and teacher feedback were used to make significant adjustments to the program for 2014-2015. These changes included: emphasizing teacher participation in materials for schools, creation of teacher self-evaluation tools, expansion of training to multiple geographic regions, a greater emphasis on formative assessment

and active learning, and the creation of online training content to present teaching techniques that volunteers can access throughout the year. The program staff intends to continue updating and adjusting the program model each year based on new data.

5. FUTURE GROWTH AND CHALLENGES

The TEALS program began 6 years ago with 4 partner schools in the Seattle area. In the 2015-2016 school year, the program serves 161 partner schools across the US. The growth of the program has been limited by two primary factors: capacity of program staff to manage school partnerships and support volunteers, and number of volunteers available near partner schools. In future years, TEALS plans to continue growing through: hiring more program staff, expanding current geographic regions; forming partnerships in new geographic regions with a known supply of prospective volunteers; and serving schools in other areas through remote instruction with teleconferencing.

For the first time, TEALS has a large cohort of "graduating" partner teachers. During the 2015-2016 school year, TEALS began enlisting former partner teachers to help train volunteers over the summer and mentor new teaching teams. Use of paid master teachers can help facilitate the growth and expansion of the TEALS program by obviating the need for full-time TEALS staff present in every geographic location.

6. CONCLUSIONS

In this experience report we have presented the TEALS model of in-service teacher professional development. TEALS provides deep PD by connecting educators to industry professionals, thereby establishing ongoing connections for teachers and students with the technology industry. The TEALS model works with teachers during their school day, and provides an estimated 300+ hours of professional development through the program (over 2 years). Both teachers and volunteers in the program report successes and overall satisfaction with the process, and data from the AP CS A exam indicates some level of success in student outcomes.

The TEALS program welcomes additional collaborations for recruitment of volunteers from university alumni networks, or research partnerships with faculty to further study the volunteer or teacher participants in the TEALS program.

7. ACKNOWLEDGMENTS

The TEALS program is made possible by the nearly 1,000 volunteers who have given their time, energy and passion to support the growth of high school CS programs, the classroom teachers who have accepted the challenge of a new subject area, and the school and district administrators who have encouraged and enabled these partnerships. The authors would also like to thank WestEd for the contribution of their observational data on the TEALS program.

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Question	Domain	Obs.	Not Obs.	Unsure
Provides clear learning goals	High Expectations	14	3	3
Builds positive rapport with students	High Expectations	14	3	3
Celebrates student successes	High Expectations	9	6	5
Helps students interact with new knowledge	DETP: Content	15	2	3
Organizes for students to practice and deepen knowledge	DETP: Content	14	2	4
Asks questions (and provides support to) struggling students	DETP: Content	16	4	0
Monitors student engagement and reengages when necessary	DETP: Engagement	10	6	4
Provides appropriate scaffolding and pacing	DETP: Engagement	7	4	9
Uses knowledge about student background, skills, & interests	DETP: Engagement	6	11	3
Students have some choice in task completion	DETP: Engagement	8	9	3
Students serve as resources for one another	DETP: Engagement	14	5	1
Establishes, practices, and reinforces standards of conduct	Learning Environment	9	10	1
Responds to student behaviors effectively	Learning Environment	12	7	1
Tracks student progress	Data	9	8	3
Adapts Instruction Based on Student Data	Data	7	10	3
Modifies instruction and planning to meet students' needs	Data	6	8	6
Domains: Centering Instruction on High Expectations, Effective Teaching Practices: Content, Effective Teaching Practices: Engagement, Fostering and Managing a Safe, Positive Learning Environment, and Uses Student Data in Instruction and Planning.				

Table 4: WestEd/TEALS Observation Protocol

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