



Weaving a Computer Science Tapestry: Results of a Workshop Promoting the Recruitment and Retention of Girls in High School Computer Science

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Abstract

Although enrollment and degree production in Computer Science (CS) bachelor's degree programs have been increasing, enrollment of and degrees awarded to women have continued to decline as a result of poor experiences prior to entering college. A lack of prior computing experience, unenthusiastic teachers, gender stereotypes, and uninformed parents and administrators are the most frequently suggested reasons for the continued low participation of female and minority students in high school computing courses. This paper reports on a workshop designed to prepare high school CS teachers to meet the challenges of recruiting and retaining a diverse student population in their CS courses. We had three overall goals for the workshop: 1) introduce pedagogical strategies designed to dispel stereotypes and be engaging and accessible to all students; 2) demonstrate proven strategies and techniques for recruiting and retaining more students, and especially girls and minorities, into CS courses; and 3) provide a variety of reliable, research-based resources that outline the importance of CS education and the opportunities the discipline can offer to use when talking to students, parents, other teachers, and school administrators. We present evidence of the immediate success of this workshop through an overview of each of the workshop sessions, a comparison of the participants' expectations as stated before the workshop with the results of a formal evaluation and assessment independently conducted at the end of the workshop, and an assessment of the workshop from the invited speakers' perspectives. We also discuss the lessons learned in the organization and production of this workshop from both technical and participant perspectives and how we plan to apply these lessons in future iterations of this workshop.

1 Introduction

Computing has become ubiquitous in the modern world, touching nearly every aspect of our lives. The widespread application of computer technology is creating higher demand for computing professionals in areas other than science, technology, engineering, and mathematics (STEM) disciplines [6]. Results of the annual Taulbee survey reported by the Computing Research Association indicate that enrollment and degree production in Computer Science (CS) bachelor's degree programs have increased over the past four years after a decade-long decline, although this increase is not sufficient

to meet the increased demand for computing professionals [20]. This report also indicates that while enrollment and degree production overall has been on the rise, the percentage of women enrolling in and completing B.S degrees in CS has been declining. A lack of prior computing experience, unenthusiastic teachers, gender stereotypes, and uninformed parents and administrators are the most frequently suggested reasons for the continued low participation of female and minority students in computing courses [9,11,16,19]. One program that has shown consistent positive results in reversing this trend is the *Teachers Attracting Girls to High School Computer Science* (TAG) initiative, led by Drs. Joanne and Jim Cohoon at the University of Virginia (UVA) [8].

High school teachers are at a critical nexus in their students' lives as they prepare for the college or the workforce, but are often poorly prepared to help guide students into computing majors [1,10,17]. To help address this issue, the TAG initiative delivers and sponsors Tapestry Workshops for high school teachers at UVA and other collaborating institutions across the country. The overall goals for these workshops are to provide high school teachers with strategies to attract and retain more and diverse students into computer science classes, pedagogical tools to engage and motivate their students in the exciting discipline of computing, and resources to influence the perceptions of administrators, other teachers, students and their parents about the importance of computing education [7]. Instead of providing a "workshop in a box" to collaborating institutions, the TAG initiative provided guidance, financial and logistical support, and other resources to assist in the organization and delivery of the satellite Tapestry Workshops. The Tapestry Workshops began at UVA in 2008 and were delivered there through 2010. In 2011, the program was expanded to include two satellite workshops at the University of Delaware and the Tennessee Technological University [18].

In 2012, the North Carolina State University (NCSU) Department of Computer Science partnered with UVA to organize and deliver a satellite Tapestry Workshop on the NCSU campus in July, 2012. The NCSU Computer Science Department has a strong commitment to recruiting women and other under-represented minorities into the undergraduate program, and the opportunity to host a Tapestry Workshop was an ideal fit to these institutional goals. This paper reports on our experience organizing and hosting the 2012 NCSU Tapestry Workshop, highlighting the thematic organization of the workshop as well as the evaluation results and feedback received from the participants and speakers. Section 2 reviews other initiatives to intended improve high school computer science education. Section 3 describes the theme of our workshop and how it was organized to fit within the TAG initiative guidelines while delivering unique and valuable content. The primary interests of the participants are summarized in Section 4 as a basis for examining the evaluation and feedback obtained for the workshop. We conclude this report in Section 5.

2 Related Work

There many professional development initiatives with the goal of improving high school computer science education. In 2009, the most recent year for which we could find reliable data, the Computer Science Teachers Association (CSTA) reported that there were 90 professional development workshops with these goals for high school teachers [10]. This section reviews the most prominent of these programs, drawing a contrast between their goals and the overarching objectives of the TAG initiative and the NCSU Tapestry Workshop. The primary focus of most of these workshops is on pedagogy, which is only one area of emphasis for the Tapestry Workshops.

Examples of these other workshops include the CS Unplugged Workshops [2], Carnegie Mellon University's CS4HS and CSBots workshops [3,4], Georgia Techs Disciplinary Commons for

Computing Educators (DCCE) [15], the Computer Science Equity Alliance Summer Institute for Advanced Placement Computer Science (APCS) [12], and “Georgia Computes!” [5], among others. The CS Unplugged, CS4HS, and CSBots workshops offer training on fun and engaging ways to teach computer science and on helping teachers motivate students to study computing in college. CS Unplugged focuses on teaching computer science without computers and the CSBots workshops concentrate on the use of robotics in the classroom. The DCCE program is an effort to build a state-wide community of computing educators and is a year-long program with bimonthly meetings. The Summer Institute for APCS was a program in the Los Angeles Unified School District providing students and teachers with instruction, development, and opportunities for collaboration, focusing on increasing the participation of minorities in computer science courses and motivating them to continue their computing education after high school. The “Georgia Computes!” alliance is a broad ranging partnership between different units of the University System of Georgia, the Georgia Department of Education, the YWCA, and the Girl Scouts of Greater Atlanta, Incorporated. The goal of the project is to expand and diversify the pipeline of computing students from pre-teens through the undergraduate and graduate post-secondary levels.

“Georgia Computes!” incorporates pedagogy at the high school and undergraduate levels, as well as a socialization component through the partnership with the YWCA and Girl Scouts. While this alliance may develop into a model for other states, participation is currently limited to the State of Georgia, and major challenges remain for the project, particularly in the area of assessment [5]. The DCCE program is also restricted teachers in Georgia. The Summer Institute for APCS was also a limited-scope program. The CS Unplugged, CS4HS and CSBots workshops have national and international reach, but are focused primarily on pedagogical resources intended to make computing education fun and engaging for students.

In contrast, the Tapestry Workshop guidelines are intended to provide computer science teachers with a broad interactive and motivational professional development experience that includes:

- Content and high quality print and electronic resources from the National Center for Women and Information Technology (NCWIT) and CSTA for informing school administrators, other teachers, parents, and students about the diverse and rewarding career opportunities in computing;
- Content emphasizing the importance of gender and racial diversity in computing;
- Strategies, methods, and messages for recruiting and retaining students, particularly girls, to computing courses;
- Pedagogical resources for introductory computer science courses that help make these courses fun and engaging for students;
- Cutting edge research topics with insights and experiences on using them in the high school classroom;
- Opportunities for networking and collaborating with high school teachers from across the country to help plan applications of what they learn in the workshop.

Furthermore, the Tapestry Workshops are promoted on a national scale and open to computer science teachers from anywhere in the United States. The NCWIT and CSTA resources, combined with supporting presentations and discussions also set the Tapestry Workshops apart from other initiatives. While recruiting girls and under-represented minorities is an emphasis area of the Summer Institute for APCS and “Georgia Computes!” it is not a primary focus of most other professional development programs. The inclusion of local cutting edge research modules is also unique to the TAG initiative and Tapestry Workshops.

3 Theme and Organization

The Tapestry Workshop guidelines, shown in Table 1, are grounded in a broad range of sociological and pedagogical research [7]. While the TAG initiative does not endorse a workshop-in-a-box approach to organizing Tapestry Workshops, these guidelines were emphasized as a requirement for UVA sponsorship of satellite workshops. Within this framework we were free to develop our own workshop agenda.

Table 1: Tapestry Workshop Content Guidelines [7]

Content Area	Recommendations
Stereotypes	Characterize stereotypes and their influence on high school students' aspirations towards computing.
Teacher Influence	Make teachers aware of their influence on their students and the importance of creating a positive image of computing and computing careers.
Student Self-perception	Affect on achievement and methods to help students overcome stereotype-driven negative self-perceptions.
Diversity	Importance of diversity in computing and pedagogic strategies and practices that encourage diversity.
Teaching Practices	High-quality teaching modules, particularly for introductory courses, that encourage all students towards computing majors in post-secondary education.
New Directions in CS	Leading edge research in Computer Science that can generate additional interest in Computer Science coupled with complementary teaching modules based on that research.
Influencing Decision-makers	Professionally produced, research backed materials that participants can take with them to demonstrate the importance of diversity in computing to school administrators, other teachers, parents, and students.
Peer Successes	Presentations from other teachers who have attended previous Tapestry Workshops and successfully applied what they learned.

Prospective attendees were asked to describe their expectations for the workshop as part of their application. One common theme through many of the expectations was to learn practical classroom activities that would be stimulating and enjoyable for their students. Many participants also expressed a desire for activities and/or content illustrating the broad relevance of computing. Nearly all of the attendees expressed the desire to make the computer science courses more interesting and attractive to potential students, and particularly to girls and under-represented minorities. Based on these expectations, we developed a workshop theme of “Computer Science is relevant, practical, and fun.” Computer science is relevant for high school students because of the pervasiveness of computing in our world, with computers integrated into everything from cars to communication devices to entertainment. The practicality of teaching learning computer science is reflected in the broad range of learning resources available to teachers and students at little or no cost as well as in

the tools that allow students to create their own programs that are immediately useful. Finally, to attract and retain students, computing must be a fun and fulfilling activity for students and teachers.

3.1 Content

The workshop content was driven in part by several components that were required in order to receive the sponsorship funding from the TAG initiative at UVA. These requirements included sessions devoted to explaining key issues in gender and computing, pedagogical practices for high school CS 1 courses, proven methods for actively recruiting diverse students to computing courses, and creative lessons for computer science classes. To these core sessions we added sessions from NCSU faculty and nationally known speakers on topics that have demonstrated value in K-12 education.

The workshop was kicked off with **Icebreaking Exercises** led by Robert Luciano, a high school computer science teacher from Pocono Mountain East High School in Pennsylvania. These exercises helped participants get to know each other and illustrated innovative ways of teaching important CS concepts in the high school classroom. This was followed by the workshop **Keynote Address** by Dr. Lecia Barker of the University of Texas-Austin and the NCWIT. Dr. Barker's presentation highlighted many reasons girls and women do not enter computing, including both obvious social barriers as well as implicit biases and stereotypes. The remainder of the workshop consisted of a variety of informational, technical, activity-, and discussion-oriented sessions, which we briefly summarize below.

Gender & Computing: Dr. Joanne McGrath Cohoon, UVA, introduced gender awareness issues and the strategic importance of computing education through research data on diversity in high school and college computer science courses and programs.

Teaching CS with Games: Dr. R. Michael Young, North Carolina State University (NCSU), presented novel ways he and his colleagues are using games to teach computer science at levels from middle school through college, highlighting activities and results from middle and high school summer camps for girls that he helps lead at NCSU.

CS Unplugged: Dr. Lynne Lambert, Christopher Newport University, introduced Computer Science Unplugged [2], a series of free to use, technology-free, kinesthetic computer science activities and provided several examples of how to use these activities in the high school computer science classroom.

Sit with Me - The Red Chair: Drs. Barker and McGrath Cohoon introduced the NCWIT "Red Chair" [14], an initiative designed to highlight the role of women in computing and information technology. Workshop participants were given the opportunity to be photographed with the chair, graciously provided by the NCSU Computer Science Department.

Creative Lessons: Mr. Luciano and Seth Reichelson of Lake Brantley (FL) High School each led a session introducing activities, projects, and other teaching techniques that they have successfully used to attract and retain girls and minorities in their high school computer science classes.

Rethinking CS1: Dr. Jim Cohoon, UVA, presented effective and proven pedagogical practices for high school-level CS courses that has been shown to attract all types of students to computing-related courses and motivate many of them to follow computer science careers.

Promising Practices: Mr. Reichelson presented a variety of novel and innovative methods for attracting high school students, especially girls, to computer science. The effectiveness of his methods are demonstrated by dramatic increases in student participation and retention in his courses at two different high schools.

The New CS AP Exam: Dr. Tiffany Barnes, University of North Carolina at Charlotte, discussed important aspects of the new CS AP exam based on her involvement with the development of the test and leading one of the pilot curriculum groups.

Recruiting for Diversity: Dr. McGrath Cohoon presented attendees with a variety of research-backed information about the value, methods, and effectiveness of actively recruiting women and minorities to computing [7].

Student Stories: Ashley Gaie, Brittany Johnson, and Brittany Strachan, undergraduate, Masters, and Doctoral students (respectively) in CS at NCSU talked passionately about their inspirations and experiences as women in computer science programs in high school and college.

Snap! (Build Your Own Blocks): Dr. Barnes gave a activity-based mini-workshop on the Snap! [13] programming environment used in two of the five new CS Principles pilot courses.

Off-site Dinner: Special guest speakers Keith Collins, Senior VP & CTO, and Berni Mobley, Senior IT Director of Enterprise Solutions at the SAS Institute discussed the importance of a diverse IT and computing workforce and the real-life experiences of a woman who has successfully climbed the corporate ladder while maintaining a balanced life.

Pair Programming: Dr. Laurie Williams, NCSU, introduced pair programming and documented its effectiveness as an inclusive pedagogical practice.

Teaching with Mobile Devices: Leslie Keller, Apex (NC) High School Academy of Information Technology, engaged attendees with a programming environment and teaching techniques that allow high school students to create and use app for mobile phones and other devices.

Could Computing for K-12 Teachers & Students: Dr. Henry Schaffer, NCSU, discussed and demonstrated cloud-based computing resources that are available a low or no cost to K-12 school teachers and students.

Daily Brainstorming and Reflection sessions: provided opportunities for participants and presenters to discuss the day’s topics and develop ideas and strategies for using those topics and resources in their classrooms.

3.2 Organization

One of the greatest challenges was developing an agenda for the workshop that worked with the speakers’ schedules and fit within the time available. Our final workshop agenda, less entries for most meals and breaks, is shown in Figure 1.

Day 1		Day 2		Day 3	
9:30 am	Workshop Check-in & Socializing	8:00 am	Creative Lessons	8:00 am	Creative Lessons
10:30 am	Welcome	9:15 am	Rethinking CS1	9:15 am	Pair Programming
11:00 am	Icebreaking Exercise	11:00 am	Promising Practices	10:45 am	Teaching with Mobile Devices
12:45 pm	Keynote Address	1:00 pm	The New CS AP Exam	1:00 pm	Cloud Computing for K-12 Teachers & Students
1:45 pm	Gender & Computing	2:00 pm	Recruiting for Diversity	2:00 pm	Brainstorming Session
3:15 pm	Teaching CS with Games	3:00 pm	Student Stories	2:45 pm	Workshop Assessment
4:15 pm	CS Unplugged	3:45 pm	Snap! (Build Your Own Blocks)		Workshop Ends
5:15 pm	Reflection & discussion	5:15 pm	Reflection & discussion		
5:45 pm	Sit With Me - Introduction to The Red Chair	6:00 pm	Off-site Dinner		

Figure 1: NCSU Tapestry Workshop Agenda

Workshop content has been disseminated through a website, <http://www.csc2.ncsu.edu/workshops/tag/> that contains links to the presentation slides and other resources provided by the

speakers. A variety of other online resources are also provided. NCWIT and CSTA also provided a wealth of printed materials that attendees could take with them to support their recruiting and teaching efforts.

4 Evaluation

All of the attendees expressed an interest in learning new strategies and techniques for attracting and retaining a more diverse student population in the computer science courses. The second-most common expectation (expressed by 15 of 27 participants) was to collaborate with other teachers and CS education professionals to develop ways of strengthening their CS curricula and informing school administrators and parents about the importance of computing education for all students.

At the end of the workshop, attendees completed a post-workshop evaluation survey. This evaluation produced a wealth of information about the attendees' experiences at the workshop, and due to space limitations, we highlight the key results of this evaluation, focusing on 2 major parts of the survey. The first part involved rating the following nine workshop elements:

1. Material will help me attract more students.
2. Material will help me attract diverse (girls and minority) students.
3. Material will help me persuade decision-makers of the importance of my CS courses.
4. Workshop material was credible.
5. Workshop logistics were well done.
6. NCWIT materials will be very useful.
7. Speaker handouts will be very useful.
8. Compares favorable with other high school teacher workshops I have attended.
9. Recommend this workshop to other high school teachers

Attendees were asked to respond to each of these statements for the workshop as a whole, using a 4-point scale from Strongly Agree to Strongly Disagree with an additional value of Not Applicable. The results of this evaluation are shown in Table 2. We note that the attendees did not Strongly Disagree with any of these nine statements for their overall workshop experience, although 4 of 24 respondents did Moderately Disagree with the statement about the workshop logistics. In their open comments about the workshop, 5 attendees did suggest that the schedule may have been too full and lacked enough down-time to absorb and process the presented information. We comment on this further in our conclusions in the next section.

The participants' open comments about the workshop were strongly favorable, with many remarking positively about the diverse range of topics presented and that much of the material was presented in ways that could easily and directly be applied in their classrooms. Comments about the workshop as a whole included:

- It was a great workshop with such varied information.
- I am excited about returning to school to apply so many of the things I have learned this week. I know my students will benefit from the time I spend this week.
- I am going home with many ideas which will be implemented.
- The days were long, but very good presentations.

Table 2: Overall Workshop Evaluation Results

	Strongly Agree	Moderately Agree	Moderately Disagree	Strongly Disagree	N/A	Response Count
1	91.7% (22)	8.3% (2)	0.0% (0)	0.0% (0)	0.0% (0)	24
2	83.3% (20)	16.7% (4)	0.0% (0)	0.0% (0)	0.0% (0)	24
3	66.7% (16)	33.3% (8)	0.0% (0)	0.0% (0)	0.0% (0)	24
4	91.3% (21)	8.7% (2)	0.0% (0)	0.0% (0)	0.0% (0)	23
5	66.7% (16)	16.7% (4)	16.7% (4)	0.0% (0)	0.0% (0)	24
6	62.5% (15)	33.3% (8)	4.2% (1)	0.0% (0)	0.0% (0)	24
7	66.7% (16)	33.3% (8)	0.0% (0)	0.0% (0)	0.0% (0)	24
8	79.2% (19)	12.5% (3)	0.0% (0)	0.0% (0)	8.3% (2)	24
9	91.7% (22)	8.3% (2)	0.0% (0)	0.0% (0)	0.0% (0)	24

- I liked the many presentations that I gave me many lessons and activities that I can help use in my class room and that will help me stimulated student interest.

In the second major part of the workshop evaluation, participants were asked to rate the usefulness of the material presented by each speaker, using the same scale as they used for the overall evaluation. The results of this part of the evaluation are shown in Table 3. We note that Strongly Disagree appeared in only one speaker’s rating. Moderately Disagree appeared more frequently but did not outweigh the positive ratings for any of the speakers. Open responses for several of the speakers/sessions indicated that some of the workshop participants had significant exposure and/or experience with the tools presented in the sessions, and did not feel that they gained anything new from these presentations. This is a risk for any diverse professional development experience: if enough topics are presented, some of the participants will likely have had experience with one or more of the topics, often at a deeper level than the introduction commonly presented in this type of workshop.

Participants were also asked to comment on the individual presentations, particularly those they rated highest and lowest. Ampng their comments were:

- Laurie Williams presented the information in an entertaining way, she didn’t read her slides and even skipped over the ones that were not necessary to the flow of information.
- Seth was so dynamic and infused a lot of energy into his lessons and used visuals to grab attention.
- Leslie Keller tried to present TOO much information is TOO short a time.
- Seth and Robert gave great info with activities that I could take straight to my class.
- Logic groups. Gave a new insight into a different way to make Computer Science fun! Plan to use this to raise recruitment.
- Recruiting. It made me realize that I can attract way more females to CS.
- The logic games, girls recruiting, rethinking CS 1, Pair Programming. These are all things that I think I could easily implement into my programs and have an immediate impact.

Table 3: Individual Presenter Evaluation Results

	Strongly Agree	Moderately Agree	Moderately Disagree	Strongly Disagree	N/A	Response Count
Keynote (Barker)	54.2% (13)	37.5% (9)	8.3% (2)	0.0% (0)	0.0% (0)	24
Gender Issues in Computing (Cohoon)	70.8% (17)	25.0% (6)	4.2% (1)	0.0% (0)	0.0% (0)	24
Teaching CS with Games (Young)	58.3% (14)	29.2% (7)	8.3% (2)	4.2% (1)	0.0% (0)	24
CS Unplugged (Lambert)	50.0% (12)	25.0% (6)	20.8% (5)	0.0% (0)	4.2% (1)	24
Creative Lessons (Luciano)	87.5% (21)	12.5% (3)	0.0% (0)	0.0% (0)	0.0% (0)	24
Rethinking CS1 (Cohoon)	62.5% (15)	37.5% (9)	0.0% (0)	0.0% (0)	0.0% (0)	24
Promising Practices (Reichelson)	83.3% (20)	8.3% (2)	8.3% (2)	0.0% (0)	0.0% (0)	24
New AP Exam (Barnes)	53.8% (14)	29.2% (7)	8.3% (2)	0.0% (0)	4.2% (1)	24
Recruiting for Diversity (Cohoon)	54.2% (13)	41.7% (10)	4.2% (1)	0.0% (0)	0.0% (0)	24
SNAP (Barnes)	75.0% (18)	12.5% (3)	12.5% (3)	0.0% (0)	0.0% (0)	24
Creative Lessons (Reichelson)	83.3% (20)	12.5% (3)	4.2% (1)	0.0% (0)	0.0% (0)	24
Pair Programming (Williams)	75.0% (18)	20.8% (5)	4.2% (1)	0.0% (0)	0.0% (0)	24
Programming with Mobile Devices (Keller)	41.7% (10)	41.7% (10)	4.2% (1)	0.0% (0)	8.3% (2)	24
Cloud Computing for K-12 (Schaffer)	58.3% (14)	25.0% (6)	16.7% (4)	0.0% (0)	0.0% (0)	24

Finally, participants were asked to identify what they intend to take back to their classes and apply right away. Their responses included:

- I intend to do some of the interesting CS Unplugged activities.
- Joanne Cohoon shared great statistical information to take back not only to our students, but to their parents, our administrators, and our teaching communities.
- Pair programming - to ease student apprehensions. More visual aids and graphical teaching programs such as byob — catchy and students will be more interested.
- I will definitely use the pair programming, SNAP, recruitment materials to try and get more students enrolled in my class.
- Logic games, pair programming, marketing to groups, fun first before syllabus.
- In particular, girls are social and (in general) care more about issues involving improving their community.
- The logic games, girls recruiting, rethinking CS 1, Pair Programming. These are all things that I think I could easily implement into my programs and have an immediate impact.

However, it is impossible to judge how well the workshop content will actually be used based on the participants' assessment at the end of the workshop. To help assess the long-term effectiveness

of the workshop, a follow-up evaluation will be performed in the spring of 2013 which will give us a better picture of the effectiveness of our workshop content. While these results are not yet available, we expect to be able to incorporate a summary in our conference presentation.

5 Conclusions and Future Work

Overall, we feel that this workshop was a success in terms of meeting the goals and objectives laid out in the TAG initiative guidelines and our own thematic development. The attendees' post-workshop evaluations were positive both in the overall assessment as well as for all of the presenters. We also received positive feedback from the speakers regarding the organization and resources provided for them.

During our post-workshop interview with UVA and assessment staff, we identified a number of areas for improvement for future workshops, both here at NCSU and potentially at other institutions. Among these ideas, the following were seen as the most valuable insights from this workshop:

- Work with external relations, strategic advisory board, and college level to find additional funding and other resources.
- Do not try to pack the agenda so tightly - allow more time for brainstorming and collaborative networking. This came out of our observations of the workshop progress as well as comments by many of the workshop attendees. In particular, provide time for participants to relax and socialize to help them build better relationships which can have long-term educational value.
- Find someone specifically trained in brainstorming techniques to lead those sessions each day.
- Minimize redundancy, particularly in presentations of tools. Several of the programming tools presented (e.g., SNAP!, AppInventor, Alice) share a common underlying structure and development environment.
- Develop a module/session specifically about talking to principals, administrators, and guidance counselors about the value of computing education.

The structure of the TAG initiative is such that full funding is provided to satellite institutions in support of their first workshop delivery. Funding for future workshops will be the responsibility of those institutions. In light of this, we are actively engaged in fund-raising efforts from sources inside the university as well as from our corporate partners. We hope to be able to secure enough funding commitments to deliver a workshop again in the summer of 2013.

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References

- [1] BARKER, L. J., AND ASPRAY, W. The state of research on girls and it. In *Women and Information Technology: Research on Underrepresentation*. MIT Press, Cambridge, MA, 2008, ch. 1, pp. 3 – 54.
- [2] BELL, T., FELLOWS, M., AND WITTEN, I. Computer science unplugged. Web, 2011. Retrieved Mar 16, 2012 from <http://csunplugged.org/>.
- [3] BLUM, L., AND CORTINA, T. J. CS4HS: an outreach program for high school CS teachers. In *Proceedings of the 38th SIGCSE technical symposium on Computer Science Education* (New York, NY, USA, 2007), SIGCSE '07, ACM, pp. 19–23.
- [4] BLUM, L., CORTINA, T. J., LAZOWSKA, E., AND WISE, J. The expansion of CS4HS: an outreach program for high school teachers. In *Proceedings of the 39th SIGCSE technical symposium on Computer Science Education* (New York, NY, USA, 2008), SIGCSE '08, ACM, pp. 377–378.
- [5] BRUCKMAN, A., BIGGERS, M., ERICSON, B., MCKLIN, T., DIMOND, J., DISALVO, B., HEWNER, M., NI, L., AND YARDI, S. “Georgia Computes!”: improving the computing education pipeline. In *Proceedings of the 40th ACM technical symposium on Computer Science Education* (New York, NY, USA, 2009), SIGCSE '09, ACM, pp. 86–90.
- [6] BUREAU OF LABOR STATISTICS. *Occupational Outlook Handbook*, 2012-13 edition ed. U.S. Department of Labor, Washington, DC, 2012. Retrieved Jul 13, 2012 from <http://www.bls.gov/ooH/computer-and-information-technology/software-developers.htm>.
- [7] COHOON, J., COHOON, J. M., AND SOFFA, M. L. Focusing high school teachers on attracting diverse students to computer science and engineering. In *Proceedings of the 2011 Frontiers in Education Conference* (Washington, DC, USA, 2011), FIE '11, IEEE Computer Society, pp. F2H-1-1–F2H-5.
- [8] COHOON, J. M. TAG Workshops. Web, 2011. Retrieved Jan 17, 2012 from <http://www.cs.virginia.edu/~cohoon/tagworkshops/>.
- [9] COHOON, J. M., AND ASPRAY, W., Eds. *Women and Information Technology: Research on Underrepresentation*. MIT Press Books. The MIT Press, Cambridge, MA, 2006.
- [10] COMPUTER SCIENCE TEACHERS ASSOCIATION. The state of secondary level computer science education in the United States. Presentation, 2009. Retrieved Jun 4, 2012 from <http://csta.acm.org/Communications/sub/DocsPresentationFiles/StephensonNewNZPres.pdf>.
- [11] CUNY, J. Transforming high school computing: a call to action. *ACM Inroads* 3, 2 (Jun 2012), 32–36.
- [12] GOODE, J. Connecting K-16 curriculum & policy: making computer science engaging, accessible, and hospitable for underrepresented students. In *Proceedings of the 41st ACM technical symposium on Computer Science Education* (New York, NY, USA, 2010), SIGCSE '10, ACM, pp. 22–26.
- [13] MÖNIG, J., AND HARVEY, B. Build your own blocks. Web. Retrieved Jun 4, 2012 from <http://byob.berkeley.edu/>.
- [14] NATIONAL CENTER FOR WOMEN AND INFORMATION TECHNOLOGY. sitwithme.org. Web. Retrieved Jun 10, 2012 from <http://sitwithme.org>.
- [15] NI, L., GUZDIAL, M., TEW, A. E., MORRISON, B., AND GALANOS, R. Building a community to support hs cs teachers: the disciplinary commons for computing educators. In *Proceedings of the 42nd ACM technical symposium on Computer Science Education* (New York, NY, USA, 2011), SIGCSE '11, ACM, pp. 553–558.

- [16] POHL, M., AND LANZENBERGER, M. How to explain the underrepresentation of women in computer science studies. In *Proceedings of the 2008 conference on Current Issues in Computing and Philosophy* (Amsterdam, The Netherlands, The Netherlands, 2008), IOS Press, pp. 184–193.
- [17] SIMARD, C., STEPHENSON, C., AND KOSARAJU, D. Addressing core equity issues in k-12 computer science education: Identifying barriers and sharing strategies. Presentation, 2010. Retrieved Jun 4, 2012 from <http://csta.acm.org/Communications/sub/DocsPresentationFiles/ABI-CSTAEquityFinal.pdf>.
- [18] SIRAJ, A., KOSA, M. J., AND OLMSTEAD, S. Weaving a tapestry: creating a satellite workshop to support HS CS teachers in attracting and engaging students. In *Proceedings of the 43rd ACM technical symposium on Computer Science Education* (New York, NY, USA, 2012), SIGCSE '12, ACM, pp. 493–498.
- [19] STOCKARD, R., KLASSEN, M., AND AKBARI, A. Computer science higher education pipeline. *J. Comput. Sci. Coll.* 20, 3 (Feb. 2005), 102–113.
- [20] ZWEBEN, S. Computing degree and enrollment trends from the 2010-2011 CRA Taulbee Survey. Tech. rep., Computing Research Association, Washington, DC, May 2012.