A Google Computer Science for High School Workshop

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(Research-to-Practice)

Strand: Other

Abstract

In the summer of 2013, a Computer Science for High School Workshop was held in West Virginia University Institute of Technology, sponsored by Google Inc. It was the first Computer Science for High School Workshop in the State of West Virginia. The two-day workshop provided professional development training to high school teachers, with the goal to improve high school education related to computer/computing. A total of fourteen high school teachers attended the workshop. Through multiple theoretical, hands-on, and discussion sessions during the two-day workshop, the participating high school teachers learned about state-of-the-art computing knowledge and technology, obtained hands-on training on pedagogical tools, and had extensive interactions with university educators to discuss how to inspire high school students (particularly those from minority groups) to choose majors related to computer/computing. Assessment was conducted primarily via a series of surveys before and after the workshop, which included both formative measures and summative evaluations to address the workshop's effectiveness. One survey was completed by the participating high school teachers over a Google website; plentiful positive feedback indicated the workshop is a success overall. A range of follow-up activities are currently ongoing. For example, after the workshop university faculties and students are making visits to the participating high schools to provide on-site assistance to the high school teachers. Also, a website was constructed and maintained as a forum, with the purpose of seeking long-term collaborative relationships among high schools and universities. Several high school teachers have reported that they had incorporated what they learned at the workshop into their teaching. In summary, we found the workshop had made significant impact on the high school education related to computer/computing in the State of West Virginia.

Motivation

By 2018, there will be 1.4 million computer specialist job openings, and US universities will have generated enough graduates to fill only one-third of these openings[1]. In this perspective three interrelated challenges have been identified: the significant underproduction of degrees needed for the computing and computing-related workforce[2], the longstanding underrepresentation of many segments of our population[3], and the lack of a presence of computing in K-12. At present, development of pre-college education on computer/computing is far from advanced in the State of West Virginia. Most high school teachers are not adequately trained on computer knowledge and skills[4,5], and consequently, have difficulties to take the full advantage of available resources to offer high-quality education on computer. Obviously,

addressing these challenges calls for collaborative efforts between K-12 schools and higher education institutions.

This Computer Science for High School Workshop aims to provide professional development training to high school teachers on computer knowledge, skills, and pedagogical tools. Furthermore through post-workshop activities, university faculty/students visit high schools and assist high school teachers to develop effective course materials/tools/projects related to computer education.

Previous work

In the course of preparing our Google workshop (along with continuing post workshop activity), we followed four successful models:

(i) Improving Teacher Quality in Southern Illinois: Rural Access to Mathematics Professional Development[6];

(ii) Outreach Programs and Professional Development Activities at the Colorado School of Mines[7];

(iii) School Level Computer Science Education and Computer Science Teacher Training in the US: An Overview and an Example Solution[5];

(iv) A Five-Week Online Course on Robotics for Middle and High School Teachers using Their Own Lego Mindstorms NXT Robot Kits[8].

The first model[6] offered professional training to teachers from twelve rural schools to increase math content and to reduce math anxiety. In the second model[7], teachers from two school districts completed summer workshops designed to strengthen their content knowledge in mathematics and science. It is reported in the second model that, teachers always showed strong desire of real-world applications linked to abstract math and science concepts. We took this observation into account by including a range of fascinating real-world applications such as cloud computing and Internet of Things in our workshop. One lesson reported by the first two models is that, the contents delivered to teachers must be compatible with the established standards. However, the discipline of computer science is not well established in the core K-12 standards[5]. To address this challenge, the third model[5] implemented a computer science endorsement program for secondary school teachers with focus on the national level model curriculum set by Association for Computing Machinery (ACM)[9] and Computer Science Teachers Association (CSTA)[10]. Following their successful experience, we designed our workshop to be closely aligned with the CSTA standards. The fourth model[8] offered an online professional development workshop for high school teachers. Inspired by the fourth model, online forum and online technical support are integrated in our post-workshop activites. In summary, this workshop intends to address the following two major research questions.

- Would exposing high school teachers to state-of-the-art computer technologies and tools motivate them to incorporate computer science in their teaching?
- Would activities designed according to the CSTA standards help high school teachers?

As shown in the Results section, the data collected from our workshop indicate that the answers to the above questions are fairly positive.

This workshop was also based upon our prior endeavors. In the summer of 2012, we organized a workshop for high school teachers in mathematics and general science disciplines, with the sponsorship from NASA[11]. Through the 2012 NASA workshop, solid pipeline relationship was established between us and a large number of local high schools, which greatly facilitated our 2013 Google workshop.

Objectives

The goal of this workshop is to promote high school education on computing in the State of West Virginia. It aims to achieve six (6) specific objectives, as detailed in the following.

Objective 1: Provide professional development opportunity for high school teachers
The workshop is closely aligned with CSTA standards[10]. The broad range of topics delivered at the workshop are applicable to curricula at grades 9 – 12. After attending the workshop, the high school teachers are anticipated to gain knowledge to better prepare high school students for West Virginia statewide assessments.

Objective 2: Train high school teachers to integrate modern tools with their teaching
The workshop offered multiple sessions to train the participating high school teachers about utilizing modern pedagogical tools to enrich their teaching. High school teachers gained hands-on experience with the software tools at the workshop. In the follow-up activities of the workshop, university students will visit high schools to help implement these tools in the classrooms and labs.

Objective 3: Acquaint the high school teachers with the cutting-edge computing technologies
As one of the fastest-growing fields, computing is changing every day. Meanwhile, computing is becoming an inevitable component of virtually all the science/engineering disciplines. This workshop exposed the participants to exciting examples of computing in a wide range of practical applications, and as a result, helped high school teachers to retain a broader view of computing and the way it is shaping the world.

Objective 4: Inspire innovative ideas and strategies for effective teaching in the computing field

The workshop offered a special session for the participants to discuss about their approaches to develop and improve high school computing courses. Numerous innovative ideas and methods have emerged out of the discussion.

Objective 5: Establish networking among high school teachers and university educators
The workshop served as a platform for high school teachers and university educators to share/exchange their teaching experiences, not only during the workshop but also outside the workshop. A website was constructed before the workshop and maintained after the workshop. Long-term collaborative relationship is being sought between the high school teachers and university educators.

Objective 6: Attract minorities to the computing field
In the United States, the demand for well-trained computer scientists and engineers has been steadily growing. However, the number of students majoring in computing is far from sufficient to meet the forecasted demand. It is therefore critical to encourage the traditionally underrepresented groups in technological fields, namely women and minorities, to choose computing as their major. In this workshop, high school teachers had opportunities to interact with experts on initiatives to recruit more females and minorities in computing and other STEM areas.

Implementation of the workshop

The Computer Science for High School Workshop was held on the campus of West Virginia University Institute of Technology in the summer of 2013. Participants of the workshop include twelve (12) in-service teachers, one (1) pre-service teacher, and one (1) administrator. They are from nine (9) different counties of West Virginia. Most of the participants are from rural high schools. All the instructors at the workshop are university faculties.

Agenda of the two-day workshop is shown in Tables I and II below.

Next, all the sessions in this workshop are briefly described.

Inaugural session
In the inaugural session, welcome speeches were made by our Associate provost, Associate Dean, and Computer Science Department Chair. Next, Google representative Ms. Liz Arnold gave a one-hour presentation on Google's high school programs via Google hangout. She also answered questions raised by the high school teachers. Photo 1 of Figure 1 was taken when a high school teacher was communicating with Ms. Liz Arnold via Google Hangout.

Table I: Agenda of Day 1

Time	Session	Topic	Location
9 – 9:30	Inaugural session	Breakfast, welcome from organizers	Ballroom
9:30 – 10:30		Speech from Google representative	Ballroom
10:30 – 11	Attracting minorities	Increase minorities' interest	Ballroom
11 – 12	Share ideas in computing	Improve curricula using computers	Ballroom
12 – 1:30	Lunch	Speech of industry expert	Ballroom
1:30 – 3:30	Curricular innovations and pedagogical tools	Webpage development	Computer Lab
		Introduction to Alice	Computer Lab
3:30 – 4	Break		Ballroom Lab
4 – 5	Computational thinking	Computer education in 21st century	Engineering Lab

Table II: Agenda of Day 2

Time	Session	Topic	Location
9 – 9:30		Breakfast	Ballroom Lab
9:30 – 10	Share ideas in computing	Upward Bound program	Engineering Lab
10 – 12	Curricular innovations and pedagogical tools	Game programming	Computer Lab
		Robotics	Computer Lab
12 – 1:30	Lunch	Speech from school administrators	Ballroom Lab
1:30 – 3	State-of-the-art of computing	Cutting edge technologies	Engineering Lab
3 – 3:30	Break		Ballroom Lab
3:30 – 4		Surveys to Google	Computer Lab
4 – 5	Concluding session	Post-workshop activities	Engineering Lab

Session 1: Computational thinking

This session intends to educate the audience (i.e., high school teachers) about the fundamental concepts of computing. During this session we demonstrated how high school teaching would better prepare the students for statewide assessments and for college degrees that involve computers and computing. Extensive examples were presented to relate the classroom teaching to real-world applications.

Session 2: Training on curricular innovations and pedagogical tools

This session provided training on employing modern pedagogical tools to achieve curricular innovations. Two parallel hands-on sessions were conducted in parallel on each day of the workshop. The two sessions on Day 1 included "web development" and "introduction to Alice;"

while the two sessions on Day 2 included "game programming" and "robotics." During these sessions, the participating high school teachers had opportunities to gain hands-on experience with various software and tools. Photo 2 of Figure 1 was taken when the high school teachers were learning about game programming with the instructor's help; Photo 3 of Figure 1 shows two instructors working with robots. Detailed manuals together with online support are provided to the participating teachers so that they could implement the software/tools in their high school classrooms.

Session 3: Discussion session on "share ideas in the computing field"

In this discussion session, the participants discussed about their approaches to develop and improve high school computing courses. They also exchanged their experiences about the high school curriculum on computing as well as other science disciplines in their own counties. On the other hand, the university faculty members explained the challenges faced by our freshman students as they go through the transition from high school to college. Numerous innovative ideas emerged out of the discussion. In the pre-workshop survey, several high school teachers requested to learn more about a specific program called "Upward Bound," which is a program of US Department of Education designed to provide fundamental support to participants in their preparation for college entrance[12]. On the second day of our workshop, we invited the director of "Upward Bound" on our campus to meet the participants. As another outcome of the discussion session, we jointly founded the CSTA Chapter in the State of West Virginia after the workshop.

Session 4: State-of-the-art about computing

As one of the fastest-growing fields, computing is changing every day. Meanwhile, computing is becoming an inevitable component of virtually all the science/engineering disciplines. On the second day of the workshop we conducted a special session to expose the participants to exciting examples of computing in a wide range of practical applications like "cloud computing" and "parallel processing." Equipped with the state-of-the-art computing concepts, the participating high school teachers are expected to integrate exciting supplements into their regular teaching.

Session 5: Attracting minorities in computing field

In this interactive session, we first described the situation with minorities in computing field in the State of West Virginia as well as in the United States. Then the high school teachers joined the discussion about several initiatives to recruit more females and minorities in computing and other STEM areas.

Lunch with industry representatives

On the first day of the workshop, we invited a few local industry representatives to the lunch. One industry representative, Mr. Dennis Jarvis, made a resourceful speech during the lunch time.

Photo 4 of Figure 1 was taken when some high school teachers were having informal conversations with Mr. Dennis Jarvis after his speech.

Concluding session

Dr. Paul Steranka, Associate Dean of Engineering College on our campus, gave a concluding remark and conferred certificates to the participants. The workshop organizers also discussed with the participants about post-workshop activities and schedules. Photo 5 of Figure 1 was taken at the end of the concluding session.

Table III illustrates the mapping between the sessions and our objectives.

Table III: Mapping between sessions and objectives

	Objective 1	Objective 2	Objective 3	Objective 4	Objective 5	Objective 6
Session 1	×					
Session 2		×				
Session 3				×	×	
Session 4			×			
Session 5						×

Results

In order to assess the workshop's efficacy at achieving the expected objectives, a series of surveys were conducted before the workshop and after the workshop (Google online survey and additional paper based post-workshop survey). The pre-workshop survey was conducted a few months before the workshop. Its major purpose is to collect the participants' expectations and specific needs. Based on the pre-workshop survey, some agenda items were adjusted accordingly. For instance, Upward Bound was included into the agenda upon the participants' request. We spent sufficient efforts to map the participants' needs to CSTA standards. After considering multiple factors comprehensively, we offered four hands-on sessions, "game programming," "robotics," "introduction to Alice," and "webpage development." These four sessions are relatively easier for the teachers to apply in their classrooms, and meanwhile, they are aligned with CSTA Standards 3A-4, 3A-3, 3B-3, and 3A-2[10].

At the end of our workshop, we handed out surveys to the participants about post-workshop activities. In the surveys, the participants were asked whether they would like our faculties and students to visit their high school classrooms and help them reinforce what they learned from the workshop. All of them answered "yes." We also asked them to identify techniques to help setting more effective collaboration with their class rooms. Most participants requested for yearlong support through web based material.

Photo 1 (inaugural session): A high school teacher communicating with Ms. Liz Arnold (Google representative) via Google Hangout

Photo 2 (curricular innovations and pedagogical tools session): High school teachers learning game programming

Photo 3 (curricular innovations and pedagogical tools session): High school teachers working with robots

Photo 4 (lunch): High school teachers having informal conversations with Mr. Dennis Jarvis, an industry expert

Photo 5 (concluding session): Some of the workshop participants together with the workshop organizers

Photo 6 (follow-up visit): A photo taken when Dr. Afrin Naz (standing in the middle) visited Chapmanville Regional High School

Figure 1: Some photographs from the two-day workshop as well as from post-workshop visits

Thirteen (13) participants completed a survey over a Google website, which includes quantitative evaluation to address the workshop's effectiveness as well as formative measures to provide feedback to workshop organizers. In the rest of this section, results of the Google online survey are presented.

Table IV exhibits the results of the quantitative questions; they unequivocally indicate that the workshop is a success overall.

Table IV: Results of quantitative questions from Google survey (13 participants completed this survey)

Survey question	Results
If you are a teacher, how likely is it that you will incorporate knowledge you've learned into your curriculum?	7 participants rated 5 (scale of 1 – 5); 6 participants rated 4 (scale of 1 – 5)
Overall, I found this workshop to be worthwhile	5 participants rated 5 (scale of 1 – 5); 8 participants rated 4 (scale of 1 – 5)
I felt a sense of community among participants of this workshop	8 participants rated 5 (scale of 1 – 5); 5 participants rated 4 (scale of 1 – 5)
Would you recommend this workshop to your colleagues?	12 participants answered "yes;" 1 participant answered "maybe"

In response to the formative questions of Google online survey, the workshop participants provided enormous feedback. Most of the feedback is complimentary. Below are the answers to question "what did you like about the program?".

- *I like that the focus was on computer science education because it is seriously lacking in West Virginia high schools.*
- *Learning about different areas in the STEM field, the collaboration between the university and high schools, and the Google application to the classroom.*
- *Information concerning inspiring students to participate in CS and CE fields.*
- *I loved everything. I learned many things and I will be able to take concepts to my classroom. I have no complaints.*
- *I liked the atmosphere of joined learning and making the K12 and secondary education connection so that our learning goals were more aligned. I liked the support and concentrated learning in the computer science areas.*
- *I like the hands on activities and the time we spent understanding how things function together. I did robotics and Alice, both of which I can use in my classroom.*
- *I especially enjoyed the robotics and Alice programs. I learned a lot of background knowledge about computers that will help me in several ways.*

In the following, answers to question "what didn't you like about the program?" are listed. Although this question asks the participants to identify flaws or drawbacks associated with the workshop, most of the comments are positive in nature.

- *Nothing.*
- *Nothing!!!!!*
- *I think there should be more focused sessions on tools or programs that we can take back to our schools (administrators, other teachers, and students).*
- *There isn't anything that I disliked.*
- *I didn't understand the parallel computing too much.*
- *Being a mere Science teacher, a little of the technology was a bit deep, but I learned a lot that I cannot apply later.*
- *I liked it all! Very wonderful people and support!*

Follow-up activities

In the concluding session of the workshop, we collected surveys from the participants about follow-up activities. In addition, we had discussed with them about tentative follow-up schedules. Based on the surveys and discussions, we are conducting the following three post-workshop activities.

(1) Visits to high school classrooms

Our faculties are currently visiting high schools to give topical lectures and seminars. Also, our students will visit high schools to help reinforcing the workshop outcome. Specifically, the workshop offered trainings on the following four specific techniques: webpage development, Alice, game programming, and robotics. When being asked whether they intend to integrate some of these techniques into their teaching, all high school teachers answered "yes" in the surveys. Based upon their needs, our university students will provide assistance accordingly. For instance, our university students will take the robots to high schools and help with designing certain projects. The university students will also help the high school teachers as classroom assistants, lab instructors, and/or website developers. This follow-up activity follows the successful model of our workshop held in 2012[11]. The follow-up visits have been proved very effective to reinforce our relationship with the high schools. Photo 6 of Figure 1 was taken when Dr. Afrin Naz visited Chapmanville Regional High School in September 2013.

(2) Found a local chapter of Computer Science Teachers Association (CSTA)

During the workshop, most participants agreed to make a joint effort to found a West Virginia Chapter of CSTA. The local chapter is expected to create a platform to promote the high school

education on computer. In addition, the local chapter is eligible to receive consistent support (such as course materials) from CSTA. The West Virginia Chapter of CSTA was successfully founded in November 2013.

(3) Online forum

A website was constructed for the workshop in March 2013. Through the website, all the agenda and activities were publicized. The website is maintained after the workshop as an online forum to seek long-term collaborative relationships between high school teachers and university educators.

The feedback we have received from our follow up activities is highly constructive. Based on our Google workshop, one high school teacher had created a new course on game programming. Two other teachers had incorporated robotics and web development, which they learned at our Google workshop, into their classes. Two teachers had established Computer Science Clubs in their schools. In addition, quite a few high school teachers are working closely with us to explore new opportunities; as one of the outcomes, we have received funding to organize a STEM Camp for high school female students in the summer of 2014. One of the major research questions to be addressed by our workshop is

> "Would exposing high school teachers to state-of-the-art computer technologies and tools motivate them to incorporate computer science in their teaching?".

Based upon the data we have collected from our post-workshop activities, the answer to the above research question is fairly positive.

Conclusions

This paper reports a Google Computer Science for High School Workshop. A total of fourteen high school teachers attended the two-day workshop in the summer of 2013. They learned about state-of-the-art computing knowledge and technology, obtained hands-on training on pedagogical tools, and had extensive interactions with university educators. Assessment was conducted primarily via a series of surveys before and after the workshop; plentiful positive feedback indicated the workshop is a success overall. A range of follow-up activities are currently ongoing. A website was maintained as a forum to seek long-term collaborative relationships among high schools and universities. Several high school teachers had incorporated what they learned at the workshop into their teaching. From this workshop it is concluded that, exposing high school teachers to state-of-the-art computer technologies and tools would motivate them to incorporate computer science in their teaching.

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