An Online Computer Science Workshop for High School Teachers based on Free Google Software Tools

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***Abstract*—In the summer of 2014, an online Computer Science for High School Workshop was organized by West Virginia University Institute of Technology, with sponsorship from Google Inc. The online workshop lasted for four weeks. 123 high school teachers from USA and Canada registered for the workshop. The workshop offered two tracks: software track and hardware track. In the software track, the participants learned programming language Java; and the hardware track instructed basic computer architecture to the participants. The online workshop was primarily based upon Google software tools. Specifically, the course materials (such as PowerPoint slides and videos) were delivered using Google Course Builder, and live sessions and tutoring sessions were offered through Google Hangouts. During the four-week workshop, 24-hour online support was provided to the participants. A series of surveys before and after the workshop demonstrate that the participants' average "after-the-workshop knowledge" is significantly higher than their average "before-the-workshop knowledge" (3.6 versus 2.7 on a 5-point scale). The surveys also show that, the participating high school teachers have less concern in teaching Computer Science after the workshop. In the surveys conducted after the workshop, 60% of the participants plan to incorporate at least 25% of the workshop activities/resources into their teaching.**

***Index Terms*—Computer Science, Google software tools, high school teachers, online workshop.**

Introduction

"Online" is a popularly-employed method to teach Computer Science nowadays. The best example is probably Code.org, a non-profit online community dedicated to expanding participation in Computer Science [1]; the online videos distributed by Code.org include Bill Gates (from Microsoft) teaching "if-else" and Mark Zuckerberg (from Facebook) teaching "repeat loop." CS4Alabama [2] and GUTS (Growing Up Thinking Scientifically) [3] are two other successful programs that offer year-round free online instructions in Computer Science. The online Computer Science for High School Workshop presented in this paper is one of the few pilot programs sponsored by Google Inc., aiming to promote Computer Science education world-widely [4].

In the summer of 2014, an online Computer Science for High School Workshop was organized by West Virginia University Institute of Technology, with sponsorship from Google Inc. The online workshop lasted for four weeks, starting on July 19th and ending on August 18th. 123 high school teachers from USA and Canada registered for the workshop. About 80% of the participating teachers have at least 6 years of teaching experience. Approximately two-thirds of the participants taught Computer Science or other IT-related subjects in the past; and, most of the remaining one-third participants taught STEM subjects (but not Computer Science). When asked "why are you interested in participating in this workshop," 40% of the participants indicated that they chose to teach Computer Science, 20% of the participants answered they had been assigned to teach Computer Science, and 35% of the participants said they were considering teaching Computer Science in the future.

The workshop offered two tracks: software track and hardware track. In the software track, the participants learned programming language Java; and the hardware track instructed basic computer architecture to the participants. Both tracks included three types of sessions: theoretical, hands-on, and discussion. The theoretical sessions intended to educate the audience about fundamental knowledge related to computer software and hardware. The hands-on sessions included lab sessions and pedagogical tool training sessions, where the lab sessions supplemented the theoretical sessions and pedagogical tool training sessions provided training on how to employ modern software tools to achieve curricular innovations. Both the software and hardware tracks had multiple discussion sessions on various topics such as "networking," "attracting minority," and "cutting-edge technologies." The online workshop was primarily based upon Google tools. Specifically, the course materials (such as PowerPoint slides and videos) were delivered using Google Course Builder, and live sessions and tutoring sessions were offered through Google Hangouts. During the four-week workshop, 24-hour online support was provided to the participants. In order to maintain efficient communication with the participants, multiple methods were employed, including e-mail, Google Hangouts On Air, and Piazza. Our university students offered online support to the workshop participants until August 2015.

A series of surveys were administered by Google Inc. to the participants before and after the workshop, which included both formative measures and summative evaluations to address the workshop's effectiveness. The survey results demonstrate that the participants' average "after-the-workshop knowledge" is significantly higher than their average "before-the-workshop knowledge" (3.6

versus 2.7 on a 5-point scale). The survey results also show that, the participating high school teachers have less concern in teaching Computer Science after the workshop. In the surveys conducted after the workshop, 63% of the participants specify they will recommend the workshop to others, and 60% of the participants plan to incorporate at least 25% of the workshop activities/resources into their teaching.

The rest of this paper is organized as follows. Implementation of our online Computer Science for High School Workshop is detailed in Section I. Some of the survey results collected from the participants are presented in Section II. Finally, Section III relates to our conclusions.

I. Implementation of the Online Workshop

Our Computer Science for High School Workshop in 2014 was delivered completely online. The contents of our workshop are classified into two tracks: software track and hardware track. The homepage of our software track is depicted in Figure 1.

Figure 1. Homepage of software track

Both the software track and hardware track included three different types of sessions: theoretical, hands-on, and discussion sessions. Next, these three types of sessions are described.

Theoretical sessions

Theoretical sessions intend to educate the audience about the fundamental knowledge related to computer software and hardware. In both the software track and hardware track, theoretical sessions included multiple units. Each unit further included multiple lessons along with specific activities. The lesson materials were posted through Google Course Builder, so that the audience could access them any time. Each theoretical session offered PowerPoint slides and video tutorials. Figure 2 displays a snapshot of video tutorial in a theoretical session on Java programming. Figure 3 shows one activity including auto-graded multiple-choice and true-false questions; these activities not only helped the participants assess their learning but also provided instant feedback to the instructor.

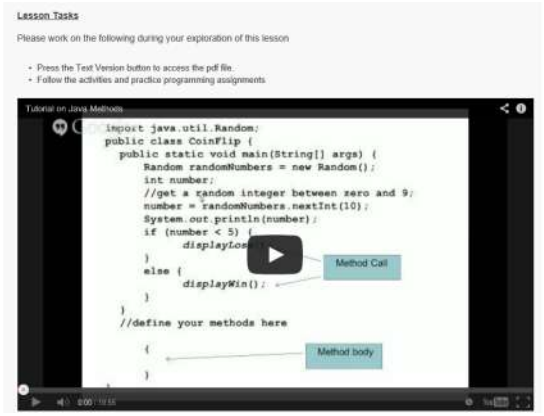

Figure 2. Video tutorial in a theoretical session on Java programming

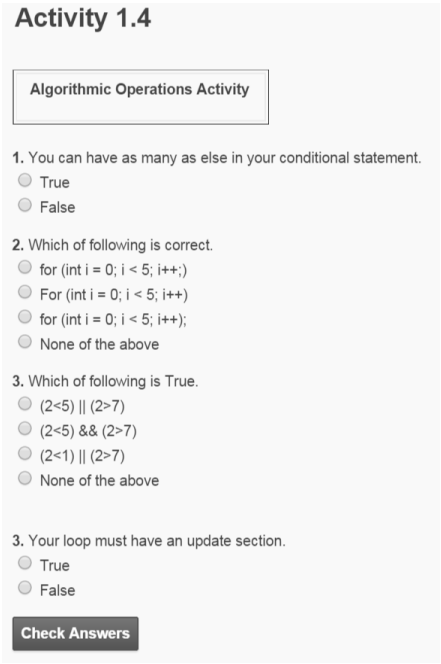

Figure 3. One example of activities linked to theoretical session

Hands-on sessions

Two types of hands-on sessions were offered: lab sessions and pedagogical tool training sessions. To be specific, lab sessions supplemented the theoretical sessions and pedagogical tool training sessions provided training on how to employ modern software tools to achieve curricular innovations. For instance, the software track included multiple labs for the audience to write, compile, and debug computer programs. The tools instructed at our workshop included Google Course Builder, Google Hangouts, Piazza, and Wix. Each hands-on session offered PowerPoint slides and video tutorials. Figure 4 demonstrates a lab of the hardware track.

Figure 4. A lab of hardware track

Discussion sessions

The workshop had multiple discussion sessions. In one session "networking," the participants exchanged their teaching experience and discussed how to prepare high school students for college majors related to computer. Another session "attracting minority" was devoted to inspiring students from minority (including female) groups to choose computer/computing as their college major. In another session "cutting-edge technologies," university faculties presented several cutting-edge computing technologies (including parallel computing and cloud computing) to high school teachers. Piazza was used for questions and answers in the discussion sessions.

Agendas of the software track and hardware track are displayed in Tables I and II, respectively.

TABLE I.
AGENDA OF SOFTWARE TRACK

Week	Date	Content
1	7/19	Theoretical session: Introduction to Java
	7/20	Theoretical session: Java fundamentals
	7/21	Theoretical session: Different data types Hands-on session: Pedagogical tool training on Piazza
	7/22	Hands-on session: Pedagogical tool training on Jcreator
	7/23	Theoretical session: Introduction to algorithms
	7/24	Hands-on session: Pedagogical tool training on HOA
	7/25	Hands-on session: Lab 1, general questions and answers
2	7/28	Theoretical session: Java methods and files
	7/29	Hands-on session: Group Hangouts
	7/30	Hands-on session: Group Hangouts
	7/31	Theoretical session: Class and objects Hands-on session: Lab 2
	8/1	Discussion session: Networking
3	8/4	Theoretical session: Array
	8/5	Hands-on session: Group Hangouts
	8/6	Hands-on session: Pedagogical tool training on web development
	8/7	Theoretical session: Stack Hands-on session: Lab 3
	8/8	Discussion session: Cutting-edge technologies Hands-on session: Group Hangouts
4	8/11	Theoretical session: Sorting
	8/12	Hands-on session: Group Hangouts
	8/13	Theoretical session: Conclusions
	8/14	Test
	8/15	Discussion session: Attracting minorities in computer science

TABLE II.
AGENDA OF HARDWARE TRACK

Week	Date	Content
1	7/19	Theoretical session: Under the cover
	7/20	Theoretical session: Revisiting numbers
	7/21	Theoretical session: Performance Hands-on session: Pedagogical tool training on Piazza
	7/22	Theoretical session: Below your program
	7/23	Theoretical session: Instructions
	7/24	Hands-on session: Pedagogical tool training on HOA
	7/25	Hands-on session: Lab 1, general questions and answers
2	7/28	Theoretical session: More on instructions
	7/30	Theoretical session: Integer and floating point operations
	7/31	Hands-on session: Group Hangouts
	8/1	Discussion session: Networking
3	8/4	Theoretical session: CPU
	8/6	Theoretical session: Hazards Hands-on session: Pedagogical tool training on web development
	8/7	Hands-on session: Group Hangouts
	8/8	Discussion session: Cutting-edge technologies
4	8/11	Theoretical session: Memory
	8/13	Theoretical session: Conclusions
	8/14	Hands-on session: Group Hangouts Test
	8/15	Hands-on session: HOA Discussion session: Attracting minorities in computer science

Our Computer Science for High School Workshop was developed primarily using Google Course Builder and Google Hangouts. Specifically, lecture notes, PowerPoint slides, video tutorials, activities, exams, programming assignments, and assessments were delivered through Course Builder; live sessions and tutoring sessions were offered through Hangouts. Other than these two primary tools, we also employed Piazza, Wix, YouTube, and Google Docs, to store/handout our online instructions and to communicate with the participating high school teachers.

Google Course Builder and Google Hangouts are both free of charge and readily available from the Internet. Meanwhile, they are powerful, flexible, and user-friendly. From our experience, they are excellent candidates when a teacher considers offering online instructions, especially when he/she has no prior experience. For instance, Google Hangouts makes it an easy job for a teacher to create live instructions with video, audio, voice, and PowerPoint slides integrated; the only hardware he/she needs is a regular personal computer, a regular microphone, a regular webcam, and Internet connection.

During our four-week workshop, 24-hour online support was provided to the participants. Our average response time was less than 30 minutes, which was well appreciated by the participants. We made sure that at least one teaching assistant was available to answer questions any time during the four weeks. In order to communicate with the participants effectively and efficiently, four communication methods were employed:

(i) One-to-one tutoring through personal e-mails

(ii) Group tutoring through Google Hangouts

(iii) Live sessions through Google Hangouts On Air

(iv) Discussion board through Piazza

Tutoring through e-mail and group Hangouts were more personal ways for the participants to interact with the teaching assistants when they had questions or topics to discuss during the workshop. Hangouts On Air enabled the entire class to listen to a broadcast message from the instructor and to ask questions in chat mode. All the Hangouts On Air sessions were recorded and archived for participants who could not attend them. In order to respond to participants' questions more quickly, we used discussion board with Piazza. Over Piazza, questions and answers were visible to all the participants unless certain questions were marked private.

II. Survey Results Collected from Participants

A series of surveys were administered by Google Inc. to the participants before and after our Computer Science for High School Workshop. Overall, the survey results indicate that our workshop is a success. Some of the specific results are presented in this section.

The most important item of the surveys is the participants' self-assessment of their Computer Science knowledge. The survey results in Table III show that the participants observe significant improvement of their Computer Science knowledge after the workshop. Specifically, 7% of participants rated their knowledge to be "very high" after the workshop, 50% of the participants found their knowledge in the "high" category (whereas only 17% of the participants were in the "high" category before the workshop), and particularly after the workshop, the numbers of participants in the "very low" and "low" categories were zero. To be more specific, the average "after-the-workshop knowledge" in Computer Science is 3.6 on a 5-point scale, significantly higher than the average "before-the-workshop knowledge" 2.7.

TABLE III.
SURVEY RESULTS OF THE PARTICIPANTS' SELF-ASSESSMENT OF THEIR COMPUTER SCIENCE KNOWLEDGE

	Before workshop	After workshop
Very high	0% of participants	7% of participants
High	17% of participants	50% of participants
Moderate	40% of participants	43% of participants
Low	40% of participants	0% of participants
Very Low	3% of participants	0% of participants

Table IV is on the participants' average concern levels (on a 5-point scale, with "5" denoting "highly concerned") regarding teaching Computer Science. In almost every category, the participants have less concern after the workshop than before the workshop. The only exception is the last item "deciding whether I want to teach Computer Science," in which concern level increases slightly from 1.7 to 1.8 after the workshop.

An encouraging outcome revealed by the post-workshop surveys is that, 47% of the participants agree on "the workshop achieving a sense of community." We find it a piece of strong evidence supporting "online teaching could be as accommodating as regular face-to-face teaching."

TABLE IV.
SURVEY RESULTS OF THE PARTICIPANTS' AVERAGE CONCERN LEVEL REGARDING TEACHING COMPUTER SCIENCE

	Before workshop	After workshop
Working with others to improve how Computer Science is taught	2.5	2.1
Improving how I teach Computer Science	3.2	2.5
Improving student learning outcomes	3.3	2.8
Finding out what students need to know	3.1	2.6
Preparing to teach my Computer Science course	3.0	2.5
Assessing my ability to teach Computer Science	2.6	2.3
Understanding what teaching Computer Science requires	2.8	2.2
Understanding what Computer Science is	2.2	1.8
Deciding whether I want to teach Computer Science	1.7	1.8

In the post-workshop surveys, the participants were asked a question "if you are a teacher, what portion of what you learned in this course you will incorporate into curriculum?" We are very delighted to learn that, 60% of the participants plan to use at least 25% of our activities and resources in their teaching. Indeed during the workshop, our participants frequently requested permission for them to use our lecture slides, assignments, and video tutorials in their classrooms. In response, we kept most of our materials available online for extended time after the workshop to allow the participants to download them.

After the workshop, our university students offered online support to the participants until August 2015. Several participants have reported to us that they incorporated what they learned from the workshop into their teaching successfully.

Overall as indicated in the post-workshop surveys, 63% of the participants would recommend the workshop to others, the remaining 37% were neutral, and none of the participants selected "do not recommend."

III. Conclusions

In the summer of 2014, an online Computer Science for High School Workshop was organized for 123 high school teachers from USA and Canada. The online workshop was primarily based upon Google software tools including Course Builder and Hangouts. During the four-week workshop, 24-hour online support was provided to the participants. Surveys collected from the participants indicate that the participants' average "after-the-workshop knowledge" is significantly higher than their average "before-the-workshop knowledge" (3.6 versus 2.7 on a 5-point scale). Overall, it is demonstrated that "online" is an effective and accommodating method to instruct Computer Science. Moreover, we find Google Course Builder and Google Hangouts are excellent software tools to deliver online instructions, as they are powerful,

flexible, user-friendly, and free of charge. At the 2015 Annual Conference of Computer Science Teachers Association, we offered a workshop to K-12 teachers on how to employ Google Course Builder and Google Hangouts to facilitate their teaching. We are planning further activities to promote the application of Google software tools in online education.

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