How to Inspire K12 Students to Study in Computing Disciplines in the Age of Artificial Intelligence?

Reflections on three computing workshops for K-12 students

Abstract*—This paper summarizes a hosting team's reflections on three computing workshops sponsored by *******. The BAD (Byte-A-Dynamo) is a series of workshops to support students (ages 10-16), especially from low-income families in Maryland who have no or very limited computing background or experiences to explore the computing fields especially in the age of artificial intelligence (AI). The participants will have opportunities to learn basic Python coding and AI-assisted coding skills, introduction to cybersecurity, and team-based Science, Technology, Engineering, Art and Mathematics (STEAM) projects infusing Arduino into art pieces. A mixed method was used to evaluate participants' learning outcomes and experiences of the workshops. The three free computing workshops planted seeds to inspire students to explore computing fields according to the evaluation results. The recruitment strategies, and pedagogies of the three workshops could be a model for other computing and engineering educators, researchers of higher education and K-12 teachers. The hosting team plans to continue to broaden the impacts of computing education in a larger scale of participation.**

Keywords—computing education, engineering education, K-12 education

I. Introduction

This series of computing workshops responded to the ********** to inspire K-12 students to explore and excel in IEEE Computer Society related disciplines [1]. The three free computing workshops intend to 1) help students (age 10-16) especially those from low-income families in Maryland to explore interests in computing; 2) build a sustainable learning community; 3) establish mentorships between participants and professionals. Specifically, the three BAD workshops focus on the three themes: AI-assisted coding, Introduction to cybersecurity and STEAM. The three workshops were held in July 2025 at two branches of Howard County Library System (HCLS) in Maryland USA. The hosting team includes a professor from ******** University as the workshop Chair, several undergraduate and graduate students as mentor leads, high school students as mentors and middle school students as student assistants. The workshops were also supported by the officers from the local section of IEEE, members of Howard County Board of Education, teachers from Howard County Public School System (HCPSS), the Chief Operating Officer, the STEAM outreach director and staff of HCLS, as well as the volunteers from communities. The workshop activities were supervised by the board members of IEEE Computer Society (CS).

This paper is organized as follows: the main pedagogy of each workshop is introduced in the second section followed by the planning and implementation strategies explained in the third section; the section IV indicates our evaluation using a mixed research method and the evaluation results; we will discuss the team's reflections and future work in the last section.

II. Pedagogies of Workshops

In this section, we will explain how we adopt and adapt the pedagogies and evidence-based practices to design and develop each workshop. An example of each workshop is given to explain how the hosting team worked with students to inspire their learning and enhance their workshop experiences.

A. Workshop 1: Let's code

The mentors started with a lecture covering the basic Python coding such as variables (strings), conditional statements and loops. The mentors carefully chose the corresponding examples and exercises to make sure most students can digest the key points and have time to work on coding questions. It is always challenging for beginners to understand the concept of "recursion" when they learn it for the first time. However, the hosting team still decided to cover it as it is very important for students to go further in coding. The team spent a good amount of time discussing how to deliver this concept based on mentors' own learning experiences of understanding the recursion concept. Finally, the team decided to start with the known game "Tower of Hanoi" to let students play and learn. The corresponding coding exercise was designed based on the pedagogy—"learning by doing" proposed by D. Kolb [1-4].

We introduced Python Integrated Development and Learning Environment (IDLE) first rather than Visual Studio Code or PyCharm so that students can actually code from scratch and learn several basic debugging skills. By the end of the workshop, the mentor lead introduced another software which includes the AI-assisted features to expose students to emerging technologies and emphasized the importance of mastering the coding basics first.

An Officer from IEEE Baltimore Section who is also a system engineer of a company in Maryland was invited to give an interactive talk about computing in engineering design. Fig. 1 shows his interaction with our students.

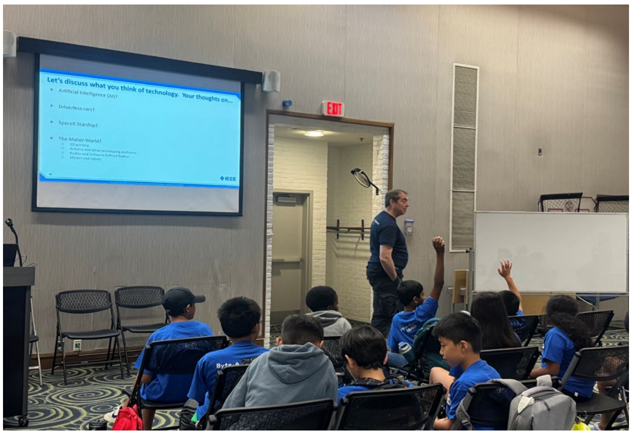

Fig. 1. Industry Speaker's Talk

B. Workshop 2: Introduction to Cybersecurity

This game-based workshop started with an ice breaker—mentors prepared and printed the "secret names" or say "fake names" based on participants' names and the Caesar cipher (shift 7). Then the secret names were selectively handed to students carefully so that students did not get their own names. After the Caesar cipher was taught, the students began to decrypt the secret names to figure out participants' real names with the help of a cheat sheet of the Caesar Cipher. Through the workshop, three ciphers (Caesar, Pigpen, which looks like alien words, and Vigenère) were designed and developed built upon the game-based learning [5, 6].

We were fortunate to have Dr. Hironori Washizaki, the current President of IEEE CS, to virtually give an opening remark around mid-night in Japan to welcome and inspire student participants. Fig. 2 shows his opening remark moment. We also invited one speaker who is the CEO of the Global Foundation of Cyber Studies and Research to introduce the possible careers of cybersecurity. The second speaker, a senior student majored in the Computer Science at the University of Maryland College Park, shared his experiences of working on an undergraduate research project about the cybersecurity of drones sponsored by the National Science Foundation.

Fig. 2. An Opening Remark by IEEE CS President

C. Workshop 3: STEAM

The STEAM stands for STEM+ART. This workshop was designed based on the evidence-based practice—project-based learning (PBL) [7-12]. The workshop mentors first delivered the circuit basics and Arduino key functions and pins using an existing Arduino with LED setup. A STEAM work example shown in Fig. 3. was presented to help students to understand the meaning of STEAM and have their own designs. After mentors explained what to be expected by the end of this workshop, the students were divided into small teams to do brainstorming about their art pieces and how to integrate an Arduino setup with their art design. The mentors facilitated brainstorming to make sure the students' designs would be feasible and guide the teams to their project plans. The teams were guided based on the PBL and they spent most of the time on finishing this project in each team. The participants had a chance to watch a short video made by Dr. Kathleen Kramer, the 2025 President and CEO of IEEE at the beginning of the workshop, listen to a talk given by the Chair of Student Activities of IEEE Baltimore Section, and interact with Dr. Caroline Walker, the Chief Officer of Equity and Innovation of HCPSS in the end of this workshop.

The students of three workshops presented their teamwork by the end of each workshop. In the end of each presentation, two specific questions we asked them were: "What did you learn from this workshop?" and "What did you learn from your peers?" Their work and presentations were evaluated by mentors and volunteers.

Fig. 3. An Example of STEAM Project

III. PLANNING AND RECRUITMENT STRATEGIES

The hosting team did not only design and develop each workshop based on the pedagogies and evidence-based practices, but also carefully planned how to implement each step of key topics. As this was the first time the whole team worked together, it was pretty important to have a thoughtful collaboration plan to pair graduate students with high school students to lead each workshop according to their computing backgrounds, project experiences and their interests.

Recruitment is always challenging for any new program or initiative. A lot of efforts were made to reach out to various organizations and communication channels to spread words to recruit student participants. The Workshop Chair in collaboration with various local entities such as IEEE Baltimore Section, HCLS, HCPSS and K12 schools, published the workshop information on the community websites, Canvas, and school newsletters, dropped the workshop flyers in two branches of the HCLS, and Title I schools, which receive extra federal funding to help students from low-income families succeed academically. In a month, we got 103 applications and finally about 60% of the applicants participated in the three workshops.

The application form was thoughtfully designed in order to get enough information about student participants in terms of their grades, schools, computing backgrounds, their dietary restrictions and their T-shirt sizes. We particularly asked for their preferences of each workshop so that we could best assign students to their most favorite one and balance the number of participants of each workshop. After the hosting team assigned students to three workshops, another email was sent to inform the students of their assignments. In the email, the parent or guardian of each student was required to submit a release form required by IEEE so that the workshop photos can be posted on social media. The final email was sent to students' parents to include more details of each workshop, logistics and their to-do-list several days before each workshop. We found several emails sent periodically to communicate with parents helped us to get a better response rate and make the workshop go smoothly. We tried to invite three different cohorts of students to three workshops. The first two workshops (Let's code and Introduction to cybersecurity) targeted at middle school students while the third workshop (STEAM) focused on the fourth and fifth graders in elementary schools. We did minor adjustments based on participants' availabilities.

IV. Evaluation and Survey Results

The pre-workshop and post-workshop surveys were designed on Poll Everywhere. A mixed qualitative and quantitative research method was used to design the two surveys in order to have a baseline to identify students' preparedness and measure their learning outcomes of each workshop [13-17]. A new trial method used by our mentors is to use ChatGPT to generate the evaluation rubrics and then having mentors tune the rubrics based on the pre-workshop survey results and their observances of each workshop. On average, the response rate of the pre-workshop surveys was about 80% and that of the post-workshop surveys was about 97%. The response rate of the Likert-scale questions was higher than that of the open-ended questions. The survey results showed that a good number of students had already either heard of several computing concepts or Caesar cipher or Python but most of them did not use Python so much nor had a deep understanding of those computing concepts. Fig. 4 shows students' expectations from the workshop 2.

Student mentors compared the evaluation rubrics generated by AI with the evaluation rubrics designed by themselves. They did not find so many differences in terms of students' learning outcomes. Four awards were given at each workshop to recognize the best teamwork, best presentation, best achievement and rising stars in computing.

Fig. 4. A Survey Result—Students' Expectations from Workshop 2

V. Reflections and Future Work

The hosting team met on Zoom after each workshop to have reflections on what we did well and what did not work well due to our workshop design, logistics, and other factors. As our workshop was held on three Saturdays, the team had time to adjust our plan and details for the next workshop. We found it was wise for a team of members who worked together for the first time to build trust, find common elements of each other's work styles and adjust our steps. We also found such a non-consecutive workshop schedule can give the hosting team some time and flexibility to figure out who did well in the previous workshop so that we can invite them back to the next workshop as an incentive to them. Those returning students also helped us to run the workshop smoothly as peer mentors.

After hearing the suggestions from middle school students and high school students, we deliberately separated the sixth graders from the seventh and eighth graders due to their different levels of computing knowledge and skills. We found such a grouping was correct. Student participants indicated that they liked this team setup so no one can dominate in any group. Fig. 5 is a group photo showing participants' enjoying experiences. Another thought from the hosting team is this grouping could indicate a possible gap or a jump between the six grade and seventh grade.

Fig. 5. A Group Photo of Workshop 2

The pairings between graduate students and high school students proved the power of mentorships. They also learn from each other in terms of technology knowledge and communication skills. The hosting team was inspired and we have already started working on another proposal to broaden computing participation in a larger scale.

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