A Summer Camp Experience to Engage Middle School Learners in AI through Conversational App Development

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ABSTRACT

The ubiquity of AI-based conversational apps such as Siri, Alexa and Google Assistant means more young users are interacting with these apps. The increasing popularity of these conversational applications brings a potential opportunity to attract learners to AI, CS and STEM fields. CS Education researchers need to explore how to leverage this opportunity, in particular to serve learners who are underrepresented in CS and STEM. This experience report describes the design and iterative refinement of a series of two-week summer camps in which 62 predominantly Black students participated in hands-on AI-based learning experiences to design and develop their own conversational AI apps. We discuss the organization of this summer camp experience, including strategies for recruiting from and building trust within the target community, designing professional development for camp facilitators, structuring the camp activities, and encouraging projects that are personally and socially relevant. We share challenges and lessons learned from this AI summer camp in the hopes that they will inform other researchers and practitioners who are interested in designing and deploying similar experiences.

CCS CONCEPTS

• **Social and professional topics → Computer science education**; **Informal education**; **K-12 education**.

KEYWORDS

Summer camp, CS and AI learning, conversational apps development, middle school

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1 INTRODUCTION

Over the past decade, AI-based conversational applications, such as Siri, Alexa and Google Assistant, as well as smart devices, such as smartphones, smart watches and smart speakers, are becoming increasingly popular among young users. In fact, the use of smart speakers and voice assistants is predicted to double between 2020 and 2024 [5]. The increasing popularity of these conversational applications and smart devices brings a potential opportunity to attract learners to AI, CS and STEM fields. There is tremendous potential for CS Education researchers and practitioners to explore how to leverage this opportunity, in particular to serve students from communities that have been historically marginalized in CS and STEM. A key approach is to empower learners to go beyond *using* technology to *developing* their own conversational apps. By

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creating conversational apps with AI, learners may be able to develop a much deeper understanding of CS and AI concepts such as bias and ethics, provide transparency to some "black-box" misconceptions about AI, and increase AI literacy [24].

While K-12 AI education researchers have been exploring ways to foster AI learning, there are still very limited opportunities for learners, especially for those who have minimal resources, to have authentic AI learning experiences. One way of providing authentic and engaging AI learning experiences is through summer camps, which have been shown to help middle school learners develop AI literacy [21] and have positive attitudes toward AI [1]. With that in mind, we implemented a hands-on AI-based learning experience for middle school learners to design and develop their own conversational apps. In this experience report, we present the design and iterative refinement of a series of two-week summer camps across two different summers, in which a total of 62 predominantly Black students participated in hands-on AI-based learning experiences.

This experience report makes the following contributions. First, it aims to advance existing knowledge about how to conduct successful informal learning experiences around CS, by detailing an innovative AI summer camp around building conversational apps. Second, it describes the ways in which we designed and deployed this camp with the participation and feedback of predominantly Black learners and their families. Finally, we share notable challenges and lessons learned regarding camp facilitator preparation and partnership; the success of a free-of-charge summer camp; and ways in which summer camps can engage learners with very little prior experience in computing to build socially and personally meaningful projects even within the first week. We hope that this experience report will inform other researchers and practitioners who are interested in designing and deploying similar experiences.

2 BACKGROUND AND RELATED WORK

In recent years, the CS Education community has been utilizing summer camps to introduce computer science and artificial intelligence to young learners with the goals of enhancing their socio-cognitive attitudes towards, and increasing their interests in computing careers [2, 8, 10]. For example, Aritajati et al. [2] implemented a series of four programming-centered summer camps with a total of 59 middle school and high school learners and found that the camps had an overall positive impact on young learners' computer self-efficacy and their attitudes toward computing careers. In another CS learning summer camp, Roy [17] and Wagner et al. [25] used App Inventor to introduce middle and high school students to computational thinking and programming concepts. Roy appealed to the interest of young learners by introducing them to programming through mobile app development. Wagner et al. report positive attitudes from students who are able to study CS and understand its relevance to their lives by utilizing meaningful learning contexts such as AI [25].

In addition, informal learning environments can provide opportunities for broadening participation in CS and STEM tailored towards communities that have been historically marginalized [4, 10, 15, 19]. For example, Camp CyberGirls was a one-week residential camp geared towards middle school girls with the objectives of introducing them to computing concepts and encouraging their interest in computing [10]. Another informal learning project, COMPUGIRLS, aimed to motivate girls from urban districts to become technologists through culturally responsive multimedia activities [19]. While these efforts have shown improvements in young learners' socio-cognitive and socio-emotional attitudes towards computing, there is additional work to be done to provide more access to these programs, in part to address ingrained negative attitudes towards computing development and careers [9, 20]. Stereotypes—that computing is too difficult to learn, requires being a "genius", or breeds socially awkward individuals—remain prevalent [6]. African American/Black, Hispanic/Latinx, and Native American students may be less engaged with computing because they do not identify with traditional computing culture [12, 19]. DiSalvo et al.'s results emphasize the significance of group mentorship and show that utilizing technology that is socially desirable for Black male youth can help foster a strong computing identity [12].

Furthermore, research by Comber et al. [6] suggests that people will be more likely to identify with something that is reflected amongst their community and has cultural relevance. These researchers conclude that frequent social interactions and experiences with people in the computing profession can have a strong influence on students' perception and bias building toward the field. As such, adverse stereotypes and a lack of representation of minorities, girls and women in computer science could create a self-fulfilling prophecy, limiting this exposure and reducing students' interest in STEM-related fields. In implementing our summer camp, we are adamant about addressing these challenges by making computing social, interesting, and creative and by providing role models for campers. We provide details about our innovative approach in the next section.

3 CAMP ORGANIZATION

3.1 Camp Design

Our camp was designed to serve middle school learners (rising 7th and 8th graders) from a community that has been historically marginalized in CS and STEM, specifically Black learners. To do so, we introduced AI through a familiar, accessible consumer technology (conversational apps) and minimized technical barriers to app development. Our undergraduate facilitators provided close mentoring, and a career panel of STEM professionals of diverse identities provided positive representation. In addition, our focus on pair programming allowed campers to have positive, substantive peer interactions as they constructed and took ownership of their computing knowledge.

During the summers of 2021 and 2022, we planned and implemented three two-week summer camps. At a time when many summer camps pivoted toward virtual participation due to the COVID-19 pandemic, we opted to hold our camps in person with safety precautions following national and local guidelines at the time. This decision was primarily because our target community has limited access to computing devices and often do not have reliable internet access. We held the camp at a well-known community center that is within walking distance from our target neighborhoods and included several meeting rooms and an indoor basketball court. The camp was offered at no charge to participants thanks to funding from the National Science Foundation. We provided meals and snacks during the day and a laptop for each camper to use. Campers who completed the two-week course took home a camp t-shirt and a Google Home Mini.

3.2 Camp Lessons and Activities

Over the course of the two weeks, campers learned about CS and AI concepts with the bulk of the new content taught in the first week. The second week was project-focused. We first drafted lessons based on existing CS and AI curricula designed for middle school classrooms. Then, for Year 2, we iteratively refined the content to better suit the informal learning context. For example, many classroom modules are designed for approximately one hour, but in a summer camp this is too long a period of teaching. We redesigned each lesson into a 30-35 minute instructional session: 5 minutes for warm-up or recap, 10-15 minutes for core instruction and 15-20 minutes for hands-on activities. The goal was to ensure that campers could learn without feeling like they were in "school". We mapped the AI lessons to the AI4K12 Big Ideas Guidelines [21, 22] and developed a total of eight short, general lessons with accompanying slides that included interactive activities and games. Six lessons were covered in the first week of camp and two in the second week. For example, a lesson about Intro to Data is mapped to Big Idea 3, "Computers learn from data", and has students interact with Google AI experiments such as "Quickdraw" and "Teachable Machine." We also selected unplugged activities from CS Unplugged and AI Unplugged to engage campers physically [3, 14]. An overview of the camp lessons and activities is shown in Table 1.

In addition to the CS and AI lessons, we designed specific conversational app lessons to serve learners who had no experience building conversational apps and may have had no experience with coding at all. During the first-year camp, we used Google's Dialogflow [7] as the conversational app development environment due to its robust natural language understanding and ease of connectivity to the Google Assistant and compatible Google Home devices [18]. Although Dialogflow is a powerful interface for designing and developing conversational applications, it does not cater to the middle school age group. During the camp, we noticed that the campers had difficulty navigating through the interface.

Over the academic year between the two summers, we developed a new development environment that provides a user interface to Dialogflow tailored for young learners to create their conversational apps (Figure 1). We designed seven lessons using the Use⟶Modify⟶Create pedagogical approach to support campers in mastering conversational app development within the development interface [13]. This approach introduces the concept of conversational app development using scaffolding during guided hands-on lessons and allows creativity during campers' project development. For instance, in one of the early sessions, campers tested sample projects via the development environment's testing panel. In the subsequent lessons, campers modified an existing chatbot while learning about conversational app programming concepts. Then, campers were walked through creating a chatbot from scratch. Campers were introduced to design thinking and were encouraged to apply the design thinking process: Empathize ⟶ Define⟶ Ideate ⟶ Build⟶ Prototype ⟶ Modify ⟶ Test to develop their individual and collaborative projects. Camp facilitators supported campers as they developed their own conversational apps and assisted them in setting up their chatbots to work with a smart speaker.

Table 1: Camp Lessons and Activities

Week 1	
Day	**Camp Lessons & Activities**
1	Arrivals/Check-in, Icebreakers & Opening Event, Intro to CS, Intro to AI, Marshmallow Challenge
2	Introduction to Conversational App Development & Chatbots, Human Crane, AI Ethics & Bias, Facilitators' Project Showcase, Intro to Intents: Special Intents
3	Intro to Data, Intro to AI and ML, Teachable Machine, Intro to Intents: Modify and Create New Intents, Intro to Follow-up Intents, Conversational Design Principles, Create a Chatbot from Scratch
4	Minefield, Design Thinking, Voice Customization, Individual Project Planning & Development, Careers in Tech (with Speaker Panel)
5	Individual Project Development, Peer Testing & Feedback, AI & Arts, Self-reflection & Finalizing Individual Project, Fun Friday
Week 2	
Day	**Camp Lessons & Activities**
6	Motivational Monday, Introduction to Pair Programming, Collaborative Project Planning and Development, Arts & Crafts
7	Collaborative Project Planning and Development, Project Testing and Mentoring, AI in Music
8	Project Testing: Google Assistant Integration, Debugging and Finalizing Collaborative Project, Mentoring: Project Showcase Presentation Practice & Demo Video Recording, Facilitator Panel
9	Final Project Testing: Google Home Device Integration, Campers' Project Showcase
10	University Campus Tour

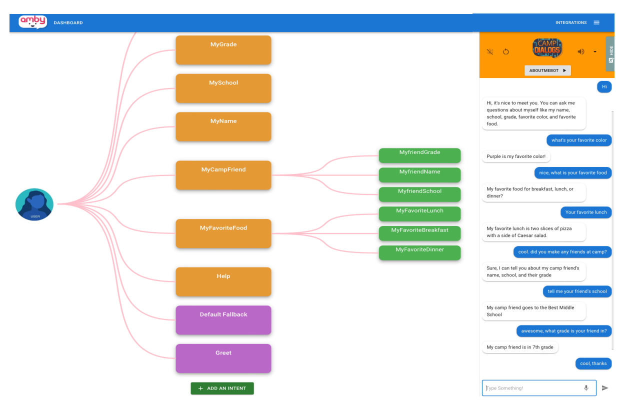

Figure 1: Conversational app development environment

4 RECRUITING CAMPERS AND CAMP FACILITATORS

4.1 Camp Facilitator Recruitment and Professional Development

The camp facilitators were undergraduates recruited and hired from the large research university in the United States where the project is based. We selected one facilitator for every 2-3 campers. Four camp facilitators were hired for the first year and eight camp facilitators (one returning, seven new) for the second year. In the first year, we provided a one-week, half-day professional development (PD) workshop for our facilitators. A major piece of feedback from the first year's facilitators was that this PD left them less-than-adequately prepared for camp. Based on the feedback, we extended our PD to a three-week half-day workshop in Year 2. With Year 2's expanded PD, we had enough time to adequately prepare the facilitators to instruct lessons, provide technical guidance, assist in data collection, and interact with campers in accordance with COVID-19 social distancing protocols.

The first week was focused on introducing facilitators to conversational app development, culturally responsive pedagogy (CRP), and Universal Design for Learning (UDL). CRP refers to effective teaching in which learning opportunities are designed from the learner's culturally diverse perspective [11]. UDL involves designing learning in a flexible and inclusive way that adapts to the learner's needs [16]. In addition to gaining pedagogical knowledge, we introduced facilitators to programming concepts of conversational apps and how to set up our development environment, then invited them to develop their own conversational applications. Facilitators were given an opportunity to develop their own sample apps for two purposes. First, the creation of their own apps helped them understand what the campers would be doing and empathize where the campers might have challenges. Second, some of the apps created by the facilitators were selected as samples for the campers to begin their learning in a use-modify-create activity during camp.

The second week was designed to prepare the facilitators to assist the researchers with data collection and other research activities. Facilitators were introduced to behavioral science research methods, ethics, and best practices. Camp facilitators were also given a walk-through of all camp lessons and learning activities. They provided feedback on the lessons and activities, and were invited to volunteer to instruct or co-instruct each lesson. Finally, facilitators were also instructed by an experienced middle school teacher on supporting the developmental needs of middle school learners and on strategies for teaching CS and AI to this age group.

The third week was aimed at camp preparedness. Facilitators were instructed in classroom management specific to the informal summer camp setting, practiced setting up laptops and other data collection equipment, visited the camp location, and reviewed the camp schedule and structure. On the last day of Week 3, the research staff interviewed the camp facilitators to investigate their feelings of preparedness for the camp following the three-week workshop.

Following the completion of the first session of camp in Year 2, we held a three-day mini-PD refresher prior to the second camp session, which was several weeks later. The development environment had been iteratively refined between the two camps, so on the first day of the mini-PD, facilitators tested the new updates to the conversational app development environment by creating a new project from scratch and testing each other's projects. The second day was a review of updated lessons and activities which had also undergone iterative refinement between camps, and featured micro-teaching sessions to hone the camp facilitators' instructional skills. On the final day, the facilitators assisted the team with technical preparations for the camp activities and data collection.

4.2 Camper Recruitment and Population

During our first year, we faced challenges in recruiting our target population of campers. After the first year, we reached out to parents within the community and conducted brief interviews. The feedback from parents was used to inform recruitment materials such as revisions to the flyer and suggestions for recruiting locations. Additionally, we designed a recruitment website to provide information about the camp and highlight activities and events from the first year. We also partnered with a community liaison, an experienced field social worker, to connect us with recruitment opportunities at local libraries, churches, and community centers. Our community liaison helped bridge the gap between our research team and the community by establishing trust.

In Year 2, we received a total of 200 applications. We had planned to admit 30 campers per session, but due to the rise in COVID-19 cases shortly before camp, we could only offer admission to 20 participants for the first session. Of the 20 accepted campers, 15 campers attended all of the two weeks of camp for the first full two-week session. For the second camp session several weeks later, we were able to offer 30 seats. Of those admitted, 20 attended all two weeks. Table 2 shows the demographics of the campers in Year 1 and Year 2.

	Summer 2021	Summer 2022
Number of Campers (N)[1]	18	44
Black or African American	78% (14)	77% (34)
Hispanic or Latinx		14% (6)
Asian American / Pacific Islander		2% (1)
White / Caucasian	22% (4)	7% (3)
Male	75% (14)	52% (23)
Female	25% (4)	48% (21)

Table 2: Demographics of campers 2021-2022

5 CAMP OUTCOMES

To better examine the success of the camp, we collected and analyzed a variety of data, including surveys and campers' projects.

5.1 Surveys

We administered pre-surveys on the first day of camp and post-surveys at the end of camp. For this paper, we focus on a subset of the survey items covering ability beliefs administered to campers in Year 2. We included these survey items to answer the question: "Did campers' attitudes toward AI change over the course of the camp?" Figure 2 compares the average of the responses from three pre- and post-survey items for 30 campers who attended majority of the camp: 1) *I can do well in AI* , 2) *I am confident that I can understand AI*, and 3) *I can figure out how to solve hard AI problems if I try.*

To determine any significant difference between and pre- and post-survey responses, we compared the average responses using a paired-samples t-test. Using a statistical threshold of $p < 0.05$, we found significant difference in two items: *I can do well in AI* ($t(29)$=4.19, p<0.01, d=0.76, M=0.7, SD=0.92) and *I am confident that I can understand AI* ($t(29)$=2.28, p<0.05, d=0.42, M=0.33, SD=0.80).

[1]the total number of campers refer to campers that attended majority of the two-week camp

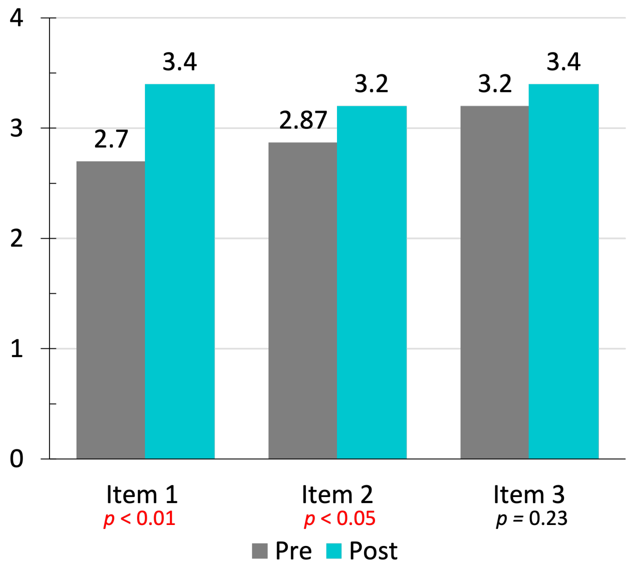

Figure 2: Pre-/post- survey results for Summer 2022 (N = 30)

5.2 Campers' Projects

Each camper worked on two different projects: during week 1, campers created individual projects and during week 2, they collaborated in pairs to create a new project. We encouraged campers to brainstorm personally and societally relevant projects for their conversational app. We paired campers based on their project ideas and ability to work well together. Campers engaged in pair programming to develop their collaborative projects, switching roles between driver and navigator after 12-15 minutes. Campers were able to develop their projects in "shifts" with breaks during role switching, which also led to continuous idea generation and project improvements. At the end, each pair recorded a short video presenting and demoing their app on a Google Home device. Table 3 shows the collaborative projects developed by campers in Year 2. Some of the campers' projects are as follows:

Project Highlight: Jarvis. For this project, two campers collaboratively developed a conversational app that will alert parents and/or emergency services when they were home alone or with their siblings and in danger. During the demo, one of the campers shared the reason for their conversational app idea:

> *"I programmed it because I want it to call the police. Because what happened if it's one night when a man or a woman or anybody, just knock on my door and try to bust into my window and try to take ... Trying to harm me or harm my sister. So that's why I wanted to make it a program ... To call the police."*

Project Highlight: Jerry Berry. For this project, two campers collaboratively built an app that teaches users about Black history and Black historical figures including Martin Luther King Jr., Harriet Tubman, Barack Obama, Al Green, and Rosa Parks. During their project demo, they shared the reason why they made their conversational app:

> *"Jerry berry can tell you about Obama, Harriet Tubman, Rosa Parks, Al Green... Our design represents Black power. Black power is something we need..."*

Table 3: Campers' collaborative projects in Summer 2022

[2] App Name	Description
FashionBot	Gives information about fashion and advises you on clothing options for different occasions
Goldie	Gives information and tips about stress, dealing with stress, and emotions. It is also able to cheer you up with jokes.
RelaxationBot	Recommends Music, Yoga & other activities to help you relax
Gaming Bot	Helps new gamers learn about different video games such as, Fortnite, Roblox and NBA 2K
ShopBot	Helps people by giving them suggestions for stores based on their personal style
Jerry Berry	Informs people about black history, particularly, influential people in the Black/African American community
Olympic Bot	Tells you about different aspects of the Olympics
diamond	Teaches about basketball tips and provide information about Steph Curry
Ezmae	Recommends music to people based on their preferred genre
Grimothy	Recommends horror movies to people that are unaware of good horror related movies to watch
Twinnem	Tells you interesting facts about fraternal twins
Football Bot	Tells you facts about football, such as the best player, best team, fun facts and their positions
Artist Helper	Helps bored artists figure out what to draw and which styles to draw them
Basketball Ben	Uses a cool and fun way to help users learn about basketball tips, history and facts
Angel bot	Recommends interesting music and tells you facts about singers
ZooBot	Tells you fun and interesting facts about animals
KingBot	Teaches people about LeBron James' basketball stats and his outreach programs to help his community

The final projects demonstrated the campers' creativity in designing conversational apps with personal or societal relevance. We invited parents and guardians to a project showcase on the second-to-last day of camp (the final day was a field trip to the local university). Campers gave a presentation to their families and friends about the app they developed in pairs and conducted a live demo with a Google Home device. After the presentations, families could interact with each app.

5.3 Lessons Learned

- **Deeply Engage the Community for Recruiting.** In Year 1, we applied the common recruiting technique of distributing flyers to middle schools within the community. These flyers yielded very few applicants. Instead, successful recruiting in Year 1 came from directly engaging with the community: we personally visited food distribution programs and residential events. In Year 2, we took this community engagement a step further and partnered with a community liaison who helped us identify recruitment locations and strategies, and was instrumental in establishing trust with the community. These recruitment efforts yielded 200 applications in Year 2 compared to only 30 in Year 1.

[2]Campers themselves composed these descriptions. Minor modifications were made to shorten the description to save space.

- **Kids with No Prior CS or AI Experience Can Thrive in Building Conversational Apps.** None of the children who attended our camps for the first time had built spoken conversational apps. Many of them also had no prior coding experience. Their projects, which they successfully demonstrated to their peers and families, show that a two-week camp is sufficient for introducing the concepts and skills needed for kids to build new conversational apps that they design.
- **Treat Camp Facilitators As Full Partners.** The cohort of trained undergraduate camp facilitators served as mentors, instructors, and assisted with data collection during the camp. The undergraduate facilitators' input was crucial in improving the curriculum, camper management, and camp schedule. Facilitators completed a daily "brain dump" to capture their observations about what went well, or not, each day.
- **Campers May Have Different Needs from Day to Day.** Summer camps are informal learning experiences that kids and parents expect to be fun. It is important for summer camp staff to adapt to campers' needs each day. For example, one camp facilitator's "brain dump" noted, *"There were a lot of high emotions today, so be more observant"*. The camp also highlighted the importance of giving kids many breaks to move around physically. We found that we had to substantially reduce the planned duration of focused work and screen time in order to keep campers engaged.
- **Give Returning Campers a Leadership Role.** Several campers from Year 1 returned in Year 2. Because we had revised the curriculum and the development environment was different, we included these campers in the same cohort activities as first-time campers. However, we noticed the returning campers wanted more advanced lessons and to have more of a leadership role. Camps should advance project options for campers who can move more quickly, and should set aside time and space to train peer mentors who are returning from prior years when applicable. Near-peer mentors have been found to increase "sense of belonging and identity, as well as improved self-efficacy" [23].
- **A Free-of-Charge Camp is Challenging but it Can Work.** Commercial tech-related summer camps in the US often cost between $400-$2000 per week. These camps are typically attended by children from families with financial means and prior exposure to high tech experiences. Our target demographic was Black children from low-income areas of our city. We offered our camp free of charge, despite the widely recognized risk that free camps can suffer from lack of engagement and drop-outs. We did observe some of these challenges: some children whose parents signed them up for the camp were slow to engage. We also had to actively support logistics: we phoned community centers that provided bus rides for some campers, reminded parents about drop-off times, and sometimes had to wait for late parents.
- **Design the Curriculum to Balance Learning and Fun.** Our campers had no background in AI. While they may have chatted with tools such as Siri, they may not recognize these experiences as a form of AI in their daily lives. One of the main challenges for our camp was designing a curriculum and activities that could fill in these gaps while being fun, engaging, and appropriate to an informal learning setting. There was a dual need for providing both general AI knowledge as well as interface-specific instruction. Modifying curricula designed for formal learning settings requires recognition that if the lessons are not presented in fun and engaging ways, then the campers may lack the incentive to return to camp. It is a delicate balance to keep lessons fun while meeting learning objectives.
- **Prioritize Extensive PD for Camp Facilitators.** We aimed at hiring undergraduates who were technically strong and were passionate about working with middle school students. Moreover, many of the graduate students on our team had experience in classrooms and had been intimately involved in the project for one year or more prior to the camp. In Year 1 we believed that one week of half-day PD would be sufficient, but the results showed this was not enough time for the facilitators to feel confident and prepared. In Year 2, we expanded the PD to three weeks of half days, and these included pedagogical content as well as substantial hands-on time for facilitators to build their own conversational apps so that they had personal experience to help campers. The additional PD time also fostered a sense of camaraderie amongst facilitators, which we observed had many benefits during the camp.

6 CONCLUSION AND FUTURE WORK

This experience report describes the design and iterative refinement of a series of two-week summer camps in which 62 predominantly Black middle school students participated in hands-on AI-based learning experiences to design and develop their own conversational AI apps. During the two-week period, campers developed personally and societally relevant conversational apps, both individually and collaboratively. Moreover, the campers' attitudes toward AI changed significantly through the course of the camp, specifically their beliefs in their ability to do well in AI and their confidence in understanding AI. This paper has described the camp's organization and shared its challenges, insights, and lessons learned. We believe the outcomes of this experience can help advance the existing knowledge and practice for building successful informal learning experiences around CS and AI.

There is much to explore within this authentic and fun AI learning context around conversational apps. Our future work includes providing public access to the development environment and teaching materials for use by schools and after-school programs. Also, there is a need for developing instruments to measure knowledge and learning gains to assess students' cognitive outcomes specific to teaching conversational AI-based learning competencies. Designing assessment instruments that are short enough and engaging enough to be used in a summer camp is a particularly important challenge. Finally, future work should investigate how to design AI-based learning experiences with learners who are historically underrepresented, as well as with other age groups in K-12, in mind.

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REFERENCES

[1] Joel C Adams. 2010. Scratching middle schoolers' creative itch. In *Proceedings of the 41st ACM Technical Symposium on Computer Science Education*. 356–360.

[2] Chulakorn Aritajati, Mary Beth Rosson, Joslenne Pena, Dana Cinque, and Ana Segura. 2015. A socio-cognitive analysis of summer camp outcomes and experiences. In *Proceedings of the 46th ACM Technical Symposium on Computer Science Education*. 581–586.

[3] Tim Bell, Jason Alexander, Isaac Freeman, and Mick Grimley. 2009. Computer science unplugged: School students doing real computing without computers. *The New Zealand Journal of Applied Computing and Information Technology* 13, 1 (2009), 20–29.

[4] Janet E Burge, Gerald C Gannod, Maureen Doyle, and Karen C Davis. 2013. Girls on the go: a CS summer camp to attract and inspire female high school students. In *Proceeding of the 44th ACM Technical Symposium on Computer Science Education*. 615–620.

[5] Canalys. 2020. *Canalys: Global smart speaker market to grow 13% in 2020 despite coronavirus disruption.* https://www.canalys.com/static/press_release/2020/pr20200227.pdf

[6] Oswald Comber, Renate Motschnig, Barbara Göbl, Hubert Mayer, and Esra Ceylan. 2021. Exploring students' stereotypes regarding computer science and stimulating reflection on roles of women in IT. In *2021 IEEE Frontiers in Education Conference (FIE)*. IEEE, 1–9.

[7] Dialogflow. [n.d.]. *Dialogflow.* https://dialogflow.cloud.google.com/ (Accessed April, 2022).

[8] Allan Fowler. 2019. Jamming with children: an experience report. In *Proceedings of the 14th International Conference on the Foundations of Digital Games*. 1–6.

[9] Sandy Graham and Celine Latulipe. 2003. CS girls rock: sparking interest in computer science and debunking the stereotypes. In *Proceedings of the 34th SIGCSE technical symposium on Computer science education*. 322–326.

[10] Caitlin Hulsey, Toni B Pence, and Larry F Hodges. 2014. Camp CyberGirls: Using a virtual world to introduce computing concepts to middle school girls. In *Proceedings of the 45th ACM Technical Symposium on Computer Science Education*. 331–336.

[11] Jacqueline Jordan Irvine. 2009. Relevant: Beyond the basics. *Teaching Tolerance* 36 (2009), 41–44.

[12] Betsy James DiSalvo, Sarita Yardi, Mark Guzdial, Tom McKlin, Charles Meadows, Kenneth Perry, and Amy Bruckman. 2011. African American men constructing computing identity. In *Proceedings of the SIGCHI conference on human factors in computing systems*. 2967–2970.

[13] Irene Lee, Fred Martin, Jill Denner, Bob Coulter, Walter Allan, Jeri Erickson, Joyce Malyn-Smith, and Linda Werner. 2011. Computational Thinking for Youth in Practice. *ACM Inroads* 2, 1 (feb 2011), 32–37. https://doi.org/10.1145/1929887.1929902

[14] Annabel Lindner, Stefan Seegerer, and Ralf Romeike. 2019. Unplugged Activities in the Context of AI. In *International Conference on Informatics in Schools: Situation, Evolution, and Perspectives*. Springer, 123–135.

[15] Margaret J Mohr-Schroeder, Christa Jackson, Maranda Miller, Bruce Walcott, David L Little, Lydia Speler, William Schooler, and D Craig Schroeder. 2014. Developing Middle School Students' Interests in STEM via Summer Learning Experiences: S ee B lue STEM C amp. *School Science and Mathematics* 114, 6 (2014), 291–301.

[16] David Rose. 2000. Universal design for learning. *Journal of Special Education Technology* 15, 3 (2000), 45–49.

[17] Krishnendu Roy. 2012. App inventor for android: report from a summer camp. In *Proceedings of the 43rd ACM Technical Symposium on Computer Science Education*. 283–288.

[18] Navin Sabharwal and Amit Agrawal. 2020. Introduction to Google dialogflow. In *Cognitive virtual assistants using Google Dialogflow*. Springer, 13–54.

[19] Kimberly A Scott and Mary Aleta White. 2013. COMPUGIRLS'standpoint: Culturally responsive computing and its effect on girls of color. *Urban Education* 48, 5 (2013), 657–681.

[20] Claude M Steele. 1997. A threat in the air: How stereotypes shape intellectual identity and performance. *American psychologist* 52, 6 (1997), 613.

[21] David Touretzky, Christina Gardner-McCune, Fred Martin, and Deborah Seehorn. 2019. Envisioning AI for K-12: What should every child know about AI?. In *Proceedings of the AAAI conference on artificial intelligence*, Vol. 33. 9795–9799.

[22] David S Touretzky, Christina Gardner-McCune, Fred Martin, and Deborah Seehorn. 2019. K-12 guidelines for artificial intelligence: what students should know. In *Proc. of the ISTE Conference*, Vol. 53.

[23] Gloriana Trujillo, Pauline G Aguinaldo, Chelsie Anderson, Julian Bustamante, Diego R Gelsinger, Maria J Pastor, Jeanette Wright, Leticia Márquez-Magaña, and Blake Riggs. 2015. Near-peer STEM mentoring offers unexpected benefits for mentors from traditionally underrepresented backgrounds. *Perspectives on undergraduate research and mentoring: PURM* 4, 1 (2015).

[24] Jessica Van Brummelen, Tommy Heng, and Viktoriya Tabunshchyk. 2021. Teaching tech to talk: K-12 conversational artificial intelligence literacy curriculum and development tools. In *Proceedings of the AAAI Conference on Artificial Intelligence*, Vol. 35. 15655–15663.

[25] Amber Wagner, Jeff Gray, Jonathan Corley, and David Wolber. 2013. Using app inventor in a K-12 summer camp. In *Proceeding of the 44th ACM Technical Symposium on Computer Science Education*. 621–626.