The First AI+ Health & Humanoids Camp for Underrepresented Minority Middle School Girls in South Carolina (Work in Progress)

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Abstract

The purpose of this paper is to provide an overview of the first AI+ Health and Humanoids Camp for underrepresented minority middle school girls in South Carolina hosted by the Artificial Intelligence, Algorithmic Integrity, Autonomy Innovation Center (AI3C) in the School of Engineering at The Citadel Military College. The National Science Foundation (NSF) funded the camp to broaden the participation of underrepresented minority girls in STEM. The goal was to inspire underrepresented minority middle school girls to close the STEM gap in South Carolina by exposure to artificial intelligence (AI) and healthcare. In the summer of 2024, this camp hosted 16 middle school girls and one high school volunteer from 12 schools across three neighboring school districts in the Charleston area. A team of 11 professors, administrators, and volunteers facilitated the camp.

Campers responded positively to the culturally responsive curriculum. The curriculum highlighted AI awareness and ethics, programming AI-enabled humanoid robots, exposure to healthcare challenges, and the need for more STEM and biomedical professionals in South Carolina. The Education Commission of States found that South Carolina's STEM pipeline failed students annually at every educational level [1]. The demand for a strong STEM workforce was expected to grow. However, there has been little to no growth in the student performance of math and science as reported in 2018 [1]. The quality of STEM teachers may be a key factor to the current state of the STEM pipeline in South Carolina.

With only 27% of 8th grade math teachers with an undergraduate degree in math, only 33% of science teachers with an undergraduate degree in science [1] and COVID-19 education deficits from 2020 still lingering, inspiring STEM experiences may be limited. In addition, minority students may have had the least amount of exposure to challenging concepts in math and science to create curiosity in STEM. Interventions such as STEM camps may positively influence an increase in STEM learning and interest.

The culturally responsive curriculum was strategic and an important aspect of the camp because studies confirm that self-perception can be a determining factor for underrepresented minority girls to join the STEM workforce [2]. Through the culturally responsive curriculum, over a third of the participants stated they learned something new about themselves of which they were proud. Campers met self-concept, AI and robotics, and social justice learning objectives through interactive teaching, workbook activities, crafts, videos, games, and research. The highlight of the camp was the Robot Rally, where campers performed original skits from their research into healthcare challenges they were motivated to solve using a humanoid robot.

This paper captures our reflections, details of implementation, lessons learned, evaluation results, and the effectiveness of exposing AI, robotics, and healthcare solutions to underrepresented minorities when presented within a culturally responsive curriculum.

Overview

The first AI+ Health and Humanoids (AI+H+H) camp was held June 10-14, 2024, by the Artificial Intelligence, Algorithmic Integrity, Autonomy Innovation Center (AI3C at The Citadel Military College in Charleston, South Carolina). The National Science Foundation (NSF) funded the camp to broaden the participation of underrepresented minority (URM) middle school girls in STEM. The long-term goal of the camp was to help close the STEM gap in South Carolina by exposing URM middle school aged youth to AI, robotics, and biomedical healthcare. The 2024 summer camp hosted 16 middle school girls and one high school volunteer from 12 schools from three school districts (Berkeley, Charleston, and Dorchester II) in the Charleston area.

A team of 11 professors, administrators, and volunteers facilitated the camp. Campers were warmly welcomed and given swag by the Citadel's Provost and Associate Provost Drs. Sally Selden and Kevin Bower.

Each day campers met the self-concept, AI and robotics, and social justice learning objectives through interactive teaching, workbook activities, crafts, videos, games, research, and creating and acting out a skit. The self-concept culturally responsive learning objectives included discussions of identity, personal values, intersectionality, and the impact of how individual decision-making can positively or negatively affect others in the community. Campers were challenged to discover their values. The social justice learning objectives included a discussion defining community, how to identify communities, and the identification of social injustice in communities. Some of the AI and robotics learning objectives included an overview of STEM, discussions on robot handling, types of robots, decomposition, debugging, and robot ethics, introductions to programming languages, and firsthand experience programming NAO-6 humanoid robots.

The demand for a strong STEM workforce is expected to grow. However, there has been little to no growth in the student performance of math and science in South Carolina [1]. The culturally responsive curriculum was strategic and an important aspect of the camp because studies confirm that self- perception can be a determining factor for underrepresented minority girls [2].

Youth and AI

AI enabled technologies are intensively applied in various fields such as healthcare, education, robotics, finance, and manufacturing in the last decade [3]. Even the personal use of AI-enabled technologies through SMART devices has increased and captured the attention of the youth through usership, therefore, adding to the societal impact of AI-enabled technologies [4]. AI has impacted the trajectory of K-12 education and should be done to broaden the participation of K-12 students hoping to inspire them beyond being end-users to becoming AI-practitioners [3], [4]. More specifically, the main objective of the AI+H+H camp is to expose underrepresented middle school girls to AI, robotics, and biomedical healthcare needs in the state of South Carolina in the hopes that exposure sparks curiosity in AI in healthcare to help close the STEM gap.

AI in healthcare (AI-Hc) is an application area which is highly promising to make healthcare technologies available for the low-income and the elderly population to improve community health. It has been proven that AI-Hc can enhance lives through ophthalmology, radiology, pathology, surgeries, and postoperative complications to name a few [5]. Using AI-enabled humanoid robots in STEM education has the potential to encourage the youth to get involved with research in AI-Hc. The foundation to be prepared for AI-Hc roles are laid in the math and science classrooms. Camps such as AI+H+H can positively influence and provide a safe space for AI-Hc exploration.

STEM education pipeline

The Education Commission of States revealed that the state of South Carolina's STEM pipeline failed students from K-12, junior college, and four-year college in 2018 [1]. Eighth graders in 2018 are now in their early twenties as of 2025. The demand for a strong STEM workforce was expected to grow. However, there has been little to no significant growth in SC student performance in math and science [1], [6]. The quality of STEM teachers may be a key factor to the current state of the STEM pipeline. In 2018, 27% of 8th grade math teachers had an undergraduate degree in math, and 33% of science teachers had an undergraduate degree in science [1].

The U.S. Department of Education's 2024 Nation's Report Card for South Carolina confirmed no meaningful growth in math from the 2000's and showed that underrepresented minorities scored an average of 25-36 points lower than other students [6]. The 2015 Nation's Report Card is the last report available for eighth grade science for the state. For SC science in 2015, the score was close to the nation's average, while still scoring lower than 29 states, and the same as 11 other states [6]. The 2015 report did indicate that income and minority gaps persisted from 2009 through 2015 among eighth graders in South Carolina as it pertained to science scores [6]. Those eighth-grade students from 2015 are approaching their mid-twenties in 2025. In addition to the collective deficit of genuine math and science teachers, minority students have had the least amount of exposure to challenging concepts with the potential to spark curiosity in math and science. Interventions in the form of camps like AI+H+H may positively stimulate the learning of underrepresented minority youth towards STEM careers. In 2023, the NSF invested over $18 million towards the STEM education of students in South Carolina [7]. The 2023 NSF investment included the support of the AI+H+H camp.

Curriculum

The basis of the curriculum for the AI+ H+H Camp was influenced by the Humanoid Engineering and Intelligent Robotics (HEIR) Lab at Marquette University for minority girls held in 2015 and 2016. The HEIR Lab's curriculum was written by The Dean of the School of Engineering at The Citadel Military College, Dr. Andrew Williams, when he served as the director of Marquette's HEIR Lab with Dr. Kimberly Scott, Ms. Kathleen Baert, and Ms. Adrianna Williams. The HEIR Lab curriculum provided the culturally responsive approach to identity, social justice, and intersectionality, an overview of STEM and humanoid robotics, and skit performance called a Robot Rally that created a space for campers to teach the audience and the other groups what they researched and the AI-enabled healthcare solutions they created. The

AI3C curriculum and Robot Rally engaged AI+H+H campers in using AI-enabled robotics to advance healthcare needs of patients or to reduce burnout of medical professionals.

Recruitment

AI-focused summer camps create opportunities to develop AI literacy in campers [3]. However, the summer is a competitive time of year for extracurricular youth activities. Parents and students are bombarded with camps for sports, band, faith-based, swimming, art, and dance, pre-planned family vacations, visiting relatives, and other opportunities in addition to STEM camps. The advertising of the AI+H+H camp began in early March 2024 through local networks such as the National Society of Black Engineers (NSBE) Charleston Professionals, the Society of Women Engineers (SWE) Lowcountry, local churches, social media, middle and high school principals, and word of mouth of parents and other community members in preparation for the April registration. There were 19 registered campers, but only 16 participated along with one high school student. The high schooler requested to participate as a volunteer because of her interest in AI, robotics, and programming. Her help was welcomed. In total, the 17 girls represented 12 schools STEM interest areas.

Programming AI-enabled humanoid robots

A major component of the curriculum was the introduction of STEM and various topics in computer science, computational technologies, and communications. The fundamentals of programming were reviewed with focused training on the decomposition of and error finding (debugging) in computer programs. The main components of humanoid robots such as motors and actuators were taught. Rigid body reference frames and degrees of freedom of the robot body were explained to the campers. High level languages (HLL) and low-level languages (LLL) programming languages were introduced with simple Python programming examples to program the humanoid robots during the camp.

The three humanoid robots used in groups during the camp were 25 degrees of freedom (DOF), AI-enabled, autonomous, programmable NAO-6 robots which were first developed by Aldebaran Robotics and currently manufactured by SoftBank Robotics. Figure 1 shows a photograph of NAO-6 robots. Since their first development, NAO robots have been used in many research and teaching institutions to study human-robot interactions. It is also known that the NAO robots are being used in healthcare, for example, as care robots for patients with cognitive disorders such as dementia. The NAO Autism Pack includes software used in special education programs for students with autism [8].

Figure 1. NAO-6 robots during the camp.

The widespread use of NAO robots both in research and education can be attributed to the following features:

Image processing: NAO-6 robot has two 2-D cameras. With its image processing algorithms, it can detect and recognize human faces, motion, and certain geometrical shapes.

Sound processing: NAO-6 robot has four microphones. Sound processing algorithms provide speech recognition and sound localization for human-robot interaction.

Sensors on board: They have sonar rangefinders for environmental perception. For navigation and localization purposes, one inertial unit is used with a 2-axis gyroscope and one three-axis accelerometer. With their infrared (IR) transceivers, they are capable to communicate and controlling with other IR-enabled devices and with each other. There are several capacitive sensors used on robots such as on their hands, feet, and heads. These sensors can receive information through touching which is particularly important for human-robot interaction. They also have loudspeakers for audio communication and LED lights for visual communication.

Camper engagement

Overall, campers enjoyed learning about AI-enabled humanoid robotics and parents reported that several campers talked about their AI3C camp experience at home and with others. During the first two days of camp, some campers showed a lack of enthusiasm and discomfort around robots despite parents reporting positive interest in multiple STEM interest areas on the registration forms, as summarized in Table 1. Some campers were apprehensive of the NAO robots due to their frequent movement and human-like gestures when connected to Wi-Fi. After naming the robots, completing the robot handling exercise, and spending time with the robots, all campers were comfortable holding their groups' robot at least once.

Outdoor breaks significantly boosted camper engagement. Initially, only campers that were exposed to robotics and STEM were engaged in open discussions, while others were reluctant to speak until day three. On day three, engagement peaked with campers forming relationships within their Robot Rally groups.

Table 1. STEM Interest Areas

Pre-Engineering	5
Computer and Information Systems	8
Biomedical Sciences	2
Health Science and Technology	11
Programming and Software Development	8
Networking Systems	7
Information Support Services	5
Robotics	8
Artificial Intelligence	6
Machine Learning	3
Curious about STEM	3
Total	66

Robot Rally

Campers on the first day were told they would be working in a group with a NAO robot to create a skit that would be performed at the conclusion of the camp called a Robot Rally. The campers were divided into two groups of six and one group of five, to include the volunteers, for the Robot Rally. Each group chose a healthcare topic that used an AI-enabled robotic healthcare solution to help patients or medical professionals solve a problem.

Anxiety during pregnancy

Group 1 researched anxiety in pregnant women. The skit involved a pregnant military wife that suffered from anxiety. The husband purchased a home-care humanoid robot named Bob to provide aid to his wife in his absence while on deployment. Figure 2 shows a photograph of Bob, the home-care robot, and his owner while she was having an anxiety attack during a contraction. Bob called 911 for an ambulance to take his owner to the hospital. Bob opened the door for the emergency medical technician and paramedic and answered questions on his owner's behalf to the doctor at the hospital to ensure his owner received the best possible care. Group 1 educated the audience on anxiety during pregnancy and the role of emergency medical technicians and paramedics when called onto a scene. The campers programmed Bob to walk, talk, and make gestures.

Figure 2. Anxiety during pregnancy skit.

Short-staffed and short of breath

Group 2 researched elderly care in nursing homes and the shortage of care providers to assist patients. In the skit a grandfather named Joe contracted pneumonia in a nursing home. Grandpa Joe was visited by his granddaughter when he suffered a coughing attack before fainting onto the floor. The granddaughter called for help, but all medical care providers were busy helping other patients, therefore, the nursing care robot, Tim, answered the call for help. Figure 3 shows a photograph of Tim, the robot, after administering CPR on Grandpa Joe in front of his granddaughter. The nurse and doctor approached the scene a little too late to be helpful. Once Grandpa Joe was revived, Tim performed a victory dance to celebrate. After the doctor's examination, she diagnosed Grandpa Joe with pneumonia. Group 2 educated the audience about staff shortages in nursing facilities and facts about pneumonia including the causes and harm to the elderly. The campers programmed Tim to talk, walk, kneel, make CPR hand motions, and dance.

Figure 3. Short staffed and short of breath skit.

Tai -chi for heart health

Group 3 researched heart disease in women. The skit portrayed the experience of a patient who was diagnosed with heart disease. The doctor sent the patient home with a robot named Crystal to provide home health services and to log the patient's activities for accountability so that the doctor will have an accurate report. Crystal helped the patient to manage her diet and to demonstrate exercises. The skit concluded with Crystal and the patient establishing a morning routine and performing a Tai-Chi exercise together. Figure 4 shows a photograph of Crystal teaching the patient Tai-Chi. Group 3 educated the audience on facts about heart disease and healthy ways it can be managed. The campers programmed the robot to talk, walk, and perform Tai-Chi.

Figure 4. Tai-chi for heart health skit.

Results

The pre-and-post assessment surveys were created with IRB approval to assess campers' self-concept, AI and robotics comfortability, and plans involving STEM for research purposes. Table 2 shows the pre-and-post assessment questions. The campers were asked to complete the assessment using a 5-point Likert Scale (5-strongly agree, 4-agree, 3-undecided, 2- disagree, 1-strongly disagree).

The optional assessments were completed by 12 of the 16 middle school campers. A strong camp experience was reported by 83% of campers. As captured in Table 3, the responses indicated a positive camp experience.

Table 2. Pre-and-Post Assessment Questions

1. I am proud to be who I am.
2. I am comfortable trying new things.
3. I am comfortable using software.
4. I am comfortable handling robots.
5. I am comfortable programming software.
6. I am comfortable with artificial intelligence.
7. I plan to work in the STEM field when I grow up.
8. I could see myself creating technology for healthcare needs when I grow up.
9. I could see myself programming robots to help people when I grow up.
10. I plan to choose a career path that involves pre-engineering, programming and software development, artificial intelligence, or robotics.
11. I plan to choose a career path that involves biomedical sciences or health science and technology.
12. Attending a high school that has a STEM or technology education program is important to me.

Table 3. Post-Camp Assessment Results

Positive Impact
• 83% reported a strong camp experience
• 69% are interested in learning more about robotics and healthcare.
• 33% are considering a career in AI-enabled robotics or health science
• 33% are more comfortable handling robots and working with AI, and trying new things
Areas of Improvement
• 61% are unsure if they would recommend the camp
• 50% are undecided about choosing a career in health science or with AI

Majority of the girls stated that they learned something new about themselves, of which they were proud. Throughout the week the activities encouraged the campers to focus on identity as part of the self-concept learning objective. The campers authored self-empowering poems, created a quilt of values to guide their actions, and saw themselves as medical professionals and decision makers impacting the lives of others through skits. This camp compelled 69% of campers to desire to learn more about robotics and healthcare.

Limitations

The campers expressed satisfaction that reflected there was value in participating in the camp. However, there were some limitations to the assessment results such as the small sample size, the short duration of the camp, and the wording of assessment question seven (I plan to work in the

STEM field when I grow up). Only 12 attendees completed the optional pre and post assessments. On the first day of camp, immediately following the check-in process, the campers were given the pre- assessment to complete. Campers asked for coffee, lacked motivation, and some complained it was too early in the day to think or work. The campers summer break had recently begun the first week of June. In the future, it would be beneficial to find an alternate strategic time for completing the pre-assessment. The second limitation of this experience is the five-day camp duration. Five days may not be enough time for middle schoolers to gain a solid foundation in the AI and programming curriculum, especially if they did not have prior exposure to AI-enabled robotics. The post-camp assessment results shown in Table 3 suggest that the campers were intrigued by the camp and a STEM interest is still developing as they begin to envision their future lives and careers.

Lessons learned

Executing the first AI+H+H camp was no small feat. The camp facilitator observed that student engagement with additional activities, sponsorships to collect donations to purchase props for skits, and the need to onboard computer programmers to assist the instructor and to help students troubleshoot programing errors, would enhance the experience of campers. During the Robot Rally, it was learned that the NAO-6 robots can overheat quickly, therefore, giving the robots a minimum of 1-2 hours rest between the final practice and Robot Rally may help robots not to overheat during the performance. The facilitators learned that students value going outside for fresh air. Campers were more productive after returning from outdoor breaks, versus indoor breaks. Creating a workplace outside may be helpful when electronics are not required. Other important highlights for lessons learned include the need for student interest letters, transportation, and laptops and robots.

Student interest letter

Campers that were slow to engage on the first two days of camp shared they did not have a STEM interest as indicated on their registration forms their parents completed. The student interest letters were optional for Year 1. After experiencing the delay in engagement, it may be best to require a student interest letter from all applicants to understand how the student feels about the camp's offerings. Four optional student interest letters were received with the 2024 applications. Figure 5 shows a picture of a student interest letter. The student interest letter proved the continuous need for STEM camps geared towards robotics are needed to engage those that desire to learn.

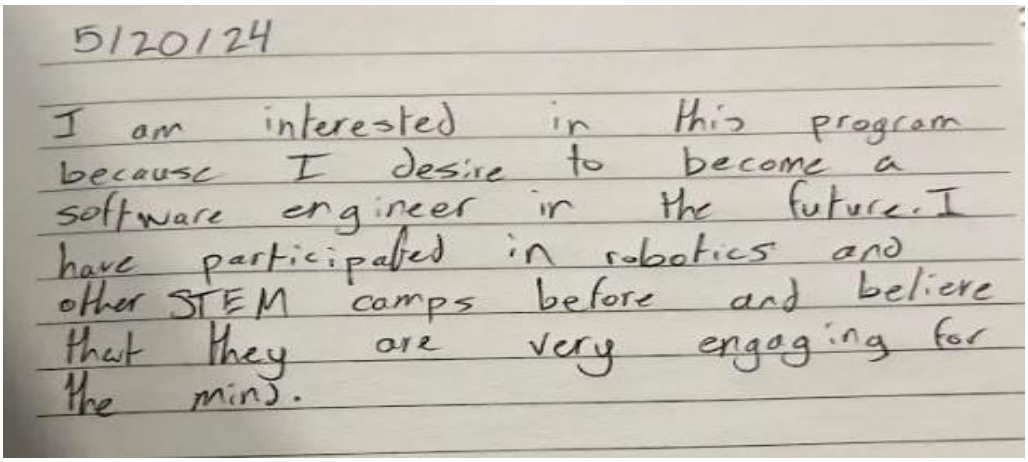

Figure 5. Student interest letter.

Transportation

The budget for transportation was insufficient for the multiple bus routes in the Tri-county area to cater to campers across three school districts. The team planned to provide one bus route within the constrained budget 7 miles from camp location. However, parents felt it was easier to drop off and pick up their campers to avoid an earlier drop-off time and a later pick-up time to accommodate the bus route times. For future camps, the transportation estimate should be significantly updated to accommodate multiple routes.

Laptops and robots

During the NAO programming practice exercises, some campers were not engaged. While each group had an assigned NAO robot and laptop with the programming software Choregraphe downloaded, the campers had to take turns practicing within their groups. Some group members were bored and did not find value in watching team members while waiting for their turn. Additionally, the same issue was present during the research portion. Majority of the campers engaged as a group to conduct research, while one group preferred to divide and conquer their research, resulting in some using their cellphones to search online for ideas with close supervision of the camp counselors. In the future, additional activities should be offered during the NAO programming practice to keep all group members actively engaged. The need for additional laptops was requested for future camps. The new goal is to provide laptops on a 1:2 ratio instead at minimum instead of per group. Reserving a computer lab only resolves access to computers for research but does not provide access to the software to program the robots and adequate space for the campers to practice giving commands to the robots.

Conclusion

The first AI3C AI+H+H camp successfully engaged 16 middle school girls in STEM, particularly in AI and robotics, as evidenced by the results of the pre- and post-assessment surveys. The responses revealed that most campers expressed an increased interest in learning more about robotics and healthcare because of the camp. Additionally, a significant number of

girls felt a stronger sense of self-worth through a newfound comfortability with coding and AI. The culturally responsive curriculum and focus on self-concept resonated with many campers. On the other hand, despite the positive outcomes, campers were undecided about recommending the camp to others, indicating potential areas for program improvement. However, campers expressed they were not sure if other students they knew would be interested. Underrepresented minority campers were uncertain if their peers would be interested in participating in an AI, robotics, and healthcare camp, confirming the lack of frequent group exposure to advanced STEM activities. The lessons learned were truly valuable in preparation for the execution of future camps.

The camp staff was excited that some campers indicated an interest in learning more about AI-enabled robotics or health sciences. Their inspired interest aligns with the camp's initial goal to broaden the participation of STEM among underrepresented female minorities. Overall, the first AI+ Health and Humanoids camp was successful.

Acknowledgements

The successful execution of the first AI+H+H camp was made possible through the camp facilitators, administrators, counselors, and volunteers from The Citadel Military College, including Dr. Andrew Williams, Dr. Eva Singleton, Dr. Oguzhan Oruc, Dr. Nahid Vesali, Col. Linda Riedel, Mrs. LaSonya Calhoun, Mrs. Anitra Williams, Ms. Abigail Giordano, Ms. Elizabeth Quarles, Ms. Sara Kau, Dr. Deirdre Ragan, Associate Professor at Pennsylvania State University, and a community member who helped recruit campers, Mrs. Salley-Ann Archie, For Inspiration and Recognition of Science and Technology (FIRST) Tech Challenge (FTC) and CyberPatriots mentor. This work was supported by the National Science Foundation EPSCoR Program under NSF Award #OIA-2242812 and the School of Engineering at The Citadel Military College. Any opinions, findings, conclusions, or recommendations expressed in this material are those of the authors and do not necessarily reflect those of the National Science Foundation.

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