



Commentaries in Urban Education

Art, AI and Robotics: A New Pathway for Youth to Voice and Identity

Abstract

To address the critical lack of representation in computer science and STEAM (science, technology, engineering, art, and mathematics), we designed learning experiences for high school youth using culturally situated art and design principles structured to increase authentic engagement, particularly for underrepresented and underestimated youth. Referencing sociocultural practices from hip-hop, we invited students to engage with us in an iterative process of storytelling, creation, and fabrication. Through design cyphers, we centered student knowledge to define the why behind making robotic prototypes and address the benefits and dangers of artificial intelligence such as bias and stereotypes. By integrating cyphers into the design thinking process, we created spaces for students to communicate, collaborate, and create innovative solutions to prototype, iterate, remix, and advance to their final project. In collaborative peer

reviews and gallery walks, the groups received constructive critiques at each step of the design process, from prototype to final project.

Keywords

STEAM, artificial intelligence, 3D design thinking, culturally relevant, robotics

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Data suggest that the thoughtful integration of creative computing, the arts, real-world connections, and collaboration into computer science courses and experiences is making a difference in attracting the attention of students from underrepresented, underserved, and underestimated groups and is leading to significantly greater participation in computer science and robotics (Anderson, 2020). In recent years, educators (see Escobar et al., 2021) have designed intensive programs that explore culturally responsive, project-based learning

experiences that connect advanced computing concepts to students' personal lives and career aspirations. Additionally, educators are following the emergence of artificial intelligence (AI) that facilitates teaching and learning. Machine learning (ML), a subset of AI, involves training algorithms to recognize patterns in data and this has the potential to revolutionize the way young people learn and make things, like robots. Roboticists can use ML to detect human faces and motions of the body, called face sensing, and artists can use face sensing and other AI applications to create and experience art and technology in new and different ways. Young people need opportunities to explore these developments and gain new skills.

Educators at Lesley University and Somerville High School (SHS) created a plan to bring together the latest developments in art, ML, AI, and robotics to attract underrepresented, underserved, and underestimated students. The course, titled "Art, AI & Robotics," was initially offered during the summer months of 2021 and 2023. After summer 2023, SHS adopted the course for subsequent school years. SHS teachers recruit students to enroll in the course to earn high school and college credits, as well as earn a stipend for their participation. Although the course is designed to attract students from underrepresented groups, any student who expresses an interest can enroll. As a result, classes are diverse across race, ethnicity, and gender, including Black, Latino, female, and non-binary students. No prior knowledge of computer science or robotics is required. In the course, SHS students learn how to design, build, and program robots and teach their machines how to make art. Students participate in activities that help them apply art and design concepts to computational thinking and action, social justice, and culturally relevant STEAM (science, technology, engineering, art, and mathematics) learning. For the Art, AI & Robotics course, educators designed the following learning outcomes, so that students learn:

- core three-dimensional (3D) design skills rooted in and extending from contemporary art.
- how to demonstrate knowledge of 3D concepts in sculptural and robotic forms.
- the fundamentals of computer programming through block-based coding.
- to build and program robots using AI to imitate human creative expression.

Course activities culminate in the presentation of capstone projects that demonstrate the students' mastery of these skills. Students engage in project reviews to evaluate their peers' work in a mutual exchange. Members of the community are also invited to experience and respond to the students' work. The content that follows explains the rationale for combining historically segmented subjects such as the arts, computer science, and robotics. The next sections present the novel, culturally relevant methods, activities, and examples used during the teaching of the course to keep students and the community engaged.

Youth Voice, Art, and Culturally Relevant Design Thinking

Youth voice refers to the ideas, opinions, attitudes, knowledge, and actions of young people, both individually and as a group. Youth, as students, bring to classrooms their own values, lifestyles, and world views, reflecting the diverse cultures to which they belong. Pedagogically, this can be translated into social and group activities or projects in which students gather to do research, express themselves, and collaborate to solve problems. This approach unleashes youth voices, breaking a "culture of silence" (Freire, 2001) so that everyone in the classroom feels included, which creates a space for intercultural dialogue that promotes constructive critique and reflection. This dialogue extends to the arts, especially to express emotions and ideas. Through art, barriers can be transcended in universally comprehensible ways, promoting transformative creativity and imagination, and with a powerful potential to become a necessary component of peace-building (Knight, 2014). The Art, AI & Robotics course hosted at Somerville High School in 2021 and at Lesley University's College of Art and Design in 2023 pedagogically combined youth voice and art (with AI and robotics) to engage high school students from underrepresented and underestimated groups.

Expression through the arts in educational settings contributes to intercultural dialogue and exchange (Gonçalves, 2011) and provides young people with engaging and challenging tasks. For example, combining cultural practice, art making, and design thinking helps students build 3D robots that communicate a message or art style. Teachers exposed students to artists from diverse backgrounds whose works demonstrate the elements of 3D design such as form, mass and volume, space, and line. Next, students created and shared slide

presentations on how artists' works explore 3D design principles such as balance, symmetry, movement, and proportion. Some students chose to study the work of sculptor Lee Bontecou who made abstract sculptures with organic shapes. Others looked at Heather Hart's participatory installation art, Olalekan Jeyifous's large-scale public artworks and 3D computer models, or Sanford Biggers use of the hip-hop cypher in his public art to promote youth voice and inclusion. During the course, the hip-hop cypher became a protocol for peer engagement and teacher-student collaboration, design thinking, and group learning experiences.

According to Emmanuel Adelekun (2018), a cipher—an informal gathering of performers in a circle—can form anywhere including in a classroom or makerspace. As a cultural practice, cyphers provide a structure for sharing knowledge and for people to demonstrate and practice their skills, as well as a place to enact self-definition and theorize one's existence in the presence of community (Gaskins, 2021). Cyphers represent kinship-building that suggests the sharing of characteristics or origins, with a shared learning process of working together as a group to achieve common objectives. During the pilot summer courses, Leslie College STEAM staff who are trained in youth development, modeled the cypher protocol for SHS teachers. This practice included small group work and design thinking (i.e., design cyphers) to foster intercultural dialogue and cultural exchange and to help students tackle and solve complex issues. SHS teachers reported an increase in student engagement because of the cypher activities that are explored below.

Daily, as an opening and closing activity, SHS and STEAM teachers join students in a class cypher where everyone takes turns talking about ideas, challenges, and successes. Participants start by talking about what they look forward to or what they need to work on. Everyone talks about what went well and what didn't go as planned. The design cypher includes concept mapping to help students come up with innovative solutions to prototype. Small groups of up to five students are tasked with brainstorming with a main idea or theme that branches out into more ideas. Students will choose one of these ideas to develop into a project. Additionally, as part of the design process, students participate in collaborative peer reviews and gallery walks, with each group providing constructive critiques for other groups' projects. In rounds, each group answers worksheet questions about the projects they see. In their groups, students are encouraged to read and discuss their peers' feedback. They are given time to respond by iterating on their

projects. This review process can happen more than once before projects are completed.

Culturally Responsive Computing and Robotics

Culturally responsive computer science (Scott et al., 2014) and robotics (Williams et al., 2017) can help teens reach developmental milestones, such as fostering a sense of self and identity. Adolescence is an important stage for developing self and identity, including activities they are involved in, goals they set for themselves, their motivations, having a sense of purpose, and control over their own lives (Becht et al., 2016). Teenagers also seek autonomy, particularly from adults such as parents and teachers, along with increased social engagements and greater needs for connection with peers (Meeus et al., 2004). Relatedly, self-assessment becomes increasingly differentiated and complex across various roles and relationships (Harter, 2015). Teens also frequently report greater self-consciousness and are more concerned with and interested in others' perceptions of themselves (Pfeifer et al., 2009). All these aspects make up what is referred to as *self-concept*, which is an idea of the self that is constructed from young people's beliefs about themselves, and beliefs based on the responses of others. A key goal of Art, AI & Robotics is to attract and engage underrepresented, underserved, and underestimated teens who may lack an awareness of who can do computer science or robotics, as well as show them projects that counteract stereotypes people have about these professions.

The Art, AI & Robotics course helps teens develop self-concept in the age of AI by interrogating AI bias, which has crept into facial recognition systems. Students learn about Joy Buolamwini (2023), a Canadian-American computer scientist and digital activist who discovered AI bias when she found that a robot recognized her face better when she wore a white mask. Based on the data it is trained on, AI systems can perpetuate stereotypes of who does computer science and robotics. Students in the Art, AI & Robotics course are tasked to make a distinction between facial recognition AI that is often coded with biases and face detection or *face sensing* that can be used to make art and build robots. Students learned how to access face sensing in Scratch, an online programming language that uses visual blocks to create computer code. Face sensing blocks make use of onboard computer webcams, and the extension can tell whether a face is present, and where eyes, ears, nose, and mouth are located on the face.

Students also used a Scratch extension for the BBC micro:bit, which is a microcontroller or a small computer on a single integrated circuit. The microcontroller is programmed to control the functions of robots. After designing their projects, students created robots that make art using responses from users' eyes, nose, and other parts of their faces.

Students in Art, AI & Robotics create robotic characters with personality traits that contribute to their sense of self and identity. By learning new tools and applications, collaborating with peers, and making art-based robots, students can increase their self-concept and see themselves as people who can do computer science and robotics. Art, AI & Robotics students use face sensing AI to control a variety of moving, interactive robot characters such as "Cube," which aptly describes a cubic robot that uses two BBC micro:bits to control the robot's functions such as eyes that light up and a mouth that opens and closes. Two girls made a cheerleader robot with pom-poms that rotate back and forth. Another girl's double-jointed robotic arm imitated the movements of its creator. A male student made a "Bobox" that moves its head at the same time as the human interacting with it. Two boys built a robot that responds to a person's facial movements by turning its head around, walking, and drawing lines and circles. These examples demonstrate how art and AI help youth explore notions of self and identity. The projects show personally and culturally relevant applications of computer science and robotics.

Constructionism and Community Engagement

The Art, AI & Robotics course takes inspiration from Seymour Papert's *constructionism* theory of learning (1993) that encourages student exploration and discovery within social contexts, where learning is iterative, ongoing, and collaborative in nature. Aspects of this theory include authentic student experiences, taking a student-centered approach to learning, and ensuring that activities are identity-affirming and community-based. With Papert's work in mind, Art, AI & Robotics teachers can suggest a short design challenge for students to complete such as making an electronic kinetics sculpture, otherwise referred to as *#Movement*. This challenge is inspired by South Boston's Learn 2 Teach, Teach 2 Learn (L2TT2L) program that fosters youth voice and creatively engages youth in STEAM to catalyze deep cultural change in their communities. The objective of the *#Movement* challenge is to incorporate information about a

social movement using text, images, and symbols into an electronic project that can sense and/or control things such as LEDs and motors. Students choose which social movement they want to represent with a kinetic sculpture. In 2023, for example, one student chose “climate change” and created a small model of a scene in which a 3D-printed, jointed human manikin surrounded by a garbage-collage and a sign for dangerous chemicals encounters a painted paper flower growing in a laser-cut acrylic terrarium. Powered by a micro-servo, the flower spins back and forth.

The *#Movement project scaffolds* a process that leads to students designing and building robots. As a follow-up activity, teachers introduce students to artist Sougwen Chung by showing her 2019 talk at TED@BCG Mumbai titled “Why I draw with robots.” Chung explores how ML AI can be applied to the drawing style of the artist’s hand. Students take what they learn from the *#Movement project* and Chung’s work to design robots or “drawbots” that respond to the movement of the student’s body, using an ML AI extension in Scratch and a micro-servo that controls movement. Students can attach water-based markers to the end of their drawbot arms to draw lines on paper in response to someone moving their hands back and forth in front of a laptop’s webcam. Making robots that respond to human input demonstrates *embodiment* that reflects both a user’s physical presence in the world and a social embedding in computational practices and purposes (Dourish, 2004). Using AI to draw with robots is an example of *constructionism* that promotes learning, collaborating, and communicating through making (Papert, 1993), as well as encourages dialogue between youth and machines.

Building face sensing AI drawbots familiarizes students with *improvisation*, which involves a spontaneous and inventive use of materials (Gaskins, 2021). It also highlights the participatory nature of robotics. Students, peers, and their communities can engage with drawbots through *call-and-response participation* (see Smitherman, 1977), where body gestures, facial expressions, or movements are “call” statements that trigger “responses” from the robots, i.e., the machines perform different actions. Improvisational activities situate creative robotics in embodied interaction, which combines being manifest in and a part of a community with the direct physical and temporal qualities of making things. This type of interaction is activated by the cypher where students can build on each other’s projects and work together to move their human-robot performances along. Through improvisation, participation, and interaction, students can explore

creative expression and social issues, then use robotics to generate and transmit data from or about themselves or their communities to machines to make art.

The Art, AI & Robotics course prioritizes community collaboration and consultation with student capstone projects that culminate in events that involve families, high school teachers and administrators, students, and university staff and faculty. Throughout the course, community members are engaged as early as possible and at different levels such as during collaborative peer reviews. In 2021, community members were invited to participate in the students' collaborative peer review at Somerville High School that included providing constructive critiques for students. In 2023, the course was part of the Lesley University College of Art and Design's Summer Pre-College Program that included a special exhibition and reception on the last day of the program. Students' families, friends, and peers from other pre-college courses were invited to experience the drawbots and interactive robots. After these events, project photos and video demonstrations were shared via the Lesley STEAM website and blog.

Conclusion

Art, AI & Robotics is a course that brings together art and design, AI, and digital fabrication—combining 3D modeling or computing-aided design with 3D printing, laser cutting, and electronics—to attract and engage students from underrepresented, underserved, and underestimated groups, as well as those who are historically more represented in STEAM fields. The course addresses the notion of who gets to do computer science and robotics. It also fosters the integration of coding, art, real-world connections, and collaboration through the creation of robots that use AI to respond to human movements and make art. This course acknowledges that art or creative expression is a universal human behavior that benefits individuals and society (Dissanayake, 2022). The need for culturally relevant STEAM activities speaks to the importance of diversity in creative and technical fields. This imperative encompasses access to opportunities for students from underrepresented or excluded groups and the ability of marginalized youth to see creative output that mirrors their identities and experiences. Students in the Art, AI & Robotics course learn about diverse artists who explore art and design, computer science, and robotics. They learn about and apply essential 3D elements and principles in their construction of

robots and use coding with face sensing AI to control their robots' movements.

Youth voice is used as a strategy in Art, AI & Robotics to engage students, especially ones from underrepresented and excluded groups. The course employs culturally relevant strategies to foster youth voice such as the use of cyphers, call-and-response participation, and embodied interaction during the design and making processes, as well as when engaging their peers and the community. The design cypher is part of a culturally relevant design thinking process that includes concept mapping and collaborative peer reviews that promote constructive critique as well as intercultural dialogue to express emotions and ideas. Students also have access to teachers, staff, and facilities to bring their ideas and capstone projects to reality. These strategies provide a structure for sharing knowledge and for young people to demonstrate and practice their skills, as well as a place for them to enact self-definition and theorize their existence in the presence of their communities.

Art, AI & Robotics aims to inspire youth to pursue STEAM education and careers by enabling them to solve problems through computer science and robotics. Students learn that algorithmic bias and racism in these fields can move from one system to the next, especially when varied sources of information and data are not considered during the development phase. The use of biased algorithms in facial recognition and surveillance has the potential to have very negative impacts on historically marginalized, underrepresented communities. Teachers showed students how artists have addressed algorithmic bias and other issues through projects that explore AI in creative ways, such as artists who use drawing to enable communication between humans and robots. This paper presented several examples of student projects that show a different side of AI technology such as face sensing that can be used to trigger robots built by students to create art. For future consideration, more needs to be done to attract students from underrepresented groups, which can be challenging when the people doing the recruiting do not represent the communities where the students belong or understand the dynamics or nature of the marginalization of these groups in STEM and STEAM fields. The strategies, methods, and project examples mentioned here hold tremendous promise to help other educators, developers, and researchers address bias, and racial and gender inequity in STEM and STEAM.

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Authors

Nettrice R. Gaskins (Lesley University) 

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