"Teaching a Computer to Sing": Preliminary Findings from *A Middle School After-School Pilot Program Integrating Computer Programming and Music Education*

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Abstract: This paper presents initial outcomes from the first year of a two-year project funded by the Advancing Informal STEM Learning (AISL) program of the National Science Foundation (NSF). The project is a partnership between the Bartlett Community Partnership School in Lowell, Massachusetts, and the Computer Science and Music departments at the University of Massachusetts Lowell. The authors are frequent collaborators, with mutual research interests in interdisciplinary education, computing and music-related technologies, artistic performance, and community learning. They offer varied perspectives on how an integrated Computing+Music program encourages diverse skill acquisition through supportive and nurturing environments for middle school students.

Building on recent multidisciplinary research in two predecessor NSF-funded projects, "Teaching a Computer to Sing" investigates how middle school students—aged ten to fourteen—build critical thinking and problem-solving skills through informal, yet cogent learning activities in a voluntary after-school choral program. This paper explores how deploying age-appropriate, music-centered, and technology-mediated pursuits gives middle school students a chance to explore the connections between academic fields that are normally offered as isolated, grade-specific courses in formal classrooms. It argues that pertinent, multidisciplinary instructional experiences engage middle school students at a pivotal stage in their cognitive and emotional development through the collective appeal of popular music, informal learning, sociocultural mentorship, and accessible technology.

Several important factors guide the evidence-based, mixed-method research that the project inspires.

First, both authors, due to their mutual professional and personal interests in music and computing technology, share a passion for exploring how learning can be dramatically improved by exploiting the intersections among art, STEM, and educational praxes for all ages. Led by the premise that each discipline supports the other—or can perhaps function "in service to each other"— our work attempts to show that humanities and STEM education need not be presented as disparate factions. Indeed, music's broad appeal seemingly unites people of all backgrounds

toward a common purpose—particularly those involved in solo and ensemble performance in local communities.

Second, we attempt to show that free and open-source technology that reinforces multisensory learning through visually pleasing graphical interfaces and manageable learning curves, can inspire middle school students to sketch out their favorite song forms and record vocal parts using Scratch and Audacity. These tools, both available at no cost and relatively simple to learn, align basic coding principles with creative sound manipulation and student-centered design. The authors contend that employing technology should not upset the musical focal point of or be cost-prohibitive for an after-school choral program.

Students in the after-school program perform in the a choir and get basic instruction on how to use computer software to program their parts, capture and edit audio, generate MIDI note values, and improve their listening and organizational skills. This paper offers an early report on how the students develop and refine their vocal parts through the simple recordings each singer makes using Audacity. As they take charge of their own creative production approaches, encouraging the students to reflect on how the sound changes using creative production techniques helps bridge STEM and music concepts. The informal learning program also encourages them to experiment with the digital effects each finds most appealing.

Initially, the students receive practical direction in how to use Scratch to code and Audacity to record. Over the course of time, the authors intentionally "step back" from guided programming instruction to give the students room to work with each other. The authors are especially interested in how the students generate multiple recordings and whether Scratch and Audacity help middle school students learn multiple-part vocal harmony. "Teaching a Computer to Sing" involves not only generating two, three and four-part harmonies through MIDI note values in Scratch, but also empowering students to process how simple coding, order, design, logic, revision, and assembly are among the core tenants of both art and science. In this scenario, Scratch helps students make connections between two seemingly opposite disciplines. Likewise, these activities happen with less and less formal supervision over the course of the academic year. The authors propose this is a central part of how informal STEM learning functions.

In keeping with the vision of "Building Interdisciplinary Bridges Across Cultures" and the conference's second strand on the "Creativities, collaborations and the intersections of Arts and Science," we offer a preliminary report on how the after-school choir participants, many of whom come from underrepresented and minority backgrounds, realize that informal STEM learning shares many similarities with ensemble membership through strategic relationships with outside mentors sharing the same racial and cultural backgrounds. These singers, arrangers, programmers and staff members support the "Teach a Computer to Sing" vision through their purposeful involvement as role models for the students of the Bartlett Community Partnership School.

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