Music Theory Pedagogy and the Makerspace

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The Sound Lab Workshop at Duquesne University

Duquesne's Sound Lab is a flexible space where aspiring entrepreneurs, engineers and artists come together to explore connections between technology, music, sound, visual arts and movement. It is a low-stakes community of learners, where experimentation is encouraged and failure is seen as a necessary step in an iterative process of design, fabrication and innovation.

In 2024, internal grants allowed us to establish the Sound Lab in our music building. Our Weekend and Summer Workshops launched that year. This program is so popular that we will soon partner with the Kamin (formerly "Carnegie") Science Center in Pittsburgh to co-host programs with regional reach.

The cost to students is minimal. Everyone receives free lunch and a bag of electronics components, which they can keep. All software we use is free and open source.

At our workshops, students explore & learn fundamental music theory concepts such as frequency (pitch), waveform (timbre), envelope (articulation), quantization (scales), and basic harmony.

Research Problem

The current music education paradigm only reaches a small portion of the overall student population.

- Factors such as socioeconomic status, academic achievement, and out-of-school arts engagement significantly predict students' participation and persistence in high school music courses (Elpus & Abril, 2024).
- 24% of the class of 2013 enrolled in one or more music ensembles (band, orchestra, or choir) during any of their four years of high school (Elpus & Abril, 2019).
- Only 29% of American high schools offered courses in music theory (Elpus, 2022).
- 27% of adults participated in school music performance or appreciation courses (Elpus, 2018).

Who: Makers identify as coming from a variety of professions, including scientists, technologists, engineers, artists, students, teachers, and lawyers (Brahms & Crowley, 2016). Makers are differentiated by their collaboration within the larger community to share their processes, products, and expertise (Anderson, 2012; Hatch, 2014).

What: Some of the most common resources for making include 3D printers, laser cutters, wood and metalworking tools—a modern evolution of industrial arts classes (Dougherty, 2013). Within the maker movement, makers make artifacts that are personally meaningful (Clapp et al., 2017). Some examples of maker artifacts include a phone case, wind turbines, an hourglass, bike chain sculptures, video game controllers, social media videos, and clothing (Sheridan et al., 2014).

Where: Makerspaces are places where tools and technologies are available for people of varying ages and skill levels to engage in the construction and sharing of tangible artifacts (Sheridan et al., 2014). Makerspaces have sprung up in churches, libraries, museums, and schools (Halverson & Sheridan, 2014), incorporating aspects of classrooms in industrial arts, home economics, art, and science (Dougherty, 2013).

Definitions

The maker movement refers broadly to the growing number of people who are engaged in the creative production of artifacts in their daily lives, and who find physical and digital forums to share their processes and products with others (Halverson & Sheridan, 2014).

Putting Makerspace Research Into Action

Maker environments fuel engagement with music

- Students play physical and digital instruments
- They interact with a community of musicians
- They share musical works (Hable, 2025)
- They develop meta-representational competence (diSessa & Sherin, 2000) by following representational trajectories (Halverson, 2021).

Maker music is authentic, interdisciplinary STEAM learning

- Participants engage concepts in STEM disciplines that have musical counterparts (Hable, 2025)
- They engage concepts implicitly & explicitly (Clapp & Jimenez, 2016)

Learning music through musical artifacts

- Learners construct knowledge of musical concepts by experiencing music through listening, performing, and creating (Wiggins, 2015)
- Participants created external representations of their internal musical ideas (Clapp et al., 2017).

Implications

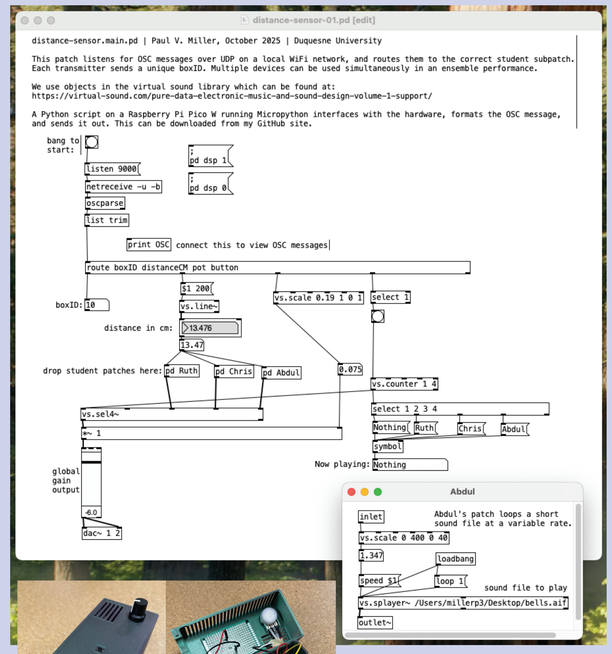
Maker music provides opportunities for makers to authentically engage STEM content and the discipline of music (Hable, 2025).

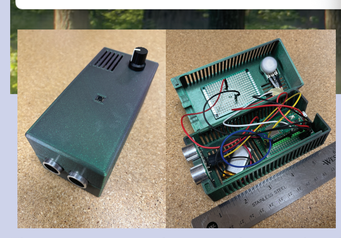
Maker environments are built and curated by educators who are properly trained to support student engagement across multiple disciplines (Oliver, 2016a, 2016b; Socol et al., 2018). Educators should consider:

- what knowledge and expertise are required to explicitly engage STEM and music content embedded in the maker activities educators design (Hable, 2025);
- what tools & technology are necessary, with specific purposes in mind (Brahms, 2014);
- how to intentionally design environments and activities that encourage engagement in multiple disciplines (Bers et al., 2018).

A Sample Pedagogy

Early on, students create a simple patch (program) in Pd (Pure Data) that takes one variable (distance) from a sensor, and makes any sound from it. The instructor can easily insert student work into the main patch, shown below. A wireless controller processes sensor data and cycles through everyone's patch sequentially by pressing a button.





The total cost of all of the components in this build is less than $30 USD, however it does require a laptop and WiFi router. The 12 × 6 cm enclosure is designed and 3D printed in-house.

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