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Music in STEAM: Beyond Notes

Hao Huang
Scripps College

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Abstract

Given current debates about STEAM, it would be well to remember that more than five centuries before STEM was conceived, the original Renaissance man, Leonardo da Vinci, wrote in one of his notebooks that "To develop a complete mind, study the science of art, study the art of science. Learn how to see. Realize that everything connects to everything else." (Spong 2006) A discussion of the effectiveness of teaching music and its accompanying technology in conjunction with math and the science education follows. .Given the recent shift from in-classroom teaching to online instruction compelled by the Covid 19 pandemic, an examination of online music education is relevant. The essay concludes with a discussion of Heidegger's thoughts on *techné*.

Keywords

music, pedagogy, Heidegger, Boethius, techne

Cover Page Footnote

Thanks to the American Council on Education for giving me the opportunity to engage in relevant thinking and discussions about this subject as a Fellow at Queens College CUNY.

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Introduction

The 21st century presents pedagogical and logistical challenges for teachers in higher education, as well as administrators of educational institutions; how can higher ed prepare students to be ready to achieve success in a constantly changing world? Real world problem-solving in the 21st century not only requires technical knowledge and skills, it involves creative thinking and adaptability. (Gregorio et al 2015).

The founding researcher and creator of the STEAM Education initiative, Georgette Yakman, raised the idea of adding the arts to the STEM acronym in 2006. Her current research focuses on cross-connecting common practices and learning patterns across the traditional academic subjects (silos) of science, technology, engineering, arts and mathematics that can form a framework for integrative curricula. She has emphasized the need for these disciplines to coordinate in order to adapt to the many varieties of disciplinary combinations that that people in contemporary society pursue. Yet it would be well to remember that more than five centuries before STEM was conceived, the original Renaissance man, Leonardo da Vinci, wrote in one of his notebooks that "To develop a complete mind, study the science of art, study the art of science. Learn how to see. Realize that everything connects to everything else." (Spong 2006)

Thoughts about the intersection of music and science education often dwell on neurological developments involved in learning music (e.g. Levitin, 2006; Mannes, 2011).. This leads to the idea that music is important in education not only for its own pedagogical value, but also for the

ways in which music can aid understanding of non-musical ideas for students (a review of these ideas and studies is found in Gershon, 2013).

Erica Andreotti and Renaat Frans (2019) have proposed a STEAM pedagogical model grounded in interdisciplinarity rather than integration. Such a model connects concepts and procedures which are typical of different disciplines, without sacrificing depth and cohesion inside each discipline. They suggest that integration and interdisciplinarity are not at all synonymous. The danger of following an integrated approach is to miss deep understanding of each separate discipline; an interdisciplinary approach makes relevant connections between STEAM disciplines apparent to students while teaching them to recognize specific concepts and processes that distinguish different disciplines:

> Interdisciplinary STEAM education is far closer to the real STEAM world outside school, than integrated STEAM is: indeed in the real world of research and industry different people with different backgrounds are working together to solve problems. These people need not to know everything, but rather must be able to talk to each other, by bridging the gap between disciplines. (Andreotti and Frans, 2019)

Due to its interdisciplinary nature, STEAM promotes a shift from an expert teacher-centered classroom to a more self-reliant student inquiry-based learning environment. In a STEAM environment or lesson, the teacher's role changes from authority to facilitator or guide. Developing the soft skills encouraged in a STEAM educational approach challenges teachers to adjust and change their approach to teaching and learning beyond establishing competency in one subject. Muhammad H Zaman, a professor of biomedical engineering at Boston University., has noted that developing a historical awareness is a way to teach students that the scientific quest is

often marked by disappointment and failure, and that perseverance in the face of adversity is a key to success: “Indeed, the discussion of struggles, obstacles, failures and persistence can lead to significant academic improvement of students, particularly for those who may be facing personal or financial difficulties or feeling discouraged by previous instructors and mentors.” (Zaman 2016)

Similarly, music students actively engage in the process of learning from making mistakes. When learning how to understand and make music, all students find out that mistakes occur far more often than flawless execution. Students learning music find that they must dare to experience multiple failures in order to achieve eventual success. At its best, music education provides students with the experience of being wholly present during the process of combining musical inspiration, emotions, ideas and performance skills that is its own reward. Ryan Holiday writes in The Obstacle is the Way (2014), “It’s okay to be discouraged. It’s not okay to quit…Failure shows us the way – by showing us what isn’t the way… Think progress, not perfection.”

Thoughts About Music Education

The centrality of music in education was established as early as 476 A.D. by the Roman philosopher Boethius, who translated Greek texts, including Euclid on geometry and Ptolemy on astronomy, and wrote texts on arithmetic and music. He formalized the educational model of the quadrivium as comprised of the pure (arithmetic), the applied (music), the stationary (geometry) and the moving (astronomy). This framework endured for more than a millennium. It became the model of medieval monastic system of education, which was structured around seven subjects – the seven liberal arts – that comprised the quadrivium and the trivium. The trivium concerned the three language arts: grammar, for ensuring proper structure of language; logic, for arriving at the truth; and rhetoric, for the beautiful use of language.

Eisner (2002) has proposed that a crucial quality of a modern artistic experience is

[of] paying close attention to what is at hand, of slowing down perception so that efficiency is put on a back burner and the quest for experience is made dominant. There is so much in life that pushes us toward the short term, toward the cursory, toward what is efficient and what can be handled in the briefest amount of time. The arts are about savoring… Enabling individuals to learn how to attend with an eye toward the aesthetic and with time to undergo its flavors is a nontrivial outcome of education that is perhaps most acutely emphasized in effective art education.

While appreciating music demands spending adequate time to savor aesthetic expression, learning how to perform requires systematic pedagogical strategies: progressive stages of teaching technique proficiency, repertoire, interpretation); problem-solving that demands physical and aesthetic choices in interpretation and improvisation, instrumental and vocal conventions; applying language acquisition skills to learning musical notation, transposition, orchestral arranging; and understanding historical context in the form of historical performance practices, instrument history, and socio-historical context. Moreover, learning to make music contributes to development of an individual's emerging self-identity, and can contribute to mental health as well as literacy, fine motor skills and spatial reasoning.

Music in STEAM

In 2014, the National Association for Music Education (NAfME) sponsored a panel called "Music Education Powers STEAM: The Broader Minded Role of Music in Preparing a 21st Century Workforce" that included Congresswoman Suzanne Bonamici of Oregon, NAfME President Glenn E. Nierman, David Dik, National Executive Director of Young Audiences Arts for Learning, and Dru Davison, Arts Administrator for Shelby County Schools in Memphis. NAfME President Nierman asserted, "The goal of our teachers is not to make music majors, but lifelong persons [sic] who

appreciate the arts and there are number of 21st century skills like communication and collaboration that happen almost every day in the music classroom." Rep. Bonamici concurred: "Everything can be connected. Instead of saying 'now we are studying science and then we are studying art,' it can be integrated curriculum that can be really engaging to students…because we all know students learn in multiple ways." (Donachie 2017).

The panelists agreed that successful music education advocacy depends on highlighting how music develops key skills in students, including self-reflection, communication, collaboration, creativity and innovation. The diversity of professions represented by this panel demonstrate how STEAM can be used as an effective advocacy tool. The more non-arts colleagues, administrators, and community leaders learn to understand the importance of what is taught in music courses, the more likely people from outside the discipline will appreciate how crucial and integral the arts are to a well-rounded curricular program.

Mika Shino, the executive director of the International Jazz Program at the Thelonious Monk Institute of Jazz, has suggested that music can be successfully utilized to teach math. In 2016, the Institute launched https://mathsciencemusic.org/, a website that is designed to be a resource for teachers to access curriculum that uses music to illustrate STEM skills and concepts. This was inaugurated with a panel hosted by the U.S. Department of Education with the Scratch Jazz project, which teaches students coding via the creation of their own music, and Making Music Count, where students can use the software program Impromptu to learn about proportionality and counting through hearing it out in a musical composition. Shino asserts that a great deal of effort has been invested in making the software user-friendly for math teachers who may be intimidated by the prospect of utilizing music as an education tool in the classroom.

Online Music Learning in STEAM

Given the recent shift from in-classroom teaching to online instruction compelled by the Covid 19 pandemic, a discussion of online learning has become even more relevant and appropriate. Our techno-scientific age is dominated by instrumentalism, which uses education as an instrument for practical job-related objectives, rather than for more ideal purposes. Considerable research is being done about the role of computer scaffolding in teaching the arts as part of educating well-rounded people who are capable of thinking critically and creatively about problems. (Guyotte, et al, 2014). Less attention has been paid to question, is technology implicitly changing our very understandings of what it means to be musical?

Given the rapid rate of technological change in our contemporary world, education is challenged to keep pace by incorporating available means into innovative learning approaches (Brown and Adler, 2008). Certainly, the current progress of online learning technologies compels music educators to reconsider the potentialities of learning music online (Crawford, 2013).

Heretofore, online music learning has been classified into two categories: informal individual online music learning that addresses specific affinity groupings that emphasize identity, community or curriculum skill sets; and formal institutional online music learning that offers academic students flexibility in time and location, community of collaboration, and assistive learning modalities for a diverse range of students – economic, social, cognitive and geographic (Crawford, 2013; Johnson, 2016). Experiences in informal music teaching and learning over the Internet have clearly influenced the overall development and understanding of formal online music learning. Furthermore, Miller (2014) describes the inclusion of the arts (including music) in STEAM as an avenue for developing authentically creative problem-based learning. This suggests

the ways in which informal and formal online and STEAM pedagogies can conjoin to produce multi-faceted. online music learning possibilities. (Johnson, Hawley 2017)

Apropos the affinity groupings that informal online music teaching appeals to, Ailbhe Kenny (2017) has proposed the concept of *communities of practice,* emphasizing the potential of online technologies to create and sustain communities not previously possible. This relates to Christopher Small's concept of *musicking*, whereby the play element and social nature of music making makes music not a thing, but rather a verb that encompasses all musical activity from composing to performing to listening. *Musicking* constitutes a ritual through which all participants explore and celebrate the relationships that constitute their social identity. For Michael Medvinsky, the pedagogical possibilities in various computer technologies offer ways to bypass traditional roadblocks and barriers in music education to potentially liberating learning experiences. (Wiggins and Medvinsky 2013) Medvinsky's engineering background spurs him to advocate for the integration of technology and global collaboration into learning environments where experiential learning enables students to look closely, think deeply, and wonder unceasingly on their own. He proposes that new ways of being musical can be facilitated through the integration and scaffolding of developing technologies.

One ideal area for online music education is audio engineering - an interdisciplinary field that incorporates both music and mathematical skills. An online learning approach aligned with a STEAM educational values can provide support for audio engineering students who take physics as part of learning about the audio, visual and practical aspects of music and physical mathematics. Online learning can provide students with interactive learning opportunities.

Since 2007, the Music Entertainment Technology Lab (MET-Lab) at Drexel University has hosted the Summer Music Technology Program (SMT) for high school freshman and

sophomores with objective of raising interest in STEM-related fields through engaging with current music technologies. By using music as a medium, SMT has taught engineering concepts that relate to students' personal interests in music. The interdisciplinary intent of STEAM (STEM + Arts & Design) has been met by teaching students how to relate knowledge learned about how instruments they play produce sound and how the Internet music services use algorithms to recommend music to material covered by their math and science classes in high school. (METlab 2019)

SMT has maximized student interaction with course materials by minimizing lecturing (most activities are limited to a five minute brief introduction before students initiate hands-on activity). Each student is loaned an iPad for the SMT term, and most teaching modules make use of a custom-developed app, AudioWorks (which is made available to students for free via the App Store). AudioWorks has been designed to cultivate a strong visual intuition for the physical parameters of sound production and modification. The app affords the essential functionality of a basic oscilloscope (with a time domain plot capable of displaying waveforms at scales ranging continuously from tens of milliseconds up to three seconds) and spectrum analyzer (with frequency domain plot showing an averaged spectrum over the currently visible portion of the time domain plot) in three modal contexts: audio analysis, synthesis, and effects. (Morton *et al,* 2017)

Conclusion

Within America's historical memory, Benjamin Franklin and Alexander Graham Bell represent figures who successfully integrated artistic and scientific pursuits. Their accomplishments support contemporary evidence that there is a significant correlation between arts participation and top levels of scientific achievement. A study by American psychologist

Bernice Eiduson has determined that Nobel Prize-winning scientists are 25 times more likely to sing, dance or act than the average scientist. They are 17 times more likely to create visual art and four times more likely to be a musician. (Ahmed 2019)

This data provides a frame of reference for several recent initiatives of the National Academies of Science, Engineering, and Medicine that have concentrated on making creative connections between the STEM fields and the arts to advance discovery, innovation, and learning. This goal was articulated in the 2018 consensus report, "The Integration of the Humanities and Arts with Sciences, Engineering, and Medicine in Higher Education: Branches from the Same Tree." (Skorton 2018)

More than a half century ago, Martin Heidegger proposed that both technology and art stem from ancient Greek concept of *techné*, which applies to the way to reveal reality through embodied praxis. On its most fundamental level, *techné* was used to refer to both manufacturing (e.g., the techniques of shoemakers and silversmiths) and to the arts (e.g., the techniques of poets and sculptors). *Techné* was an element in *poeisis*, "a bringing forth of the true into the beautiful." (Heidegger 1993) Heidegger concluded that *techné* is a way of knowing, which moderns might conflate with mere technical expertise. And he warned about "the crisis that in our sheer preoccupation with technology we do not yet experience the coming to presence of technology, that in our sheer aesthetic-mindedness we no longer guard and preserve the coming to presence of art." (Heidegger 1954/Hanks ed. 2009)

More than two millennia after it was originally conceived, the instrumental meaning of *techné* – understanding technology as practical application of science – has eclipsed its alternative artistic meaning. Our current time represents an ideal moment for educators to restore the dual meaning of *techné* as technology and *techné* as art.

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