Orchestrating Computer Science Education through Music and Collaborative Visual Programming

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ACM Reference Format:
Will Hedgecock, Devin Jean, Gabriel Barnard, and Ákos Lédeczi. 2025. Orchestrating Computer Science Education through Music and Collaborative Visual Programming. In *Proceedings of the ACM Global Computing Education Conference 2025 Vol 2 (CompEd 2025), October 21–25, 2025, Gaborone, Botswana.* ACM, New York, NY, USA, 2 pages. https://doi.org/10.1145/3736251.3747302

This poster presents an innovative educational framework called BeatBlox that integrates music composition with computer science (CS) instruction through visual block-based programming. It addresses the critical need to make CS education more engaging, accessible, and culturally relevant for diverse student populations.

Traditional computer science education faces significant challenges in engaging students from diverse backgrounds, particularly underrepresented groups who often find CS dry, difficult, and disconnected from their interests. With computing becoming essential across all aspects of society, there is an urgent need to make CS education more appealing and accessible. Music represents a universally appealing topic that transcends cultural and socioeconomic boundaries, making it an ideal vehicle for CS instruction [2].

BeatBlox builds upon NetsBlox, a browser-based visual programming environment that uses the internet to connect CS concepts to contemporary topics like climate change and social justice [1]. This new framework leverages the browser-based Web Audio API to provide comprehensive musical capabilities including:

- Individual note programming and duration control
- Virtual instruments and prerecorded audio clips
- Beat mixing and sound effect integration
- Real-time synchronization across multiple devices
- MIDI and external device support

The development process for this tool was informed by co-design sessions with both students and educators, ensuring that the tool addresses real classroom needs while remaining accessible to users from varying backgrounds, musical or otherwise. BeatBlox offers multiple engagement pathways, including:

- **Musical Creation:** Students can compose music using virtual instruments, manipulate prerecorded sounds, and create complex compositions using visual programming blocks.
- **Cross-Disciplinary Integration:** The platform enables students to create graphics and visualizations, combining art, mathematics, and computer science in a single project.
- **Collaborative Computing:** Built-in networking allows for creation of digital orchestras where multiple computers play synchronized music, demonstrating distributed computing concepts.
- **Accessibility Features:** Augmented reality instruments (air guitar, paper drums, theremin) ensure students can engage with projects at home using only a laptop and basic materials.
- **Device Integration:** Support for MIDI devices and smartphones as instruments accommodates various technology access levels.

BeatBlox simultaneously supports meeting STEAM requirements while addressing required CS education standards. The framework is also geared toward supporting administrative efforts to recruit cross-domain CS teachers, as educators from non-CS backgrounds may be able to more easily connect with musical concepts than traditional programming paradigms, facilitating broader implementation of rapidly expanding educational mandates.

Initial feedback sessions revealed several takeaways. The platform is versatile enough to successfully engage novice 6th graders while offering challenges for experienced high schoolers. Support for varying levels of musical background and diverse genres encourages accessibility across cultures and interests. Increased creativity and student confidence are exhibited when CS concepts are personally relevant,and the ability to create tangible outputs in the form of meaningful, shareable musical compositions leads to reduced intimidation compared to traditional programming environments.

The primary differentiator from similar tools stems from first-class networking features that open the door for increased collaboration and teamwork. Some existing tools utilize Python, leading to a steep learning curve, while others focus more heavily on *either* CS or music composition. BeatBlox aims to make computer science education more inclusive, engaging, and accessible by *connecting* fundamental CS concepts to the universal language of music. Future work will focus on creating comprehensive curricula and professional development materials to support widespread adoption.

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CompEd 2025, Gaborone, Botswana.
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ACM ISBN 979-8-4007-1942-4/2025/10
https://doi.org/10.1145/3736251.3747302

Acknowledgments

This research was partially supported by a Vanderbilt University Seeding Success grant, as well as by the National Science Foundation (NSF) VITAL Prize Challenge, with funding from the NSF, the Bill & Melinda Gates Foundation, Schmidt Futures, and the Walton Family Foundation.

References

[1] C. Brady et al. 2022. Block-based abstractions and expansive services to make advanced computing concepts accessible to novices. *Journal of Computer Languages* 73 (2022), 101156. doi:10.1016/j.cola.2022.101156

[2] F. Jamshidi et al. 2024. Striking a Chord through a Mixed-Methods Study of Music-Based Learning to Leverage Music and Creativity to Bridge the Gender Gap in CS. In *Proceedings of the 55th ACM Technical Symposium on Computer Science Education V. 2* (Portland, OR, USA) *(SIGCSE 2024)*. 1694–1695.