Coding Music Together: How Elementary Computer Science Students Collaboratively Translate Musical Ideas into Code

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0. Abstract

This study investigates the complex relationship between collaborative group dynamics and creative coding in the context of an open-ended music+coding activity with elementary students. Drawing on collaborative learning theory and creative computing research, we examine how students adopted collaborative structures as they tried to create music+coding artifacts in a web-based platform. Using written field observations across two different student groups, we analyzed the two groups' collaborative and creative efforts to complete the activity. Findings indicate that musical composition and coding were not separate tasks, but intertwined processes shaped by peer interaction and creative ideas. Our findings offer insights for software design, which should support flexible and fluid collaborative arrangements and scaffold support for collaboration in open-ended creative coding.

1. Objective

Educators and researchers have increasingly turned to creative coding as a way to engage learners in computer science, while integrating artistic domains such as visual art, poetry, and music (Weisberg et al., 2024). This shift has given rise to hybrid practices where coding becomes not just a technical skill but a medium for creative expression. However, learning environments that integrate art and code introduce additional layers of complexity: learners must translate artistic intentions into code, often moving between different representational systems and forms of expertise. Another layer of complexity is introduced when collaboration is involved, as learners must also externalize and communicate their creative and technical thinking to their peers.

Music-based coding environments, in particular, present unique opportunities and challenges for learners, as they must navigate both computational logic and musical structure to realize their ideas (Roberts & Horn, 2024). In this paper, we analyze two groups of learners as they engaged in a music+coding activity within a 5th grade computer science unit. We found that learners engaged in a rich, cognitive-social *translation* where they negotiated roles and ideas in order to collaboratively realize musical ideas as code. Understanding how learners engage in this type of creative and collaborative coding can help design STEAM learning environments that better support collaborative engagement, equitable participation, and the development of computational and artistic literacies.

2. Perspectives

2.1 Collaboration

Much of the work on collaborative learning in K-12 has been influenced by socioconstructivist theorists, such as Vygotsky (1978), who advanced the idea that learning is shaped by social interaction and cultural tools. Building on this socioconstructivist work, Roschelle and Teasley (1995) framed collaborative learning as the joint construction of knowledge through interactions and shared meaning-building. Collaboration in itself has social and cognitive dimensions that involve peer communication, interactions, and knowledge construction (He et al., 2023), in which learners coordinate around a shared goal or problem space (Dillenbourg, 1999; Mercer and Littleton, 2007). Prior research has investigated student roles in collaborative problem solving (e.g. Barron, 2000) and in pair programming, where students share one computer and take turns in pre-defined “driver” and “navigator” roles to write code (e.g. Murphy et al., 2010). However, we know much less about how students work together with separate devices using real-time collaborative editing software.

2.2 Music and coding

Collaborative skills are often a key goal in music+coding work, which frequently aims to cultivate 21st-century competencies such as computational thinking, creativity, and collaboration (Weisberg et al., 2024). Moore (2014) examined how collaborative learning and reflective activities affected students’ confidence and motivation in an undergraduate audio programming course. Pre- and post-surveys showed that these strategies positively impacted both confidence and motivation to learn computing. Similarly, Fields et al. (2015) investigated how collaborative structure supported high school students’ use of advanced programming concepts in a Scratch-based music workshop. Each student worked on a specific section, later combined into a complete video. The study found this approach helped students apply key concepts while promoting a more equitable division of labor. Xambó et al. (2016) explored collaborative live coding in classrooms using EarSketch, based on teacher interviews and observations. While students in this study relied on workarounds like Google Docs, the authors emphasized the need for dedicated coding platforms to support real-time collaboration. They outlined several collaborative configurations: *pair programming*, where two students alternate control of a single project; *pair live coding*, where two students edit the same codebase simultaneously; and *group live coding*, which involves multiple students working concurrently on the same project.

A segment of research on music and coding has also explored learners’ creative processes. Roberts and Horn (2024) showed that previous music or coding experience did not necessarily transfer to a music+coding context, but rather the ability to link between the two domains. The authors described the process of moving between music and code as a form of *translation*. Participants first developed musical ideas through traditional means and then translated them into computational forms, often encountering challenges or discovering new creative possibilities.

3. Data Sources

This study examined how fifth-grade students collaborated in a computer science classroom over a ten-week period using a music and coding platform that supports real-time collaborative editing (Horn and West et al., 2022). Each 45-minute class session began with 5–10 minutes of instruction on music and coding concepts, followed by activities applying those concepts (e.g., writing code for chords in three different ways).

Over the ten week program, two researchers collected written field observations on self-organized groups of 2–4 learners, focusing on learners' collaboration and creative process. During field observations, researchers sat beside the group they were observing and used Google Documents to record student-software interactions, students' spoken words, and relevant classroom events. The field observations were collected with approval from the Institutional Review Board, and all names are given as pseudonyms.

3.1 Methods

We employed constructivist grounded theory (Charmaz, 2017) to examine how the learners negotiated collaborative music-making. Initially, the first author reviewed field observations looking for variation in collaborative efforts between students' groups. Two focal groups were chosen due to the richness and variation of interactions between learners. Group one (G1) consisted of four male-identifying students: Riley, Oliver, Mason, and Jaden. Group two (G2) consisted of two female-identifying students: Tessa and Lily.

As collaboration-efforts were the foci, we inductively coded for moments of collaborative discourse and interactions. Through this analytical process, we identified key moments of negotiation, bidding, idea generation, and off-task behavior that contributed to the efficacy of the groups' successful collaboration. The following question emerged from this process: What conditions foster sustained and active student collaboration during an open-ended music+coding activity?

4. Findings

We observed students' adopting two collaborative structures, which in turn contributed to their ability to successfully create musical artifacts. Notably, one student from G1 and one student from G2 initiated similar approaches to communicate ideas and execute action with their respective groups. Tessa and Oliver both took on *driver* roles and aimed to lead the collaborative and creative efforts. In the following section, we will introduce both groups and their journeys as they work to co-construct knowledge as they write code for chords.

4.1 Group One: Trouble Reaching Creative Consensus

Tessa and Lily enthusiastically agreed to work together by joining a collaborative project, which allowed them to see each other's edits in real-time on their iPads. Immediately, Tessa asked Lily "*Have you heard the song bang bang bang?*" Lily responded, "*Yes.*" Tessa hummed the song and tried to play it on a virtual piano keyboard to begin translating her musical knowledge into code and share that with Lily. As Tessa tinkered with the virtual keyboard, she checked in with Lily, saying: "*Ok, listen,"* and, "*Want to do that?"* Lily responded to Tessa's humming and tinkering with, "*Oh, that song."* Lily then began tinkering with the virtual keyboard on her screen. As both students discussed and tinkered with ideas, they were unable to find a consensus. As the activity progressed, neither student was able to successfully translate the ideas they discussed into code. At one point, Tessa frustratedly announced she wanted to "*work alone."* Tessa and Lily's collaborative efforts had broken down as they transitioned to independently coding their chords into their respective iPads for the remainder of the session.

Near the end of the activity, the instructor played another group's music. After listening, Tessa jumped up and announced to the student that shared their work, "*Emma! My chords go perfectly with yours!*" While collaborative efforts had broken down between Tessa and Lily, when presented with another group's work, Tessa looked to reconfigure her collaborative structure. Tessa moved tables and joined a new shared project with Emma. This restructuring of collaboration showcases students' motivation to continue to collaborate even after breakdowns occur. Tessa and Lily's collaborative breakdown occurred due not to lack of software proficiency, but rather from an inability to translate their discussed musical idea into code.

4.2 Group Two: Distributed Responsibility and Shared Feedback

While a four-person group assembled around a table, the collaboration primarily unfolded between three students: Oliver, Riley, and Mason. Although they were not working in a shared project initially, Oliver, Riley, and Jaden began negotiating what instruments to use. Oliver said to Riley, "*You do guitar."* The students verbally organized their collaborative contributions, despite not utilizing the collaborative project functionality. As the students worked on the instruments they distributed across their group, the facilitator walked by and noticed Riley and Oliver were working on something similar and suggested they start a shared project. The two students joined a collaborative project, with Mason announcing he would like to join after he finished his project. Jaden continued to work silently on his own iPad. Throughout the activity, Oliver and Riley discussed which instruments to add and began coding their shared musical ideas.

Notably, the group shifted between collectively discussing ideas and independently inputting those ideas into code, allowing them to take responsibility for their contributions in the shared project. Near the end of the class session, Oliver carried his iPad to a neighboring group to show them his group's project. Oliver then announced, from the neighboring table, to his original group, *"Jaden, are you ready? Three, two, one–everyone is going to play!"* The group responded by experimenting with the keyboard's range and with Mason typing a lowpass filter into code. Oliver noticed and asked, "*Who is typing lowpass?*" Mason, without looking up, responded, "*Me. Trust me, trust me.*" Each students' individual efforts in the software successfully contributed to the group's collaborative efforts.

5. Discussion

By requiring students to both co-construct musical ideas and implement them in code, our analysis highlights the complex relationship between collaborative group dynamics and creative output. Musical composition and coding weren't separate tasks, but intertwined processes shaped by peer interaction. While both Tessa and Lily were able to independently develop and code musical ideas, they struggled to communicate those ideas to one another, and thus their collaboration broke down. Meanwhile, Oliver's group adopted a different collaborative structure, where each student took responsibility for composing and coding their own layer of the track. They coordinated by planning instrument roles, sharing their progress, and offering feedback throughout the process. This emergent collaborative structure allowed for each student to develop their own ideas while maintaining a degree of ownership over the final product.

This is not to suggest that either one of the collaborative configurations was *better*, but rather to consider the social and cognitive moves the learners had to make to realize their creative product. Their processes involved a complex cognitive-social translation in which learners had to draw on their prior knowledge of music and coding, as well as negotiate interpersonal roles, ideas, and agreements towards writing working code. When translation succeeded, the groups were able to create a musical-coding artifact that reflected their collective vision. When it failed, even technically proficient students produced fragmented or incomplete artifacts despite rich discussions.

6. Scholarly Significance

This paper contributes to the emerging body of work on how learners create music with computer code, focusing on how students choose to organize themselves and how those decisions impact the creative process. Extending Xambó's (2016) work, we investigate how learners make use of real-time collaborative editing. Additionally, it extends Roberts and Horn's (2024) research by examining how collaboration influences the translation of musical ideas into code in more naturalistic learning environments.

We see implications for supporting more successful collaboration in creative coding. Software should be designed to support flexible and fluid collaborative arrangements. While interface design and tool functionality matter, equal attention should be given to how different forms of collaboration are made available or foreclosed within the learning environment. Additionally, learners benefit from explicit guidance on how to work together effectively—how to share, negotiate, and communicate their ideas clearly with one another (Palincsar &

Herrenkohl, 2002). Designing for this kind of socially and cognitively complex collaboration means attending not just to what the software allows, but to how learners are supported in navigating collaborative creative coding activity.

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