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Computational Art Practice in Transdisciplinary Contexts

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Abstract: Leveraging Dewey's vision of learning as an aesthetic experience, we join other contemporary scholars in arguing for transdisciplinary approaches to STEM education that harness computational thinking and art. We present a transdisciplinary STEM context: a game design course, Modeling Time, focused on supporting students' exploration of history. We use a mixed-methods approach to capture the ways students create and share computational and art knowledge with peers. This work contributes to understanding computational art practices.

Introduction

Computational thinking (CT) education has largely focused on integration within computer science (CS) and, more recently, in science, technology, engineering, and mathematics (STEM) (Grover & Pea, 2013; Weintrop et al., 2016). We seek to broaden this perspective, drawing upon Dewey's vision of learning as an aesthetic experience (Dewey, 1934) to argue that these computational practices should not be siloed within one field. Proponents of transdisciplinary education in STEM argue for the importance of bringing art together with STEM disciplines (Sengupta et al., 2019; Kafai, Proctor, Lui, 2019). For these contemporary scholars, art is not simply a context for STEM integration. Instead, art fundamentally shapes the experience of STEM in a way similar to Dewey's notion of aesthetic experience (1934). Within education, efforts to combine CT, art, and STEM have been shown to be successful in engaging children's deep thinking while sparking creative epistemologies (Sendova & Grkovska, 2005; Turkle & Papert, 1990). In this paper, we respond to this call with the design of a computational learning environment at the intersection of history, art, and STEM, or game design more specifically. We build on the successes of other scholars who designed and implemented game design environments to support computational thinking and creative practices in learners. We also add a historical layer to game design. In this paper, we explore the ways that students gained, shared, and co-created knowledge related to their computational art practices. More specifically, we ask: How do students collectively explore and share computational art practices within a STEM context?

Methods

We explore this intersection of art and computational thinking through the context of a game design course called Modeling Time, which took place during a weekend enrichment program in a Midwestern city in the US. The course totaled 10 educational hours. In this course, eight 5th grade students learned how to create 2D and 3D game environments using the Unity game engine. Both authors designed and co-taught the course. More information about the design, educational scaffolding, and student artifacts can be found in the authors' prior work (Martin & Anton, 2018). Seven students, ranging from 10-11 years old, participated in the research study (4 F, 3M). For this paper, researchers analyzed 5.5 hours of video of the class while the students were working in a large group with computational tools. We coded the data with themes and practices related to sharing knowledge and critiquing design found in literature on practices of art spaces (Becker, 2008). The finalized coding scheme captures the four codes: *showcasing* (a student showing others their work)*, auditory reaction* (a student vocalizing a reaction to their design without response from others), *peer help seeking* (a student asking another student a question), and *facilitator prompted design* (facilitators providing support or help without prompting).

Findings

A total of 99 episodes were identified across the 5.5 hours of video analyzed. The total counts for each code are as follows: *showcasing,* 37; *auditory reaction,* 35; *peer help seeking,* 21; and *facilitator prompted design,* 23. We graphed these codes to show their occurrence over time (in minutes) (see Figure 1). This graph shows that there were more episodes of *facilitator prompted design* during the first day. The students were more expressive about their designs starting near the end of the first day and continuing throughout the second day. We observed higher occurrences of s*howcasing*, a*uditory reaction*, and *peer help seeking* during these periods, especially during the second day. There were more coded events, and higher occurrences of these student-initiated events (*peer help seeking*, *auditory exclamations*, and *showcasing*) on Sunday compared to Saturday.

There are several explanations for why we might observe these differences across the two days of the course. From a social perspective, students got to know each other over two days, so we would expect to see more social behavior emerging as they spent more time together and became more comfortable with each other.

Qualitatively exploring the coded episodes, we found that on the first day, students more often showcased their work to facilitators; students would raise their hands to show off progress or make comments as the facilitators walked past them in the room. This pattern aligns with the social hypothesis that students may not have felt as confident to share with peers.

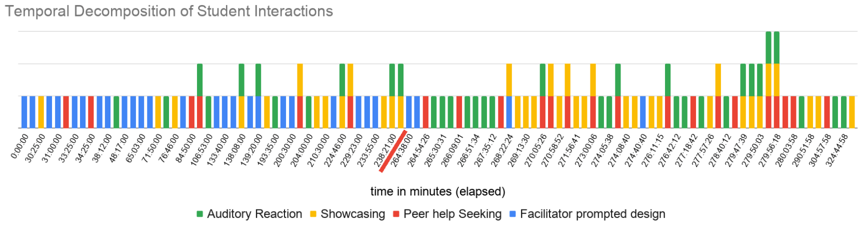

Figure 1. Temporal decomposition capturing the temporal pattern of codes across the course.

Looking more closely at the data, we began to see that these patterns of limited social engagement with peers also aligned with the times when students were exploring 2D game environments. During the end of the first day, we introduced layering 3D elements within the 2D spaces to create depth within their platformer games (specifically at 1:36:20 minutes). After this was introduced, students began to showcase with more frequency to peers. On the second day, we observed that students showcased to peers throughout the entirety of the day. Moreover, they began to engage in help seeking from peers, suggesting emergent perceived expertise. These moments of help seeking encapsulated both computational questions (e.g., “Ice? Where do you have ice? How do you do it? Show it to me”) as well as artistic or design questions (e.g., “Should I get a snow mountain?”, “Does the desert have a lot of trees?”). This shift may relate to a deeper connection with the 3D medium compared to 2D. When asked if anyone had experience with 2D platformer games, only one student indicated they had played a 2D platformer game. When asked about 3D games, all students indicated at least some experience with 3D games, and several compared it to popular sandbox videogames.

Discussion and conclusion

We explored the role that students take in creating and sharing computational art practices within a transdisciplinary STEM course. We found that students, if interested and inspired, are vocal in reacting to their designs and seek to share their achievements with others, particularly peers. This work reflects the outcome of a small group of students over a short period of time. As such, these patterns of engagement may not appear in larger, more traditional courses. We seek to explore how this work translates into formal classrooms to further support sustainable efforts in transdisciplinary computational art practices. Additionally, future work will explore the deeper interactions between learners. The success of this course design in sparking the interest and computational artistic practices in learners suggests the utility of this type of transdisciplinary, aesthetic STEM learning experience.

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