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Designing for Immersive Technology: Integrating Art and STEM Learning

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Abstract

Students struggle to learn science, technology, engineering and mathematics concepts. The arts have been proposed as a means to engage students in STEM education, resulting in the idea of STEAM. This study investigates how two students in a six-week summer program solved technological and design production problems to create public service announcements for the immersive fulldome on the topic of water conservation. Qualitative data were collected, including interviews, observations, artifacts of student work and reflections. Qualitative analysis focused on integration of STEM content and practices with the arts. The study contributes to what is known about how people learn when they design for immersive media, and identify potential barriers and affordances for learning STEM through the arts.

Keywords

Immersive media, STEAM integration, Learning, Designing

Cover Page Footnote

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Designing for Immersive Technology: Integrating Art and STEM Learning

Jane Crayton & Vanessa Svihla

Introduction

Evidence suggests that art can improve STEM learning (Kariuki & Hopkins, 2010). The arts can support the development of critical thinking skills (Burton, Horowitz, & Abeles, 2000; Catterall, 2012; Lampert, 2006; Milkova, Crossman, Wiles, & Allen, 2013), which are highly valued in STEM fields. Similarly, creativity is valued in STEM fields, making STEAM an attractive approach (Henriksen, 2014; Kleiman, 2008).

Furthermore, because real world challenges are commonly interdisciplinary, integrated approaches to teaching and learning can support deeper understanding of the complexities involved (Clark & Button, 2011; Petrie, 1992). However, integrating fields effectively is a difficult endeavor (Sochacka, Guyotte, Walther, & Kellam, 2013), raising concerns that STEAM might lead to a lack of depth in STEM learning (Ghanbari, 2014).

Less is known about higher education enactments of STEAM, and there have been calls for further research that can contribute understanding of such programs, especially to better understand how specific models of STEAM can support learning (Ghanbari, 2014). We present such a case that highlights characteristics of (un)successful integration.

A STEAM internship to design for the immersive fulldome

Mark and Connor (pseudonyms) participated in a summer university internship to develop a video for the immersive fulldome—essentially a planetarium that has other media developed for it. Developing videos for the immersive fulldome presents STEAM

challenges because accomplishing an aesthetic intent in this immersive environment requires applied technology, engineering and mathematics. In this case, the students were tasked with creating a public service announcement (PSA) about water conservation, introducing science into the STEAM mix.

Mark revealed that one of the driving aesthetic intents for their PSA was to create a Hollywood-style movie, “We were trying to use some technical things that we didn't know if we could do or not within the dome. So we were trying to figure out some of these technical issues even before the story was even, you know, kind of created. So, you know, there's not very much video shown in the dome, so we kind of had to figure out how we were going to go about that even without the story being written, ‘cause we knew we kind of wanted to go in that direction from the beginning.”

Integrating Engineering and Technology

The aesthetic decision to produce a fulldome PSA using traditional cinematic styles created several challenges. One such challenge was related to distortion of live action. In figure 1, you can see the line of people across the bottom of the screen; this was created through a complicated process of green screen stitching. There are gaps between groups of characters to support postproduction stitching. In this image, you can see two such gaps: between the fourth and fifth people in line, and between the seventh and eight people in line. The students stitched these three different green screen shots together to make one big scene across the bottom of the dome (Figure 2).

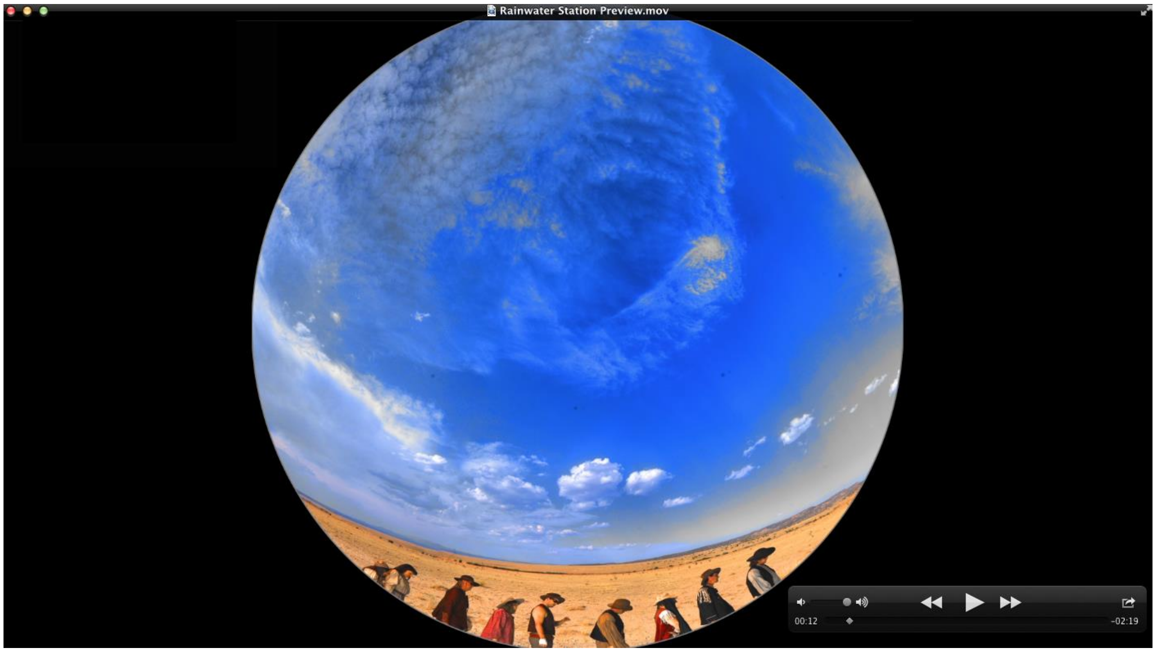

Figure 1. Gaps related to green screen stitching. The image is warped on the 2D screen, but projected into the fulldome, creates a realistic, immersive effect

Their solution for this problem can be seen in the shot list, which included a “3-4 foot gap between character 1 and 2” (Figure 2). This gap helped them stitch the shots together during postproduction. The students devised this process for stitching together large format green screens using standard video resolutions. This technique accomplished not only some important technological innovations, but it also helped the students express their aesthetic intention of having the PSA feel like a movie.

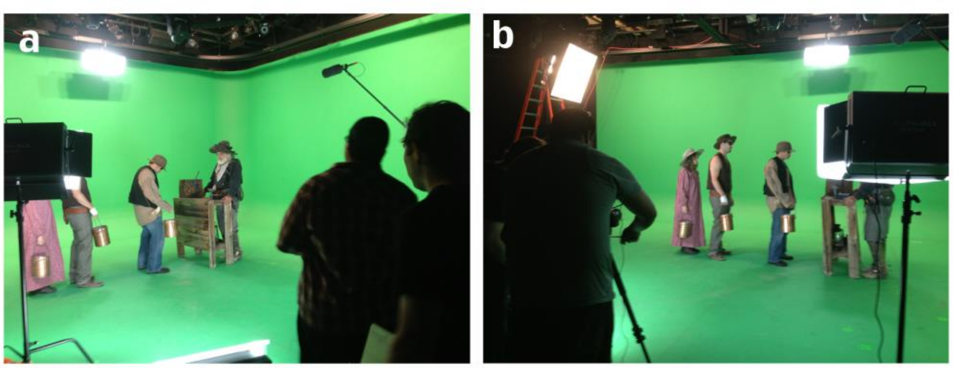

Figure 2. Spacing of actors during the green screen shoot. (a) shows the water bearer—the man with the white beard behind the water stand. The man holding the bucket who is facing the water stand is separated from the man and girl behind him in line by several feet. Note the gap between the first two and last two actors in (b).

Science and Math Content

The students were introduced to mathematics concepts about the fulldome environment, such as the geometry of domes and spheres. They began with a superficial understanding of the relevance of the mathematics. Connor described using mathematical concepts, such as parallax, when shooting spherical photography; however, we also see he discovered a way to circumvent calculations, “We're dealing with a 360 degree space and how to break that up for the field of view of the camera and how many degrees you had to move up and down, like vertically and horizontally, was very—engaged my math skills a lot, but I kind of ended up just using an application that (an instructor) showed me that like kept me from, or kind of helped me avoid having to do the math… I think it was the parallax, to try to figure out like you know how much the camera moves every time and then just kind of being able to figure out how many degrees that would end up being.” Connor engaged his math skills for the fulldome and expanded his understanding of the geometry of spheres. However, he missed an opportunity to really learn how to calculate this on his own.

The students brainstormed over 60 ideas for their PSA and researched ideas like water harvesting and annual rainfall. However, these ideas mostly showed up in their PSA as facts tacked to the end of their PSA.

Discussion

The aesthetic decision to produce the PSA in the format of a movie forced the students to explore and innovate new ways to accomplish traditional cinematic techniques such as cuts, transitions and capturing large format green screen shots. The students integrated technology and engineering with arts successfully.

Designing for the immersive fulldome environment created opportunities for students to learn math concepts; however, students were able to use technology solutions to avoid certain calculations, suggesting that while they integrated conceptual understanding of the mathematic concepts, they did not need to gain or apply an algorithmic understanding. This finding highlights how well the technology and engineering were integrated with the arts.

While the students did learn about rainwater collection, the science was not well integrated with the arts. In fact, it was a literal postscript to their video.

To make sense of the relative depth of integration of each field, we reflect on the task design. Accomplishing the aesthetic vision made technology and engineering integration requisite; this was somewhat less true for the mathematics content, in part because of the ability to offload this work onto a technology solution. In contrast, the science was poorly integrated. Had the design task been set in a semester-long course, better science integration could have been motivated through a combination of instructor-issued grades and client-issued feedback. In the context of an internship, the relatively brief timeline did not allow for iterative feedback and revision.

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