STEAM Powered Tools For Art Education

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Abstract

This paper seeks to highlight an effort by Computer Science and Visual Arts faculty to create opportunities for students from both departments to work with interactive technology in cross-disciplinary creative teams. The focus of the paper is a group project assigned within a STEAM course co-taught by faculty from both disciplines. The project, which challenges students in the course to build interactive educational tools for use in K-12 art education, will be presented in terms of its pedagogical role as a "bridging" assignment unifying the disciplines, and also tying together the skill acquisition and the skill application portion of the course.

Introduction

Course creation in the field of Interactive Digital Art can present challenges for both designers and instructors, since it draws skills from the very different disciplines of Visual Art and Computer Science. It is particularly challenging to bring together students with experience limited to one discipline or the other and effectively engage and teach both groups simultaneously; particularly if the goal is to leave them empowered to continue exploring the subject beyond the end of the semester. To address the issue, the course creators developed a project that tasks the students with working collaboratively to create educational tools for K-12 art classes. This project was created so that students would learn elements from both disciplines while creating an attainable result that is also useful and fun.

Foundations

The highlighted project is situated within a course designed and co-taught as a collaborative effort between faculty in computer science and visual arts. The intention of the course is to have students explore topics in Emerging Media and Interactive and Generative Art, topics that require a range of skills not commonly found in students from either of the academic disciplines. An additional goal of the course is for students to gain insight and experience regarding how to work collaboratively with individuals from outside their own discipline in creative teams. The fact that the course is co-taught by both computer science and visual arts faculty means that variations in perspective, logic, and creative approach can be continually addressed and discussed. As such, the teaching process also models the cross-disciplinary collaborative process the faculty found necessary in order to communicate ideas, provide instruction, and create sample projects.

Throughout the course, students work individually and in small groups to explore programming, animation, electrical circuits, input/output devices, and interface construction. Processing, a Java based framework designed to make it easy to programmatically create animation and many other results, is the primary visual creation tool used in the course. That programming language was chosen because it provides an easy entry to programming for artists and a means for the computer scientists to learn more about artistic concepts. The Arduino microcontroller board, and devices such as buttons, motors, lights, and dials, are used to teach students the basics of electrical circuits for the purpose of building unique interfaces to control visuals, animation, audio, and other results.

Problem

Part of the struggle for the instructors in the previous iterations of the course has been balancing the approaches and content being presented. The course brings together students from different disciplines which poses interesting obstacles for course creators. These obstacles go beyond a difference in skill sets and include issues related to general temperament, expectations of course assignment, timing, and grading, as well as the context within which learning should occur. In general, the art students enrolling in the class tended to adopt a more flexible and open approach to tasks and tended to have some misgivings about technology. These students brought a

willingness to see activities as continual processes and to be a bit wary of structure. They were used to three hour long classes twice a week, more subjective evaluation, and varied workspaces. The computer science students on the other hand favored structure and clearly defined processes and goals. They tended to struggle with tasks that lacked a defined functional end and were used to a traditional computer lab as the space in which learning occurred. Furthermore, they were used to classes that were half as long as those experienced by art students and expected a more objective approach to evaluation. They had the expectation that If they adhered to the constraints of the assignment, then that should result in a perfect score on any assignment.

Course creators had intended for their to be a balance between these different outlooks, but in early iterations of the course instructors struggled to move beyond the need to teach technical abilities in a way that would help students develop projects grounded in artistic concepts. This technical focus, especially in the early weeks of the class, left the art students feeling uncomfortable with the programming heavy content and functional focus of tasks. Other assignments where students were required to apply the technical skills to communicate an artistic concept left computer science students struggling to find a functional purpose behind the project. Group projects in the early iterations of the course were purposefully designed to be open-ended in order to allow the students to apply the wide variety of hardware, software, and technical processes in any way they wished to achieve an articulated artistic concept. Unfortunately, this broad amount of opportunity left both art and computer science students overwhelmed and struggling to define a path forward in the projects.

To an extent this disconnect in student perspectives is to be expected based on the nature of the course, but the instructors sought a way to create a more integrated approach that would more effectively unify these divergent outlooks. Toward this end, a project was designed to simultaneously provide a functional focus for the computer science students to learn the artistic concepts and an artistic grounding that allowed the art students to incorporate technical elements. It was decided that this project would act as a"bridge" to address the issues in discipline expectations. Furthermore, the project would tie the early weeks of the course which were focused on small skill acquisition assignments to the later weeks of the course which were focused on larger concept focused interactive art installations. The solution they landed upon was the "Color Theory Project" described below.

Solution

The Color Theory Project was created to address the problems of contextualizing knowledge for both groups of students. The intention was to do so in a way that allowed them to teach each other by building tools for a specific need, but in a context that seems achievable despite limited experience. Students in the course were grouped into teams of three, consisting of one artist, one junior computer scientist, and one senior computer scientist. Each group was tasked with creating an interactive visual meant to help K-12 students learn a specific aspect of color theory.

Each group was given a different color theory concept as the focus of their project and then needed to design both a screen based interactive visual and a physical interface for controlling the visuals. Students were asked to include multimedia elements and to explore ways to teach the concepts to children in a manner that was fun and interesting. The expertise of Art Education specialists was sought to determine what artistic elements K-12 students struggle with at various grade levels and what content goals an instructor would want to achieve through the use of such a tool.

Four groups were created within the class and were randomly assigned the following color concepts to address in their creations:

- Color Harmony
- Color & Contrast
- Additive & Subtractive Color
- Color Context

Core requirements for the project included:

- An initial segment or screen that presents this color theory concept, and indicates a way to move on to a second screen.
- A second segment that challenges the student to apply the color theory concept (and gives feedback regarding whether they have applied it correctly).
- A clearly defined end that resets to the first screen.
- A physical interface constructed of cardboard and incorporating arcade buttons or other input devices.

Students were given time in class and were also required to work outside of class to create the project. The projects were to be completed in a two-phase process wherein the first phase focused on the creation of the visuals, content, and gameplay using the Processing language. This phase of the project covered roughly two and a half weeks and students were required to provide weekly updates both to the instructors and the rest of class on the current progress of the project including the successes and issues they had experienced during the creation process. This was done in order to allow the entire class to benefit from any solutions to specific problems other groups had come across and to allow all students to suggest solutions to existing problems in the development of the projects. This activity also allowed the instructors to offer suggestions and address any issues within the creative teams or re-focus the students on their assigned color-theory concept as needed. The first phase culminated in a class-based demonstration of the visual portion of the project and an opportunity for instructors and students to try out the current state of the project and offer suggestions on revisions. Art Education majors also attended this demonstration to give feedback on appropriateness and the overall feel of the visuals.

A gap between the first and second phase of the project occurred as students worked on small assignments related to soldering, wiring, and use of electronics as controlled by the Arduino microcontroller. During the gap between the two phases, students began the ideation process for their final group projects and began acquiring resources to complete this semester project. Before the gap in work on the Color Theory Project, students were told that they would need to be working on a physical interface for the visual element of the Color Theory Project consisting of a painted/decorated cardboard-based prototype enclosure integrating functioning arcade buttons wired to an Arduino. They also had to set up the Arduino to accept those signals and pass them along to the Processing code running on the computer. Students were informed that they would be presenting this final phase of the project to the public at a Creative Arts & Research Symposium held at the university where the course is taught. All groups would have the week before the symposium to finalize their physical interfaces but they would need to be working on this second phase of the project in the background while the class focused on other related activities concerning the Arduino.

The second phase of the project concluded with the various creative teams presenting their projects for use by the public at the symposium. A large room that normally held tables and chairs for approximately 40 individuals was the context for this public showing and tables and chairs were rearranged in the room to allow the public to move around the room where the various projects were set up. Student projects were presented in various states of functionality. The majority of projects' physical interfaces consisted of enclosures that masked the laptop computers (driving the visuals) as well as the wiring and Arduino (controlling physical input). The only parts of the project that were visible to the public In these creations were a screen, the tops of arcade buttons, and the enclosure covering. Some projects relied on constructed coverings for a traditional mouse as well as button based controls to interact with the visual elements of the project.

Results

Overall the majority of the groups were able to complete a functional version of the Color Theory Project that included a game based visual tutorial for the assigned color concept and a prototype physical interface. One group was not able to get a functioning physical interface ready for the symposium and resorted to the standard keyboard and touchpad of a laptop to control the visuals. At the symposium the projects were well received and several attendees encouraged others in different venues of the symposium to come and interact with the projects. Some attendees mentioned that they enjoyed trying out the creations and felt that the projects might work well in a classroom when advanced to a more solid physical interface of plastic or other material. Students reported feeling satisfied with the knowledge gained about the various technologies and the experience of developing prototypes. The instructors felt that the experience did advance the students' abilities to work with Processing and Arduino microcontrollers. However, the main benefit of the project within the course was to simply allow students to practice and apply skills related to the use of the technology and it did not fully meet the goals of the creators.

While some of the physical interfaces reached a generally complete state, the groups struggled to create physical interfaces beyond those which masked and mimicked the normal functions provided by a computer. The creators had hoped that the students would exercise some creativity in exploring different ways of controlling the visuals, but the interfaces generated by the students tended toward the purely functional. Many students underestimated the time necessary to create and troubleshoot the physical interfaces, and thus resorted to the easiest path to completion. This in part may be due to the functional focus of many of the computer scientists who largely maintained directive control over the projects and adopted a "meet the base requirements" approach to the project.

It was hoped that the content of the project being focused on a formal element of art would allow art students to see an avenue into the project that would allow them to direct the group creatively and generate

interesting and aesthetically appropriate projects. However, this did not happen. The art students tended to struggle to find a role for themselves in the project and some fixated on a specific artistic element regardless of its relevance to the project or ability to easily integrate into the concept or gameplay. Others simply separated themselves from the process and focused on other assignments. This disconnect may in part be due to an unconscious assumption by the creators that the art students would naturally fill the role of creative director. In hindsight, that supposition on the part of the creators failed to take into account the tendency among art students to work on their own. Furthermore, this disconnect may be the result of the project being too focused on a specific task which might be considered rudimentary from an artistic perspective. The art students may have felt that they did not see a way that they could express their own creative intentions within the context given.

Additionally, many of the created projects were vague in how they tested the color concepts they were assigned to address. Often there were contextual choices that confused or distracted from the main concept. The computer scientists often became overwhelmed with the possibilities for gameplay and struggled to achieve some of the technical requirements programmatically. They seemed to adopt a "good enough" attitude and took visual shortcuts because it was more expedient. Image choice and programmatic structure were often chosen because of easy availability rather than because of conceptual appropriateness. While the project provided a clear functional goal for the computer science students and an artistic component for the art students, the project as a whole was more utilitarian than conceptual. The technical difficulties prevented the groups from reaching a point where they could explore alternative iterations, and a lack of opportunity for creative expression seems to have resulted in diminished morale.

Discussion

Ultimately, the course creators felt that the Color Theory Project did not meet the needs it was designed to address. This is not to say that the project did not have value, but the value of the project in this course was more as an opportunity for students to learn the value of iterative development. The course creators feel that the project was ineffective in supporting the development of artistic concepts. The project offered insight into the assumed abilities of students and the need for projects based on prepared technical solutions that allow students to quickly reach a level where they can explore artistic concepts. This is not to say that the course creators seek to remove all technical difficulty from future projects, but rather they feel that the are enough inherent difficulties in implementing and adapting prepared solutions to unique situations to be sufficient for learning. In essence, the goal will be to bootstrap the students up to a point where can achieve initial success in specific applications before branching out to more self-directed interactive digital art applications for the final project and beyond the course.

Furthermore, while the Color Theory Project will probably not be included in future iterations of the Interactive Digital Art course, it has been the potential to be the basis for development of other inter-disciplinary efforts. Specifically discussions are underway to form a partnership between computer science and education that stems from the example set by the course for which the project was originally developed. This sort of partnership provides a better context for the Color Theory Project and the opportunity for expansion and could potentially benefit from more motivation based on authentic interest from students.