Using Projection AR to Add Design Studio Pedagogy to a CS Classroom

Amber Solomon¹, Dingtian Zhang², Ryan Jones³, Elizabeth Disalvo⁴, Blair MacIntyre⁵, Mark Guzdial⁶
School of Interactive Computing, Georgia Institute of Technology, Atlanta, GA USA

ABSTRACT

The goal of this project is to use projection augmented reality to add design studio learning models to a classroom for an introductory Media Computation computer science class. The system “pins” students’ work to the walls, where teachers and students can see and discuss the work. We hope that by seeing each other’s work, the system will foster collaboration and support the creation of STEM learning experiences that encourage creativity, innovation, and help build strong peer learning environments.

Keywords: Educational technology, embodied learning, projection augmented reality.

Index Terms: H.5.2 User Interfaces: Graphical user interfaces, Input devices and strategies, Interaction styles.

1 INTRODUCTION

Computer programming has traditionally been taught and practiced as a solitary activity. Teachers usually do not allow collaboration, considering it cheating, and students feel uncomfortable talking to their peers. This is unfortunate because cooperative and collaborative pedagogies are shown to be beneficial to students [12]. Some classrooms have used pair programming to allow opportunities for collaboration, but this still limits awareness of others’ work, and social learning is limited to who can see the screen [12].

In this research, we use augmented reality presentation and sensing technologies to integrate design studio learning models into screen-based classrooms. The goal for this design studio based approach is to create STEM learning experiences that encourage creativity, innovation, and help build strong peer learning environments. This open ended learning experience is directly influenced by the physical space, tools, and learning practices that allows a selection of personally meaningful projects and directed communal reflection [4]. This style has been used successfully in architecture, industrial design, and mathematics classrooms, but has not been used successfully in classrooms such as computer science because of limited technology, and a culture of individual student work [13].

To support collaboration in our classroom, the technology “pins” student work to the wall, allowing teachers and students to walk up to the wall and comment about the work. We enhanced a development tool, Pythy, to capture students’ work “as they work,” and then display it around them on the walls.

Augmented reality allows users to interact with virtual material superimposed on their view of the physical world. Using AR technology, we can simulate the studio environment by using AR as a peripheral display. RoomAlive demonstrated how any room can be transformed into an immersive AR space [7], and our system is based on the RoomAlive software.

Our approach enables students work to be automatically displayed in real time in the room. Some forms of embodiment, or more natural gesture interactions, will soon be implemented using the depth cameras, to allow students and instructors to interact with the content displayed in the room, supporting discussion and collaboration. Possible gestures include tapping to reveal more details, zoom in/out with both hands, and swap to view history.

We are initially testing this approach in an introductory computer science class, Media Computation, where students learn computer science concepts by manipulating media (i.e. images, sounds, videos, and web content). The visual nature of the class makes it an ideal testbed for this idea. We hope to understand what features are necessary for the system to promote learning and understanding, what are students’ sentiments toward the technology, and does this technology change the computer science classroom’s culture by allowing a more collaborative environment.

We can imagine future work that creates open classrooms that move beyond the on campus experience. By integrating these new presentation and sensing technologies into a networked environment, we can open the walls of the classroom to enable synchronous high-fidelity collaborations, allowing any room to become a classroom. We can use open classroom technology to create shared, virtually “face to face” components for informal learning, either to enable distributed meetups or to personalize and re-humanize MOOC learning situations.

2 LARGE DISPLAYS AND EMBODIMENT IN THE CLASSROOM

2.1 Large Displays to Support Learning

Large displays (e.g. projectors and interactive whiteboards) are becoming more common in educational settings [2, 8, 9, 10]. In studies conducted by Lambert et al, they discovered “including a large display in the periphery helped students to keep track of what their peers were doing by allowing them the opportunity to create and select information to share while keeping an audience in mind. Students benefited from creating personally meaningful artifacts for an audience, especially when those artifacts embody the concepts the learners aim to understand [10].” Large displays allow students to display designs to others anywhere in the room and helps increase student’s awareness of their peers’ designs. The displayed designs became an anchor for their discussions [9].
allowing projections in the classroom may not be enough to engage students by allowing them the opportunity to interact with their peers' work, it does not guarantee that the student will be more engaged. Although projecting students’ work may make them more aware of their peers’ work, it does not guarantee that the student will be more engaged. Lindgren et al. suggest technology in the classroom also needs to engage students by allowing them the opportunity to interact with the technology [11]. Thus simply allowing projections in the classroom may not be enough to change the culture.

Research suggests body activity can be an important catalyst for generating learning [1]. Embodied learning supports the idea that using one’s body to learn makes the student more engaged in the lesson [3]. Lindgren et al. suggest, “central to the various efforts is a common belief that, when the underlying content to be taught becomes situated in terms of authentic use, it changes the essential meanings of that content for the learner [11].” Body movements, like gestures, can help retrieve mental or lexical items [11].

Our studio based classroom has characteristics of a mixed reality environment. Mixed reality (MR) refers to educational practices that mix embodied learning with immersive technologies in the classroom, which for us includes mixing AR projection technology in a traditional classroom setting [11]. MR environments engender embodied learning because these environments allow two main characteristics: “first, an immersive technology experience that situates the student inside the to-be-learned system, and second, these environments include an interface that is in some way responsive to students’ natural movements and physicality, such as taking gestures as input or tracking their position across spacious environments [11].”

3 Methodology
To build a room-scale augmented reality, we extended Microsoft’s RoomAlive toolkit to map the room structure and project students’ work on the walls. To build a workspace for students, we modified the Python web IDE, Pythy. The RoomAlive Server and the Pythy Server actively communicate to each other to ensure real-time update of the content. Pythy is a web IDE for Python created for computer science instruction [5]. We currently display the student’s pseudonym (their initials) and generated picture.

3.1 Observations in the Classroom
Currently we have been observing two introductory Media Computation recitations for seven weeks. Recitations are similar to workshops or labs. Two teaching assistants (TAs) teach a specified topic each recitation, while the students practice programming. Students can interact with other students and TAs in a less formal environment and ask specific questions about programming assignments. One recitation is modeled after a studio, where students’ work is projected onto the walls in real time. See Figure 1 for an illustration of this concept. The other recitation is run without the studio design and taught more traditionally. Observing both recitation classes will allow us to make comparisons between teaching styles and ways students interact with other students and teachers. We hope to understand if the projections on the walls fosters more collaboration amongst students and if it creates more visibility in regards to students more obviously noticing their peers’ work.

4 Conclusions and Future Works
In this work we demonstrated how AR technology can be used to transform a computer science classroom into a studio learning environment. By integrating the RoomAlive Toolkit and the Pythy programming environment, we automatically capture students’ work and “pin” it to the surfaces in the room around them, where students and teachers can see it. By moving work-in-progress out of the individual student computers and into the room, we hope to transform the learning experience and culture of CS education. Some preliminary findings from our observations suggest some evidence of students noticing their peers’ work. For instance, one student decided to manipulate the image of a famous figure, and as soon as the figure was “pinned” to the wall, all the students began laughing. Students also tend to gaze at the wall and proudly exclaim, “there’s my picture.” There has even been an instance of two students noticing another student’s work and asking the student how she accomplished it.

We hypothesize that to increase students’ awareness and effectiveness of the studio design, training needs to occur for both teachers and students. An embodied learning approach dictates the culture of the classroom must change [3]. When discussing the culture of the traditional classroom, Barab suggests the following: “The traditional social structure of schools is one in which teachers dispense knowledge to students through classroom activities, textbooks, and possibly other media.” Such an arrangement privileges the teacher as controlling student learning and portrays the teacher and the textbook alone as bearing legitimate knowledge [3].” Thus, a teacher should grant permission to allow students to interact with one another and to interact with the “pins.” To fully integrate this technology, gestures must become a part of the classroom ethos. Teachers may also need to be trained to learn how to integrate this technology
into their teaching styles. From observations, it seems somewhat successful for teachers to walk up to “pins” and casually point out “pins” of interest to students. Students may also need to be trained to learn how to talk about code, including describing their code without giving away answers, and asking specific questions about their code. Students will also have to become more comfortable learning how to critique and figure out what questions to ask.

We would imagine computer science courses that deal with visualizations or images (like media computation and graphics) would be an ideal match for this studio design. Alternatively, visualization techniques can be applied to many topics to make changes and points of interest more salient to occupants of the room. Having some type of image to manipulate and interact with would be more visually appealing than simply projecting code on the wall.

References


