



Projects in VR

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StorySpace: Technology Supporting Reflection, Expression and Discourse in Classroom Narrative

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As former and perhaps still current students, we can all remember essays we've written, dioramas we've built and posters we've pasted together. All these are forms of classroom narrative, a basic and important activity used by instructors to reinforce learning. The very fact that many of us can still remember these narratives decades later shows the success of this type of activity.

The power of classroom narrative lies in the wide range of abilities it engages. Most importantly, narrative engages the student's reflective and interpretive faculties. In producing a narrative artifact, students must internalize the classroom topic and most often also adopt a certain point of view about it. Narratives can also engage a wide range of expressive abilities. For example, writing an essay requires composition and language skills. Building a diorama is a much more tangible experience, in which students must select a key scene or concept from the classroom topic, and then physically illustrate it using inexpensive building blocks or materials. Composing a poster taps into graphic and editorial skills, with students searching for good illustrations of key concepts in other media (for example, *National Geographic*), and then arranging them into an informative and illustrative whole. Finally, narratives sometimes exercise student ability in presentation and discourse. When narratives are group projects or are presented before the class or at school fairs, students must collaborate with fellow group members to select and shape narrative content, then introduce and explain the result to other students, parents, and the wider community.

Designing technology for classroom narrative

The StorySpace project studies the role new interface technologies might play in high school education.^{1,2} Unfortunately, technology often seizes center stage in the classroom, becoming itself the topic of instruction. We argue that learning in general and learning about technology in particular will be most successful when technology is used in the service of learning, rather than learning in the service of technology. Certainly, outside of the classroom, technology is rarely an end in itself; application gives technology its power. The classroom should be no different.

With this approach in mind, StorySpace is specifically designed to support and enhance classroom narrative, an already well-established classroom activity. StorySpace strives to achieve this through adherence to three design goals. The first is to trigger student reflection and interpretation. The narrative medium created by StorySpace should represent the topic of classroom discussion and learning in all its complexity. In building their representation, the students will then be confronted with that same complexity. The medium should also itself be exciting and compelling, making classroom narrative interesting and fun.

Next, StorySpace must accommodate individual student expression. Each student's perspective on the classroom topic should be easily captured and represented in the narrative artifact they produce. Students have a wide range of personalities and come from various ethnic, cultural, and educational backgrounds. To reach all of them, the StorySpace medium should therefore be more than textual and include easily learned physical, visual, and auditory elements. Students should initially have confidence that they can use the medium, and become fascinated by the opportunity to improve the artifact they have already built.

Finally, the design should encourage student discourse. Many classroom narratives take the form of largely one-way, one-to-one communications between students and their teacher. Many researchers believe that learning increases when narratives instead become a true discourse, with students engaging in a two-way conversation with not only their teacher, but also their peers and community. StorySpace needs to allow and encourage the two-way, many-to-many forms of communication that are the hallmark of rich classroom discourse and discussion.

By adhering to these goals, StorySpace will act as an effective tool for classroom narrative and for learning about technology. The best artists are not only knowledgeable about their subject, but inevitably also experts in their medium. Similarly, students building a compelling narrative in StorySpace will become familiar with its technology. This will be particularly true if they find the StorySpace medium rich and exciting, if they see clear opportunities to express themselves, and if they can address their peers and community in addition to their teacher.

StorySpace design

StorySpace enables the construction and display of a new form of narrative that is simultaneously digital and physical, a form similar to the traditional paper poster. Narratives are represented visually on a two-dimensional tabletop board, and physically with three-dimensional tokens, see Figure 1. Audience members can experience the narrative passively or interact with the narrative by manipulating the tokens, changing the visual representation. The many tokens around the table provide multiple points of access for the audience, supporting collaborative group interaction. Audience members can also alter the narrative itself, leaving annotations and graffiti behind them.

StorySpace supports student design of the narrative itself as a special form of narrative alteration. Students collect and build media using the Web and a variety of portable devices including PDAs, mobile phones, digital recorders, and digital cameras. Students load these media (including imagery, sound, and movie clips) onto a blank board through an attached PC. Once on the board, they can manipulate media using predefined tokens for moving, removing, resizing, zooming, playing, and stopping media. An additional token provides an undo operation. Users make these manipulations by placing the appropriate token on a piece of media, and, if appropriate, moving that token (for example, to indicate the new location of the piece). Users can also record manipulations as macros, enabling higher-level interaction semantics such as playback of a movie clip that first expands to fill the entire board.

We constructed StorySpace's board from interactive chessboard substrates built by DGT. These inexpensive substrates attach to a PC and track the location of the pieces on a chessboard. Radio frequency tags identify the pieces. We cover the substrates with a white laminated surface, reflective enough for projection and durable enough for interaction. A lighting stand and attached custom cantilever mount holds a digital projector over the surface (see Figure 2). We embed the tags into the StorySpace tokens. We custom fabricated the design tokens using a rapid prototyping 3D printer, with shapes suggesting their function and receptacles for the RF tags (students can also design custom tokens specialized to each narrative). A host PC accepts input from the substrate and sends board output to the projector.

StorySpace was inspired by research in both tangible and ubiquitous interfaces. Tangible user interfaces¹ embed the human-computer interface in physical objects, exploiting the natural spatial abilities of their users and opening not only visual but also physical communication paths. The StorySpace board has much in common with these interfaces. Ubiquitous user interfaces² stress the embedding of computational devices



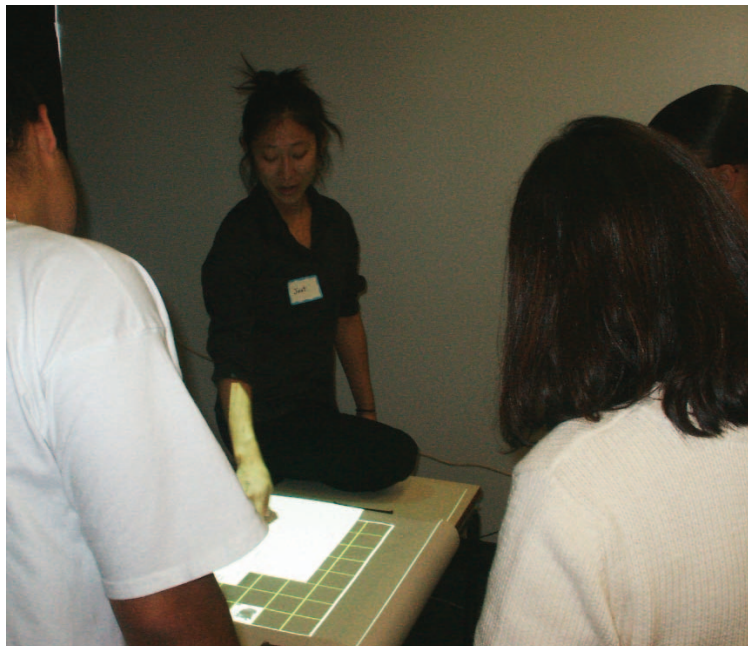
1 Close up of the StorySpace board in its design mode.



2 StorySpace table, projector, and stand.

into our everyday lives, specializing those devices to make their use minimally disruptive, and often miniaturizing them to make them portable and accessible. StorySpace's media collection devices exploit this technology to take learning out of the classroom and into students' communities and personal lives.

This design adheres well to our goals for a successful classroom narrative tool. The use of digital imagery, video, and audio as source material triggers student reflection and interpretation. Today's students know and love these types of rich, dynamic media. StorySpace lets



3 Students learn how to use StorySpace.

students sample and combine these media in many modalities, like much of the art in this postmodern age. The easily manipulated, tangible interface accommodates individual student expression, lowering barriers to use by those with different cultural and educational backgrounds and capturing the expressive strengths of visually and tactilely oriented students. The collaborative tabletop interface affords discussion in design and display, ubiquitous components that take media collection into students' social and community lives, and a nonlinear, self-referential medium accommodates many perspectives and encourages student dialogue and discourse.

StorySpace in the classroom

Of course, the real test of any design is its use and evaluation in practice. We are currently integrating StorySpace into the curriculum of an English literature class at Clemente High School in Chicago.

In a previous class, students used Apple's iMovie to construct narratives about Jonathon Edwards' essay, "Sinners in the Eyes of an Angry God." The results were quite compelling. Students learned about technology of digital video and search (for imagery), but also demonstrated a deep metaphorical understanding of the text. Student effort and standards of quality were raised by the highly visible display of their work to peers.

A pilot group of these same students is now using StorySpace to build in-class narratives about Shakespeare's *Macbeth*. Our focus at this early stage is on narrative design, as opposed to a ubiquitous media collection or display to an audience. The students have already received instruction in the use of StorySpace (see Figure 3), and are now collecting media in the classroom. The students are clearly excited and intrigued by the tool. Experience to date has already resulted in some design changes, including a simplified set of design manipulations, streamlined procedures for loading

media onto the board, and the use of multiple projectors supporting wider classroom discussion.

After they have built their narrative, our pilot group of students will answer questions requesting suggestions for improving the technology, about the strengths of StorySpace as compared to text and other digital media, and probing their engagement in a discourse with their peers about the narrative content and technology. The students will then present their narrative to the rest of the class, giving their perspective on *Macbeth* and educating them in the use of StorySpace. At this point, the entire class will be split into groups to build a number of narratives examining the characters, themes, and ancient and modern interpretations in detail.

The Future

Beyond these immediate goals, we plan to expand the use of StorySpace at Clemente High School to study its effectiveness in display to an audience of peers. We also hope to create new connections between the school and its community by using StorySpace to display classroom narratives in neighborhood centers, and by sending students equipped with ubiquitous media collectors into the streets and blocks around their homes.

The StorySpace board is unique and currently still a fragile resource, and loading media onto it can be tedious. In the long term we plan to improve the board and accommodate its shortcomings in pedagogy. We also anticipate improving the utility of StorySpace by using it in classes centered on the physical and social sciences, for which we will have to develop matching pedagogies. Ultimately, we hope StorySpace can eliminate some of the digital divide by giving students of diverse backgrounds a new perspective and comfortable mastery of technology. ■

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