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Mixed-Media Learning Environments

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ABSTRACT
We discuss "mixed-media" learning environments, in which students combine "high-" and "low-" tech in designing and creating artifacts. We describe the rationale and implementation of three projects in diverse domains, in which students immersed in media-rich learning environments demonstrated high engagement in completing challenging construction tasks. We articulate advantages of a "mixed-media" approach to the design of learning environments: relaxed media specificity, multiple entry points, and residual artifacts.

Keywords
Constructionism, mixed-media, mathematics, robotics, art.

INTRODUCTION
Seeking to guide successful introduction of technology into schools, scholars of education have articulated design principles for engaging student interest and supporting content learning [5, 3]. This paper focuses on designs in which students work with both "high-" and "low-" tech media and materials to create artifacts. Each of the first three authors describes one such mixed-media design and briefly reports findings from implementations. We use the term *mixed-media* as in art, to refer to the combination of two or more media in a single work. Our term and, *inter alia*, our focus on student artifacts, is motivated by a vision of learning as a project-based endeavor in ecologies that support creativity, wonder, and perseverance in problem solving, such as in the atelier of an artist or artisan. The term 'mixed-media' is intended as distinct from 'multimedia,' which has come to mean audiovisual artifacts, such as presentations, interactive CD-ROMs, or websites.

ProbLab
ProbLab [1] is an experimental unit in probability and statistics under the umbrella of the 'Connected Probability' project [6]. One thematic learning activity in ProbLab is that students first use traditional media (paper, crayons, scissors, glue, etc.) to create histogram-shaped combinatorial spaces of complicated stochastic objects (see Figure 1, on the left) and then run computer-based simulations of probability experiments (in NetLogo, [7]) in which they receive outcome distributions that converge on the same shape (see Figure 1, on the right, compare to the shape on the left). The immersive quality of the construction project, the dynamic quality of the stochastic simulations, and the perceptual resemblance of the twinned artifacts are all designed to support classroom discussion of the central limit theorem as reconciling determinism and randomness. Each medium plays a critical role in student understanding of the artifact in the other medium, and students build new understandings that bridge the two media.

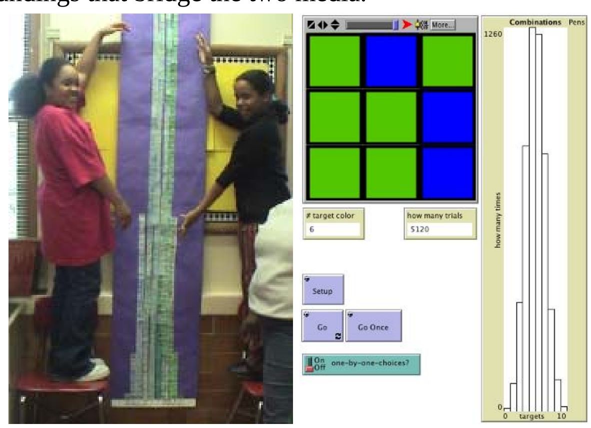

Figure 1. Combinatorial space (on left, traditional medium) and stochastic distribution (on right, computer-based)

"The City That We Want"
The "City That We Want" was a school reform project undertaken by the MIT Media Lab, the University of São Paulo and the Secretariat of Education of São Paulo, Brazil. We will focus on the first implementation that consisted of a 13-day after-school workshop for 18 students (5^{th}-8^{th} grades) [2], in which we took a radical stance in offering high- and low-tech media and on- and off-screen activities and repurposing broken/found materials. Computers, robotics, still/video cameras, and arts materials were freely available. Students were expected to suggest their *own* project ideas within a community-relevant *generative theme*.

Collaborations that are very rare in single-media environments occurred (see Fig. 2): students who liked arts teamed

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up with others who loved robotics to make their projects come to life. In the process, the first group also became interested in technology. Unusual "entry-points" also came about. For instance, one student was very shy in the beginning and never engaged for more than ten minutes in any activity. However, she liked the video camera, and started to document other students' work. In this process, she became proficient and self-confident and decided to make video documentaries of problems in her community. Then, inspired by these successful documentary projects, other students became engrossed in the idea of designing robotics devices to help solve neighborhood problems. The presence of those objects and tools, which were simultaneously available, "mobile", and had to be shared, created new dynamics that are very rare in regular classrooms, where content is mediated symbolically—on paper—and where there is little if any opportunity to develop democratic control.

Figure 2. Various media employed in the workshop.

DigiQuilt

DigiQuilt (see Figure 3) is a computer-based construction kit for learning about math and art by designing patchwork quilt blocks [4]. Learners create quilt block designs by placing pieces into patches. The software currently offers learners several sizes of quilt-block workspaces with a variety of grids that can be superimposed on them. In addition, there are facilities for saving, reloading, and clearing designs; stepping through a design's history; and rotating, copying or swapping patch-level patterns. Learners are given feedback about the fractional area of their design that is covered with each color in the palette.

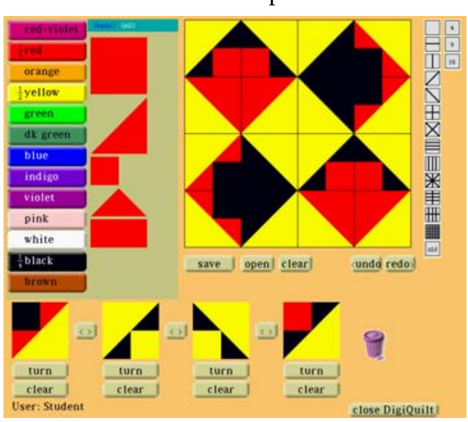

Figure 3. A screenshot of DigiQuilt.

Students work in the DigiQuilt environment both with software and paper manipulatives to solve challenges that highlight different concepts. The artifacts created using DigiQuilt can be saved, printed, displayed, and shared in many ways. For instance, the quilts can be printed in multiple copies on paper, magnets, business cards, iron-on transfers, etc. These artifacts provide contexts for discussions of the targeted contexts and support the evolution of new practices. For instance, one of the students' favorite activities was trading business cards bearing their designs. This versatility of the mixed-media design encouraged students to expand the learning environment beyond the classroom into after-school time and their family space.

CONCLUSIONS, IMPLICATIONS FOR DESIGN

Despite the increasing sophistication of computer simulations, there is, perhaps, a limit to what should be simulated. Mixing media relaxes the constraint that a single medium must provide a comprehensive hospice for an entire learning experience. MMLE afford students multiple entry points into participation. Students, who come to these flexible environments with different skills, inclinations, and literacies, have increased opportunities for expression and for development of expertise and, thus, for finding their niches, where they willfully contribute to collaborative efforts and receive group esteem. Also, residual classroom artifacts created in MMLE support continuity in content-specific learning processes, thus facilitating social construction of knowledge. Finally, leading mixed-media activities requires able facilitators who can sensitively engage and leverage students' diverse interests, talents, and perspectives in patiently steering this richness towards rewarding learning experiences.

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