Encouraging Awareness of Peers' Learning Activities Using Large Displays in the Periphery

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Abstract

Learners benefit from creating personally meaningful artifacts for an audience, especially when those artifacts embody concepts the learners aim to understand. In this pilot study, we explored ways to expand opportunities for sharing mathematical artifacts with a larger audience (beyond learners seated next to each other) by incorporating structured ways to share work on a large display. We changed the functionality of the large display throughout the experiment to explore different content management schemas. Early results suggest children's awareness of their peers' work increases with the use of the large display, but that they tend to share only finished work.

ACM Classification Keywords

K.3.1 Computer Uses in Education: Collaborative learning, Computer-assisted instruction (CAI); H.5.2 Information Interfaces and Presentation: User interfaces – Evaluation/methodology

General Terms

Design, Human Factors

Keywords

ambient, awareness, children, large display, learning, math, peripheral display

Introduction

Research on learning through design suggests that when learners are engaging in design activities, thinking about their work from the perspective of an audience helps them reflect on their learning [13, 5, 10]. When students work in pairs, they can see each other's artifacts and progress at a glance. In larger groups, keeping tabs on what is happening is more challenging. Using a large display that everyone could see in the periphery, we helped learners leverage opportunities for discussing their artifacts with more than just their nearest neighbors.

In this paper, we begin by describing related and previous work and then describing our system in these terms. Then, we describe our study, including our observations and changes we made to our system. We conclude with a discussion of our results and ideas for future work.

Related Work

Constructionism, an approach to education based on the constructivist theory that people learn by building their own knowledge, suggests that people learn "most felicitously" when they are *consciously* constructing artifacts for an audience [10]. Including an audience in the cycle between internal knowledge structures and external artifacts causes learners to consider how the audience understands or perceives the constructions. Supporting learners in open-ended design activities is difficult, but important [5, 13]. Learners' limited time in the classroom setting has increasingly shifted the focus

of research on supporting open-ended design activities to informal settings. These informal learning environments pose different challenges for coordinating opportunities for collaborative learning, particularly if learners work individually or are otherwise unaware of what others are doing.

The use of large, shared displays in the workplace is useful for helping colleagues maintain awareness of each other's work and ideas (e.g., [3]). Large displays (e.g., projectors and interactive whiteboards) are appearing more frequently in educational settings. Although most studies of large displays have focused on supporting adults' activities in the workplace (e.g., [3, 4, 2]), there have been some studies on large displays in educational settings [1, 9, 4]. The studies we found focused on systems where children either interacted with the large display directly, through the use of multiple mice, through an individual display that matched the large display, or in some manner where the large display was meant to be the focus of attention.

Previous Work

In the DigiQuilt project (see Figure 1), elementary school children design patchwork quilt blocks that address a series of mathematical challenges [6, 7, 8]. The software includes tools that help the learners look at their artifacts in a mathematical way as they work to solve these challenges. The software tools highlight the relationship between the designed artifact and the targeted math content of fractions and symmetry [8]. In [6], 4th and 5th grade students were able to share their designs in a mathematical way with the support of the system of challenges, peer interaction, teacher-provided guidance, and the DigiQuilt software.
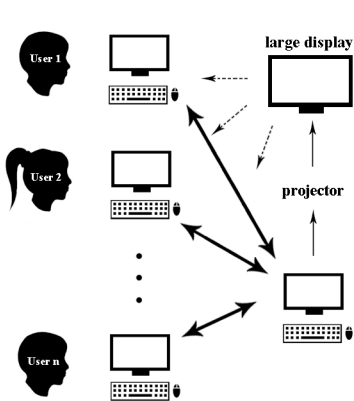
Figure 2. Our setup utilized a large display that all the children could see in addition to their own screens where they created quilt blocks using the DigiQuilt software.
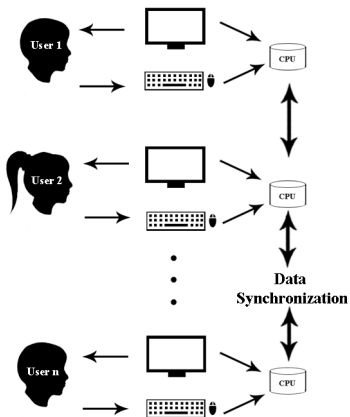
Figure 3. Traditional groupware (figure adapted from [16])
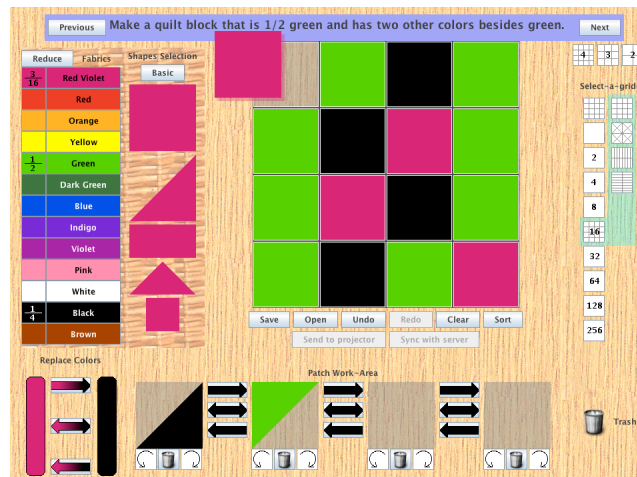
Figure 1: A screenshot of the DigiQuilt software as it would be seen on each child's individual display in our study.

However, the students seemed largely unaware of the design activities of their peers whose screens were not visible to them. We hypothesized that the use of large displays for sharing selected information among learners would help students achieve awareness of opportunities to discuss their activities with each other.

Our System Setup

We developed a system where a server controls the content projected onto a screen that is visible to learners who each have their own client computer with a display, keyboard, and mouse. The clients were all in the same room and connected to the server (see Figure 2). Children used the DigiQuilt software to create quilt block designs that solved fractions and symmetry challenges. When they saved a design, their client synchronized with the server – uploading the new design and downloading any other quilts that had been added to the server since the last synchronization.

Alternatively, they could choose to download new quilts from the server at any time if they became aware of and wanted to see a design someone else saved. We tried several different approaches to managing the content of the large display with the goal of helping children discuss the mathematical and artistic elements of their designs, which we elaborate in the next section.

Our setup shares traits with traditional groupware (see Figure 3), Multiple Display Environments (MDE) [15], and Ambient Information Systems [12]. Like traditional groupware systems, each user has a mouse, keyboard, and display, along with data synchronization. However, our system introduces the use of a large display with different content from what is on the individual displays. Like MDE systems, in our system each user has a display and also a shared display. However, it is not a "What you see is what I see" (WYSIWIS) environment because users are using their individual displays to create their designs and can simply choose to share them when they wish. Another difference is that no user is directly controlling any content on the large display. Though the amount of control over the content on the large display varied throughout our study, none of the users ever directly interacted with the large display. In that regard, our large display is an Ambient Information System [12].

The authors of [12] introduce a taxonomy to categorize peripheral and ambient displays in terms of information capacity, notification level, representational fidelity, and aesthetic emphasis. Our peripheral display has high information capacity, with each quilt and its comments acting as a nugget of information. For notification level, its intent is to draw attention, but not demand it. It has high representational fidelity since it shows the actual

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artifacts the children made rather than any abstraction of them. Aesthetically, our goal was to present the information clearly in a pleasing manner, while not focusing too much on its artistic appeal. Based on these observations, our ambient display could be categorized as a "multiple information consolidator" [12].

Our Study

We conducted a pilot study using our system. We worked with six children in grades 3-5 (ages 8-11) in five sessions of approximately 45-60 minutes per week. We gave the children in our study a series of design challenges related to fractions and symmetry, and then asked them to create quilt blocks that solved these challenges using the DigiQuilt software (see Figure 1). We encouraged them to discuss their designs and share them on the large display.

We observed the children's interactions with DigiQuilt and with each other. We used our observations of their interactions with the software, the information and artifacts on the large display, and each other to shape our approach to selecting and managing the contents of the large display. Between sessions, we made changes to DigiQuilt that reflected our observations with the goals of helping participants to notice the large display, share meaningful information, and discuss the mathematical aspects of their designs.

Observations and Changes

For the first session, we used the large display to show children how to use DigiQuilt, including how to select a challenge to solve and use some of the interface options for supporting their quilt designing. The children could add comments about their quilts when saving or sharing their designs; however, the shared

comments were not saved, and the saved comments were not shared, except when opening a previously saved quilt. They could also open any designs that were previously saved by the other children.

For the second session, the children had more time to design quilts and to make use of the large display. We initially gave them fairly direct control over what was shared, where they simply needed to select the "Send To Projector" button when they wanted to share a design. The display had the six most recent quilts, and the notes that they entered in the process of sharing their designs were shown below each quilt; however, the font was small and difficult to read. We found that the children often cleared their designs without saving them, particularly if they had shared them on the large display. We took this to mean they liked their designs and were accidentally forgetting to save them (a flaw on our part that might cause them to lose their work). We also noticed that they seemed to complete each challenge only once. This observation led us to hypothesize that if they could see the challenges associated with the quilts, they would be able to see different ways of solving any given challenge and want contribute multiple solutions.

For the third session, we used two different views of the data for the large display: the "recent work" and the "challenge" views. In the "recent work" view, the large display showed the eight most recent quilt blocks, along with the children's comments in a larger font (see figure 4). We also added prompts that the children could select and complete when saving their work and entering their notes: "I like my design because," "I struggled with," "I didn't understand," and "I was wondering." They seemed to have more thoughtful

I like my design because: it's a snaaaaaaaaaaaaaaaake! WATCH OUT!

I didn't understand: why the red and green were 1/4

comments when using these prompts rather than having to start from a blank text field. These changes resulted in the children commenting about the displayed designs and asking who created them. During this session, some of the children realized that they could take over the "recent work" view and raced to fill the entire display with their own design.
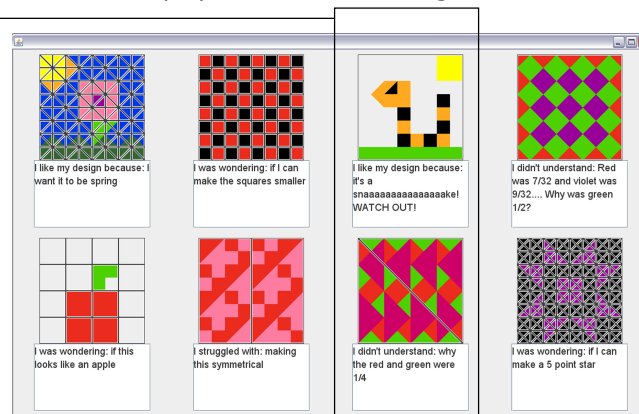
Figure 4: The "recent work" view of the large display – these comments are samples of ways the prompts might be used.

We also introduced the "challenge" view on the large display, which went through the list of challenges and displayed the associated quilts the children had saved (see Figure 5). During this session, they helped think of new fractions and symmetry challenges to add and try.

There was much more interaction and enthusiasm during this session. We wanted to inspire the children to share their design more frequently than they already had done. We thought that if there was something exciting and attention-grabbing that was unique to the large display, they might increase their interaction with the large display and with each other. We wanted to increase the notification level of the large display [12].
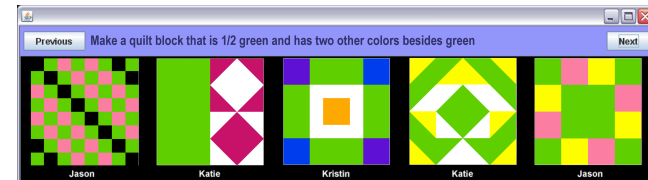
Figure 5: The "challenge" view showed collections of quilts made by students that solved a particular challenge.

For the fourth and fifth sessions, we altered the "challenge" view to include animated transitions between the quilt blocks that solved the same challenge. A quilt block would break into pieces, which then fly between their initial and final positions, thus changing one design into another. Since this animation could only happen on the large display, it seemed to encourage the children to contribute. The literature advises against using animations in ambient displays because it can be distracting [11], but we wanted to draw the learners' attention. In addition to meeting our goals regarding novelty and noticeability, it also increased the overall aesthetic emphasis of our display.

Discussion

Including a large display in the periphery helped students to keep track of what their peers were doing. It gave them the opportunity to create and select information to share while keeping an audience in mind. We made design decisions for the display based on our observations, but these decisions were not always without tradeoffs. One decision we made, for example, was to remove the "Send to Projector" button, and instead have the large display show quilts that the children had saved. This had the benefit of being less confusing, but also meant that unfinished work had to be saved before it would show up on the large display. Unfortunately, this design decision

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markedly reduces children's likelihood of sharing in-progress work since they can't share it on the large display without saving it, and children are reluctant to save incomplete work. In addition to encouraging learners to share their finished work more frequently, we'd like to find ways to encourage children to share and discuss their in-progress work so that they can learn from each other and struggle together in a comfortable environment.

Acknowledgements

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