Low-Resolution Ambient Awareness Tools for Educational Support

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Abstract
We examine an approach in technology-enhanced learning that avoids deviation from existing pedagogical practices as these are often reluctant to change. This is accomplished by designing technology to augment learning activities that are already in common practice. We implemented two ambient awareness tools, Lantern and Reflect, in line with this approach. The former is tailored for recitation sections and improves student productivity while the latter promotes participation balance in face-to-face collaboration. Both devices allow very limited interaction and provide low-resolution feedback, keeping the actual learning tasks at the center of the student's focus. We show that the approach we examine coupled with this simple design makes these tools effective and easy to adopt.

Keywords
Technology-Enhanced Learning, Computer-Supported Collaborative Learning, Ambient Awareness

ACM Classification Keywords
K.3.1.a Computers and Education: Collaborative Learning

Introduction

Technology has always had a difficult time penetrating into the classroom. This is often attributed to the difficulty many educators have in modifying or adapting their existing and well-tested teaching mechanisms to fit the new technology. We examined an approach to Technology-Enhanced Learning that tries to circumvent this problem by designing technology around existing pedagogical mechanisms, rather than requiring changes in the latter. With this approach, we look at learning activities and teaching practices that are already in widespread use, and develop technology specifically designed to make them more effective requiring minimal changes both to the way the teachers plan these activities and to the way students perform them.

In order to explore this approach, we built two ambient awareness tools aimed at different aspects of classroom learning and studied their effect on students' behavior. The first tool, Lantern, targets recitation sections in which students work in small teams on exercise sets while one or more teaching assistants provide support by answering questions. The second, Reflect, targets more casual collaborative groups of students meeting together to work on assignments, study for exams or discuss the course material. Both tools display dynamic but minimal information relevant to the given situation, and involves very limited interaction. The constrained interactivity and low-resolution display prevent the tools from taking too much attention away from the actual task the students are expected to be performing.

Lantern

Our empirical study on recitation sections shows that students devote too much attention to manage their relationship with teaching assistants and other students, which is mostly due to a lack of awareness information, specifically about the availability of TAs and performance of students. Our first awareness tool, Lantern, tries to address this problem.

figure 1. Lantern can be controlled by turning and pressing and uses a column of light to indicate its status.

Lantern, shown in Figure 1, is a small and portable lamp which consists of five pairs of Light-Emitting Diodes (LEDs) installed in a column and covered by a blurry plastic cylinder. A microprocessor controls the LEDs.

Each team is provided with a Lantern which makes use of a very simple visual grammar to show the status of that team:

- **Color:** The color of the team's Lantern indicates the exercise they are currently working on, while the intensity of the light specifies the time that has been spent on that exercise.

- **Blinking:** indicates that the team is calling for help; the faster the rate of blinking the longer the team has been waiting.

Users can interact with Lantern by *turning* it to choose an exercise and by *pressing on* it to call for help.

Our study on two classes of students using Lantern during seven weeks of recitation shows that Lantern considerably improves the quality of interaction between students and TA as well as among students. On the one hand, students put significantly less effort to catch the attention of TA which makes them be more productive while waiting for the TA. On the other hand, stronger collaboration among teams has been observed. This can be explained by the fact that knowing about a team's progress could encourage others to seek their help [1].

Reflect

When students are engaged in any collaborative learning activity, some balance in participation is needed to make sure all members of the group achieve desired learning gains [3, 4]. When the learning activity requires verbal discussion, such as collaborative problem solving or co-construction of knowledge, then balance in *verbal* participation becomes important. The second tool we developed addresses this issue and uses an ambient display to promote balanced collaboration.

Reflect is an interactive table that uses embedded microphones to listen to the conversation taking place around it, and uses an 8x16 matrix of multi-color LEDs to display a visualization of that conversation. By filtering out sounds coming from different directions, the table can determine which member of the group is speaking at each point. This is done without the users needing to wear any additional device such as a lapel or head-mounted microphone allowing for natural use of the table. The LEDs are covered with a sturdy frosted glass pane that can be used as a regular working surface.

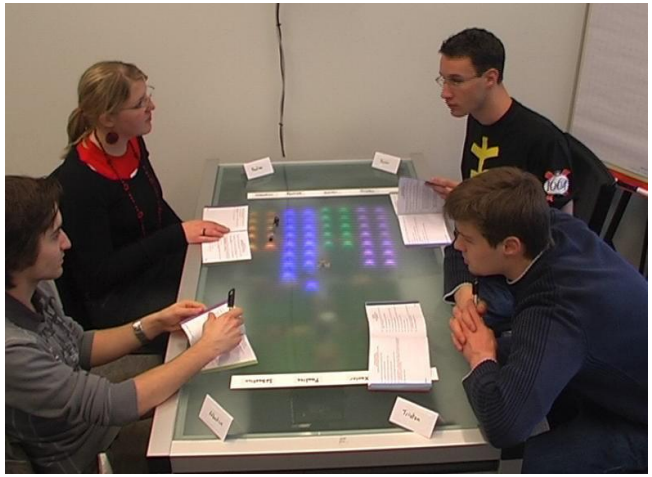

figure 2. Reflect showing levels of participation to members of a group in the form of columns of light.

The display shows members of the group their levels of participation in terms of how much they have spoken during the collaboration. The low-resolution and simple display makes it possible for users to perceive and interpret the visualization without extending too much cognitive effort that could otherwise be used for the task.

A user study conducted with 72 subjects showed that there is a significant difference in how balanced participants are when they believe it is beneficial to participate equally, but no significant difference when they didn't. Our results also showed that over-participators were more influenced by the table than

under-participators. Only 6% of the subjects reported being bothered by the display, but about a quarter said it was distracting [2].

Discussion and Conclusions

We examined an approach in technology-enhanced learning by designing tools around existing pedagogical practices without requiring significant changes in the way learning activities are planned and performed. We implemented two tools, Lantern and Reflect, that adopt this approach while having limited interactivity and low resolution. We believe that this approach coupled with this design makes the tools both effective and easy to adopt. In fact, empirical studies have shown that they were able to influence student behavior by promoting balance and collaboration. Also, both tools have been integrated into existing courses by teachers.

Intuitively, one would see the effects these tools have as being in spite of their limited interactivity. We believe, however, that it is because of this limitation that these tools are effective. Indeed, these tools were designed to be inherently incapable of complex interactivity allowing them to quickly fade into the background. They become unobtrusive tools that remain in the periphery of the interaction, only providing support when they are needed.

Reflect and Lantern show that, when developing technologies for learning, we do not need to change pedagogical practices in order to have an effect. Existing classroom activities can remain intact, but augmented with technology to make them more effective.

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