A Mouse on Each Desk: A Method for Supporting Unison Response during Remote Teaching

Taemie Kim
Media Lab
M.I.T.
Cambridge, MA
taemie@media.mit.edu

Udai Pawar
Tech. for Emerging Markets
Microsoft Research India
Bangalore, India
udaip@microsoft.com

Neema Moraveji
Center for Interaction Design
Microsoft Research Asia
Beijing, China
neemam@microsoft.com

ABSTRACT
We introduce a real-time, remote education system that uses Single-Display Groupware in a classroom to support students to participate actively while sitting at their desks. The interaction design is based on the literature and an observation made of rural Chinese classrooms: the importance of unison response. Based on this, we designed a set of techniques for the students to interact with the teacher. We conducted a pilot study using the system with its intended users and found that the students easily learned to use the unison response feature and that the teacher appropriated the techniques so as to increase the student's awareness of her attention.

Author Keywords
Remote collaboration, distance learning, rural computing, developing regions, education, single-display groupware.

ACM Classification Keywords
H.5.2 [Information interfaces and presentation]: User Interfaces

INTRODUCTION AND MOTIVATION
In the winter of 2005, Tibet University in Lhasa, China contacted our lab about a project to 'wire the schools' in the sparse Tibetan countryside. They were hoping we would be able to create a distance education system to disseminate the educational resources concentrated in Lhasa to the remote areas. To do so, we took a step back and looked at the distance education ecosystem as it exists in China and abroad.

The uneven geographical distribution of skilled teachers begs the design of remote teaching systems to connect urban teachers to rural children. Distance education (or "distance learning") is often seen as a panacea for improving economic and quality-of-life levels in developing regions of the world. Such laudable goals have resulted in the creation of numerous remote collaboration and web-based education systems in both developing and developed countries (some listed in [7]).

Observational research in Chinese schools led to the design of a real-time remote teaching system, a Mouse on Every Desk (MED). The resulting design of MED is unique in that it uses single-display groupware [10] for remote collaboration where a group of collocated students sit at their desks as in a traditional class and only the teacher is remote. Further, the unique characteristics of teacher-class social interaction in Chinese classes informed the design of a set of interaction techniques that we evaluated in a pilot study. The initial user evaluation of MED showed that students from rural backgrounds who are novice computer users can learn to use the novel interaction techniques quickly. Further, the teacher quickly understood how to control the anonymity of the students in the classroom responses.

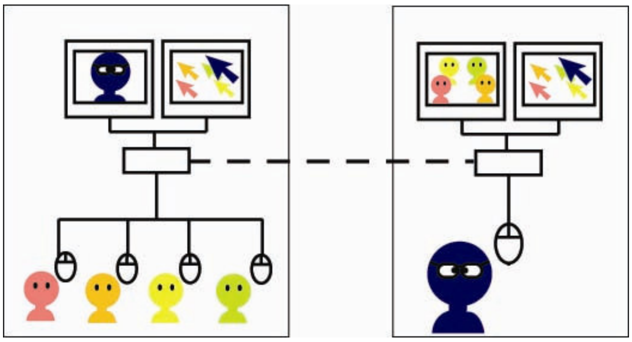

Figure 1: Using single-display groupware for the purposes of remote teaching in developing regions. Mice cables are extra long so students can sit at desks.

RELATED WORK
Many remote collaboration systems exist for use in distance education (e.g. [11]), both real-time and pre-recorded. A relevant finding from this research is a need for simplicity in the representation of social interactions.

Instructors in the remote teaching process should have sufficient feedback [11] to stay engaged and motivated [7,8]. Common ground helps to transmit the "presence, positions and actions of other people in the virtual space", relating to the concepts of social and workspace awareness [5].

A different body of work focuses on technology use by individual students within a traditional classroom, primarily to give real-time, anonymous, non-anonymous, structured, and free-form feedback and submissions [2, 9] to remain motivated and aid the instructor.

Single-display groupware [10] in education has been found to lead to higher engagement, better task performance, and also affect collaboration and motivation [3].

Telepointers have been found to help in mediating conversations, supporting gestures, communicating focus of attention [6], and also have advantages in education [1], especially as they give visual cues to a person's activity and intentions.

OBSERVING UNISON RESPONSE IN RURAL CHINESE CLASSROOMS

We visited 5 schools in 2 Chinese provinces: 1 was urban, 3 semi-rural, and 1 rural. Among them, we observed 10 classes of grade 2-10 and interviewed 20 teachers. Each class had 50-80 students.

A highly salient characteristic of the classes compared to Western classes was the nature of how the teacher interacts vocally with the class as a whole. The teacher asks questions aloud and students respond as a group – either vocally or physically (e.g. by raising their hands). The result is an atmosphere of an enthusiastic military drill. For the purpose of this paper, we focus specifically on exploring this phenomenon.

The teacher-class interactions maintain engagement, motivation, and pace, especially in large classes. We observed two types:

Rhetorical: Quick, rhetorical questions to maintain student attention, gauge superficial comprehension, and set class rhythm. Response is almost always verbal. E.g., "..and we saw that earlier, right?" and "Is everybody with me?"

Quiz: Short questions or recall exercises looking for an actual response. Used to gauge comprehension and to review noteworthy concepts. Response is verbal or physical. E.g., "Raise your hand if you understand" or "What is this a picture of, class?"

SYSTEM DESIGN

The MED system as a whole is a remote teaching system designed to use SDG to enhance social awareness between a group of co-located students and a remote teacher. Students in the classroom are able to participate from their desks using mice with long cables (Figure 1). If possible, each student has a mouse at their own desk. If this is not feasible, small numbers of students can share mice. Audio is transmitted by telephone or computer and video of the remote party is optional.

This paper focuses on our attempt to model the design of the MED application after that of a traditional classroom.

Figure 2. UpperLeft: Student list opened and students activated. UpperRight: A student raising his/her hand. LowerLeft: Binary mouse gestures with student cursors invisible. LowerRight: Multiple-Choice with the Tally Window displayed and student cursors invisible.

Supporting Unison Response via SDG

Each participant or group of participants is represented on MED by a unique cursor. The teacher's cursor is larger than the students', which are represented by an animal in a unique color (Figure 2, UpperLeft). The visibility of a student's cursor is controlled by the teacher, as explained below.

The application contains activities that the teacher can launch at any time (e.g. multiple-choice or lecture slides). Each activity allows certain interaction techniques for students, allowing them to choose answers and generally augment audio communication to address unison response. The techniques are presented here.

Student

Binary: In the binary answer activity, students use mouse gestures modeled on shaking one's head "Yes" (up/down) and "No" (left/right). This method could supplant or augment voice responses, depending on the audio connection quality. If a student's cursor is invisible, the gesture is still interpreted by the system.

Multiple-Choice: Up to 4 choices are shown as rectangles on corners of the screen. Users move their cursor atop the rectangle to choose that answer. If a student's cursor is invisible, the mouse position is still recorded by the system.

Hand-Raising: Like related systems, students can 'raise their virtual hand.' At any time, students can do this by right-clicking. A hand icon is shown next to the student's name in the student list and, in case the student list is hidden, another icon appears in a space that is always visible on-screen.

Teacher

Student List: The student list, triggered by the teacher, summarizes the status of all students, who are aligned for scanning. Here, the teacher can toggle the visibility of individual students, see who is raising their hand, what the current answer of each student is, and how many 'stars' have been awarded to each student.

Tally Window: If the teacher wishes to make students' responses anonymous, she can click an empty space on the screen to see a tally of the choices. In Multiple-Choice, she can click on individual answers to see that answer's tally.

Though Binary, Multiple-Choice, and Hand-Raising can be done when cursors are invisible, the teacher can reveal the answers of each student by displaying the student list. If she wants to keep answers anonymous, she uses Tally Window.

USER STUDY

We conducted a small user study with a prototype of the system to address two hypotheses:

1. The techniques for unison response are easy to learn for the target user group.
2. The techniques for unison response help to increase social awareness of both parties in the class.

Two studies, separated by 1 week, were conducted one hour outside of Beijing, China at a semi-rural school founded by a philanthropist to cater to the children of rural migrants from other provinces. The first (S1, 28 students, 14 female) was a study of the system where the teacher conducted 2 remote training sessions (30 minutes each) with 2 classes. The primary study (S2, 30 students, 16 female) included 2 training sessions and a 40-minute mathematics session using MED. Some of the students of S1 also participated in S2 – they are referred to as "old students" (OS, 12 students). Those in S2 for whom it was their first interaction with the system we call "new students" (NS, 18 students).

58 students (Figure N) ranged from grade four to grade eight. 83.3% of the students used computers only once a week. Indeed, only 56% of the students rated themselves as "comfortable using a mouse." A 24-year old teacher from Beijing, unknown to the students, with regular computer skills was hired as the remote teacher and given a 2 hour training session.

We simulated a remote teaching session by placing the teacher in a room adjacent to the class. We attempted to recreate plausible remote teaching conditions. In the classroom, two 16" by 12" monitors were used rather than a projector. Audio/video transmission quality was too low for the teacher to detect facial expressions or hear clearly what the speaker is saying; there were 10 mice per class, so some children shared.

Figure 3: MED with two displays for visibility purposes.

RESULTS AND DISCUSSION

Given that both parties had never used a tool resembling this before, the experience was positive. In the post-session feedback, they reported that they "liked the system," and "felt comfortable using the system" (mean of 3.38 and 3.73 on a 5-point scale, respectively). The teacher heavily relied on the common unison response behaviors while using the system.

Student

Mouse Gestures (Binary and Multiple-Choice)

One student noted that mouse gestures were "Eeeeeasy and good because everyone could participate." The teacher taught the children how to use mouse gestures by practicing first with the visible cursors. During S2, she decided to give them short tasks to ensure comprehension of gestures with invisible cursors. A 94.29% accuracy rate (140 instances) was recorded for Binary and 64.55% (110 instances) for Multiple-Choice. A trend existed that older students did better on Binary ($F(1,30)=4.785$, $p=0.005$) but not for Multiple-Choice ($F(1,30)=0.401$, $p=0.806$).

Binary response was easy to learn (cursors visible or invisible) but Multiple-Choice was generally difficult for the students when cursors were invisible.

Multiple-Choice was less successful because it was difficult to describe this concept of using a mouse gesture that would place the cursor in the desired target (by a repetitive diagonal gesture). The low accuracy rate of Multiple-Choice with invisible cursor (64.6%) was because many students could not correlate their mouse movements to an invisible cursor.

Hand-Raising

Unlike related systems, the hand-raising feature was used heavily in MED. When the teacher was asking for a volunteer, a few students used it repeatedly to catch her attention (up to 174 times in 40 minutes). This speaks to the need for the teacher's attention to be visible. Its utility lies in the fact that it is always available and it closely matches the practices of real teachers. The teacher often opened the Student List to show she was looking at the people who were raising their hands.

In one instance, the teacher asked the math class to "raise their hands if they understood" which was a feature that the teacher fabricated in impromptu. Interestingly, all children used their virtual, not physical, hands in response, although they knew that the teacher could see them. We attribute this to the fact that they could infer the teacher's attention better on the shared display than through the video.

Teacher

Student List

The most common way for the teacher to assess responses of the class's responses was to open the student list (20 times in the 40 minute math class). This act was very much like scanning the class explicitly. The reason for its success lied in its visibility: because the student list had to be explicitly displayed by the teacher, when it was open the students knew she was inspecting them. The feature made her attention more transparent, mirroring a real classroom. Similarly, it implies that the children knew when they might be activated (i.e., "called upon") individually. The Tally Window was rarely used.

Voice

Although transmission quality was low, if the whole class said "yes" or "no", the teacher was able to understand the group's answer. Voice was still the preferred choice for Rhetorical interaction.

CONCLUSION

The present work has identified a unique characteristic of schools in China (and perhaps in other developing countries) and introduced techniques to support it in remote collaboration systems using low-cost components.

Through the user study, we found that MED was not used to mediate Rhetorical communication between the teacher and class, although we designed it to be used as such. This was because of two reasons: using this feature was not as convenient as verbally asking a question; and though limited by audio quality, rhetorical questions could still be verbally asked and answered. MED was, however, used to afford Quiz interaction in multiple ways.

Binary mouse gestures, with cursors visible or not, are a promising way of communicating in unison in the present system design. On the contrary, Multiple-Choice with invisible cursors proved to be too difficult to use.

The teacher adeptly appropriated the Student List to augment her focus of attention on the class as a whole. By controlling its visibility, students had higher awareness of her attention and she used it as a method of creating anticipation in the students. Replacing the eye contact lost in this way is a powerful addition to seeing where the teacher's cursor is on the screen.

Next steps

After iterating on the visual indicators for gestures, the system needs more longitudinal evaluation to assess its educational value. Using such a system with a co-located teacher has potential value, especially if free-form input is possible via a mouse.

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