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SHARING VISUAL CO-PRESENCE OF THE TASK FOR MONITORING AND ACQUIRING CONVERSATION MEANING

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Abstract. *Coordinating in a world of small devices can take many forms. For co-located people, often that is through traditional conversational cues. However, this is more difficult if they are latecomers to a pre-existing conversation. Establishing common ground as a latecomer when everyone has their own small screens is even more difficult. While we are motivated to study this by the needs of students and teachers in classroom group projects, this situation occurs in many work settings. This study presents a network service, Look, which during collaborative activities enables latecomers to share visual co-presence of the task. In particular, the study articulates how in a foreign language learning activity they can, with handheld devices and Look, catch up with an in-progress conversation quickly and efficiently.*
Keywords: Common ground, Empirical investigations, Handhelds

1. **Introduction.** The mobile nature of handheld devices provides students with greater opportunities for collaborative interaction. Rather than restricting collaboration to desktop or even laptop computers, handhelds permit students to move around the classroom or learning environment, which increases their potential for peer interaction. Like other people interested in educational technology devices, we have been investigating as a classroom delivery mechanism small devices with both pragmatic and transformative functionality [1,2]. The devices are pragmatic because they boast a much-reduced price, which by itself solves a number of problems posed by adoption and usage. They are transformative because their small, mobile form serves as a generator of pervasive, ubiquitous activities.

However, establishing common ground when everyone has their own handhelds with little screens is not entirely simple. While voice, eye gaze, facial expression, and gesture, and physical environment can be monitored easily, simply observing interlocutors' facial expression proves equally ineffective [3]. Instead, successful collaborative problem-solving demands the sharing of visual workspaces [4].

The focal artifacts or workspace on the handheld screen and the user's activity on the screen are not easily shared among collaborators. Because of device's glare and size, available methods of gaining perspective, such as glancing over the shoulder, prove insufficient. The need to show the screen to other people explicitly interrupts the work. To join appropriately into difficult problem-solving activities requires intense, tacit coordination.

Latecomers are late entrants to the activity, who attend to the conversation overtly but are not current addressees or responders. While they may eventually participate actively, they are, initially, usually *overhearers*. Typically, latecomers watch and listen to on-going activity until they are in a position to participate competently. Latecomers have different

access to information and different cognitive burdens versus central participants, such as a speaker or an addressee [5].

Although latecomer joining and participation has wide-spread importance for small devices, we are motivated to study it by the needs of students in classroom group projects. In traditional classroom group projects, a slow student learns by collecting ongoing evidence of how other students are working toward the goals, what task(s) they might perform next, and how they can advance. However, for handheld-equipped activities, students face some challenges collecting, reviewing, and tracking the work of others. Due to the small size of the handheld screen, students' ownership can be private and exclusive. This restricted affordance creates interesting research opportunities. Within this context, our study focuses on how a handheld network service, *Look*, addresses the need for formative self-assessment of a student's understanding in group activities when that student is tasked with learning foreign language without imposing an unpleasant or untenable burden on the other group members. A particular challenge presented by the small screens here is the need for latecomers who are not direct participants in the activity to be able to establish visual co-presence and come to understand the on-going communications.

Previous literature showed the use of chat, desktop videoconferencing and web-based groupware for mediated communication in workspace [6,7]. The most obvious shared visual space can be continuous video monitoring. However, recent study showed that the use of video as a supplemental communication media was suspect to a decrease in common ground establishment although initially effective at negotiating common ground [8]. Conversely, real-time text transcripts were a better supplemental communication media over repeated collaborations [8]. Like real-time text transcripts, *Look* involved a kind of sharing that was punctuated rather than continuous. The innovation and contribution of the current study is that we investigated whether, instead of full videoconferencing, implementing a *minimal* shared visual workspace (i.e., screenshots) using wirelessly connected handheld was worthwhile to support latecomers' monitoring and acquisition of meaning in ongoing discussion.

In the following, Section 2 discusses theoretical foundation for the proposed system, which permits a latecomer to engage in self-reflective formative assessment by unobtrusive screen capture from other handhelds. Section 3 describes the overview of experimental task and system, and the general hypothesis tested. Section 4 presents the experiment result about the effect of "Look" on the latecomer. The final section, Section 5, addresses the conclusions.

2. Utilizing Visual Co-Presence of Tasks as Formative Self-Assessment for Latecomers.

Formative assessment is assessment that provides information that may be used to refine short-term goals for learning within the framework of a long-term goal. When a teacher undertakes formative assessment, she is seeking to learn how to adjust instruction to engage with what has not yet been learned by students. Formative assessment is in contrast to the more usual *summative assessment* which tests how well a student has mastered an area. When a student undertakes formative assessment, the student is seeking to monitor how well he or she understands. Ideally, formative assessment is interactive, learner-centered and oriented toward promoting students' ongoing learning on a micro level. According to Cowie and Bell [9], the process of interactive formative assessment consists of four distinct features: *noticing*, *recognizing*, *responding*, and *purpose* (Figure 1).

The purpose of interactive formative assessment is simple: improvement of students' learning through intervention and mediation. Noticing involves ephemeral information gained through observing students' comments and questions, the tone of their discussions, their body language, and how they interact with their peers. This information measures the progress of students' thought processes and actions. Recognizing is appreciating the

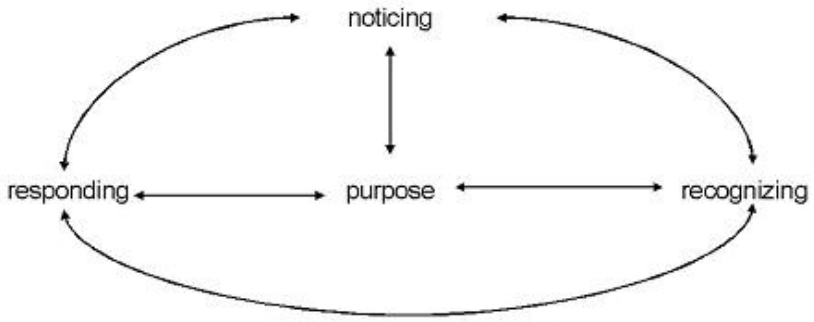


FIGURE 1. Interactive formative assessment

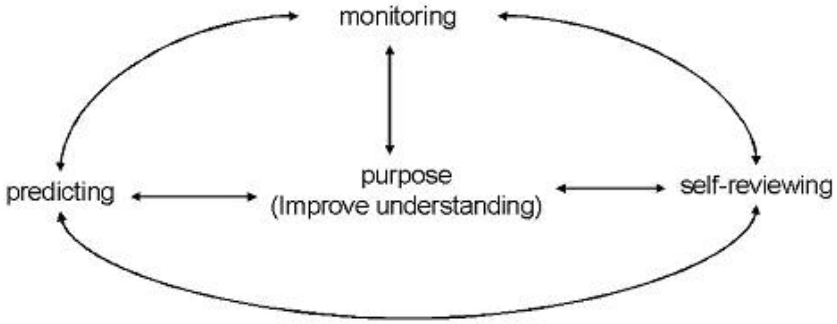


FIGURE 2. Latecomer's formative self-assessment

significance of noticed information for educational and personal development. Noticing and recognizing are context-dependent rather than pre-determined. Responding depends on the teacher's knowledge of individual students and the context regarding what is worth acknowledging at the time (or the student's need to seek more information).

Cowie and Bell's process model of interactive formative assessment can be modified to describe the process we hope to promote, which we call formative self-assessment (Figure 2). Here the purpose is to understand the conversation and thereby approach the content. During the process of group activity, a latecomer allocates attention to monitoring ongoing discussion. This monitoring activates any relevant background or prior knowledge necessary to an understanding of the primary subject. Monitoring leads to critical self-review of understanding for internal consistency and compatibility with prior knowledge and common sense. By engaging in periodic review and self-interrogation, the latecomer draws predictions, interpretations, and conclusions about his or her understanding of the conversation.

Look allows latecomers to view peers' handheld activities dynamically without interrupting ongoing activities of the peers. By tapping or writing into a device, a student can access others' work virtually in real-time, which permits her to self-review her own understanding of what the others are doing and talking about. The incorporation of handhelds to facilitate formative self-assessment enables sporadic monitoring/measurement, and permits a latecomer to engage in self-reflective assessment of her own prediction of the conversation.

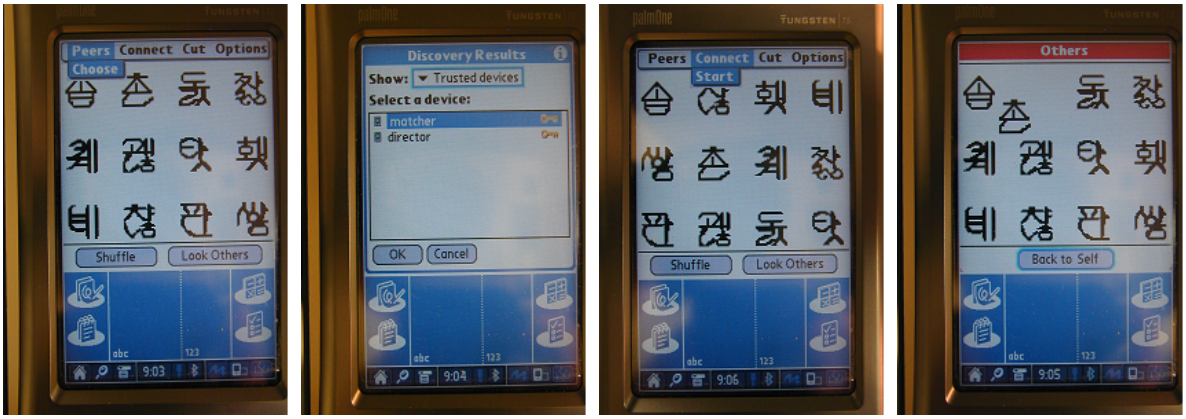
Look was implemented through Bluetooth communication, which provides latecomers with the ability to engage in unobtrusive real-time screen capture from other handhelds. The synchronous capture of activities and of focal artifacts allows latecomers to explicitly share focus on a given task without either latecomers or early participants to suffer a high technological burden or interruption. Our experiment, which involved difficulty of the indexical task, was designed to investigate how visual context of activity and artifacts

can permit latecomers to monitor and review whether their comprehension is progressing smoothly or requires remedial actions.

3. **Experiment.** The experiment investigated two different settings. In the first setting, the Look condition, latecomers were able to view the screen of the addressee, at will. In the other setting (which we will call NoLook), latecomers worked without Look and were unable to retrieve data in this manner. In this experiment, we were able to examine the following research hypothesis:

Hypothesis: Since the Look network service can facilitate latecomer's formative self-assessment by providing shared visual co-presence of workspaces, compared to NoLook, Look improves how the latecomer understands a conversation.

Because Look allows the latecomer to capture a screenshot from other handhelds simply by clicking the Look Others button, Look supports visual co-presence of focal artifacts in real time (Figure 3).



(a) (b) (c) (d)

FIGURE 3. Korean characters tangram game. Students can choose an opponent from the trusted peers discovered by Bluetooth (a-b) and start connection (c). By clicking the Look Others button, a latecomer can capture a snapshot of an opponent's screen (d).

Look network service was implemented by using handheld OS Bluetooth Exchange Library, which provided a high-level socket structure. With its omni-directional signaling, classroom-wide communication, and capacity to covert transmission, Bluetooth technology complements handheld's primary infrared-based narrow angel of sight (30 degrees of less), short-range (three feet or less), point-and-shoot, overt connection option. We embedded and tested this Look function in the context of our Korean "Tangram" game (Figure 3). The base task consisted of two phases. During the first phase, a pair of students carried out a task in which one person assumed the role of director, while the other one played the role of matcher. In front of the director was placed a handheld screen that contained twelve Korean characters (i.e., instead of the tangrams used in other similar studies [5,10]) in the same order as those on the matcher's device. By clicking the Shuffle button, the director randomly rearranged the characters on his screen. The goals of the game were for the director and the matcher to work together to rearrange the twelve complex characters on the matcher's screen into a new order on the director's screen and for the director to teach the matcher the pronunciation of each Korean character. Director and matcher were not allowed to look at each other's screen. The director could describe the characters out loud, identifying which should go first, second, and so on. The matcher then used the stylus to move her characters around. The activity was finished when the matcher and director agreed that all twelve characters were in the same order. They

repeated this task for five trials. The first two trials allowed the matcher and director to establish common ground.

During the second phase, starting in the third trial, a third person, latecomer, entered the activity. The latecomer joined trials 3, 4, and 5 and sorted the characters using clues she was able to learn from the director and matcher's conversation. Half of the latecomers, in the Look condition, were allowed to use the Look Others button to find out what was on a matcher's screen; by clicking the button, the latecomer could capture the screen view of the matcher's handheld. However, the other half, constituting the NoLook condition, was not able to use the Look Others button at any point.

Through announcement on the Psychology Department Experiment Management System, we recruited 114 students to participate in the experiment in 38 groups of three. The results of each condition were analyzed to compare the impact of Look on latecomers' abilities to understand the conversation and to learn Korean characters, as well as to explore the effects of visual co-presence of workspace for collaborative activity. During each trial the sessions were timed and videotaped. In addition, as the measure of learning, we collected quantitative evidence regarding correctness on quizzes that asked participants to name the characters. Each session took about 1.5 hours. Students were given extra credit for participating in the experiment.

4. **Results.** Schober and Clark's work indicates that an inadvertent participant (i.e., latecomer) may not be given the opportunity to establish common ground with discourse participants and so performs much more poorly than those already involved in the conversation [10].

The principle benefits of Look are that an inadvertent participant can perform formative self-assessment with the captured visual evidence, that is, can monitor how well s/he understands the import of the conversation and thereby improve her/his understanding. Participant's understanding is measured by the matching of tangram figures [5]. Figure 4 shows the matching results of latecomers both with Look and without Look. The difference in the performance of latecomers was not significant in trials 4 and 5. However, in trial 3, statistical analysis (one-sided Fisher's exact test) confirmed that the latecomer with Look was significantly more likely to conduct the task more accurately than was the latecomer without Look ($p < .005$). Latecomers might get the most benefit from Look before they accumulated enough common ground by repeating trials (compared to trials 4 and 5).

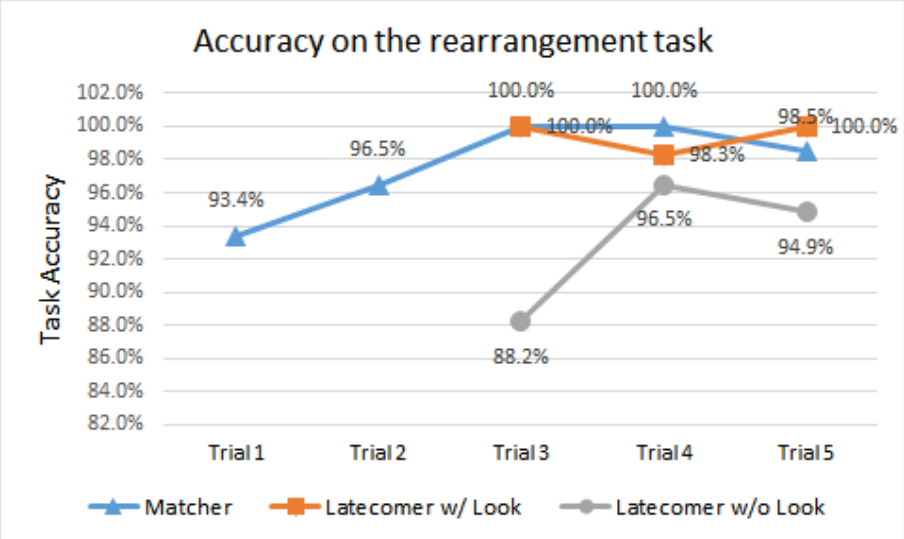


FIGURE 4. Correct placement of Korean characters by latecomers with and without *Look*

We also investigated whether the latecomer was able to remain in the secondary role of an overhearer, rather than being immediately accepted as a ratified, though quiet, participant. To investigate whether it was possible to simulate different participatory roles, we examined ratings of participants' interpersonal awareness. Interpersonal awareness was measured by several post-experiment questionnaires, which used a 10-point rating scale (1 as negative experience and 10 as positive). The expectation was that two central participants (i.e., director and matcher) would be highly aware of each other but much less aware of inadvertent participant (i.e., latecomer). Consequently, the latecomer would feel that she was less known to the central participants. Table 1 shows the mean rating scores for different discourse participant roles. These results show that the two central participants were far more aware of each other than of the latecomer. Therefore, it seemed that the experiment tasks succeeded in creating situations that satisfied the concept of inadvertent participant status.

Table 1. Interpersonal awareness ratings in experiments

Rater	Rated	"How much cooperate with"		"How much cooperate with"
		w/o Look	w/ Look	Mean (w/ and w/o Look)
Director	Matcher	9.2(1.2)	9.1(1.3)	9.13(1.23)*
	Latecomer	8.1(2.4)	7.4(2.9)	7.74(2.62)*
Matcher	Director	9.0(1.3)	8.9(1.2)	8.92(1.22)**
	Latecomer	6.8(2.8)	5.6(3.2)	6.18(3.02)**
Latecomer	Director	7.6(2.6)	7.3(2.9)	7.45(2.72)
	Matcher	6.1(3.5)	6.7(3.2)	6.39(3.31)

*$F(1,74) = 8.83$, $p < 0.004$ **$F(1,74) = 26.83$, $p < 0.001$

5. **Conclusions.** Look enables a coherent activity in which students attempt to understand what others are talking about – in other words, what they are learning. One effective use of Look is to support latecomers in group activity. A latecomer is at a disadvantage in "grounding", the joint process of establishing mutual belief. To catch up with the accumulated understanding in a discussion, a latecomer typically enters into a conversation about a particular object by merely observing the interaction until he or she can make an informed contribution. Look supports the latecomer's ability to capture workplaces from other handheld screens. Therefore, a latecomer seeking to join an activity can understand the context of the discussion quickly and easily and can participate in conversation without paying too high a price in grounding.

The effect of the shared visual context was not highly obvious in our task. This might suggest that the advantage of Look is felt most strongly in particular moments. It may also be due to a ceiling effect in the task performance of participants. Because the conducted task itself was not complex or varied enough, there might not have been scope for the advantage of sharing visual context after the initial exposure. Shared visual context might produce greater benefits when tasks are more visually complex or when there is no simple vocabulary for describing the task state. In particular, it is rare to repeat difficult references to absolutely the same items.

Overall, this pilot study was successful in demonstrating that the distinction between central- and peripheral-participation can be managed in the experiment and that by using Look, latecomers do not have to request to stop an ongoing activity to gain understanding quickly; instead, they can seamlessly, and without disruption, capture data from the other students' handhelds.

Having students actually embrace the technology into their curriculum and effectively communicate contextual data in a continuous process is critical. The prevalence of small screen displays means that, in the future, similar situations will arise with more and more

frequency. This study shows that research is needed to address the subtle conversational needs of learners of workers using them.

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