Keeping Watch: Exploring Wearable Technology Designs for K-12 Teachers

Rebecca Quintana

OISE

University of Toronto

Toronto, ON M5S 1V6, Canada

rebeccamquintana@gmail.com

James D. Slotta

OISE

University of Toronto

Toronto, ON M5S 1V6, Canada

jslotta@gmail.com

Chris Quintana

School of Education

University of Michigan

Ann Arbor, MI 48109, USA

quintana@umich.edu

Cheryl Madeira

OISE

University of Toronto

Toronto, ON M5S 1V6, Canada

madeirc@gmail.com

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Abstract

Emerging wearable technologies (or wearables) are promising in different contexts, but continuing research is needed to explore their utility. One such context is K-12 classrooms where teachers engage in “classroom orchestration” to manage activities and information, monitor student activity, and track their own curricular plans. In order to explore how wearables might support teachers with classroom orchestration, we used the Apple Watch as a technology probe where we co-designed three use cases with teachers. These use cases involved sending teachers activity notifications about student activity, lesson reminders about teachers' pedagogical activity, and allowing moment capture, where teachers photographed classroom events for further study. The technology probe illustrates how the watch fits with teachers' practice, and details teachers' new ideas for supporting classroom orchestration. We also outline design implications and objectives for wearable design.

Author Keywords

Wearable technologies; teachers; classroom orchestration; technology probe.

ACM Classification Keywords

H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

Introduction

Emerging wearable technologies (or *wearables*) increase opportunities for new functionalities in many work settings. Their form factors and connected nature allow designers and researchers to think about ways to more closely integrate wearables into a particular context. For example, wearables now include hands-free/hands-minimum or voice-activated usage, Internet connectivity, increasingly crisp displays, and notification engines that provide visual, auditory, and haptic notifications. These features can help people monitor information and activity streams, notifying them about important events, and allowing them to engage in various activities in new ways.

With wearables still emerging, there is a need to explore their role in different professional contexts. One interesting test-bed context for exploring wearables is K-12 classrooms, specifically the growing number that use technology tools to support active, inquiry-based curricula where teachers oversee students as they engage in problem-solving activity [2]. Such classrooms are complex spaces where teachers must “orchestrate,” or manage multilayered activities and information streams in a context with multiple constraints, all in real time [7]. Teachers must judiciously manage various tasks and information streams, monitor student activity and their needs for help, and track their own curricular plans [13]. These characteristics provide motivation for exploring wearables in this context.

In order to explore the potential for wearables in contemporary classrooms, we engaged teachers in a co-design activity where we used a smart watch (i.e., Apple Watch) as a technology probe. Hutchinson et al.

[10] define a technology probe as an instrument to “combine the social science goal of collecting information about the use and the users of the technology in a real-world setting, the engineering goal of field-testing the technology, and the design goal of inspiring users and designers to think of new kinds of technology to support their needs.” Specifically, we wanted to use the Apple Watch as the technology probe to explore the following questions:

- What are the functionality needs of teachers that would require or benefit from wearable technologies? What is the potential role of wearable technologies for classroom orchestration?
- Why should we consider wearables for classroom orchestration over other mobile technologies (e.g., smartphones or tablets)? Do wearables provide functionalities that those technologies do not?

A technology probe approach lets us field-test wearables in the classroom. The social science perspective considers the needs and desires of classroom teachers. The design perspective lets us think about new ways that wearables can support those needs. Wearables are not necessarily a “one size fits all” technology, so studying their use in an underexplored context gives new insights into their possibilities. We hope to make HCI contributions by describing new functionalities and uses for wearables in classrooms and to set an agenda for further study.

Related Work

Related work on orchestration tools for teachers varies across a continuum, ranging from minimalist tools that convey simple signals to more complex tools that

convey denser streams of information. Examples of minimalist monitoring tools include CawClock [4], Lantern [1], and TinkerLamp and TinkerBoard [7]. These ambient tools are visible to everyone in the classroom, and they use either simple binary on/off signals, or limited color options to notify teachers about student activity or needs for help.

Other tools include teacher dashboard systems that incorporate more complex information streams about student activity and student progress. These tools include CodeIt! [9], ArgueGraph [7], and other tablet-based applications designed for teacher monitoring of student work [14]. These tools include information-rich screens that are visible only to teachers, and they provide more dimensions of information about classroom activity than the more minimalist tools.

Another category of functional tools helps teachers capture classroom events for future study. NoteLet [4] is a wristband tool that allows teachers to mark classroom moments by using a wristband to take photos so they can reflect on those moments later. A common approach in teacher professional development includes the use of mobile device cameras to capture significant pedagogical events in class [11].

Thus we see that initial explorations into teacher orchestration support have resulted in various specific, single-purpose tools. Some of this work has resulted in different design principles about these types of orchestration technologies [3, 7, 14]. In our study, we are exploring how more general-purpose, consumer wearables might not only facilitate classroom orchestration, but also help determine multiple new functionalities and design directions.

Study Context and Methods

We conducted our study at a university laboratory school in Southern Ontario, Canada. Two Grade 5/6 split classes participated in the study. Project teachers (all names are pseudonyms) included Carol, a veteran researcher/science teacher, Mark, a teacher with five years of teaching experience, and Anna, a student teacher with one year of teaching experience. This study was situated in a ten-week inquiry-based Astronomy unit, where students see and use information (i.e., textual notes, and digital media) that their peers contribute to a shared networked knowledge base called Common Knowledge (CK) [8]. Teachers conducted two 75-minute science inquiry sessions per week, where students used three CK workspaces: (1) a *brainstorm space* for students to share questions, notes, and ideas with peers, (2) a *research space* for student groups to propose a project, give and receive peer feedback, compose research notes, and manage digital resources, (3) a *digital poster presentation space*, for students to export, edit, reorganize and arrange notes and digital media.

Thus within this context, we see that teachers must (1) maintain awareness of student activity within various CK workspaces, (2) coordinate the flow of activities and respond to emergent events, such as when students begin a new research topic or are ready to present their digital poster, and (3) capture important moments as the class unfolds. With these overarching requirements in mind, we engaged Carol, Mike, and Anna in a co-design activity [10] to devise three use case designs using the Apple Watch as the wearable technology.

Figure 1: Activity notifications to teacher describing student activity, e.g., student (name redacted) sent text to his digital poster (first five words of text shown).

Figure 2: Activity notification to teacher with accompanying image being used by the student.

The **Activity Notification** use case alerted teachers to student activity (i.e., contributions to their project research space and digital poster) in real time. Every time a student published a text note or image to their group's project workspace or digital poster, teachers received a shorthand text message (and accompanying image) (Figures 1 and 2). Using a "Wizard of Oz" approach [12], a researcher who had access to the system's log files sent the text messages, which were associated with a haptic tap on the teacher's wrist.

The **Lesson Reminder** use case sent reminders about anticipated scheduling and logistical arrangements that would be relevant for that session (e.g., "Is there a group that is ready to present?") to the teacher's watch in the form of a text message. Teachers worded the reminders in advance and specified their timing (e.g., every ten minutes) (Figure 3).

Finally, teachers proposed a **Moment Capture** use case that paired the watch to an iPhone that was strategically set up in the classroom where it could capture student activities. Teachers used the watch to take a photo whenever they determined that a classroom moment should be captured for later personal reflection and future study (Figure 4).

These use cases were implemented one at a time (i.e., one use case per class session) to address the requirements identified by the teachers. Since this was a technology probe, rather than building a new watch application from scratch, we used existing watch features (e.g., text messaging and the watch's iPhone connection) to implement the necessary functionality.

Data Collection and Analysis

Teachers wore the watch for these use cases in classroom sessions where students engaged in research activities, digital poster preparation, and presentations. Data sources include: (1) log files of watch notifications received by teachers, (2) photographs captured by teachers using the watch, and (3) semi-structured interviews with teachers. Immediately following each classroom session, we interviewed teachers for 20-30 minutes to elicit feedback about the watch and to ask for descriptions of how each use case affected their decision-making and actions in class. We transcribed the interviews and analyzed them using Dedoose, cloud-based software for qualitative analysis [6]. We used an open coding scheme to develop conceptual categories and descriptive themes [5]. We reviewed the interview transcripts and extracted excerpts in two categories: (1) watch functionality and usability and (2) watch use in class, including instances where the teachers referred to how the watch could impact their practice. We reviewed these excerpts (n=45) to create sub-codes in each category. Finally, we flagged several references from the interviews for ideas about how the use case designs could be modified and improved.

Findings and Discussion

Functionality and Usability of Apple Watch

Teachers described their experience wearing the watch, made observations about how it compared to other mobile devices, and considered its social acceptability in the classroom. Teachers stated that wearing the watch felt "natural" to them, and that it did not interfere with their regular activities. However, some issues did arise, such as Anna noting that she sometimes had difficulty feeling the haptic watch taps, which caused her to miss some reminders in class.

Figure 3: Lesson reminder set by teacher.

Figure 4: Classroom moment captured by teacher using watch and paired iPhone camera.

Teachers also discussed previous experiences using mobile devices in the classroom to contrast with the watch. Mark noted that he had rarely used his mobile phone, only using it to “take the occasional picture.” He previously used an iPad to view student work and noted that the watch provided him with information in “tinier pieces,” whereas the iPad provided him with a “more comprehensive picture” of student activity. He found watch activity notifications useful during class time, but before and after class he found it easier to review students’ research and digital posters on an iPad. Anna noted that she previously used her mobile phone often to set timers or reminders, and to capture student work samples. She said that she could use the watch for some tasks she previously did with her phone.

In terms of socially acceptable behavior, teachers noted cautions and advantages of the watch over mobile devices. Mark acknowledged that he had to resist checking all the notifications from the watch during interactions with students, because “then it become that social thing, with people just looking at screens.” Both Mark and Anna described feeling uncomfortable using their mobile phones in class, even if for pedagogical purposes. Mark noted that he could capture classroom moments using the watch in ways that were invisible and less disruptive to students, allowing them to focus on class work and not on him. Anna said that she did not like to use her mobile phone in class because, “Then the kids notice me at this point. I don’t want them to think I’m texting or whatever.” She said “having a mobile phone in your hand is a different feeling” from wearing the watch—and she preferred to wear the watch.

Impact on practice

Our analysis also revealed four ways the watch could potentially impact teacher practice. First, teachers indicated the watch could help gauge student progress in class. Mark noted that feeling the steady stream of activity notification taps gave an indication that the class was making progress, even if he had only interacted with one or two student groups during that time. Anna also remarked that the view the watch gave her of different classroom areas (via the iPhone camera) reassured her that students were on task.

Second, teachers said the watch enabled them make timely student interventions. For example, Carol described how receiving an activity notification prompted her to speak to a student pair about a complex astronomy concept in the moment that they were creating their explanation. This allowed students to expand and improve the work they eventually exported to their digital posters. Mark echoed Carol’s experience, describing how activity notifications and reminders helped him intervene in situations where students could benefit from his assistance.

Third, the watch served as a marker to document important events for revisiting a classroom topic or issue. For example, Anna used the watch’s photo capture functionality to document “cool, unexpected moments” during student presentations, and to create a record of which students had presented in class.

Finally, teachers felt that the watch helped guide their “next steps” during class. Mark said that receiving activity notifications made his movements more directed and gave him incentive to move in “a certain direction” in class. Similarly, Carol described how she

Figure 5: Anna suggested the watch could act as a viewfinder (below) for the teacher to check on student activity, without the need for her to move to another classroom zone (above).

reviewed activity notifications by scrolling through the record of notifications on her watch to make note of which student pairs she wanted to meet with later.

New Ideas

Our interviews also uncovered new ideas about design revisions for the use cases. First, in terms of activity notifications, Anna said that it would be useful to be notified after a period of student *inactivity*. Carol also noted that teachers should be able to pause or mute the notifications stream when necessary.

Second, concerning lesson reminders, Mark suggested it would be helpful to set a timer to remind him to return and check on a particular student's progress. Anna noted that it would be useful for teachers to set multiple *reminder paths* in advance of the lesson to allow for different curricular contingencies. Once class begins, a teacher could choose the reminder path that would be most appropriate at that time, and receive only relevant notifications for that curricular decision.

Finally, new ideas emerged about using the watch for "moment capture." Mark envisioned using the classroom photos that he captured to create a "highlight reel" of the day's activity for a shared public display. Anna said that the iPhone camera, when paired with the watch, could act as a viewfinder for the teacher to glimpse student activity without needing to move to another classroom zone (Figure 5).

Concluding Remarks

Our technology probe helped us describe multiple ways that wearables can support teachers with classroom orchestration. When we consider the ideas emerging from our use cases, and related non-wearable tools in

the literature, we can envision complex classroom ecologies consisting of different tools for classroom orchestration. One design implication is that designers need to think about how the tools in such ecologies should interact with each other in a synchronized fashion to support teachers, especially in view of ideas about minimalist design for orchestration [7]. Designers must also think about the role and limits of wearables. We saw how the smaller watch display limited the student information that teachers could view on the watch. However, the watch form factor also was useful "in the moment," and teachers preferred a wearable versus a mobile computer that they still had to hold and attend to.

Designers also need to consider issues around attention for teachers and students. Bakker [3] discusses the center and periphery of attention for technology tools. Classroom ecologies will increase the competition for attention and designers must address this from the perspective of teachers *and* students. Classroom orchestration can require information at the center of student and teacher attention, as seen in tools that sit in full view of teachers and students. But teachers in our study also discussed the need to sometimes act while remaining in the periphery of student attention. Thus we need to think about attention when designing for orchestration, specifically how and when to help different parties in the classroom context effectively shift between the center and periphery of attention.

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