Towards a Constructivist Pedagogy in the Ubicomp Classroom

Jochen Rick

Department of Computing

Open University

Walton Hall

Milton Keynes, MK7 6AA UK

j.rick@open.ac.uk

Paul Marshall

Department of Computing

Open University

Walton Hall

Milton Keynes, MK7 6AA UK

p.marshall@open.ac.uk

Abstract

One promise of ubiquitous computing (ubicomp) is that everyday environments will be augmented with digital technologies to enhance their effectiveness. As hardware matures and becomes more affordable, the possibility of a practical ubicomp classroom becomes increasingly attractive; however, the availability of high-quality pedagogically-sound software for this platform is likely to lag behind. In this paper, we outline some of the major challenges that need to be addressed for the ubicomp classroom to support a constructivist pedagogy.

Keywords

Ubicomp, classroom, interactive surfaces, pedagogy, constructivism

ACM Classification Keywords

H5.2. Information interfaces and presentation (e.g., HCI): User interfaces: Theory and methods.

General Terms

Design, human factors, standardization

The Ubicomp Classroom

In the article that launched the field of ubiquitous computing [13], Mark Weiser outlines a vision of

different-sized interactive displays. A ubicomp environment will contain many of these devices that can be seamlessly reconfigured to support a variety of tasks.

Recently, the hardware needed to fulfill this vision is becoming commercially available. Handheld devices, such as Apple's iPhone, support multi-touch interaction, automatic orientation detection, wireless connectivity, and video capture / augmentation. Large interactive surfaces, such as tabletops and whiteboards, increasingly support multi-touch interaction, object identification, and user-position detection. While larger interactive surfaces are still expensive and software availability limited, these barriers will fall as commercial systems become more available.

Given that this hardware platform will become affordable in the near-term future, it will not be too long before there is interest in developing ubicomp classrooms. A challenge for learning scientists is to ensure that the hardware can be used to encourage a constructivist pedagogy.

From Hardware to Software
Just providing the hardware platform does not ensure that it will be usable or sustainable. Technology-rich spaces intended for learning can fail because they are difficult to use and administrate [8]. If teachers and learners find them too difficult to use, the technology will be abandoned; the gain needs to significantly outweigh the effort. If too many resources, such as administrator time and repair costs, are required to maintain the space, it may be shut down, even if it is an effective learning environment.

To complicate matters, there is a tendency to simply appropriate new technology to further what Papert [9] terms *instructionism* (i.e., lecture, drill-and-practice), based and a transmission model of cognition. For instance, the eClass system, one of the first applications of ubiquitous computing to the classroom, primarily supported PowerPoint-based lectures and accessing lecture content post-hoc [1]. In evaluating the large-scale adoption of interactive whiteboards in the UK, the researchers found that electronic whiteboards can "reinforce a transmission style of whole class teaching in which the contents of the board multiply and go faster, whilst pupils are increasingly reduced to a largely spectator role" [7].

Research in the learning sciences has demonstrated the value of a more constructivist pedagogy (i.e., based on a cognitive model of learners actively constructing their own understanding). Such learning occurs particularly well in curriculums that encourage inquiry, exploration, and design [9]. While new technology can enable this kind of learning [3], it requires developing applications to take advantage of the new hardware.

Several projects have demonstrated the value of a constructivist approach to the ubicomp classroom. RoomQuake comprised a series of interconnected wall-mounted flat-panel computers and speakers, simulating earthquakes whose fault lines the children had to work out [5]. Students worked together using various physical and digital tools to find and mark the epicenter of the virtual quakes and their aftershocks. In WallCology, another project by the same group, wall displays simulate windows into the classroom wall, where simulated life forms live beneath. Classrooms of children collaborated to track the creatures and

understand what conditions allowed them to prosper [6]. Using Thinking Tags, small computational devices that can interact with each other, a class can simulate emergent behavior, such as the spread of a virus [2].

While these projects were successful, they rely on specific hardware and software applications with a limited scope. One of the challenges for creating software for the ubicomp classroom is creating applications that take advantage of a more general purpose computing ecology and / or supporting a larger number of tasks and learning goals. One example of research in this direction is Group Scribbles [12], a system by which drawn or textual objects can be moved easily between individual machines and a shared space projected at the front of the classroom.

Future Work

One of the potential benefits of a ubicomp classroom is the inclusion of existing *shareable technologies*, technologies that are meant to be used concurrently by multiple people [11]. Interactive tabletops are particularly compelling as their horizontal form factor makes it difficult to co-opt them for lecture. While some research has already addressed how these can encourage learning [4, 10], more is necessary to establish clear guidelines for designing applications to enable collaborative learning.

Another challenge is how these multiple devices can work in tandem as part of a larger system, such as the simulations mentioned above, or as part of an ecology of devices, where the appropriate device is used for the current activity. For instance, handheld devices would be suitable for taking into the field to gather field data. That data can then be taken to the classroom where

small groups analyze it using interactive tabletops. Later on, a presentation of the results can be given to the whole class using the interactive whiteboard.

Realizing such a vision requires two elements: First, the interfaces of the different devices must be similar enough so that switching from one to another does not require a steep learning curve. Second, the data must transition smoothly between devices. While it is a given that data can be transferred over wireless networks, a usable interface for transferring and accessing the data is still an open usability challenge. One possible solution would be to associate data with a specific user or a group that user belongs to. Thus, a student could identify himself to the whiteboard to gain easy access to the report that he helped prepare. For that to happen, the system needs to identify the student from biometric data (e.g., fingerprints) or other means of identification (e.g., an ID badge). Creating such a system and allowing it to be easily managed is an open challenge. For instance, would younger children be responsible enough to use a system based on ID cards?

When these two challenges (utilizing individual components, making it work as a system) are addressed, there are the further challenges of how software applications can be developed on a consumer scale, how that software can be delivered to individual classrooms with different hardware setups and gatekeepers with individual standards, and how teachers can be trained to utilize such applications. Considering how little time teachers have to prepare for teaching, it seems unreasonable to ask teachers to develop applications or content for these platforms. One model to consider is making applications available in a central repository, similar to the AppStore that

Apple uses to offer applications for the iPhone. Thus, researchers, open-source developers, and commercial developers could create a wide variety of software that teachers could adopt as they see fit.

Acknowledgements

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