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Beyond being there? Evaluating augmented digital records

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Abstract

Technological advances have made possible a new generation of digital *prosthetic memory* devices (or memory aids). Yet we currently know little about when, how and why these devices might be useful. We evaluated two novel *prosthetic memory* devices in naturalistic and controlled learning settings. Both devices provide controlled access to annotated *digital records* of lectures, potentially freeing students from taking detailed notes, allowing them to re-access lecture recordings whenever they choose. *Digital records* had benefits over traditional learning aids (e.g. handouts/personal notes): Students were more accurate in answering class quizzes using *digital records*, and spontaneous *digital records* usage outside lectures showed strategic access during important aspects of the course. Native speakers who used *digital records* performed better on coursework, and non-native language speakers used *digital records* extensively. Despite being a verbatim record, *digital records* did not substitute for attendance: students who had attended lectures performed better on quizzes and final coursework and few students listened to lectures from beginning to end. *Digital records* are thus a highly promising teaching tool, but *prosthetic memory* devices are best understood as working in synergy with current tools to aid human memory, rather than replacing it. We conclude by discussing potential theory and design implications.

Keywords: Memory; Prosthetic memory; Digital record; Speech browsing; Speech retrieval; Digital notes; Digital pictures; Empirical evaluation; Quantitative methods

1. Introduction

Human memory is fallible, and we all rely on various prosthetic devices (or memory aids) such as diaries, notebooks, sticky notes and calendars to remind us about things that we would otherwise forget. However, recent advances in storage, networking and sensor technologies have now made it possible to capture huge amounts of digital data relevant to our everyday lives. We can potentially record every experience we have, and every piece of information we touch. One potential benefit of these *digital records* is that they might address the limitations of fragile human organic memory. We use the term *organic memory* to refer to those occasions when people rely on what they can remember without the use of a memory prosthesis. This general term organic memory encompasses the use of more specific memory subsystems such as semantic, working or long-term memory.

Various 'Lifelogging' visions, have been proposed, starting with Bush's Memex (Bush, 1945) and including the influential MyLifeBits (Gemmell et al., 2006). These visions have led to the development of large numbers of proof-of-concept *digital record* demonstrators that are intended to support our fallible memories (Lamming and Flynn, 1994; Dumais et al., 2003; Dickie et al., 2004; Karger and Quan, 2004; Cutrell et al., 2006; Gemmell et al., 2006; Sellen et al., 2007). However, uptake of *digital records* has been slow, and few working applications have been deployed outside the laboratory. One challenge we address here is to find domains where there are strong memory requirements, where there are strong incentives to use *digital records*.

One domain of considerable promise for *digital records* is education, where there are high memory demands. In many pedagogic situations there is a need to master and reflect on

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complex novel information delivered verbally in real-time. Prior research has documented the cognitive problems that students experience in determining what is critical (and hence important to record) while simultaneously processing complex new information (Brown, 1987; Bransford et al., 1999).

Digital records might therefore be useful in freeing students from the pressures of 'not missing anything important', while trying to simultaneously comprehend novel ideas or contribute to class discussion (Brotherton and Abowd, 2004; Munteanu et al., 2008). *Digital records* also potentially allow students to be more self-directed during lectures, allowing more time for personal reflection about what they have just heard (Brown, 1987). The ability to re-access material after the lecture may also be of benefit to particular populations, e.g. non-native students who experience additional challenges of trying to master new material delivered in an unfamiliar language (Robertson et al., 2000). Furthermore, exploration of multimedia recording tools is timely, technologies such as MP3 players are now readily available, making it straightforward for students to re-listen to podcast recordings at their convenience, and many institutions are now actively experimenting with lecture recording for asynchronous learning (Hiltz and Goldman, 2005; Walker and Moore, 2005). Finally, multimedia access tools are mature, with well understood techniques developed for controlled access to complex multimedia recordings (Stifelman et al., 1993; Whittaker et al., 1994; Brotherton and Abowd, 2004; Munteanu et al., 2008).

Despite these arguments, the benefits of *digital records* in education have not yet been demonstrated. Although early studies (Brotherton and Abowd, 2004), found that *digital records* were well liked by students, there was no evidence that they led to measurable pedagogical benefits. There are also potential disadvantages to *digital record* deployment. *Digital records* may change students' learning strategies, making them less likely to attend classes, hence failing to benefit from social learning opportunities (Johnson, 1981; Hiltz and Goldman, 2005). Given these potential drawbacks, the increased deployment of these techniques make it crucial to establish whether *digital records* have direct pedagogical benefits (Hiltz and Goldman, 2005; Walker and Moore, 2005) and how they might be used most effectively in educational settings.

We therefore set out to test the benefits of *digital records* in an education setting. We developed two novel UIs that provided straightforward access to *digital records* of lectures, using student-generated handwritten or photo annotations (Figs. 1 and 2). We collected naturalistic data about *digital record* use from 98 students over the duration of a course, as well as more controlled data from 35 more students who used *digital records* to answer class quizzes. We addressed the following research questions:

Overall benefits: Will people make use of *digital records* in real-world settings? What are the main *advantages* of *digital records*? Do *digital records* help students to perform better on class assignments compared with more traditional instructional techniques such as

Fig. 1. Sony recorder device for capturing speech and end user photo annotations, along with PiccyWeb UI for retrieving speech using these annotations. Clicking on a photo annotation initiates playback of the speech recorded when that photo was taken.

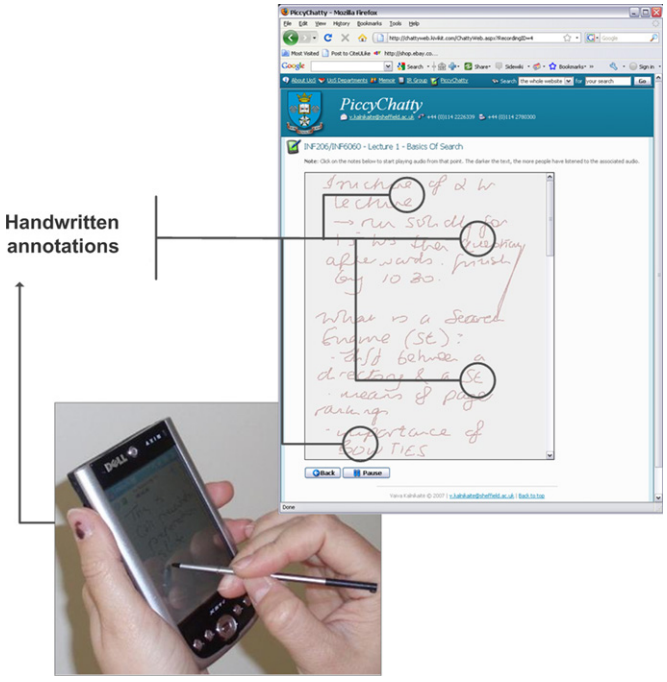

Fig. 2. ChittyChatty device for capturing speech and handwritten annotations, along with ChattyWeb UI for retrieving speech using annotations. Clicking on a digital note accesses the speech occurring when the note was taken.