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Class Time or Trip Time: A Case Study of the Use of Mobile Technologies for University Coursework in Highly Mobile Environments

Abstract

Students traveling with mobile devices while filling course work requirements face challenges related to both their class assignments and their personal needs, or Class Time and Trip Time. Device properties such as size and connectivity capabilities interact with environmental constraints in ways that affect the students' activities. Activity theory can be used to help determine the extent to which particular technologies fulfill the goal of enabling students to focus on their research and social activities rather than on the technology.

Introduction

Most of the studies of the many aspects of mobile computing and human computer interaction have involved participants using computing devices in controlled or specially-constructed and equipped environments or situations, for the sole purpose of answering the research questions posed in the studies. Though this gives the researcher more control over the independent variables and facilitates elimination of some confounds, it doesn't necessarily give a true picture of the challenges and issues encountered in everyday use of computing devices in real-world environments. This study does exactly that.

This is a case study of the EuroTour, an annual five-week trip for university students through ten major cities in eight European countries. During the trip at least two university courses are taught for credit. Every year there is a social geography course, taught by the professor who is the primary organizer of the trip. In addition, in each summer at least one additional university professor joins the trip and teaches a second course. The EuroTour has a history of more than twenty years, during which the geography course has been taught every year in much the same way as it is now, but without the aid of technology. The goals and primary assignments, data

collection and written reflections on experiences in each city, have remained essentially the same throughout this time. Technology in the form of handheld computing devices was introduced into the course in 2003 at the request of the geography professor, who was actively involved in the design of the data collection software used in his course. For all courses, professors rather than researchers have developed the use cases for technology in support of the learning objectives of their courses. In 2007, students completed surveys related to the use of the technology to meet class and personal objectives. In addition, both students and instructors participated in personal interviews with the researcher to round out the information obtained from the surveys. Because these are real university classes, the minimum number of participants needed for quantitative research cannot be guaranteed, and thus this research is more qualitative than quantitative. It is exploratory in nature because we have no extensive data from authentic instructional situations upon which we can base formal hypotheses.

It is not without theoretical basis, however. In particular, activity theory, first developed in Russia by Aleksey Leont'ev as an outgrowth of Russian social psychology of the 1920s and 1930s, provides a model for examining activities as part of their social context, and thus is relevant to a study of the EuroTour and analysis of the role of technology in it. The basic assumptions of activity theory are that any conscious human activity involves a subject in pursuit of an object, with the motive of turning that object into an outcome. The transformation from object to outcome involves a tool; tools can be tangible, such as a saw or a pencil or a computing device, or intangible, such as an idea or the facility of language. According to Leont'ev, activity is a process through which mutual transfers between the two poles of subject and object take place (Leont'ev 1978). Activity theory is concerned with the interactions between human beings and the world, with "activity" being the unit of analysis (Nardi 1998). Kaptelinin, Nardi, and Macaulay (Kaptelinin, Nardi et al. 1999) explain activity theory as a hierarchical concept with three levels: activity, action, and operation. Activity is that which is undertaken to fulfill a motive. Activities are made up of actions, which are goal-directed processes that are carried out as part of the activity in support of fulfilling the motive. At a lower level are operations, those processes that are carried

out without conscious effort as part of these actions. Kaptelinin et al maintain further that operations can become actions if something interrupts the normal process and causes a change in the object of the activity. This transition takes place many times in our everyday activities without our being aware of it. We pick up a camera to take a photograph, with the subject of the photograph being uppermost in our minds. The camera itself becomes the object of the activity only if it misfires or is too complicated to operate and becomes the focus of our attention. We use a telephone in an even more operational mode because of the frequency with which we engage in the activity of calling someone. The intended recipient of the message we wish to deliver is the object of that activity. The phone itself becomes the object when we cannot get a cellular signal or a dial tone, or when the phone malfunctions in some way.

Of particular interest in this study are the activities of students traveling with computing resources. Weiser (Weiser 1991) imagined a world where our computing resources would be imbedded naturally in our world. The world of ubiquitous computing is one where objects we use routinely enable us to interact with information, sometimes creating it, sometimes using it to guide immediate interactions with our surroundings, or sometimes absorbing the information to become part of later activity, actions, or operations. This is entirely consistent with activity theory. As Kaptelinin so aptly put it, “while traditional HCI models focus on abstract, formal representations of individual component parts of interaction (the user and the system), activity theory emphasizes the importance of studying the real-life use of technology as a part of unfolding human interaction with the world.” (Kaptelinin 2006, p 34) Thus the focus is squarely on the activity, with the technology assuming a background position as mediator, a supporting actor in the larger production of our interactions with our environment. It was the goal of this research to determine the role that the technology played as supporting actor in the students’ and instructors’ activities. Weiser’s vision and activity theory taken together form a new perspective for in-situ studies of human interaction with twenty-first century technologies. [nice statement]

The overarching research question for this study is how and to what extent the technology was fully integrated into the students' course-related and personal activities as the "supporting actor" rather than the object of the activity. Put another way, the issue is the extent to which the use of the technology made the shift from action to operation in the activity theory sense, so that the technology was simply a mediator, and the goal of the activity rather than the technology itself was the focus of the student's attention. Several facets of human-computer interaction and human-information interaction guide this exploration. Among them are mobility, information seeking in context, and device features and characteristics. These are explored in terms of their role in the activities of the EuroTour, not as isolated theoretical or technical concepts.

Research Method

Fifteen university students between the ages of 18 and 22 enrolled as credit-seeking students in the social geography and computer science courses that comprised the EuroTour in the summer of 2007. The two technologies of interest in this study are laptop computers and PocketPC phones. The laptops are university-issued and are equipped with a full range of software needed for academic and multimedia activities, including wifi, Bluetooth, and Infrared connection capabilities. Students use these throughout their university careers and are thus very familiar and comfortable with their use and operation well before taking part in the EuroTour.

The PocketPC® phones, referred to as Mobis, are university-issued and are equipped with a camera, slide-out keyboard, touch screen with handwriting recognition, and four modes of communication: wifi, Bluetooth, Infrared, and cellular. Software included the out-of-the-box Microsoft® software suite, Metro® software for finding public transportation schedules in many European countries, and DataInHand™ software, developed at Wake Forest University, for collecting data. Each student was issued a foldable keyboard that connected to the Mobi via Bluetooth. Students received this equipment at the end of the spring 2007 semester, approximately three weeks before the trip began, and were given a one-hour orientation to use of the equipment and the software. The cellular service was a pre-paid plan purchased through a European company that promised voice and text-messaging service in all countries on the

EuroTour, at rates less than the international calling plans offered by the US-based distributor of the device. This provided students with one phone number for the entire trip and enabled them (or their parents back home) to "top up" their accounts from anywhere using a web interface and credit card.

Five students were enrolled in only the geography course; nine students were enrolled in only the computer science course. One student was enrolled in both the geography and computer science courses that were being taught, and used both a Mobi and a laptop computer. Students in both classes were provided surveys to be completed at approximately one-week intervals during the trip. Questions were identical within each group from week to week with the exception of the final survey, which contained additional questions for the respective groups. The questions were very similar between groups, though not identical due to the different nature of the technologies they were using and the nature of their class assignments. The geography students had the five surveys pre-loaded on their Mobis; they completed each survey and beamed it via Infrared to their professor after leaving each city where a survey was due. The five surveys for the computer science students were emailed to them prior to the trip; they completed them using their laptops and emailed them to the researcher at the conclusion of the trip. In addition to the 15 students taking the courses for credit, there were 22 students who were auditing one or the other of the courses and took neither laptop nor Mobi with them. These students were not surveyed.

Seven of the ten computer science students completed and returned all five surveys, for a total of 35 laptop surveys; four of the six geography students completed and returned all five surveys, for a total of 20 Mobi surveys. A comparison of control numbers revealed that the student who was enrolled in both courses did not return any surveys. One of the 10 computer science students did not bring his laptop on the trip at all because it had stopped working correctly before he left home. During the trip he periodically borrowed a laptop from another student to complete his assignments. He completed all five surveys for this research, clearly indicating in his responses

that he had borrowed a computer to do so. For some questions, such as frequency of carrying his laptop with him during the day, his responses are irrelevant and are excluded from consideration. The researcher sent a request for personal interviews to all credit-seeking students and both professors at the end of the summer. Four of the six geography students and both professors volunteered for personal interviews, which were conducted at the beginning of the fall 2007 semester. None of the computer science students volunteered for interviews.

The assignments for each course played a major role in determining the activities undertaken by the students while on the trip. Students in both courses were required to choose a topic of interest to investigate during the course. Geography students were required to develop a survey instrument prior to the trip for interviewing citizens in each country on the chosen topic. Both geography and computer science students were required to visit sites relevant to their research topics, and to use the respective technology for their courses to write reflections on their experiences. In addition, computer science students visited sites of historical significance in the development of computing, and learned digital media and web skills necessary for maintaining a blog of their activities.

Results

The primary educational activity for EuroTour students was information seeking, with the ultimate goal being a completed research paper or project at the end of the summer. The bridge from the activity of information seeking to a completed paper must be built through a series of additional activities and actions that help transform found information into meaningful building blocks of knowledge. Kuhlthau describes the information search process as “the user’s constructive activity of finding meaning from information in order to extend his or her state of knowledge on a particular problem or topic” (Kuhlthau 1991, p. 361) Solomon expands this idea to that of discovering information in context (Solomon 2002). He contends that people discover information in the process of making sense of what they encounter, those things with which they come into contact either purposefully or serendipitously. This is a much broader concept than that of information seeking as confined to intentional bibliographic or Internet searching. It extends the

process of information seeking in two ways: (1) by moving information seeking into the world rather than restricting it to interaction with either paper sources or computing devices and their underlying information systems, and (2) by recognizing the potential value of serendipitous discovery of information. Erdelez refers to this as *information encountering*, and likens it more to "gathering of information" than "hunting for information", as the term *information seeking* implies (Erdelez 1999).

EuroTour students were constantly surrounded by sources of information in their environment as they traveled and explored. Topics for their individual research projects were by design related to political, aesthetic, social, historical, or technological aspects of the culture in each country; students were urged to explore each city independently of the professors and to experience its culture fully. Thus opportunities abounded for serendipitous discovery of information. Capturing discovered information at the point of experience was an activity for which their technology might play a supporting role. To begin developing an understanding of whether their technologies served them in this way, both groups were asked in every week's survey whether they carried their assigned technology with them only when traveling between cities, a few times when visiting sites within a city, most of the time when visiting sites within a city, or always. Results were as follows:

	Only when traveling	A few times	Most of the time	always	NA
Computer Science (laptops) N=35	29 (83%)	1	0	0	5
Geography (Mobis) N=20	0	5 (25%)	10 (50%)	5 (25%)	0

Figure 1

The "NA" responses on 5 surveys were from the computer science student who did not bring his laptop on the trip at all.

Note that only once did a computer science student carry his laptop along while visiting within a city; this response came on the first survey, in the first week of the trip. These are not necessarily surprising results, but they bear out the conjecture that the Mobi was much more likely to be

available for capturing discovered information than was the laptop. This naturally brought up the question of whether there was borrowing of technology between the two groups. In anticipation of this question, all students were asked on every survey whether they had borrowed the other group's technology during that week. Figure 2 shows the results.

	Number of reports	% of total surveys
Computer science student reports borrowing Mobi (N=35)	14	40%
Geography student reports borrowing laptop (N=20)	3	15%

Figure 2

The student whose laptop had been left at home did not report borrowing a Mobi.

Figure 2 shows that in 15% of geography surveys, students acknowledged borrowing a laptop during that survey week, whereas in 40% of surveys, computer science students acknowledged borrowing a Mobi that week. In response to a subsequent question, students gave their reasons for borrowing the other group's technology. These are summarized in Figures 3 and 4.

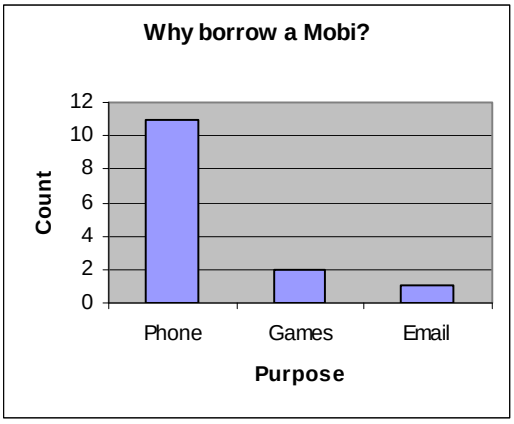

Figure 3

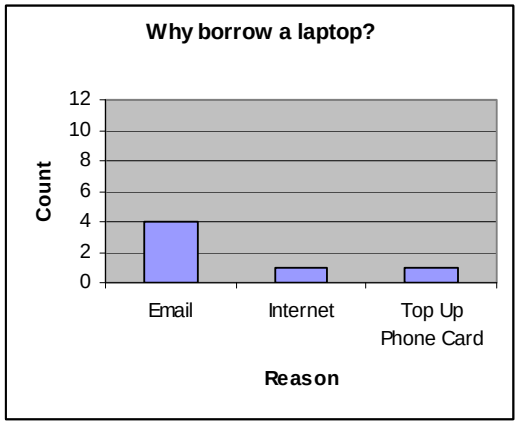

Figure 4

Borrowing a Mobi to use the phone requires no explanation. The other borrowings might. Both Mobis and laptops were equipped with wifi connectivity and thus capable of email and Internet access when a hotspot could be found. However, the wifi radios in the laptops were much stronger than those in the Mobis, and in many places where the laptops could connect successfully, the Mobis could not. This explains why a Mobi student would borrow a laptop for

email. But why would a laptop student borrow a Mobi for email or playing games? The reason may lie at least partly in Figure 1, which shows that geography students had their Mobis with them almost 75% of the time, while laptops spent most of their time locked away in students' hotel rooms. Thus the Mobi was available for use when the laptop was not. Further, the Mobi can be turned on and ready to use within seconds, whereas the laptop takes several minutes to open and boot up, and requires a lap or a flat surface for use. The Mobi has no such spatial requirements, and might be the logical choice for a quick round of gaming or for email on-the-go. One student even remarked about the Mobi, "The email function was cumbersome. Nevertheless I always had it on."

These data indicate that despite the availability of the Mobi, in particular, for capturing discovered information, this was clearly not a driver for borrowing one from another student. Whether students used their technologies for capturing serendipitously-discovered information at all can best be examined by looking at the purposes for which students reported using the Mobi from week to week. Among their choices were phone, text-messaging, reflections, searching, reading, interviews, camera, note-taking, and recording. The last four of these could be considered as functions that would support discovery of information; the interview function is included because interviews were random and impromptu rather than pre-arranged. Reported usage is shown in Figure 5

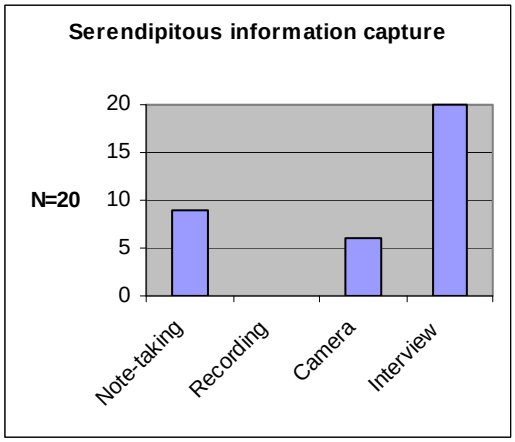

Figure 5

Note that all 20 surveys reported using the Mobi for interviewing people they encountered in different countries. Responses to a follow-up question on the survey revealed that students typed interviewee's comments as they spoke, or simply handed the Mobi to the interviewees to answer the questions themselves using the DataInHand™ software. No one used the voice-recording feature, though one student commented that he wanted to use it but couldn't remember how. In nine surveys students reported using the Notes feature, and in some cases commented on that feature in the free-text comment areas provided:

> "used Notes section to write down notes from my site visit"
>
> "random notes to myself"
>
> "having a digital notepad [was an advantage]"

Because the Mobi included a camera, geography students would have been able to capture pictorial information, but they generally preferred to use their own cameras rather than the lower-quality camera on the Mobi. However, the Mobi did fill the anticipated role of supporting actor when students had left their own digital cameras behind. In the group interview after the trip, one student remarked, "If I'd had to take pictures for my project, I would have used it because I always had it with me, and I didn't always have my camera with me. You only want to carry so many things. There wasn't anything relevant to my project that I could take pictures of." Other students agreed with his statement.

Thus there is some evidence that the Mobi did serve as a tool for students in the activity of turning unscheduled experiences and information encountered in the environment into data required for fulfilling their research goals.

Mobility:

One of the underlying differences between the geography students' and the computer science students' opportunities for information discovery was mobility during use of their assigned technology. Mobility has been defined and studied from many different standpoints, and each has its implications for activities involving people and technologies. The relevant issue for mobility during use is the portability of the computing devices themselves. We have just seen that

Mobis were a more highly portable device for the EuroTour students than were the laptops, and thus more suitable for the interviewing activity required of the geography students.

Computer science students were mobile in another sense, along with the geography students. They moved to a new city every few days, a situation that Kleinrock refers to as “nomadic computing” (Kleinrock 1995). Perry and colleagues (Perry, O'Hara et al. 2001) conducted research with professionals in this nomadic computing situation. They point out the uncertainty of the mobile environment, where access to computing support and communications infrastructures are contextual constraints. Kleinrock contends that computer communications capabilities are a requirement for supporting nomadic computing. Laporta, Sabnani, and Gitlin (1996) outline wired and wireless connection possibilities in great detail and comment on the difficulties that might await mobile device users because of intermittent coverage while traveling. This was certainly the case for EuroTour students, who are accustomed to pervasive network connectivity while on their university campus. For geography students with Mobis, the importance of connectivity and the frequent lack of it are evident in their use of the free-form comments in their surveys. Each survey included five different areas for free-text comment, and complaints about wifi connectivity were found at least once in all five areas for the geography students. No other single topic made its way into every comment area. One student summed it up by saying simply “It’s pretty pointless without wifi”. The problem stemmed partly from the Mobi’s relatively weak Wifi radio, and partly from the lack of infrastructure as described by Laporta et al.

Writing almost ten years later than Kleinrock and Laporta, Keshav (Keshav 2005) argues that this connectivity need will be met in the future by cellular rather than Wifi technologies. Though geography students made heavy use of the Mobi’s cellular capabilities for phone calls and text messaging, they were unable to use the cellular network for data connectivity. The OneRoam® cellular card did not provide data service and thus did not fulfill their need for Internet connectivity. In a group interview after the trip ended, geography students reiterated the need for Internet connectivity when mobile, as seen in the following comment:

> "Internet access would have made it easier. That would have made the course so much better. Having the [survey] form on the device makes the whole thing much less cumbersome. We just had to use Internet cafes to go look up things like where's a university you can visit a professor. It just took more time out of the trip. You're trying so hard to balance trip time with class time. The more things you could have done on the device would have saved so much time and money, actually. The data plan would have helped so much."

This infrastructure issue affected computer science students with their laptops to a much lesser extent because, as we have seen, most of their work was done in their hotels, and there was often Wifi connectivity in the lobby. In fact, as shown in Figure 6, this connectivity was second only to "assignments" for computer science students when asked to list the advantages of having the laptop.

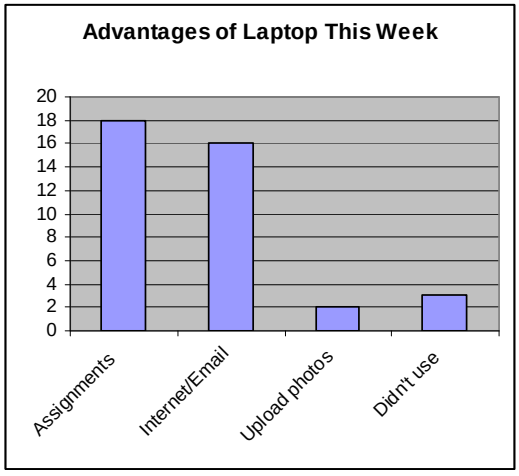

Figure 6

In their final surveys, however, computer science students pointed out that Internet cafes are abundant in Europe, and though most were glad they had their laptops, they stopped short of endorsing the idea of using a laptop for EuroTour. This was clear in their survey responses when asked what advice they would give to future EuroTour students about taking their laptops along:

> "I would say not to bring it if it can be avoided. In cities where there was internet, it was useful to have but internet cafes are everywhere in Europe, so It wasn't even necessary for basic communication. It was also useful to store photos which prevented me from buying a larger memory card."

> "Depends on how dependent you are on Internet connection. It wasn't that big a deal, just a pain on travel days to carry it around."
>
> "I would say that it is nice to have but not essential."
>
> "Buy a laptop case to protect it if you do not have one, and make sure you charge your battery before the train rides."

This last comment seems to indicate that there were infrastructure issues related to power supply as well as Internet connectivity. Thus the advantage of better Wifi connectivity for the laptop might have been counterbalanced by the advantage of better battery life for the Mobi.

Device Physical Characteristics

Wifi radios and battery life were not the only physical characteristics of the EuroTour students' technologies that affected their experiences. Most computer science students complained week after week about the difficulty of traveling with their laptops, which featured 15-inch screens and weighed more than six pounds. Both the hassle of carrying the laptop and the fear of losing or breaking it were concerns, as shown in Figure 7. One student's laptop did break approximately three weeks into the trip.

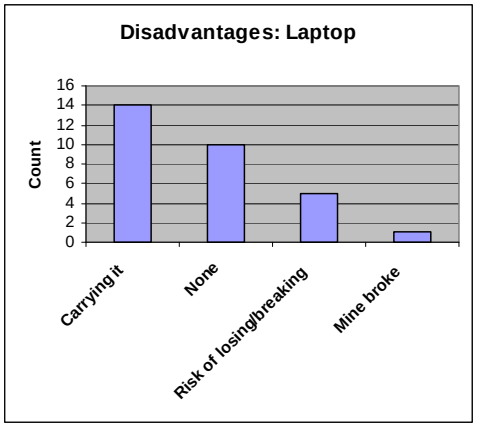

Figure 7

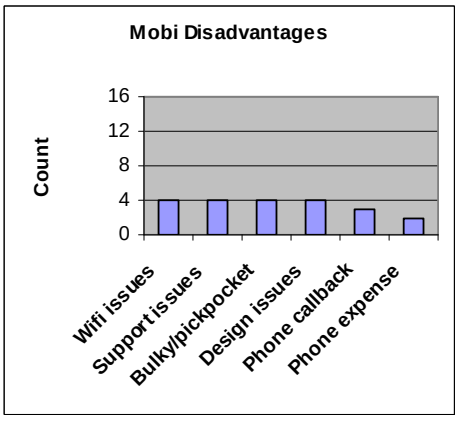

Figure 8

Interestingly, four Mobi surveys also included some complaints about the size of that device (roughly 4.4 x 2.3 x .75 inches). "Huge in your pocket" was the way one student described it. In personal interviews after the trip ended, it became clear that students had been so thoroughly warned about pickpockets in Europe that they were overly concerned about the potential visibility

of the Mobi when in their pockets. "It was a huge anxiety, probably not a huge problem," admitted one student. In the end, no student lost a Mobi to a pickpocket.

There were no comments on the laptop's physical characteristics other than size. Students are accustomed to their laptops and interacting with them to accomplish their academic tasks while in the United States, and this apparently carried over into the trip. Perhaps more surprisingly, there were few complaints about the Mobi's physical characteristics. The device's size is more than a portability consideration; it is obviously a primary constraint in determining strategies for interacting with it. Historically, input and output on handheld mobile devices have been characterized as difficult. Remembering that activities required of geography students included collecting interview data on the Mobi and writing short essays, we might have expected these students to complain about data entry. All respondents reported in their surveys that they used the slide-out keyboard for typing interview responses. One student reported also using the Notes feature of writing directly on the screen. Neither entering data nor typing essays was listed in any survey response as a disadvantage or a difficulty, and no student mentioned data entry in follow-up interviews. One participant listed "made surveys easy" as an advantage of the Mobi, and another listed "convenient for texting". All of these facts taken together indicate that the Mobi's data entry affordances met the needs of this group of students. When compared to the challenges of typing text messages on a typical 9-key cellular phone pad, the Mobi's full keyboard probably offered more rather than less functionality than students were accustomed to.

Similarly, output on mobile devices has traditionally been viewed as problematic because of the small screen. Buchanan et al (Buchanan, Farrant et al. 2001), Paelke et al (Paelke, Reimann et al. 2003), Karkkainen and Larrni (Karkkainen and Laarni 2002), and many other researchers have written on the difficulties and possible solutions for this problem. One EuroTour student complained in back-to-back surveys that the Mobi "opens undesired Windows". This is a direct comment on the touch-screen's sensitivity and is a design issue that device engineers are beginning to pay attention to. It is not, however, a comment on screen size, which has been the focus of most research on mobile device output. Examining how students felt about the small

screen begins with their survey responses to questions related to output. In each survey, students were asked to select the activities for which they had used the Mobi in the previous week. “Reading” was one of the choices, and not one student indicated that reading had been an activity. Though it is true that they did not have reading assignments on the Mobi, interacting with the Mobi on a daily basis required at least casual reading of information on its relatively small screen. The fact that no one considered this activity as “reading” indicates that it was a function students performed almost without thought, an operation in the Activity Theory sense. Similarly, there were no comments at all regarding the Mobi’s screen; the geography professor confirmed that he neither observed any difficulties nor heard complaints from students about screen size. He noted that the Mobi screen is larger than most students’ cellular phone screens, and the same size as their digital camera screens. He went on to say that he himself had no problems reading the screen, using reading glasses he normally uses for reading printed material. Students volunteered additional relevant information in the group interviews at the end of the trip in saying that they would have liked to have more of their reference material on the Mobi because they didn’t carry paper reference material with them but “always had the Mobi”. A strong indicator that reading on the small screen was not a hurdle was the interview group’s consensus that they would also have liked to have their assigned readings on the Mobi to eliminate dealing with paper. Thus the absence of “reading” as an activity in the survey responses was due to lack of opportunity rather than an aversion to reading on small screens. This may be an indication that today’s college students are so acclimated to small screens from years of using cellular phones and handheld gaming devices that this traditional HCI concern is of little importance to them.

The physical characteristic that was the real differentiator on the Mobi was of course the inclusion of cellular capability for voice and text messaging communications. As seen previously in Figure 3, the phone was the feature for which computer science students most often borrowed Mobis from geography students. Figure 9 shows that students considered communication far and away the biggest advantage of the Mobi.

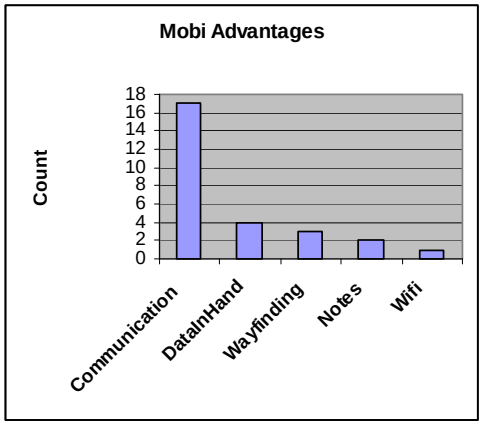

Figure 9

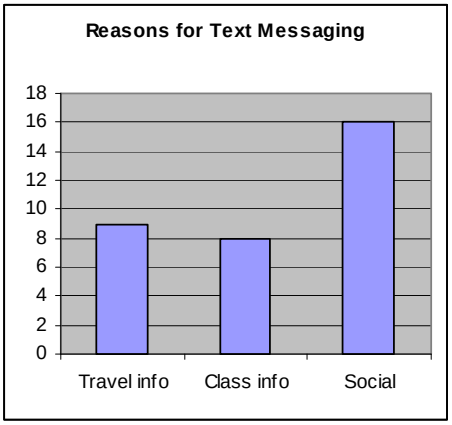

Figure 10

Furthermore, survey results show (Figure 10) that the reason for text messages was most often social rather than class- or trip-related. These facts taken together indicate that the Mobi played a major role in supporting students' social and personal lives during the trip. As was seen in Figure 8, the phone functionality also showed up in surveys three times as a disadvantage of the Mobi. These were objections to the service provided by the OneRoam® cellular card, which did not place calls directly. Students dialed a number and waited for a callback before connections were made, and they considered this cumbersome.

Discussion

The two technologies used in the EuroTour succeeded to different degrees and in different ways in disappearing into the supporting actor role in students' activities, becoming a transparent tool for students rather than an object of their attention. The division between tool and object occurred along the lines of what students themselves referred to as "trip time" versus "class time", a distinction that was made in a number of comments from students. The geography professor agreed completely that this distinction existed in saying, "They viewed the EuroTour as a European vacation during which their parents made them take a course."

The delineation between tool and object was most clearly exhibited for computer science students. During times that were devoted solely to their course work, the laptop played its role very well; it was a familiar tool that students knew how to use to achieve their academic objectives. Its importance to students was clearly in completion of assignments, an activity that

took place primarily in their hotel rooms or lobbies, where Internet access was available for posting to their assigned blogs. Class discussions and instruction on use of multimedia tools took place in these same locations, and were such an operational part of the students' experience that none of them made mention of these activities in their survey comments. These activities, and the role of the laptop in supporting them, were simply part of the larger activity of Class Time, as they would have been if students had been on campus. Trip Time, however, was another matter. Computer science students had a single and very strong complaint about their laptops. The laptop's size rendered it a burden rather than a benefit on travel days, and dictated that it spend its Trip Time locked away in a hotel room rather than accompanying the student. The lone student who tried carrying his laptop around during the first week of the trip quickly abandoned that strategy. Although the laptop met the students' social need for email communication, an activity they completed in association with Class Time in hotel lobbies with Internet connectivity, they readily pointed out the abundance of Internet cafes in Europe that could have filled this same need, and in fact did so during Trip Time. Their further social need for voice and text messaging communication was satisfied either through borrowing a Mobi from a geography student or using a personal cellular phone brought from home. No computer science student made mention of taking notes about their experiences during Trip Time, an activity that would have supported the concept of information discovery in context. It can be assumed that capturing information at the point of experience was not supported by the computer science students' technology. The laptop was a transparent tool rather than an object during Class Time, but an object rather than a tool during Trip Time, reinforcing rather than mitigating the division between Class Time and Trip Time.

The Mobi made a better transition between Class Time and Trip Time. Contrary to what one might expect, the Mobi served quite well as a tool for meeting the students' academic objectives. Neither the input methods nor the screen size was a hindrance for students in completing their assignments. Furthermore, the Mobi was a carry-along technology that supported information discovery in context, enabling students to turn experiences into information at the point of

occurrence. This was exhibited in the activities of interviewing subjects encountered in each city, and taking notes during site visits or other experiences. The Mobi's portability made it a tool that enabled easy switching between and intermixing of Class Time and Trip Time, as students easily collected data during the course of their touring activities. The awareness of the Mobi as object emerged when it failed to enable them to meet their objectives. One such instance was when attempting to find their way to destinations they had targeted for site visits. Though students successfully used the Metro® program, which requires no Internet connectivity, for finding public transportation, the difficulty of connecting to the Internet prevented on-the-fly use of the Mobi for wayfinding in general. This is illustrated in the following comments by students:

> "If there had been Google maps, it would have been so helpful, especially when you're out looking. If I'd been able to pull up the places I needed to go for site visits on Google maps it would have just made everything so much easier. You're out off the beaten track. Sometimes I just gave the address to a cab driver and let him take me, which was good because I got there quickly, but was bad because I knew sometimes they were blatantly overcharging me or taking me the long way around."
>
> "You spent an extra hour or so looking for a place. It really took away from the trip time to have to spend so much time trying to find your way around."

The fact that students had effortlessly connected to the Internet in such situations during their short experience with the Mobi while on campus had rendered connecting to the Internet an operation in that environment, rather than an activity that required attention and conscious effort. This was not the case in the environment of the EuroTour, where connecting to the Internet became an activity in itself, requiring focused effort and, to make matters worse, most often resulting in failure. At those times, which transcended the division between Class Time and Trip Time, attention was focused on the Mobi rather than the desired academic or social goal.

Wiredu pointed out that deriving personal support from the personal computing device is sometimes as important to the user as is the support for the sanctioned activity. (Wiredu 2006) This was the case with the Mobi. Its cellular capabilities were highly valued during Trip Time for meeting students' social needs for communication, as evidenced by the importance they placed on the phone and text-messaging capabilities. There were some complaints about the

OneRoam® service, whose call-back methodology turn the normally operational activity of placing a voice call into a conscious action. However this was counter-balanced by the fact that the Mobi's full keyboard reduced the effort and attention-to-object required for sending text messages. Other potential Trip Time capabilities of the Mobi were under-utilized, as few students used its camera, and reference materials such as tips for ordering in restaurants, approximate exchange rates for the different currencies encountered during the trip, and common phrases in various languages were handed out on paper rather than included on the Mobi. These elicited the following comments from students:

> "Maybe if [the professor] could just put the sheets on the Mobi instead because you have the Mobi with you and you don't have the sheets with you."
>
> 'I got the 'bluesheet' itinerary beamed to me [by the professor] and I used that constantly."
>
> "The sheets he hands out in general should be there. Like should you tip in this restaurant."
>
> "If there was a simple currency exchange program, a lot of us felt like we were just getting had in a couple of cities. If you could just pull that out at a restaurant table and figure out when the check comes, or when you're looking at the prices of something you want to buy"

Nevertheless, through its go-everywhere characteristics, the Mobi mitigated the division between Class Time and Trip Time rather than reinforcing it. It offered avenues for meeting the geography professor's stated objective for students to "take responsibility for your own learning and develop the initiative to learn from your surroundings." (Evans 2007)

Answering the research question of the extent to which the technology played a supporting role rather than becoming the object of attention requires consideration of the comments of the EuroTour participants in addition to the indicators revealed by surveys and interviews. Computer science students reflected on the laptop's role in their 5-week experience by offering the following comments in the final survey:

> "It was definitely vital for my Computer Science Class, but it did not contribute to the vacation aspect of the trip."

> "I'm glad I had it, helped me stay connected to people in the US and aided in my research. It would have been nice if all the hotels had Internet."
>
> "I really did enjoy having my computer with me. It was convenient, made communication easier, and was nice to use as storage for my pictures, videos, and blog…the biggest disadvantage of having the computer was having it lost or stolen. Unfortunately, my computer did break about 3 weeks into the trip. I have no idea if this was related to traveling, or if it was simply a coincidence."

These statements support the contention that the laptop did "disappear" into a supporting role for Class Time, but not for Trip Time for computer science students. To get similar feedback from the geography students, they were asked in their final survey to imagine their EuroTour experience using a laptop rather than the Mobi. Some representative comments included the following:

> "I would have hated to have a laptop just based on the Mobi's capabilities for research and its size in comparison."
>
> "I would not have wanted a computer. I had no use for one and it would take up too much space."
>
> "Not much different other than having another valuable to worry about. Probably would have been a little more worried during the trip."

These statements can be interpreted as indirect comments on the effectiveness of the Mobi in playing the same supporting role that the laptop would have played, but with less hassle. A similar comparison between the Mobi and using a paper-based approach yielded the following responses:

> "I would have spent a cumbersome amount of time on data collection logistics rather than just being able to focus on getting the data and site visits."
>
> "The beauty of the Mobi was its convenience and it did not take up much space."
>
> "It was easy doing the surveys on the Mobi because you could basically take it with you anywhere…If everything were on paper I could imagine there may have been some missed surveys since I would not be inclined to always carry paper surveys with me. I also think the Mobi seemed somewhat professional and did not raise suspicion among those being interviewed."

These comments support the contention that the Mobi generally performed in a supporting-actor role, enabling students to focus on their research objectives. The exception was a positive note in the last comment that the Mobi-as-object was an advantage in securing interviews with strangers in foreign countries.

Conclusions

Neither the laptop nor the handheld mobile device was flawless in disappearing into a supporting role for students. Both served students well in their Class Time activities and less well in their Trip Time activities, though the Mobi made the transition more easily between Class Time and Trip Time. The experiences of these fifteen students cannot necessarily be generalized, even to the population of college students, because their experiences were somewhat specific to their course requirements. However, they do point out some potential trends and areas for further research. It appears that the inverse relationship between degree of mobility and the degree of connectivity noted by researchers in the 1990s persists in 2007. Both growth in infrastructure to support connectedness while mobile, and improvements in engineering of mobile devices themselves will be needed to change this relationship and close the gap between connectivity and mobility. Cellular communications are beginning to address the connectivity need, but data plans that support international connectivity at a cost that American college students consider reasonable are not yet available. It is certainly possible that the students' perception of "reasonable cost" rather than the costs themselves need to be adjusted. A comparison of business models, features, and price expectations among American students and those in other countries could help answer this question. Another question raised by this study is whether in fact attitudes toward reading course materials on handheld devices such as PDA phones have changed. These students indicated a willingness to read course materials on their Mobis; following up with empirical research studies could provide information on whether reading on small screens is accepted as routine for students who have grown up with digital technologies. Perhaps most important, there was no attempt in this study to address the pedagogical questions surrounding the use of the technologies to support the professors' learning objectives for their students. It seems reasonable to asset that the support for meeting learning goals increases with

the transparency of the technology. Activity theory as well as other theories from cognitive science could form the theoretical foundations for a study of this assertion.

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