MOTEL: Designing a virtual geo-tagging framework for use in higher education

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Abstract

Higher Education students are highly mobile; they move between learning venues such as lecture halls, the field, labs, home, and excursions. In order to understand how students used technology to support them in their different learning venues, we carried out ethnographic flavored field studies where we followed biology students and faculty in their learning/research activities at the University of Bergen, Norway. We identified both a need for support in their activities and for data transfer between various learning venues. Based on these studies, we have designed MOTEL, a framework for a virtual geo-tagging. This paper discusses our views on mobile learning, describes our field studies and the resulting design decisions, and introduces the MOTEL framework.

Designing a virtual geo-tagging framework for use in higher education

> "The value may not be immediately apparent. But 10 years from now, nobody who's geotagging their photos is going to regret it" Flickr CEO Stewart Butterfield

Tools we use affect the way we conduct our lives. In particular, the development of, and innovations in digital technologies has led to profound changes in society. Säljö (2002) writes about how new technologies have changed the conditions for work, learning and communication in the 21st Century. Today, people are not only equipped with technologies that are more powerful and feature-rich than ever, but also the social transformations are perhaps even more compelling. The current digital technologies of our time influence the way we think, even the 'metaphors we use' (Lakoff & Johnson, 1980) including our complete social organization. As Bolter argues, information and communication technology is the "defining technology" of our time (Bolter, 1984, p. 11). Digital technologies are shaping how we communicate (e.g., using mobile phones, Instant Messaging, advanced groupware systems), how we retrieve and look up information (using web browsers, and SMS-services such as 'TLF 1985'), produce content (e.g., take images with digital cameras), how we utilise on-line services to share what we produce in social networks (e.g., photography communities such as bildegalleriet[1] in Norway), the way we engage in joint efforts and contribute (e.g., Wikipedia), and how we chose to express ourselves (e.g., artists using weblogs). It is important to notice, however, the influence works both ways; humans are also shaping technology through use. They appropriate the technology, customize, and add features through co-construction enabled by new and more powerful tools (e.g., social software such as MySpace.com).

The educational sphere is by no way unaffected. An increasing number of students come to school with new digital skills and experiences. As they only spend 14% of their time in formal educational settings, the digital experience they gain as a natural part of their lives has a strong impact on their identity and how they express themselves. For example, they develop these skills by being part of: 'smartmobs' (Rheingold, 2003); through coordinated or ad-hoc collective actions enabled by pervasive technologies; by participating (even lurking) in online communities such as IRC (Internet Relay Chat) networks, gaming communities or web forums; or, by customizing their weblog or editing a movie for online publishing on a video sharing sites such as YouTube. Through these forms of participation, production and self-expression they gain new forms of digital literacy. It is not just the youth who are developing these skills, adults are also appropriating this new technology-professors are sharing their material online, podcasting lectures, writing weblogs and grandmothers are having video calls with their grandchildren. Few seem to be unaffected by the digital 'revolution'.

Mobile technologies have become part of our daily lives through personal use of advanced digital devices for learning, work, communication, recreation and entertainment. Mobile phones, digital personal assistants, portable media players[2], digital entertainment gadgets (e.g., the Tamagotchi[3]) and game consoles[4] are all devices that blend transparently into our lives and, for the youth of today, are hardly thought of as technologies anymore-—they are just a 'mobile' or a 'game station'. As youth are becoming more accustomed to using a plethora of devices, using more complex functions such as mobile blogging or posting images to online sharing communities, one question is if it is possible to take advantage of these digital skills in education settings.

Baggetun (2006) is investigating how mobile technologies can enhance and support learning and research activities in higher education. While earlier ways of thinking about mobile learning were to deliver content to smaller devices to support 'anywhere -anyplace' mode learning (e.g., Rekkedal et al, 2005), the focus here is on developing tools and mechanisms in such a way that students can go from being consumers of ready made material to producers of content in collaboration. In order to understand how students used technology, we carried out ethnographic flavored field studies where we followed biology students and faculty in their learning/research activities at the University of Bergen, Norway. We identified both a need for support in their activities and for data transfer between various learning venues. Based on these studies, we designed and implemented MOTEL, an application and a framework for a virtual mobile geo-tagging.

The paper begins with a look at mobile learning research. Then we describe our field studies and present MOTEL. The paper concludes with a discussion about what mobile learning means in the context of our work.

Enhancing learning using mobile devices

One of the first to promote ideas of using a portable and personal computer as a tool for learning was Allen Kay (1972). Kay provided researchers of the time, a vision about a portable computing device (or "portable information manipulator" as he chose to call these devices), named the DynaBook, for use for learning. Kay did not claim that computers were necessary for children in order to learn, but that computers can provide children (and adults) with a better and more flexible tool. He also elaborated that the pedagogical merits of a personal computing device was undeniable—an idea even more heavily supported today through the One Laptop per Child project initiative (http://laptop.org).

In recent years there has been a focus on enhancing learning by means of digital mobile devices. This field is referred to as mLearning (short for mobile learning). The research is versatile and various approaches are taken. First and foremost the research concerns how portable devices such as ultra portables, tablets, PDA's, etc. can support learning. Approaches may, however, include fixed devices such as large shared/information displays and other infrastructure that connect the mobile use to other resources. Mobile learning can be seen to be both orchestrated and serendipitous. The type and role of technology typically varies with context of use (e.g., primary schools, higher education, museums).

While there are some that believe that mLearning´s main advantage is that learning is accessible for students independent of time and place (anywhere - anytime learning learning), other projects go beyond this initial idea. This section describes some of these promising/innovative ways to use mobile technologies in learning activities.

Participatory simulations. One innovative example of utilizing mobile technologies in education is through participatory simulations where small handheld devices are used to 'play' out an augmented reality simulation in a class. Studies such as Colella (1998) have shown that such participatory simulations motivated participants to take part in the simulation and subject matter, enabled shared task solving, provided a substrate for collaboratively designing and running experiments, and led to a new language to talk about the mechanisms to be learned in the simulation play. On the other hand Wilensky & Stroup (1999) focused on employing participatory simulations as a way of fostering the understanding of dynamic systems. A field they see as a new kind of literacy. It is also interesting to see that these researchers try to utilize and create game play in their settings in order to engage their students (e.g., Klopfer, Squire, & Jenkins, 2002).

Probeware in science education. Another area of use of mobile technology in education is the use of probes/sensors in science education. These projects are using probes attached to mobile devices in order to investigate real, often immediate (Bannasch & Tinker, 2002), natural phenomenon such as temperature, light, and acidity. Others are designing specific field trips where probes are used together with supporting infrastructure constituting complete intelligent environments (for example, see Ambient Wood, Rogers et al., 2004). The small form factor of these devices supports social interaction more easily, and the increased computing performance enables data from the probes to be processed in a way not possible before. This provides the learners with new representations, such as powerful visualizations, suitable for learning about the topic under scrutiny. These small portable devices and probes enable students and researchers to bring tools, and even complete activities that were traditionally only available in the lab, into the field.

As mini computers. Sometimes mLearning is looked upon as a pure extension of elearning where mobile devices are viewed as supporting "everywhere and anywhere learning". Research is focused on how existing learning objects, learning content, and exercises can be adapted to fit on small devices with limited resources (e.g., Rekkedal et al., 2005). Further, there are efforts to make industry standards for mobile learning. In this approach one try to overcome the fact that most mobile computing devices are inferior compared to desktop computers with regard to size of display, processing power, battery etc.

There is growing interest from commercial companies in producing both content and applications that are adapted to fit on small devices. For example, Avantgo[5] is a commercial service delivers special formatted content to small screen devices. Another example is the porting of desktop applications to mobile devices. The Inspiration mind mapping tool is such an example (see http://www.inspiration.com/productinfo/handhelds/index.cfm).

Guides. Another active area of research and development is the use of mobile devices as digital guides for use in museums (also exploratoriums) and by tourists walking around at a site. The promise is in using mobile technology to enhance the museum experience for the visitor by extending the visit with before and after visit activities. By adding a learning dimension to the guide, it becomes a tool for both exploration and reflection. Research questions often ask about how these technologies affect the engagement of the visitors with the exhibit, and how they coordinate and navigate between the augmented virtual exhibit and the real exhibit (Spasojevic & Kindberg, 2001).

Coordinated joint efforts. There is also an area of research where researchers have been orchestrating in detail collaborative activities by the use of mobile devices. In these instances, mobile devices are usually seen to be better suited for facilitating collaborative learning by supporting the close social interaction necessary to coordinate collaborative tasks (e.g., Zurita & Nussbaum, 2004). For many of these projects detailed analysis of the interaction afforded by small devices have resulted in the design of applications and activities that take advantage of the affordances of using small mobile devices in collaborate face-to-face interactions.

Geo/location systems. An area increasingly receiving attention is the utilization of location technology as an element in mobile learning systems. Simultaneous to the radical improvements in small mobile computing devices, there has been progress and important developments in location technology that has laid the foundations for using this technology as a part of mLearning. One important event was in 2000 when GPS selective availability[6] was turned off by the Clinton administration[7]. This meant that all, not only the US Department of Defense, would have access to much more accurate positioning data for free. One popular early use of GPS was the adoption of geocaching in science and math learning, or the variant ecocaching where the emphasis is on exploring natural or cultural spots in the field. In ecocaching the spot itself is the cache (e.g., a particular botanical species in the field). Other projects are focusing on using location technology to automatically input location data and create contextual adaptive applications and data for field workers (e.g., Pascoe, Ryan & Morse 2000). One larger research effort is the GIPSY project, now continued as the Manolo project (Wentzel, van Lammeren, Molendijk, de Bruin, & Wagtendonk,. 2005), which uses a commercial GIS application adapted for use on small mobile devices. Using GPS technology the students can use the handheld GIS application to navigate to real sites of interests for a particular study topic.

GPS is not the only location technology one can use. The spread of 802.11 wireless networks has lead to several projects that take advantage of this in making innovative new applications. For example, the CatchBob! application (Nova & Girardin, 2004) uses 802.11 location technology in their application as a means for students to navigate and coordinate joint efforts in a game.

This is not an exhaustive list of mobile learning categories, but rather diverse examples of some of the current approaches to using mobile devices in learning. These are examples of novel learning experiences afforded by the mobility, computing, and networking capabilities offered by these devices. We see that new innovations gives new opportunities for pedagogical innovations.

MOTEL for higher education

MOTEL (Mobile Technology Enhanced Learning) is a sub-project within a larger project named TRANSFORM[8]. TRANSFORM is a four-year project focused on productive learning practice in higher education. In TRANSFORM we take a socio-cultural perspective (Wertsch, del Río, & Alvarez, 1995) on learning where we see learning as an activity mediated by technology and what is actually going on is in focus. Project MOTEL seeks to investigate how mobile technologies can enhance and support learning and research activities in higher education. In the tradition of Scandinavian design research (see for example Ehn, 1993), we take a multi-disciplinary approach to interaction design that is based on a public dialogue with active participation of end-users and is focused on people, societal values, ICT functionality, and aesthetics. As Bannon and Bødker (1991) explain, design is "a process in which we determine and create the conditions which turn an object into an artifact of use. The future use situation is the origin for design, and we design with this in mind … To design with the future use activity in mind also means to start out from the present praxis of the future users (p. 242)". This means that there is a tight connection between design and use and that when we design, we are designing for a future practice, informed by the present. Thus, the current practice of students as they move between their learning venues, is studied with an eye on designing a mobile learning technology (i.e., identifying the role(s) for mobile technology) to support their learning activity as they move between these venues. This is similar to a study carried out by Wasson (1998) where she studied a net-based simulation used by on-campus students in order to inform the design of a future collaborative telelearning environment where this same net-based simulation game would be central.

In this section we first describe the empirical studies we have carried out. Using the results of these studies, we present a number of informed design decisions that we made before presenting the MOTEL framework.

Empirical Studies

In order to learn more about how students presently are using technology throughout the day, we carried out ethnographic flavored field studies where we followed biology students and faculty in their learning/research activities at the University of Bergen, Norway. Interviews were conduced with the student´s and we asked about: the kind of tools (both analog and digital) they used in their learning activities (to get information, to communicate); the kind of digital tools the owned and used in other lifetime activities; and where they used those tools (e.g., at home or in the reading room). The interview questions were motivated by our belief in the importance of leveraging existing resources (e.g., IM, mobile phones, weblogs, etc.) in order to take advantage of them in future learning activities—some of these resources may not be thought of as learning resources by the students themselves, just as a tool for everyday life.

From these investigations we identified the following characteristics of use:

1) Reflecting the mobile society in which we live, both students and researchers frequently change their site of learning including the classroom, home, wet labs, boats, field sites. For this they are in need of something that they can bring across these various sites, or learning venues.

2) Various uses of maps are very important for this discipline. In particular, we identified that most data requires an attached location, most frequently in the form of a coordinate, and maps are used as tools in social interactions, for illustrating purposes in papers and reports, and in analyzing data using for example Geographic Information Systems (GIS). Figure 1 shows an example of map usage. The biologists used the digital map as a resource when discussing findings and planning where to go next.

3) Researchers and students are interested in mechanisms to support sharing of data. For example, when students work together in projects. Ironically, there are some national and international

initiatives to make online databases for sharing material and collections (e.g., species databases), but they are hardly used.

4) Biology is a very technology intensive field and most tools are becoming digital. This is one kind of "convergence" where their cameras (video and still), and all sorts of measuring equipment are now equipped with a digital interface enabling computational manipulations.

Figure 1: Map usage by biologists on an excursion

The results of the empirical studies of the biology students and faculty gave us great insight into a technology rich learning discipline and gave us these four characteristics of use that we feel are relevant for other disciplines as well. Data or information belonging to a location or coordinate (and time/date) is a feature that is also important for subjects/disciplines other than biology. For example, in the study of Norwegian language dialects, the location where a dialect originates or is found today is important or in archeology where artifacts are found is extremely important. Similarly, the use of maps is also an important tool and resource for disciplines such as System Dynamics and Geography.

This led us to a decision that we would design a generic mobile learning framework, and not one for biology in particular. The observed use characteristics provide the foundations for building a more generic application where first and foremost we support the students and faculty in moving between the different learning venues. Second, it is important that the students be able to actively produce, as well as critical consume, information and content. Thus, we will focus on a system where the user is the main creator and initiator of information and communication. This is in contrast to a more traditional mass communication mode where central content creators makes/broadcasts content to consumers. The result is the MOTEL framework described in the next section.

MOTEL the framework

The basic idea behind MOTEL is to build a mobile application framework for supporting mobile students, instructors and researchers. We see MOTEL as part of a socio-technical infrastructure and an emerging framework for generic virtual annotations. Seeing it as part of a socio-technical infrastructure means that we plan to develop learning activities using the system and that the system must be seen as part of those activities and not as a separate product. This paper, however, focuses on the design and implementation of the MOTEL framework. This section presents in detail the MOTEL framework and application prototypes, focusing on the design decisions that were made.

MOTEL Overview

While mobile support can encompass a whole range of issues, MOTEL focuses on three aspects: 1) geo-tagging used for messaging and data gathering (and for later retrieval); 2) interoperability between various devices (by using platform independent protocols like XML-RPC, and open source development platforms like Java ME); and 3) easy re-use and editing of data (including conversion mechanisms between formats).

A framework for supporting virtual tagging of locations has been developed and usability testing carried out, see figure 2. This framework currently comprises an application for mobile telephones (an open source j2me application), the use of GPS, and a server back end for receiving and displaying virtual tags overlaid on maps. The application enables the creation of notes and tables, both of which have attached GPS coordinates. These notes can be stored locally or be sent to a central server.

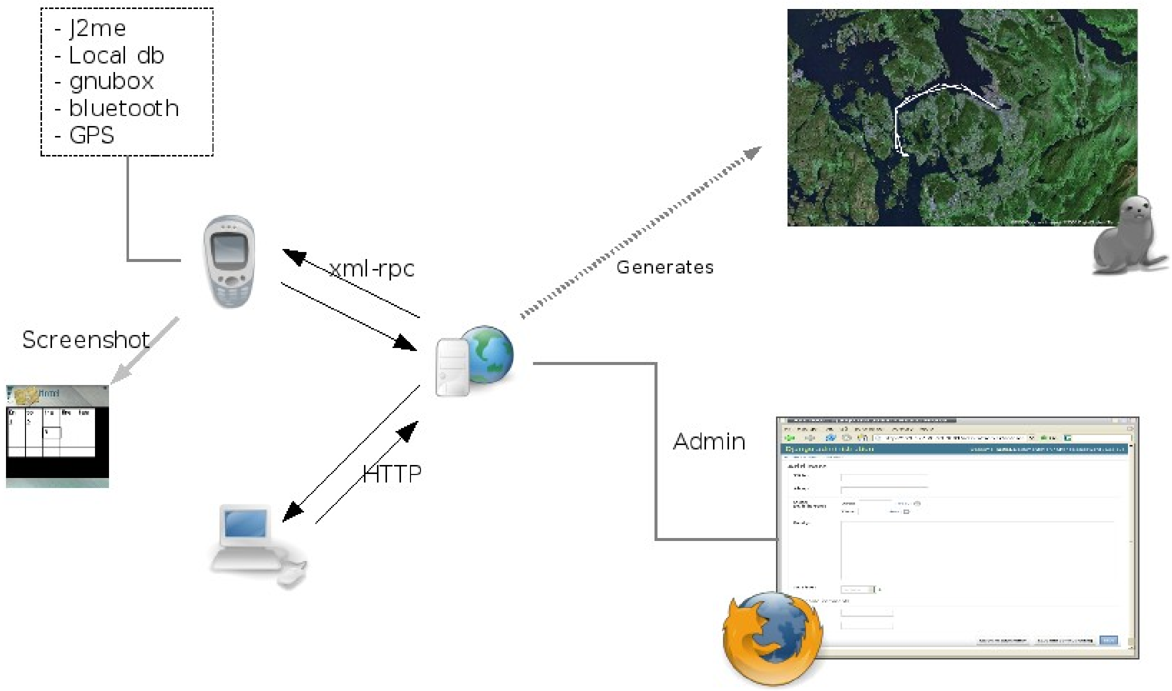

Figure 2: The MOTEL Framework

Targeted device. The mobile phone was the targeted device for the prototype and for future development. The main reasons were: 1) all 13-34 Norwegians own a mobile phone (Ling, 2006), with SMSing being very popular; 2) are truely portable. Laptops are also portable, but are best used on a flat surfaces and a WIMP (Windows Icons Menus Pointers) interaction paradigm normally demands full attention and is unsuitable for “using while moving” (Pascoe et al., 2000). 3) cost - PDA's were also considered they are more expensive than most mobile phones and are not in widespread use in Norway; 4) mobile phones are always on, or on standby, and present; 5) we believe they have an underused potential in formal settings.

Target development platform. The Java Micro Edition platform was chosen as the development platform for the mobile phone client application because we had experience with it, but more importantly it is both a widespread and portable technology. Other advantages include its further development through the Open Java Community Processes. Java ME has also become Open Source Software so it fits with our philosophy to not support a particular proprietary system. We also considered using Python since we all had Nokia S60 phones that supported Python[9], but although Nokia is the most sold mobile phone make in Norway (and the most sold smartphone in the world) we wanted to support as many makes as possible and found that with Java ME platform we could do that.

Positioning. One of the challenges was how to do positioning in order to attach location meta-data to a note or table. We considered using: 1) cell towers: J2ME has a location API in order to query cell towers, but for the best result you need an agreement in Norway with tele-operators. There are some promising initiatives (e.g., placelab.org and cellspotting.com) but at the point of development they were not an option; 2) wireless base stations (802.11). Access to base stations within the area of interested is needed and if there are no base stations available it is not possible to do positioning at all. If you have access to the base stations a second step of manual calibrating and triangulation is needed. This is however a great option for indoor positioning (e.g., see CatchBob![10]); 3) GPS positioning. GPS is the most used positioning technology used by airplanes, space shuttles, boats, ships and cars. Although its accuracy varies depending on place and device being used, it is considered accurate 'enough' for many applications (varying between 4 and 20 meters), and is very reliable. Is also covers the whole earth, but needs free sight of the sky

—while good at sea, it could be a problem in a highly dense forest, and in some area in cities with sky scrapers; 4) bluetooth base stations. This is an option for controlled scenarios (e.g., inside a museum) when short range is sufficient; 5) Embedding location data in semacodes. This, however, requires the placement of a semacode sticker at a particular location beforehand, and is thus only suited for controlled scenarios. Further, one needs a camera phone to shoot a photo of the code and the application translates the code into a URL. Thus, this is neither automatic nor a quick operation for the user.

We decided to use GPS for the location mechanism and external GPS devices. First, Bergen is cloudy and mountainous so we tested and found many integrated GPS devices poor compared to external ones. Second, mobile Phones with internal GPS devices also use a lot of battery, and third, few students owned a mobile phone with integrated GPS. Fourth, we wanted the users to move freely around in areas without Wireless and cell towers such as high in the mountains or at sea.

Local storage support. Supporting local storage on the mobile phone was a feature we needed to support for several reasons. First, when working with educational institutions it is important that costs are kept to a minimum and the user does not feel restricted with respect to annotating. With a local database functionality the user has the option of deciding later which notes/tables to upload. Second, it is possible to use a your desktop computer to connect to the server and use an existing Internet connection. In MOTEL Gnubox, a Symbian software application that lets you use a bluetooth connection to connect to the Internet using a computer, was used to facilitate this further. ('this it the other way around', the normal way is to use the mobile phone to access the Internet using e.g. a laptop).

MOTEL in action

To explain the functionality of MOTEL, we sketch a possible use case where a group of students are learning about local history exploring Bergen and making notes about historic buildings they encounter (this is similar to the task we had students carry out during the usability testing of the MOTEL application). The group of students needs to divide up in order to cover the city.

Preparation: Each student downloads the MOTEL client application via HTTP or by getting beamed over bluetooth (or infrared). An administrator makes user accounts on a MOTEL server (the client application can be used stand alone but then there is no uploading of notes and tables). The user has a GPS device in her pocket. Then the client application needs to be configured for use with the server and the GPS device; a configuration tool will automatically locate any GPS device close by and present a list from which she picks the GPS device. The student is now ready to begin the exploration of the city.

Virtual Annotating: Whenever the student encounters a historic site she wants to write about in a note or a table, she clicks on add a note (or table) in the client on her mobile and writes the note. When pressing 'save' she will be given the option to save the note with location coordinates attached—and a virtual annotation has been created.

Managing the Notes: Later the student can select from a list, see figure 3, the notes she wants uploaded to the server (needs server authentication). Since the notes (and tables) are saved locally they can be edited and deleted on the mobile before sending them to the server and when cleaning up old notes. It is also possible to wait until she is back at her office and use Gnubox and her desktop computer to send the notes to the central server database.

Retrieving Notes: One interesting feature of the client is the built in note retrieval mechanism. There are two ways to receive notes (both will send a call to the server). First a request for all notes written by a particular group ID (e.g., retrieve all notes written by my group) can be sent to the server. Second, it is possible to retrieve all notes within a radius of X meters (contains very advanced calculations due to how the earth is curved). This, for example, enables the group of students to retrieve other notes by their group that have been posted at the same spot, or near to a spot, or to check if any virtal notes already exist for location she is thinking of writing about.

Route Tracking: If the student wants to track the route she is moving a pointlogger has been implemented. The pointlogger, however, can't be used without continuous network access, as it needs to post coordinates in real time.

Figure 3: Screenshot of selecting a note to be sent to the server

Map Views: On the server side a relational database with an interface written in python and an experimental administrator interface built with the Django framework[11] is being tested. A set of python scripts generates views of the notes and tables as maps with overlaid notes and tables as clickable hotspots, see figure 4. A script, using the Google Maps API, retrieves their data from the relational database (posted by the mobile phone client). The user can also log on to this administrator interface using a web browser to get access to her notes and tables where she can edit, delete and even add new notes.

Figure 4: Shows an example google map view

MOTEL 2: Future development

Our development work has given us further ideas about how new innovative learning activities can be designed. In the next version we want to make possible richer experiences for the learner. In order to do so we will focus on three areas. First, we will explore how the various forms of locative technology can be used. In particular, we are interested in exploring how to use cell towers signal strength and ID information in cities. This could mean that the user will not need an GPS device when using the system. Second, we will implement and experiment with geofencing. Geofences are virtual fences that trigger actions or guide the user when entering or leaving a specified area. Third, we want to support crossmedia, to provide students with the possibility to use various media in learning and communication. This involves making it possible to post multimedia to the system and making mechanisms and clients for devices other than J2ME enabled mobile phones. This we believe is an important issue to be aware of when developing educational applications for the future when the range of digital devices owned by students will vary more than ever.

Mobile learning revisited

One thing in particular that has changed in recent years is the range of different mobile digital devices on the market and in possession and use among the general population. It is not only the computer, as in a desktop or workstation, which is the main digital tool in use. There is a plethora of digital appliances and devices (or 'information appliances' as Donald Norman envisioned them) including portable computers (laptops and ultra portables), PDA's, mobile phones (with various degrees of sophistication), digital cameras, digital GPS units (Global Positioning System), small portable game consoles (e.g., the Sony PSP or the Nintendo Wii), personal media assistants (e.g., Archos devices), etc.

We also see convergence. Digital devices are merging or adding features to their base—digital devices become multi-functional devices. Mobile Phones become mini computers (e.g., Symbian OS based phones) and in addition to being a game console, the new Sony Playstation 3 will be your new computer and home entertainment centre.

This leads to crossmedia communication and production. Today you can use Google maps on your mobile, Flickr, the largest picture sharing site, has made it possible to post photos using your mobile, and Instant Messaging clients are available for mobiles and game consoles. As a result, there is an ecology of online communities creating new services and technologies; commercial companies, hacker communities (gluing together existing systems, extending the use), and user communities provide feedback on design and participate in envisaging alternative/new uses and services.

What are the implications of these trends for mobile learning and for learning in general? We believe that these developments change the premises (the tools and practices) and conditions for learning activity. Our research is motivated by how to make a productive learning infrastructure around these emerging mobile devices and practices This means the challenge is to both understand the changing conditions for learning and be aware of the affordances of the technological in order to harness the synergy of these.

In the next months we are field trialing the application. Important questions we are asking include: How can knowledge about how students and professors organize their learning activities (and their life in general) and how they utilize technology be used in a meaningful way? How can we leverage existing knowledge among students and professors in order to facilitate and guide students and professors in taking new and existing technology into use? How can we build learning infrastructures that leverage on existing knowledge and takes new and emerging technology into account? What role should the mobile technology take ? Where should the learners attention be, on items in the application or outside the application such as a building?

How artefact's and mobility are pivotal to productive learning, and how to enhance and support learning activities.

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Footnotes

1 http://foto.no/cgi-bin/bildegalleri/index.cgi

2 More than 30% of all Norwegian own a portable audio player and the number is rising. Source http://www.ssb.no/emner/07/02/30/medie/art-2006-03-23-01.html

3 http://en.wikipedia.org/wiki/Tamagotchi

4 In Norway 57% of all boys and 23% of the girls (9-15 years old) are playing games each day

5 This is an application for small devices used to subscribe to content from a particular content provider, including educational content providers.

6 http://en.wikipedia.org/wiki/GPS#Selective_availability

7 http://www.ngs.noaa.gov/FGCS/info/sans_SA/docs/statement.html

8 http://transform.intermedia.uib.no

9 http://opensource.nokia.com/projects/pythonfors60

10 http://craftwww.epfl.ch/research/catchbob

11 http://www.djangoproject.com