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Design, Development and Evaluation of Mobile Learning at NKI Distance Education 2000-2005

Bekkestua, September 2005

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Preface

This publication contains papers produced by the NKI research team in connection with two EU Leonardo Projects on mobile learning, or for using the NKI concepts “*development and research on learning environments for mobile distance learners*”.

The projects are:

Leonardo da Vinci Project IRL/00/B/F/PP-119-209

“**From e-learning to m-learning**” from 1.12.2000 till 30.11 2002

Project coordinator: Ericsson Competence Solutions, Ireland

Project Partners: NKI distance education, Norway, Distance Education International, Ireland, University of Rome 3, Italy, FernUniversität, Germany.

Leonardo da Vinci Project 2003-IRL/03/B/F/PP-153-111

“**Mobile Learning: The Next Generation of Learning**” from 1.10.2003 till 30.9 2005

Project coordinator: Ericsson Competence Solutions, Ireland

Project Partners: NKI distance education, Norway, Distance Education International, Ireland, Budapest University of Economic Sciences and Political Administration, Hungary, FernUniversität, Germany.

Papers from the second project completed in September 2005 is presented in the first part, while papers from the first project is presented in the second part. The papers demonstrate the developments taking place in the two projects and technological changes during the years from 2000 till 2005. For obvious reasons there are considerable overlap in content as the most of the papers build on previous publications and developments, but also because they are produced with different objectives such as bases for development, technical specifications, presentation of evaluation results and dissemination.

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Bekkestua, September 2005

Torstein Rekkedal

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M-Learning 2:

Mobile Learning: The Next Generation of Learning



Papers prepared for the EU Leonardo da Vinci Project:

“Mobile learning: The Next Generation of Learning” 2003-IRL/03/B/F/PP-153-111

Mobile Learning Management System Specification

October 2004

Introduction

This document describes the features that a mobile LMS (mLMS) should, or could, support. It must be emphasised that not all of these features will be available in NKI's mLMS, but some services might be implemented at a later stage. This specification is divided into six categories:

- Overall framework needs
- Course content
- Access to courseware
- Communication
- Administration of users
- Others

Overall framework needs

- The mLMS must be a part of an LMS and support the mobile client as well as traditional clients.
- The mLMS should provide different types of content to different devices automatically.
- The mLMS must create a comfortable learning environment for students studying with mobile devices

Course content

- The mLMS must be able to store course content in the system.
- The mLMS should provide easy navigation
- The mLMS should provide a zoom function for illustrations and pictures

Access to courseware

- Access to resources, library, references, glossary and exam database.
- Access to course planning tools and calendar.
- Students must have the possibility for submitting assignments
- Tutors must have the possibility to answer and return assignments.
- One must have access to class list with tutor and student information.
- Students must have the possibility to answer using multiple choices, drag and drop test/exercises, etc.
- Text to speech possibilities would be very helpful.
- The mLMS must support graphics, audio and video, moving image.
- The mLMS must immediately provide answers and feedback on test/exercises to students.
- It would be useful to have searchable course content.

Communication

- One must have access to online synchronous communication such as chat.
- One must have access asynchronous communication system such as e-mail
- The mLMS could support Short Messages Service (SMS) between students and teachers for instance to notify the teacher that a student has just delivered a new assignment. The other way around, a student could get a notification that the teacher has just sent the answer to the assignment. Could also contain the score/grade.
- The mLMS could support the use of Multimedia Messaging Service (MMS)
- SMS between users of the mLMS and the mLMS to give reminders and other information as well as enrolling and signing up to exams and other arrangements.
- Students and tutors must have access to course forums to read and write messages.
- One must have access to list with both tutor and student information
- Message board.
- Announcements.

Administration of users

This is a feature that is meant for the administration of the institutions and is not actually a part of the end user system for the mobile student or tutor.

-
- The mLMS should give to possibility register for an exams
- One must have access to student records
- Student tracking

Other

- The mLMS should give the possibility to enrol to a course (students enrol from a web page)
- Provide export features to have course access even when offline.
- Adjustment of personal settings such as changing password or e-mail address.
- Access to frequently asked question (FAQ).
- Access to contact information.
- Access to general study information such exams dates, student handbooks, regulations, etc.
- Access to a sitemap.
- A possibility to print from the device.
- An area where you can upload and store personal files.
- Access to technical support services.

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Technical working paper 2004, NKI Distance Education

Exploring online services in an mobile environment

October 2004

This paper is written as a part of the project "Mobile Learning: The Next Generation of Learning" as a result of the research done at NKI Distance Education (NKI) for adapting SESAM (the learning management system (LMS) of NKI) to the mobile environment. The aim of this project is to develop and adapt courses for current and future mobile handsets where mobile learning is defined as the provision of training courses via wireless devices – Personal Digital Assistants (PDAs), smart phones and mobile telephones. These courses will be developed as part of a fully functional mobile Learning Management System (mLMS) and the courses will be tested and evaluated, and the results widely disseminated. The web page of the Leonardo project is found at: <http://learning.ericsson.net/mlearning2/index.shtml>.

This paper accounts for and discusses the challenges of mobilizing content from traditional clients to mobile users who use a PDA or similar devices. Smart phones and mobile telephones are not discussed in this article as the screen is much smaller and has other limitations that need special attention. When the term “mobile device” is used it refers to a handheld device that is capable of displaying hypertext mark-up language (html). This paper concerns PDAs used as a mobile client to an LMS, in our case, SESAM.

Summary

This paper is a technical working paper written by developers at NKI Distance Education in the EU Leonardo project "Mobile Learning: The Next Generation of Learning", and describes the work carried out in the first year of the project. We have enhanced our existing LMS to serve mobile clients that has an html compatible web browser built-in. We have simulated the future, as we believe it might be, with a wireless always-online environment with five mobile users. The services we found interesting and useful were IP Telephony and messaging services such as MSN Messenger. We also reviewed different web browsers, but we ended up with Pocket Internet Explorer that comes with PDAs with the Windows Mobile operating system. We are looking forward to the development of Opera's Small-Screen Rendering™ browser for the PDA that hopefully will enhance the readability and screen rendering on small screens. Some of the most important findings were that if the structure of the document is good the challenge of transforming to small screens or different layouts was actually requiring less time and resources than expected. We did experience difficulties with large illustrations that contained too much information for a small screens as well as large fixed width flash animations.

The need for adapting to mobile devices.

To better serve the increasing demand for different formats as well as mobility we need to give the mobile user a better experience with existing web pages. The reason for targeting mobile devices at this point is because there are more and more users who acquire mobile devices and wants to use them with our services. Today the market is small, but growing for mobile users – this is why we needed to adapt the existing web pages and services to the mobile devices. One of the biggest challenges concerning the mobile devices is find

acceptable solutions adapted to the small screen size. There is simply not enough room for all the information found on a traditional web page on the small screen. Another problem is the limited data transfer rate and processing power found in mobile devices. When people use a mobile device with Internet connectivity the data rate is usually much lower than one may expect from traditional clients. The mobile network restricts the data rate and if the user is accessing by a mobile network the cost involved is also a consideration. These challenges might be overcome with time, but until then, we must serve our mobile clients the best services possible with the minimum of effort. We might want to serve the mobile users an alternative page to that which is served to our traditional clients. There are some mobile browsers that could reduce the need for developing specific pages for the mobile client, this is not a standard at the time of writing.

Always-online test environment

For this work package we have established a wireless, broadband community counting 5 users of mobile learning. At home and at work, these users are equipped with PDAs that have wireless access to ADSL (Asymmetric Digital Subscriber Line – a broadband technology). This environment allows the users to explore wireless applications we consider to be generally available in the future. We have developed and tested out several applications and software that through this “always online” environment utilizes:

- **Synchronous communications, chat**
- **Quicker response on e-mail**
- **High bandwidth gives fast downloading of course content and use of audio, video and advanced graphics.**
- **Use of Flash, Java etc due to high storage capacity in future PocketPC**
- **Access to the resources at the Internet at all time**
- **ADSL gives you control over cost**
- **Not dependent of synchronization with desktop pc**
- **Online assessments and assignments**
- **Opens for collaboration between mobile learners**

We are using a wireless 802.11b base station connected to a broadband Internet connection that provides the basic “always online” infrastructure. We have tried out the wireless technology at home and at work to see how it influenced the way we utilized the Internet as a source for information as well as the benefits of studying wireless. We used an iPAQ PDA with wireless connection to the base station (or to a cell phone when we were on the road) as a terminal. The LMS used was NKI's SESAM that serves all our students on a daily basis. We modified some code on the development server so that our web pages also would fit the small screen of the PDA (240*320).

Browsers

We tested NetFront v3.0 for Pocket PC and ThunderHawk, we also used Opera's Small-Screen Rendering™ technology in addition to the Pocket Internet Explorer (Pocket IE). After testing the different browsers and considering their pros and cons, we ended up with the original browser Pocket IE. This was the decision after arguing that our pages have to work on the most commonly used browser on the PDA. The other two browsers were lacking functionality and they were not free ware browsers. There is work in progress to improve these browsers and even though they had features that the Pocket IE did not have, for instance the option to alter between landscape/portrait modes, we decided to go with the market

leading browser Pocket IE. To utilize flash technology we had to download a plug-in for the Pocket IE and it worked “out of the box”. In time we believe it will be installed by default. NetFront did support flash as standard but we could not find a plug-in that worked with ThunderHawk. We are also testing Opera and the Small-Screen Rendering™ technology they utilize on mobile phones and is available in the traditional browser by pressing <shift> + <F11>, this gives a view of the page with limited screen real-estate.

Synchronous communications

To explore the possibilities with synchronous communication we have tested two very different and exciting applications. One of the most interesting and useful of these might be the use of instant messages from the PDA by using MSN Messenger (MSN). MSN is Microsoft's popular instant messaging client that allows users to communicate with each other in real-time. This client lets you keep your existing contacts wherever you are, and if you add new contacts they are saved to a server that is maintained by Microsoft. The benefit is that wherever you log on, being from a desktop computer using the traditional MSN Messenger client, the web client or via the PDA Pocket Messenger, you have your contacts with you at all time. This is a great way to keep in touch with fellow students without being logged in to the LMS. This is an application many students already utilize and therefore it is possible it will be the preferred way of communication (second to e-mail) between students who wishes to cooperate. Recently numbers provided by the Norwegian MSN portal, states that there are approximately 900 000 Norwegian user of MSN Messenger.

We have also tested another form of communication, using the software Skype, which is an IP telephony application that is available for Windows, Mac OS X and Linux. There is also a version that is named Pocket Skype that works with PDAs with the Windows Mobile operating system. This allows the users to make phone calls over the Internet to anyone with a Skype account and has the same cost as being online in any other way. It is recommendable with a broadband Internet connection to avoid to much delay between the parties conduction a conversation. This has been tested between two students as well as a group conversation between three people and works surprisingly well. This might be a challenge to the long distance calls of today. Compared to MSN Messenger, Skype is so far in the very beginning and is not so widely known. The benefit tough of talking compared to typing is quite obvious. The possibility to have a conversation between fellow students even across countries is appealing to distance education, especially since the cost of the “always online” Internet connection is not an issue. This also benefits those students that are slow writers in a synchronous environment such as MSN. Another appealing development is the possibility to make calls to traditional phones for a low price via IP telephony.

Using flash on the PDA

One of the most interesting parts of this technical development has been the work with flash on the PDA. Flash is authoring software developed by Macromedia, and is used for producing vector graphics-based animations. Flash makes it possible to develop various programs/features such as navigation interfaces, graphics illustrations, interactivity in a resizable file format that is small enough to stream across a normal modem connection. Flash is very suitable for use on the web due to the vector graphics ability to adapt and adjust to different display sizes and screen resolutions and it is designed for optimized delivery.

In this project we wanted to use flash for producing assignments mainly in the form of multiple choice and drag-and-drop. We have also developed parts of the courseware with the

use of flash together with audio. This has been in a sort of pre-assignment or case as a basis for the real assignment that follows.

After experimenting with the course assignments developed in Flash, we adapted them to the PDA. The assignments have been adapted and further developed from the original version intended for use on a large screen to be used on the PDA with the Internet Explorer and the Flashplayer 6 plugin for PDA installed.

Screen format on the PDA

We found that 240 * 270 (width * height) pixels was the optimal size and filled the screen as much as possible (see picture 1).

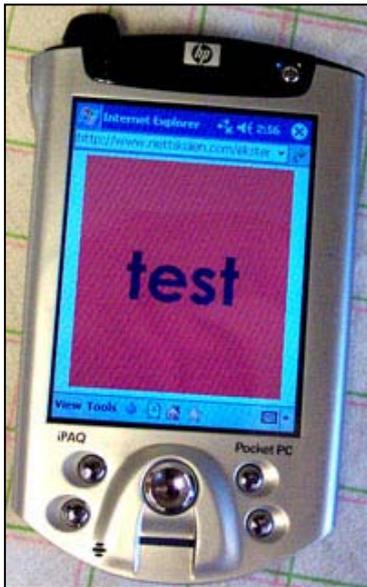


Figure 1: Full size (the red colour)

Using text in Flash

When starting our developments we found that the text we used in the assignments was too small and nearly impossible to read when presented on the PDA. We started to experiment with different font types and sizes. By default Flash uses anti-aliasing on the font and that makes the text a little blurring in the edges. To get the text more sharpen and easy to read on a small screen, we found that we could use an option in flash call “dynamic text”. This proved better concerning readability and solved our problem.

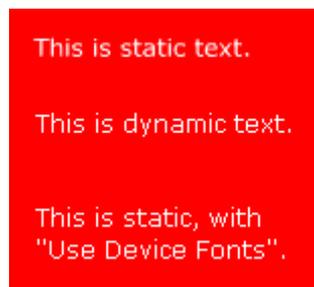


Figure 2: Different methods with text, verdana 12 pix.

On figure 2, the font is 12 pixels, but the flash program shows different sizes using two different methods. We have no good answer why Flash do so, but that's no special behaviour to PDA since this is how the program itself react. Later on, we also discovered we could keep the font static and use the options "Use Device Fonts" in flash. Flash uses device fonts to display certain text blocks, so that Flash does not embed the font for that text. This gave us the same output results as setting the text to "Dynamic" but we had more control over line breaking and text behaviour and it might also increase the file size.

We experienced a lot of difference in behaviour with the same flash file when using it on a PC versus the PDA. For instance we had textboxes that showed three lines on a PDA, could only shows two lines on a PC. We solved this by adjusting the size of the textboxes to fit the PDA. We have also made a couple of assignments that use a "drag and drop" functionality. This worked very well on the PDA, but we experienced the same issues here regarding text readability. One must also have in mind that some functions, like "onMouseOver", wouldn't work on the PDA since the PDA is equipped with a touch screen and a stylus and no mouse like on the pc.

Here are two screens shoots from these assignments made in Flash (in Norwegian).

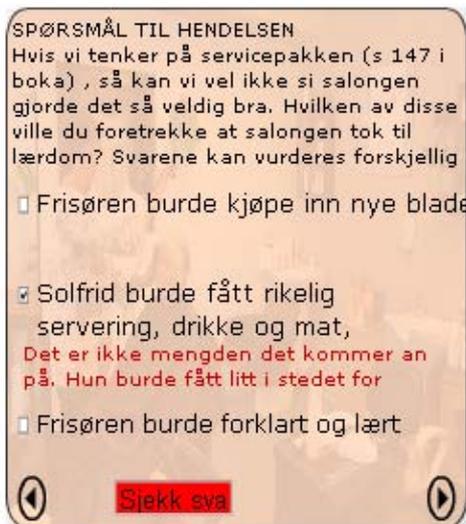


Figure 3: Multiple Choice Assignment

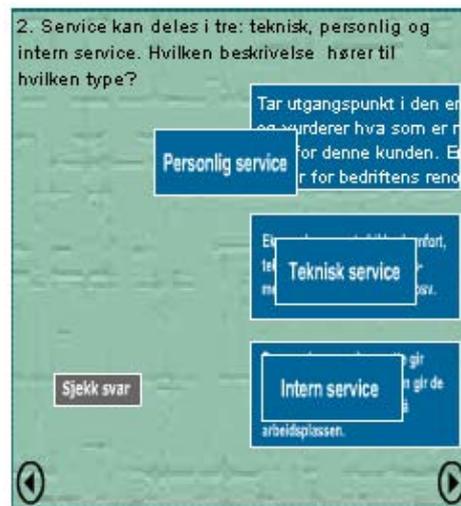


Figure 4: Drag and Drop

Video on the PDA

We have also tested out the use of video on the PDA with small video clips showing a discussion between two persons in a learning situation. This has worked very well using the Windows Media Player and we had no problems with viewing the files with high quality both on picture and audio. This is of course also due to high capacity of the wireless broadband solution.



Figure 5: Screen shot from a video clip

Synthetic speech on the PDA

As a result of previous projects working with Universal Accessibility, we have also tested out the use of synthetic speech on the PDA. So far we are very pleased with the early results and the possibilities this technology gives us. We will describe the result and experiences from this work in the first working paper in the second year of the project.

Identify target devices

To serve the correct pages to different devices we need to know which devices we want to adjust our content to. The most basic question is; how many different kinds of devices do we want to give special attention? If the answer to this is none, everyone should get the same page, we have no need to identify the devices and everyone sees the same page. If we want to serve two different pages to different clients we could check for one property e.g. screen resolution (on the iPAQ: 240*320); if the width of the available page of the client is less than a specified size, then serve page a, else serve page b. This could be accomplished by java script, but that is limited to the clients supporting java script, which are not all, and some might turn java scrip functionality off. If there are reasons for giving the users the choice between the different versions, e.g. bandwidth limitations could be a reason for wanting to access a light version of the page but still gives the basic functionality. If you would like to target more than two devices and/or give the choice to the server on which page to serve we need to know how to identify the wanted devices. This could be accomplished in different ways, but to ensure that we do it regardless of the device we want to have the server identify the client.

Identifying the client may be done by reading the http-header and serve a page based on the information retrieved. The http-header contains information about the user-agent among other information, but this is one of the possible variables we could use to distinguish between the pages we want to serve or base our layout on. If we do the testing on the server side, we know it will be adaptable to all types of clients, since the change is done on our server, and we know that if a client is to read pages from our server it needs to send a request and our server must send a response. This response could be based on the request and designed to fit the user-agent making the request for a page. We are considering a browser-sniffer called BrowserHawk that is an application that is installed on the web server to get information about the client accessing the web page. This could help us identifying the mobile devices as well as helping with either redirection to another web page or changing the layout of the page to better fit the small screen.

Server or client based adaptation?

This is in our opinion one of the most basic and fundamental choices to make. In our case we could not base our layout on the clients and their ability to handle the layout. If one bases everything on the client, there is no need to change the code if, for instance, the mobile browser is satisfactory for use on traditional web pages. This is an option if it is not business critical to serve the mobile client. If it is critical for the service, however, it has to be done on the server side. This is because this is where the business has control. We do not know what type of clients our users have and cannot tell the users to install programs to access our pages. This is possible only if the mobile services are supplied in addition to the traditional services, and if the users are aware of this fact. Then they will probably find the service as a nice addition to the other services the company has to offer. However, if the company is to gain new customers from supplying services for this medium, there is a need for a more professional approach.

By identifying the client on the server-side we have some different possibilities; we can serve a different page than what we would do if a traditional client contacts the server or we can change the layout. We can serve a different css (style-sheet) or strip away tables to avoid sideways scrolling. By using the server as the identifying part we can assure that it will work and do not have difficulties concerning users who have disabled their java script, and so on.

Concluding remarks

We have tested some of the available browsers on the market today and are closely watching the developments taking place, specifically the development of the Opera browser for the PDA. There are quite some challenges in converting existing materials from the large screen of the desktop to the small screen of the PDA or other mobile device. The optimal solution for the small screen is obviously to make the most of the space available, and the challenge is to do this globally on the server so that one does not have to do this work on every single web page. If the structure is basically good, there is already technology on the market, which solves the problem with small screens quite well.

There are still a number of challenges concerning the use of Flash and large images because of the reduced readability when shrinking the image. This has not yet been solved, but there might be possible to zoom in and out of an image to see the details. The work we have done with Flash, video, synthetic speech and different communication forms so far, demonstrates that there are great potentials built into in these small pocket computers that just waits to be released. Combined with a wireless, always online environment these online services, we are

strong believers that this could benefit both the online tutor and student in several ways. This will be further described and discussed in the second year of the project, were we will test out the didactic always-online environment for PDAs with real students.

Resources

Skype

<http://www.skype.com/>

BrowserHawk

<http://www.browserhawk.com/>

Opera

<http://www.opera.com>

MSN

<http://www.msn.no>

Media Queries:

<http://www.w3.org/TR/css3-mediaqueries/>

Netfront:

<http://www.netfront.no/>

ThunderHawk:

<http://www.bitstream.com/wireless/?wireless-web>

The World Wide Web Consortium (W3C):

<http://www.w3.org/>

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Designing an Always-Online Learning Environment for Mobile Learners and Teachers

Sub-project of the EU Leonardo Project “Mobile Learning: The Next Generation of Learning”

April 2005

Introduction

The above mentioned project builds on developments and experiences from a previous EU Leonardo Project, “*From e-Learning to m-Learning*” carried out by some of the partners during 2001-2002. This project is also led by Ericsson Competence solutions, Ireland. Other project members are Distance Education International, Ireland, FernUniversität, Germany and Covinus University, Hungary. The NKI work sub-project is carried out in close cooperation with the other partners. As NKI research in this project builds on the previous research, this paper contains some of the information published in the NKI introductory paper from the previous project (Fagerberg, Rekkedal & Russell 2002)

The above-mentioned paper discussed concepts such as, distance education, e-learning and m-learning with reference to NKI Distance Education philosophies, views on learning and experiences in developing learning materials for distance education and online learning (Ibid 2002).

For the first project the NKI research team studied international experiences concerning m-learning, analysed technological solutions and pedagogic/didactic needs based on our internal practical experiences and results from previous surveys and evaluation studies among our distance students.

The technical solution chosen was to try out the use of Pocket PC/Personal Digital Assistant (PDA) in combination with mobile phone for distribution of learning content and communication between tutor and students, between students and for students’ communication with the learning material. As technologies develop so fast that the specific technology available changes from one week to the next, it was important that the solutions chosen had some generic basis, i.e. also that the specific brands of PCs, mobile phones and keyboards etc. should not constitute any substantial restrictions concerning generalisability of our experiences.

After analysing of PDA/Pocket PC, we chose to build our learning environment around the Compaq iPAQ communicating via mobile phones with infrared connection. The solutions were tried out with two different courses, first in a partly real and partly simulated distance learning setting, while the second experiment in a fully realistic setting. The trials functioned well, and after the two trials we concluded:

“As far as we can judge from the process evaluation, including formal questions and answers in the course Forum on m-learning, telephone contacts with the students and answers to the

final questionnaire, the students were generally positive. In fact, although comparisons between small groups are difficult to make, the evaluations give the impressions that the students in the (real) trial two are more positive than the participants in the first trial (carried out in a more simulated distance learning context). This might be a result of the higher degree of realism in the second trial. ...

*NKI Distance Education gives main emphasis and priority to student autonomy, flexibility and freedom to choose where and when to study in designing the environment for distance learners. Our main aim in designing solutions for mobile learners is to maximize this freedom to support online learners who also are mobile when studying. This is also clear from all the participants in the pilot trials; the main advantage of m-learning as designed in these trials, is the **increased flexibility of online distance education.***

Our pilot trials with mobile technology (PDA and mobile phone) have demonstrated that the technology functioned according to our expectations. The participants were generally satisfied with the technological and didactical solutions. The participants differed somewhat in their acceptance. Some were quite enthusiastic; others were a little more reserved. The differences could partly be related to different learning styles and study preferences, such as preference for note taking on paper and/or general reluctance towards reading longer texts from (any) screen.

In the NKI system it will be a challenge to design solutions for learners who are users of mobile technology and wish to study also when on the move, that also allow other students to apply standard technology. The solutions must be designed in ways to allow both groups to participate in the same course. This means that we have to look for solutions that are optimal for distributing content and communication in courses, independent on whether the students and tutors apply mobile technology or standard PC and Internet connection for teaching or learning. ...

There is no doubt that NKI Distance Education faces a large challenge in further developing server side solutions and teaching methodology that include the use of mobile technology for serving our mobile distance learners more efficiently. We really look forward to continue the developments and experiments.” (Rekkedal 2002)

As a result of the experiences from the first project, NKI wished to continue research on m-learning based on the PDA solutions available in 2004-2005. After examining the different brands available, we decided to develop solutions for the follower of the previous devices, HP iPAQ Pocket PC 5500 series with built-in wireless network card. At the same time all developments were done with the main object to develop generic solutions independent on devices on the user side.

Distance education – flexibility and mobility

Flexible teaching or teaching in the ‘extended classroom’

A number of evaluation studies among distance and online learners at NKI demonstrate that students emphasize flexibility (see e.g. Rekkedal 1990, 1998, 1999).

In our view, distance education seems to develop in two quite different directions. The solution at one end of a flexibility continuum can be described as an individual, flexible solution allowing the student freedom to start at any time and follow his/her own progression according to personal needs for combining studies with work, family and social life – *the*

individual flexible teaching model'. This model represents a generic development of the model of distance teaching institutions and applies normally media and technologies independent of time (and place), such as asynchronous computer communication, video, audio and printed materials. The model on the opposite end of the scale, *'the extended classroom model'*, assumes that the students are organised into groups required to meet regularly at local study centres or individuals/groups logged into the teaching-learning system and the same time, and applies technologies such as video conferencing, satellite distribution, radio and television (Gamlin 1995).

In this connection we have chosen the philosophy for the development of Internet based education at NKI: *Flexible and individual distance teaching with the student group as social and academic support for learning*. NKI offers more than 400 courses and nearly 100 study programmes by Internet based distance teaching and recruits many thousand students (over 10,000 course enrolments) every year. These thousands of students may enrol to any course or programme or combination of courses at any day of the year and progress at their own pace.

It is also clear from NKI experiences that already many of our students and teachers have experience as mobile learners and teachers. Till now this has been restricted mainly to students and teachers carrying their laptops, possibly including communication via mobile phones.

Our main objective also in the present project has been to extend the distribution of learning materials and communication to lighter equipment, specifically PDA and mobile phone. The challenge is then to develop the system and server side to present materials in ways suitable for PDA technology, find acceptable solutions access to and interaction with learning materials and for organising, teacher to student/student to teacher and student to student communication, as well as many-to-many communication in course forums and use of all other services of the NKI internet College.

As we stated in the first project, it is our aim further to design the environment for the mobile learners to extend and increase the flexibility of distance education, that to some extent took a step backwards when converting from paper based to online learning, where students largely were required to study at a place (and at a time) where a computer with access to the Internet was available.

Views on knowledge and learning

For NKI it has been clear that the learning aims, content and teaching/learning methods in our online courses and programmes generally are far away from most e-learning courses. Most examples of m-learning experiments concern e-learning on mobile devices, often WAP and/or *'smart-phones'* (see e.g. Kynäslähti 2001, Kristiansen 2001).

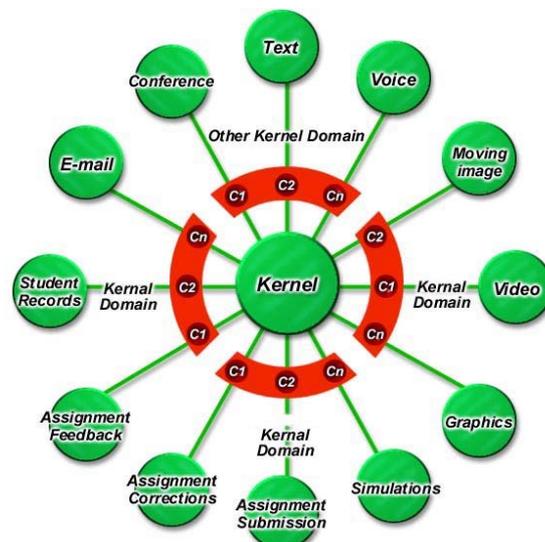
To us, learning is a change in the student's perception of reality related to the problem areas studied and increased competence in solving problems in a field, ability to differ between focal and more peripheral questions, analytical skills and competence in using the tools within a field in appropriate ways. This means that learning results are shown in a qualitative change in the student's understanding, academic, social and technical competence. The learning is a result of active processing of learning material and solving problems individually and/or in groups. This view is often different from what we can find in many so-called e-learning programmes, where knowledge often is seen as a larger amount of information or ability to

recall and reproduce facts. In addition to cost considerations, this is why NKI in general has put little emphasis on using fancy effects in a behaviouristic pedagogical tradition, programmed learning and knowledge transmission (see Marton et al 1987, 1997, Morgan 1993 on students' conceptions of learning, deep level and surface level approaches to learning). We also hold the view that learning is an individual process that can be supported by adequate interaction and/or collaboration in groups (Askeland 2001). With these considerations in mind the NKI solution for designing and trying out a new learning environment for online learners applying PDA and mobile communication in the first project seemed to be a sensible one. Our considerations and decisions for the present project are discussed below.

Internet based education at NKI today

NKI Distance Education has today well above 400 courses and nearly 100 complete study programmes on the Internet. By April 2005 we have nearly 6,000 registered active students. There will be more than 10,000 new course enrolments this year (2005). Contrary to many other educational providers where the Internet is used as a supplement to face-to-face teaching or other forms of distance education, we have followed the philosophy that in principle all communication can be taken care of through the Internet, and ideally no obligatory physical meetings should be required. (This does not mean that the students are not free to communicate by post, phone or fax or that study materials may include print, audio or video technologies.)

In connection with a previous EU Leonardo projects managed by LM Ericsson we described the programme and distribution system in Internet based learning as a '*Multimedia World Wide Web Kernel for Distance Education*' (<http://www.nki.no/eeileo/>) with the following elements:



Model of the Multi Media Kernel for Distance Education.

In designing the learning environment with the mobile learner in mind, all these aspects and functionalities have to be taken into account. However, in the first pilot experiments of the previous project we did not focus on multi-media materials. Already in describing the developments of the first project we assumed that: "*Extending the functionalities to more multi-media content adapted to the PDA should be a main objective for another project.*"

(Fagerberg et al. 2002, p. 6.) The main developments carried out in the present project are described below. First we will repeat the main developments carried out in the first project.

Development and Design of the Always-Online Environment for Mobile Learners using the Compaq iPAQ

Developments as part of the first project, “From e-learning to m-learning”

The aim for the NKI project team during the first project was to adapt courses so that it could be used on a wireless handheld device, in our case the Compaq iPAQ Pocket PC. These courses were already developed and distributed as courses from the NKI Internet College. The challenge was to design a solution to try out for mobile learners.

When planning for the first m-learning environment the NKI project team had long discussions whether to develop the learning materials for online or offline study. Taken the specifically cost considerations concerning mobile access to online learning materials, we concluded that the learning environment should include the following aspects:

Technology:

- Pocket PC
- Mobile phone
- Portable keyboard

Learning content and communication:

- Learning content to be downloaded on the mobile device to be studied offline. This solution was chosen because it would be all too expensive to interact with course materials with mobile phone connection costs
- Downloaded content to include all course materials:
 - Content page
 - Preface
 - Introduction
 - All study units
 - Resources (articles on the web, references to other resource materials)
- Online access to the discussion forum with the possibility of as quick as possible access for reading in the Forum and writing contributions
- E-mail for individual communication with tutor and fellow students and for submitting assignments. Assignments may be submitted as text-based e-mail or as Word or Text attachments.

Before taking the decision on distribution of course content to students via the Pocket PC, we analysed three alternative solutions that were discussed in depth. The discussions also included viewpoints on which materials and study activities were suited for offline or online work.

3 main solutions for distributing content were analyzed:

1. The AvantGo Mobile Internet service
2. Online access via mobile telephone to the entire course
3. ‘Download-on-demand’ version

To be able to deliver content to PDAs via AvantGo we will be required to install our own AvantGo server, and then deliver content via this server to PDAs. The costs for this solution would not be acceptable for use with NKI Internet students.

Online access via mobile phone, if it were not for costs and transmission speed, would perhaps in principle be the preferred solution. It is also the most complex solution. An online version would require that we would have to redesign the entire site to fit the Pocket PC format. Before doing this we would have to make a cost-benefit analysis up front to see if the solution really is worth the effort.

The choice in 2001 of solution 3 was partly a result of limited time and resources available at that time. Our opinion was at that time also that solution 2 perhaps would be *'the most ideal'* solution for the future, i.e. to offer a complete PDA adapted version based on the same learning materials available in the web course for standard PCs. The principle of *'one file many versions'* (html, pdf, reader, etc.) is achievable through the use of XML and CSS). We developed two different "download-on-demand" versions. The first one consists of a set of zipped HTML files, which the students could download to the desktop PC, unzip and synchronize with the PocketPC. The second consisted of a set of ready to use Microsoft Reader files, which also were synchronized to the PocketPC. These files were presented to the students from within the web course.

The reason for supplying two alternatives of content was that we as part of the empirical testing were interested in examining attractiveness and user friendliness of the different solutions for the student. The student can manipulate the Microsoft Reader content by the possibility of *bookmarking, adding highlights, notes and drawings and look up words directly in the PocketPC Dictionary*. This means that the students can use the materials actively in ways that we recognise from students' use of print materials and their personal notes. The student is, in other words, able to 'make the materials his own' while studying. It is reasonable to believe that these functionalities may help students organising the materials cognitively and support learning and remembering. The evaluation studies of the first project actually indicated that the students preferred the Microsoft Reader version (Rekkedal 2002)

The decision to go for the choice of downloading content for offline study was based on previous experiences and also the following considerations: NKI Internet students study mainly offline. Communication concerns discussion with fellow students in the academic forums, cooperation on projects and group assignments, and individual communication with other students – and, most important, according to our evaluations (see e.g. Rekkedal & Paulsen 1997), communication with the tutor including submission of assignments with correction and feedback. All our analyses concluded that the students will have all these possibilities available on their desktop or laptop PCs, including online interaction with the learning materials.

When mobile – and using mobile technologies – we found that taking cost considerations into account, it would be acceptable for the student (and the tutor) to have the course content available to study on the PocketPC. In addition, the following communication possibilities are necessary and proved possible with acceptable costs:

- Access the course forum to read messages
- Access the course forum to submit contributions to the discussions
- Send e-mail to fellow students, to the teacher and to administration (study advisor)

- Receive e-mail from fellow students, from the tutor and from the administration
- Submit assignments by e-mail including attachments
- Receiving assignments corrected and commented on by the tutor including attachments

To access e-mail and discussion forums, mobile phones were used.

Developments and functionalities for the “always-online environment developed by NKI in the project “Mobile learning: The Next Generation of Learning”

As commented above in connection with the previous developments we considered online access to course content probably to be the best solution. However, 4 years ago this solution was seen as neither technologically nor economically possible. Since then, the technological developments have made it more attractive to start developing and experimentation with solutions based on the assumption that an “always-online environment” would be available for mobile learners. This is, in fact, close to reality today, and will most probably be the normal situation in the near future.

Thus, in planning for the present project, the NKI project team would emphasize the development of solutions for m-learning where students and tutors using PDA/PocketPC through wireless systems could benefit from teaching and learning in an “always-online” environment.

Although downloaded content gives access to the course at any time, this solution has some disadvantages, such as:

- Little incentive to log into the Internet College and take advantage of a learning community
- No possibility of taking advantage of interactive materials
- No (or slow) access to other Internet resources
- Restricted communication possibilities

During the planning process we described the following aspects of an always-online solution that would possibly increase the quality of the services for mobile learners:

- High bandwidth gives fast downloading of course content and use of audio, video and advanced graphics
- Independence of synchronization with desktop PC
- Access to resources on the Internet at all times
- Easy access to e-mail at all times
- Possibilities for online assessment and assignments
- Options for easier co-operation with fellow students
- Opens for synchronous communication, chat and IP telephony
- ADSL or free access to WLAN give control over costs

During the first phase of the present project an “ideal” description of requirements for a mobile learning management system (mLMS) for the NKI context was developed by Dye & Fagerberg (2004). The requirements was based on the assumption that the NKI Learning Management System SESAM would be further developed to accommodate the needs of mobile learners with priority to learners using PocketPC. A description of SESAM and functionalities are given by Paulsen et al. (2003).

mLMS system requirements

The specifications proposed by Dye & Fagerberg (2004) are presented below with comments concerning the actual developments done as part of the present project. The specification is divided into six categories. The functionalities developed and tried out in the project as at March 2005 are marked by *(OK)*:

Overall framework needs

- The mLMS must be a part of an LMS and support the mobile client as well as traditional clients. *(OK)*
- The mLMS should provide different types of content to different devices automatically. *(OK)*
- The mLMS must create a comfortable learning environment for students studying with mobile devices. *(OK)*

Course content

- The mLMS must be able to store course content in the system. *(OK)*
- The mLMS should provide easy navigation. *(OK)*
- The mLMS should provide a zoom function for illustrations and pictures. *(OK –not actually part of the mLMS but a function on the PDA)*

Access to courseware

- Access to resources, library, references, glossary and exam database. *(OK)*
- Access to course planning tools and calendar. *(Software (JSP) not yet available in the PDA)*
- Students must have the possibility for submitting assignments. *(OK, but students must use e-mail with attachments instead of the submission system available from PC, software not available)*
- Tutors must have the possibility to answer and return assignments. *(OK, same problem as above)*
- One must have access to a class list with tutor and student information. *(OK)*
- Students must have the possibility to answer using multiple choices, drag and drop test/exercises, etc. *(OK, but solutions not satisfactory on small screens)*
- Text to speech possibilities would be very helpful. *(OK, texts are stored as synthetic speech on mp3-files)*
- The mLMS must support graphics, audio and video, moving image. *(OK, but the small screen gives some problems)*
- The mLMS must immediately provide answers and feedback on test/exercises to students. *(OK)*
- It would be useful to have searchable course content. *(Content in course pages are searchable, but no function for overall search in the materials)*

Communication

- One must have access to online synchronous communication such as chat. *(OK and also IP telephony)*
- One must have access to an asynchronous communication system such as e-mail. *(OK)*
- The mLMS could support Short Messages Service (SMS) between students and teachers for instance to notify the teacher that a student has just delivered a new assignment. The other way around, a student could get a notification that the teacher has just sent the answer to the assignment. Could also contain

the score/grade. *(Not yet implemented)*

- The mLMS could support the use of Multimedia Messaging Service (MMS) *(Not presently planned for)*
- SMS between users of the mLMS and the mLMS to give reminders and other information as well as enrolling and signing up to exams and other arrangements. *(Not yet implemented)*
- Students and tutors must have access to course forums to read and write messages. *(OK)*
- One must have access to a list with both tutor and student information. *(OK)*
- Message board. *(OK)*
- Announcements. *(OK)*

Administration of users

This is a feature that is meant for the administration of the institutions and is not actually a part of the end user system for the mobile student or tutor.

- The mLMS should give to possibility register for an exams. *(Not yet implemented)*
- One must have access to student records. *(OK)*
- Student tracking. *(OK)*

Other

- The mLMS should give the possibility to enrol to a course (students enrol from a web page) *(Possible at present, but awkward)*
- Provide export features to have course access even when offline. *(Not available as constructed as always-online)*
- Adjustment of personal settings such as changing password or e-mail address. *(OK)*
- Access to frequently asked questions (FAQ). *(OK)*
- Access to contact information. *(OK)*
- Access to general study information such exams dates, student handbooks, regulations, etc. *(OK)*
- Access to a sitemap. *(Not yet)*
- A possibility to print from the device. *(Not yet)*
- An area where you can upload and store personal files. *(Not yet)*
- Access to technical support services. *(OK)*

Features and functionalities tested in the NKI trials

Related to the requirements above NKI has developed the SESAM LMS into a functioning mLMS. The trials were carried out during March 2005 with 18 test students registered in the course "Sales and services" (Rekkedal & Dye 2005). The functionalities tested is described below:

Introduction to the PDA and use of equipment

As the majority of the test persons were not users of a PDA, we started the test by describing the hypothetical real situation lying behind the developments and how to use the PDA.

Logging in and navigation on the NKI Internet College personal page

The students were asked to log into their pages on the Internet College and to navigate and examine their personal page as it is presented on the PDA.

Navigating in the course

After having been acquainted with the personal start page, the students had the opportunity to navigate around in the course.

Reading study unit 1

The students read the text of study Unit 1.

Submissions of Study Unit 1: “What is your opinion of reading course texts on the PDA?”

Instead of answering the ordinary assignment for submission, the students wrote an answer to the above question. Submission 1 involved using Pocket word for writing the answer, storing the word document, opening e-mail programme, attaching document, sending and receiving e-mails. During the test the students received feedback from the tutor with comments.

Examining multi media (ordinary multi media in the course)

The following standard multi media elements in the course were examined:

- Sound
- Video
- Multimedia
- Multiple-choice questions
- Drag and drop exercises

In addition the test course included some multi media elements specifically developed for mobile learning:

- Sound
- Multimedia
- Multiple-choice questions
- Speaking course pages
- Drag and drop exercises
- Graphics
- Animations with and without sound
- Multiple-choice questions
- Drag and drop exercises
- Synthetic speech

Reading in course Forum

The functionality of reading in the course forum and writing messages to the forum was also tried out. The first message was written by the tutor. The test students received messages by e-mail onto the PDA and also read the same messages on the course pages.

Writing messages to the Forum

Writing messages to the forum may be done either by writing in Pocket Word and paste into the Forum text box, or by writing directly into the text box. The latter solution was applied in the tests.

More about navigation in the course

The students also examined the course functionality through reading presentations of other students and writing e-mail to fellow students, sending and receiving mails

Synchronous communication

Although NKI in general puts little emphasis on synchronous communication, as this project concerned a theoretical always-online environment, we took the opportunity to try some synchronous solutions such as chatting by MSN messenger and Skype. Skype offers primarily an IP telephony functionality, which was also tested in the trials. Thus, the students also had the opportunity of communicating orally with fellow students using the PDA and Internet telephony with Skype.

Summary and Conclusions

This paper describes the background and development work of the “always-online environment for mobile learners within the teaching and learning system of NKI Distance Education. The work has been carried out in close co-operation with the partners in the EU Leonardo project “*Mobile learning: The next generation of learning*”. The has been based on experiences and developments during a previous project “*From e-learning to m-learning*”.

The solutions are based on the assumption that students defined as ‘*mobile learners*’ have access to the NKI Internet College through a standard PC and Internet connection, and that the mobile part is seen as a supplement for students when on the move. The solutions are supposed to be generic and based on state of the art technology and also representing technologies that would give experiences of value for future assumed probable developments in software and hardware. The actual equipment used as basis and trials during development was Compaq iPAQ with wireless access technology.

The solutions were tried out with 18 students. The trial and results are presented in a separate paper from the project (Rekkedal & Dye 2005)

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Torstein Rekkedal, Director R & D, NKI distance Education

Testing of an “always-online mobile environment”

May 2005

Introduction

This paper describes the testing of the mobile learning solutions developed by NKI as part of the EU Leonardo Project “Mobile learning: The next generation of learning”.

Test group

Ideally, we would have preferred to test the functionality of the m-learning devices (PDA and mobile phone) and content and communication with real distance students in the ordinary NKI Internet College system. As our main aim in this project was to look into possibilities of equipment and communication (wireless LAN) that presently is not available to a sufficient number of students, we chose to test the “always-online” m-learning solutions in a laboratory setting simulating a distance learning setting. In principle, when not online, the students may communicate via Bluetooth and mobile phone.

The test group consisted of 18 employees of NKI. The members of the test group had all volunteered to participate in the trial. They were all registered as students in the test course three weeks before the testing started. Consequently, they had the opportunity to get acquainted with the course on their PC before testing, reading the materials, trying the interactive materials, listening to sound materials and watching video materials before the test on m-learning equipment and solutions started. Largely this is much in line with the assumptions underlying our m-learning developments; i.e. that the students normally study the course from printed materials and their desktop/laptop PC and apply PDA/mobile phone when on the move.

Another advantage with this composition of the test group was that they all had experience with distance education from different positions, insight in distance education pedagogy, problems and challenges.

Table 1 describes the test group according to their own responses on the questionnaire.

Table 1. Questionnaire section 1. Personal background

	n	%	n	%	n	%	n	%	n	%	N
1. Occupation	Manager		Employee Non-Technical		Employee Technical		Teacher/trainer				18
	3	17	8	44	4	22	3	17			
2. Age grouping	>24 years		25-29 years		30-40 years		41-50 years		> 50 years		18
	-	-	-	-	6	33	2	11	10	56	
3. Gender	Male		Female								18
	7	39	11	61							
4. Level of education	High school		1-3 years post secondary		4 or more post secondary						18
	1	6	8	44	9	50					
5. Mobile device ownership	Mobile phone		PDA		Both						18
	13	72	-	-	5	28					
10. Where did you study?	At home		At work		Both home/w		On travel				18
	-	-	18	100							

No member of the test group had in any way been involved in any developments related to the m-learning project. The 3 managers were the personnel director of the NKI group, the director of NKI distance Education, and the director of the Learning Materials Development Department. The non-technical employees were secretaries (2), student advisors (2), editors (2) a salesman and one representative from the marketing department. The technical employees were 2 consultants from the central IT department, one IT consultant and one IT technical assistant from NKI Distance Education.

The group is older than the average distance education student, over 50 percent being over 50 years. The group also have a higher level of education than the average NKI distance education student.

Concerning mobile device ownership, all test persons, naturally, owned a mobile phone, while only 5 also owned a PDA. Of the 5 test persons who had their own PDA, two had actually stopped using it (because of battery problems) some time ago, and one had newly got a PDA and consequently was not an experienced user.

Concerning our assumptions for the m-learning developments, which is that m-learning functionalities is an additional offer to online distance students who are users of mobile devices and thus may apply this type of equipment when on the move, the test students were at a disadvantage, as most of them needed an introduction to the use of the devices as part of the test. However, this did not turn out to be a problem. Most participants found the equipment quite easy to use (See table 2).

Test situation – context

The test was carried out under a sort of laboratory situation. The test was administered by two of the researchers on the project. One functioned also as tutor during the tests including correction and feedback on test assignments for submission and discussion in the course forum with students. The assistant researcher functioned as observer and guided the test group in using the devices when necessary during the test. Both students and teachers were placed in the same room. This made it possible to observe and register problems and opinions during the trials.

Three students took part at a time in each of six trials. In total 18 test persons completed the trials during the first week of April 2005. Each trial took from one and a half to three hours.

The test was carried out in an “always-online environment” with HP iPAQ h5550 PDAs with built in wireless LAN connected with the NKI Internet College Server. One test person used her newly acquired Qtec 9090 Smart Phone. The iPAQs functions well with Bluetooth and mobile phone connection, while the Qtec has a built-in mobile phone. Phone connection with the server was not included in the tests. This functionality was tested in our previous m-learning project (Rekkedal 2002a, 2002b).

During the trial, the researchers observed the test persons, and viewpoints were registered. Further, the test included submission of assignments and messages to the forum were they could give their opinions on different aspects, such as reading text, viewing graphical materials, navigating in the course etc. Immediately after completion of the trials, the test persons filled in a questionnaire (where part one was identical for students tested by the other partners in the project, and part two contained questions on the specific aspects of the NKI part of the project). The complete questionnaire is presented in Appendix 1.

Test procedures

The test procedures are described below:

Introduction to the PDA and use of equipment

As the majority of the test persons were not users of a PDA, we started the test by describing the hypothetical real situation lying behind the developments and how to use the PDA.

Logging in and navigation on the NKI Internet College personal page

The students were asked to log into their pages on the Internet College and to navigate and examine their personal page as it is presented on the PDA.

Navigating in the course

After having been acquainted with the personal start page, the students had the opportunity to navigate around in the course.

Reading study unit 1

The students read the text of study Unit 1.

Submissions of Study Unit 1:

“What is your opinion of reading course texts on the PDA?” Instead of answering the ordinary assignment for submission, the students wrote an answer to the above question. Submission 1 involved using Pocket word for writing the answer, storing the word document, opening e-mail programme, attaching document, sending and receiving e-mails. During the test the students received feedback from the tutor with comments.

Examining multi media (ordinary multi media in the course)

The following standard multi media elements in the course were examined:

- Sound
- Video
- Multimedia
- Multiple-choice questions
- Drag and drop exercises

In addition the test course included some multi media elements specifically developed for mobile learning:

- Sound
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- Animations with and without sound
- Multiple-choice questions
- Drag and drop exercises
- Synthetic speech

Reading in course Forum

The functionality of reading in the course forum and writing messages to the forum was also tried out. The first message was written by the tutor. The test students received messages by e-mail onto the PDA and also read the same messages on the course pages.

Writing messages to the Forum

Writing messages to the forum may be done either by writing in Pocket Word and paste into the Forum text box, or by writing directly into the text box. The latter solution was applied in the tests.

The question to discuss in the forum was: *“What is your opinion of navigating and finding your way in the course?”*

An overview of answers given both on the assignment (reading) and to the forum (on orientation and navigation) is presented later in this paper.

More about navigation in the course

The students also examined the course functionality through reading presentations of other students and writing e-mails to fellow students, sending and receiving mails. Some of the groups wrote e-mail to their fellow students on the theme: *“Opinions on the experience of multi media on the PDA”*

Synchronous communication

Although NKI in general puts little emphasis on synchronous communication, as this project concerned a theoretical always-online environment, we took the opportunity to try some synchronous solutions such as chatting by MSN messenger and Skype. Skype is primarily an IP telephony service, which was also tested in the trials. Thus, they also had the opportunity of communicating orally with fellow students using the PDA and Internet telephony with Skype.

Results

The first part of the questionnaire after the personal background questions concerned user-friendliness. The answers are presented in table 2.

User friendliness

Table 2. Questionnaire section 2. Student user friendliness

	Strongly Agree		Agree		Uncertain		Disagree		Strongly disagree		N
	n	%	n	%	n	%	n	%	n	%	
Equipment easy to use	4	22	13	72	1	6	-	-	-	-	18
The mobile learning exp. was fun	10	56	6	33	2	11	-	-	-	-	18
I could take another m-learning course	1	6	8	44	7	39	1	11	-	-	18
I would recommend m-learning	3	17	11	61	2	11	1	11	-	-	18

Compared with the first trial of the first project (Rekkedal 2002a, 2002b) our test students this time seem to be more positive on user friendliness of the equipment and solutions measured by the four variables presented in table 2.

Nearly all the test persons found the equipment easy to use and also found that the experience was “fun”. Concerning the questions about whether they would like to take another m-learning course or recommend m-learning to others, the answers are, not surprisingly,

somewhat more reserved, as their experiences from the test situation probably is a little restricted to enable them to answer these questions.

Didactic efficiency

Concerning efficiency for learning, it is important to consider mobile learning at NKI Internet College, as one part of a complete online distance learning environment. These assumptions were clearly presented and discussed with the test persons, who before the test took part in a two-hour seminar on the background for the project and didactic assumptions underlying the developments.

Table 3. Questionnaire section 3. Didactic efficiency

	Strongly Agree		Agree		Uncertain		Disagree		Strongly disagree		N
	n	%	n	%	n	%	n	%	n	%	
11. M-learning increases quality	5	28	4	22	7	39	2	11	-	-	18
12. Learning obj. can be met by m-l.	2	11	11	61	4	22	1	6	-	-	18
13. Access. course content was easy	3	17	15	83	-	-	-	-	-	-	18
14. Communication w. tutor was easy	7	39	9	50	2	11	-	-	-	-	18
15. M-l conven. for comm. w. students	7	39	8	44	2	11	1	6	-	-	18

Again, it is clear that the students in this project were more positive than the students of the previous project. This may be related to differences both in context (the present students studied in a laboratory setting with continuous supervision and support if having difficulties, while the students in the first project studied under more realistic conditions. Question 13 was a little different on the two occasions (first project: “Downloading course content”, this project: “Accessing course content”).

In general, we may conclude that after the m-learning experience, taken the assumed context of m-learning as a supplement to the distance online learning environment, the students believe that “m-learning increases quality, that objectives can be met by m-learning, that accessing course content and communication with the tutor was easy, and that m-learning is convenient for communication with other students.”

Technical feasibility

Table 4. Questionnaire Section 4. Technical feasibility

	Strongly Agree		Agree		Uncertain		Disagree		Strongly disagree		N
	n	%	n	%	n	%	n	%	n	%	
16. Navigation was easy	3	17	14	78	1	6	-	-	-	-	18
17. Graphics and illustr. necessary	2	11	5	28	8	44	3	17	-	-	18
18. Eval. and quest. was effective	1	6	9	50	7	39	1	6	-	-	18

Most of the students found navigation easy. This aspect was also answered during the test as an assignment for trying the use of keyboard, applying pocket Word, storing files, sending and receiving e-mails with attachments from the PDA. Some of the viewpoints are presented below:

Comments on orientating oneself, navigating and finding the way in course materials on the PDA:

- Basically, it was easy to orientate in the course materials, some guidance and some time helps, and you are really working without difficulties.

- *The challenge was to get to know the PDA. Changing between the different programmes was unusual, however, it did not take long to learn the most important functions. Navigating in the course I found easy. The action bars for the course/course pages were so dominating that it was impossible to ignore them. All in all – quite easy to use and find your way.*
- *I think this functioned very well.*
- *It was in fact very easy to orientate oneself and navigate in the course – as it was easy to recognize action bars from the PC.*
- *It was much more easy to find your way than I had actually expected.*
- *I found it very easy to get oriented on the course pages. The texts are surprisingly good to read on such a small screen. However, it is a great advantage when it is not a lot of text to read at a time. I found it easy to navigate, to find and use action bars and to change between pages etc.*
- *I found navigating not much more difficult than on a PC, but it is obviously an advantage to have used the course materials on a PC before using the PDA.*
- *I found navigating very easy, simple and easy to follow.*
- *I found it a little difficult at first, but with some experience I believe it will become very easy to navigate and find your way.*
- *Navigation was very easy.*
- *Navigation was easy, but a little bothersome.*
- *No problems.*
- *Navigating and writing were no problem, but waiting for pages to load took a little too long (QTEK).*
- *It took some time before I felt easy with the use of the PDA, but it was exciting.*
- *It works well, but downloading pages takes a little time. As I am not an experienced PDA user some actions take some time, in spite of this I find the PDA very easy to use.*

As we can read from the comments above, the students in general expressed that it was easy to navigate and find one's way in the course. Naturally, as the majority of the students did not have previous experience with the equipment, they were in a less favourable position than the assumed m-learning student, who is supposed to be a daily user of the devices. There is some indication that navigating and using the equipment is more efficient and functional than with standard PC equipment.

Although, the test was carried out with only 18 students, it became evident that test persons with a technical background were less tolerant towards the lower functionality of PDA compared with a PC. This also coloured the opinions of the technical persons on most aspects of m-learning covered by the questionnaire. This fact might be seen as surprising, that persons with technical training and experience are less positive to the new technology. However, this situation was similar in our previous research (Rekkedal 2002a, 2002b). That persons with a technical background were less enthusiastic, could also indicate that the generally quite positive opinions expressed by the other test persons, partly could be related to the experience of trying new and exciting technology. However, we find that there is reason to believe that with the m-learning devices, hardware and software is developing quickly, and that the functionality increases rapidly and hopefully will also satisfy expectations of the more demanding technologists.

The test persons did not agree whether graphics and illustrations are necessary. More than half of the students were uncertain or actually disagreed with the statement that “graphics and illustrations are necessary for m-learning to be effective”. This opinion can partly be a result of the assumed context that the students would also have the possibility to study

learning materials on standard equipment, and also to the fact that most of NKI learning programmes are quite theoretical and based on the study of text materials.

A majority agreed that evaluation and questioning was effective. But again some were uncertain or even negative. This is probably related to the fact that in the trial, some of the test and questioning materials were distributed with graphical materials, which still is far from perfectly presented on the PDA.

Cost effectiveness

The questionnaire section on cost effectiveness covered access to education and training, cost of accessing course materials and cost of communicating with tutor and other students. Questions concerning costs are not of specific interest, as the assumption to the context of m-learning is an “always-online” environment with free and unrestricted access to the Internet. The previous project demonstrated also that having downloaded course content; the cost of communication was absolutely acceptable even by mobile phone from abroad.

Table 5. Questionnaire Section 5. Cost effectiveness

	Strongly Agree		Agree		Uncertain		Disagree		Strongly disagree		N
	n	%	n	%	n	%	n	%	n	%	
19. M-learning increases access	5	28	7	39	5	28	1	6	-	-	18
20. Cost of access. course content was acceptable	4	24	3	18	8	48	2	11	-	-	18
21. Cost of comm. was acceptable	5	29	4	24	6	35	2	11	-	-	18

Most of the participants agree that m-learning increases access to learning. On the negative side is, of course, that access to technology is still lacking. The market for PDAs has not yet taken off. The opinions concerning costs should be given on the assumptions that there would be free access to the Internet. Many answered just “uncertain” as they did not know much about the real situation in practice. Those, mainly technologists, who responded negatively on costs, just did not feel certain that the assumed situation would come into being in a foreseeable future.

Opinions on functionalities specifically used in the NKI m-learning project

The NKI research covered specifically functionalities related to the “always-online environment” and the use of graphics and multi-media as well as interactive assignments based on graphics and sound. Part 2 of the questionnaire, thus contained questions on the specific developments of the NKI research.

Synchronous communication

The general teaching and learning philosophy for NKI online distance education is based on andragogy and distance education research, such as Moore’s “theory of student autonomy and transactional distance” (Moore 1991, 1993), Holmberg’s theory of “didactical conversation” (or “teaching-learning conversation”) (Holmberg 2001) and emphasis on maximum (or at least optimum) flexibility (see e.g. Paulsen 2003, Paulsen & Rekkedal 2003, Rekkedal 2004). The learning philosophy is presented as:

“NKI distance education shall arrange studies in a way so that the students can reach their learning goals through optimum individual flexibility in a community of learning where all students should be a resource for each other’s learning without being dependent on each other” (The authors’ translation) (NKI 2005).

The consequences of the learning philosophy is that NKI organises the studies so that any student can enrol for any course or programme 365 days a year and follow their own progression scheme. At the same time the learning management system and functionalities are built up to stimulate interaction and communication between the students. All organised activities are based on the assumptions that communication is asynchronous. These solutions do not restrict synchronous communication between students on their own initiatives or sporadic synchronous communication, e.g. telephone conversation or chat between a student and a tutor. But all formally organised activities take place by asynchronous communication. (It should be noted that many NKI programmes are also offered as combined (or “blended”) learning with regular classes or week-end seminars. But these programmes have not been the objects of the research in the m-learning projects.)

However, on the assumption of m-learning taking place in an always-online environment, we were also interested in trying out the functionality of synchronous communication.

Chat

Table 6. Questionnaire Part 2. Previous experience with chat.

	Yes, a lot		Yes, some		No, not at all		N
	n	%	n	%	n	%	
22. Previous experiences with chat	2	11	7	39	9	50	18

Half of the test persons were new to chatting before the trial. Consequently, it must have been difficult comparing the chat function on the PDA and on a PC. This is also shown by 5 persons not answering the question on comparing the user-friendliness of the chat function on the PDA relative to a PC:

Table 7. Questionnaire Part 2. User-friendliness of chat function on PDA.

	Better than on PC		Same as PC		Worse than on PC		N
	n	%	n	%	n	%	
23. User-friendliness of the chat function	2	15	8	62	3	23	13

No answer: 5

Generally it seems that the test persons assume that according to their experiences in the m-learning test, the chat function is similar in functionality with chatting on an ordinary PC. Most of the participants with some experience of chatting find the two media similar in functionality.

Table 8. Questionnaire Part 2. Chat in mobile learning can be very useful.

	Strongly Agree		Agree		Uncertain		Disagree		Strongly disagree		N
	n	%	n	%	n	%	n	%	n	%	
24. Chat in m-learning can be very useful	3	17	11	61	3	17	1	6	-	-	18

Most of the students answered that they believed that the chat function could be useful in m-learning. There is one response on the negative side. It should be noted that the participants in general had little experience with chat. It is probable that the one who answered negatively would hold the position that chatting is not very useful in any online distance course.

IP telephony

The Skype communication program with functionalities both for chatting and telephone communication was installed on all the PDAs used during the tests. All test persons, except the one using the Qtec did try IP telephony as part of the trials.

Table 9. Questionnaire Part 2. IP telephony functions very well on the PDA

	Strongly Agree		Agree		Uncertain		Disagree		Strongly disagree		N
	n	%	n	%	n	%	n	%	n	%	
26. IP telephony functions very well	6	35	9	53	1	6	1	6	-	-	17

No answer: 1 (test person with Qtec, Skype not installed)

The test persons generally expressed that they were impressed by the quality of IP telephony on the PDAs.

Table 10. Questionnaire Part 2. IP telephony in mobile learning can be very useful.

	Strongly Agree		Agree		Uncertain		Disagree		Strongly disagree		N
	n	%	n	%	n	%	n	%	n	%	
27. IP telephony in m-learning can be very useful	5	29	7	41	4	24	1	6	-	-	17

No answer: 1 (test person with Qtec, Skype not installed)

Most of the students also agreed with the statement that IP telephony could be very useful in mobile learning. Again, the person disagreeing probably holds the position that synchronous communication generally is not useful in distance learning mainly based on asynchronous communication.

Asynchronous communication

e-mail

Table 11. Questionnaire Part 2. Communication by e-mail.

	Strongly Agree		Agree		Uncertain		Disagree		Strongly disagree		N
	n	%	n	%	n	%	n	%	n	%	
28. Comm. with tutor functioned well	9	50	8	44	1	6	-	-	-	-	18
29. Comm. with other students functioned well	8	44	8	44	2	11	-	-	-	-	18

Table 11 clearly shows that according to the students **communication by e-mail functioned well on the PDA**. It should also be noted that there is no difference in communicating with the tutor or fellow students, except that when communicating by mail to students they might wish to send the same e-mail to a number of persons, which may involve some more difficult operations on the PDA.

Discussion forum and assignments for submission

For writing messages to the forum, the students had to open the text box on the Forum pages of NKI Internet College and write their messages. All agreed that a portable keyboard is a need for writing more than very short messages. If not online, a student will normally write the forum messages in a text processor and paste it into the text box on the forum pages. During the test all messages to forum was written directly into the text box.

When submitting assignments to the tutor, the students had to use the Pocket Word programme, store and retrieve files and attach files to e-mails sending and receiving mails. For students inexperienced with the use of a PDA, these operations may seem a little complicated. All these activities seemed to have functioned satisfactorily for most of the students.

Table 12. Questionnaire Part 2. Discussion forum and assignments.

	Strongly Agree		Agree		Uncertain		Disagree		Strongly disagree		N
	n	%	n	%	n	%	n	%	n	%	
30. Writing to the forum functioned well	9	50	8	44	1	6	-	-	-	-	18
31. Answering assignments functioned well	4	22	10	56	2	11	2	11	-	-	18
32. Sending assignments to the tutor functioned well	5	28	9	50	3	17	1	6	-	-	18

All these three aspects seem to have functioned well. There are few responses on the negative side. Again, it is typical that the technologists are the most sceptical, finding that the necessary operations for doing the work are too bothersome and less functional than on a PC. Correct or not, they argue that better functionality is necessary for mobile learning, in the assumed context, to take off in the market.

Courseware

Text

Table 13. Questionnaire Part 2. Accessing and reading text and making notes.

	Strongly Agree		Agree		Uncertain		Disagree		Strongly disagree		N
	n	%	n	%	n	%	n	%	n	%	
33. Access. and reading text functioned well	4	6	12	67	2	11	-	-	-	-	18
34. Making notes functioned well	1	6	11	65	2	12	3	18	-	-	17*

*No answer:1

The students were generally very positive towards reading text on the PDA. It should be noted that on the course pages of the NKI Internet College there is a bug (collision of style sheets) that results in some text being presented in size 12 and some in size 11.5. On an ordinary PC screen this difference is hardly detectable. But on the PDA screen the difference in text size is considerable. This problem did cause some annoyance demonstrated in the comments below (which was an answer to a question used in the trial for sending as an assignment to the tutor). From the answers in table 11 we would conclude that the students accepted the quality of the text for reading on the PDA.

Open answers to the functionality of reading texts:

- It was easy to read. I find it better to read the text on the PDA screen than on an ordinary PC screen.

- I find it quite easy to read short texts with the larger text size. Smaller texts make it important not to receive reflexes on the screen to be able to read easily. It is important with

clear breaks in texts and not to apply negative texts, for example white text on blue background (as in some of the graphical materials).

- Reading ordinary text was easy. Navigation was easy. When watching the graphical materials it was difficult to orientate oneself with increased illustration in the interactive assignments. Small text sizes were difficult to read. Negative texts were impossible to read.*
- Reading on the PDA I found reasonably fine and easy as long as the text size is sufficiently large. With sufficient and uniform text size reading is no problem at all.*
- Reading on the PDA screen is much better than one should believe based on the small size. However the smallest text size was for me too small.*
- The texts are absolutely readable. Sounds are good. It is a little awkward to scroll while reading. It might be tiresome over time, but the increased flexibility is important.*
- I found reading on the PDA surprisingly fine – very clear. The experience with the multi-media materials illustrates that the light texts on dark background do not function well.*
- Reading the texts was surprisingly easy.*
- I found it very easy to read and got good overviews of the materials – as long as there is not too much text at a time.*
- Most of the texts were easy to read, but some texts were too small.*
- The texts were easy to read, but took some more time than on the PC. The scrolling might be a little confusing, but this is probably just a question of experience.*

Concerning note taking, the students just assumed that using the Pocket PC Word processor and the portable key board making notes while reading would function well. Again, it was typical that the 3 persons answering on the negative side on the functionality of making notes on the PDA are all technologists.

Multi-media on the PDA

During the test the students had the opportunity to try the functionality of different kinds of multi-media. Sound was presented as human voice in some of the multi-media assignments, in instructional sequences with sound and moving graphics, and sound was also demonstrated by synthetic voice. One part of an instructional sequence on video clip was also included. Concerning video, the PDA with present software did not handle video very efficiently. To watch the video the student first had to download the complete video in the browser, and then copy the URL into the PDA media player, and then play the video in streaming mode from the media player.

Multi-media materials consisted both of instructional sequences with sound (voice) and moving graphics and exercises/assignments produced in Macromedia flash. These multi-media materials were of two kinds, multi-media produced specifically for presentation on PDA and standard multi-media produced originally without any relation to m-learning devices. It seems clear that the PDA screen is far from ideal for perceiving graphical illustrations with small details and more than a few words of text. If one turns off the “fit to screen” setting, the graphical materials become easier to read, but then one has to scroll both horizontally and vertically to see the whole illustration. Neither solution is generally satisfactory. In this connection, we should probably refer to the assumed context that the students also have access to an ordinary PC when not on the move, and that presently the solutions for watching graphical materials with small details are not suited for presentation on the PDA.

Table 14. Questionnaire Part 2. Multi-media on the PDA.

	Strongly Agree		Agree		Uncertain		Disagree		Strongly disagree		N
	n	%	n	%	n	%	n	%	n	%	
35. Accessing and listening to sound functioned well	3	18	14	82	-	-	-	-	-	-	18
36. Accessing and watching video functioned well	1	6	6	38	5	31	4	25	-	-	16*
37. Accessing and perceiving graphical materials functioned well	2	12	6	35	5	29	4	24	-	-	17**
38. Act./assignm. involving manipulation of graph. materials functioned well	-	-	3	19	10	63	4	19	-	-	16*

* no answer: 2, ** No answer: 1

Table 14 shows that the students were generally positive concerning the quality to both human and synthetic sound on the PDA – all responding on the positive side of the scale. The opinions differ more concerning the functionality of the video. However, it seemed clear that the uncertain and negative responses concerning video were more related to the bothersome way of playing the video (that it did not play directly from clicking the link in the browser) rather than to the quality of the video itself. In fact, the students found the quality of the streamed video quite good.

The answers concerning the graphical materials support the impressions that presently graphical materials do not function satisfactorily on the PDA.

Overall views on the “always-online environment”

The final questions concerned some overall views on m-learning in this trial defined as an “always-online” environment. Concerning the first question, “views on the always-online mobile environment compared with PC access and applications in studying this course” turned out to be ambiguous. The students obviously did not understand whether the mobile learning environment should be assessed as such compared with only PC access, or seen as an addition. It is probable that those answering negatively have seen the m-learning environment in isolation, while those answering positively have understood the question as covering the m-learning environment only.

Table 15. Questionnaire Part 2. The “always-online” environment.

	Much better		Better		Uncertain		Worse		Much worse		N
	n	%	n	%	n	%	n	%	n	%	
39. Always-online compared with PC access and applications	-	-	3	17	7	39	5	28	3	17	18

Table 16. Questionnaire Part 2. Acceptable with mobile access only.

	Absolutely		Probably		Uncertain		Probably not		Absolutely not		N
	n	%	n	%	n	%	n	%	n	%	
40. Accept. to study the course with mobile access only	1	6	2	11	2	11	8	44	5	28	18

We can clearly conclude, that although the majority of the students have responded quite positively to most of the questions concerning the m-learning environment, they do not find the solutions satisfactory for mobile access only. This is in line with our assumptions that m-learning in the NKI college is seen as an addition to increase access and flexibility of learning. This view is supported by the answers to the final questions.

Table 17. Questionnaire Part 2. Always-online and flexibility and course quality

	Strongly Agree		Agree		Uncertain		Disagree		Strongly disagree		N
	n	%	n	%	n	%	n	%	n	%	
41. Always-online mobile access increases flexibility	3	33	11	56	2	11	-	-	-	-	18
42. Increased accessibility and flexibility increase quality of course arrangements	1	6	11	61	5	28	1	6	-	-	18
43. Increased accessibility and flexibility increase quality of learning outcomes	1	6	5	28	11	61	1	6	-	-	18

A large majority of the students agree to the statement that “always-online mobile access to the course as an addition to access on standard PC equipment increases the flexibility of e-learning”. There are no answers on the negative side of the scale. 2 students answer “uncertain”. These two respondents are again two of the technologists taking the course in the trial. Their “uncertain” response probably signals that they found the solutions not efficient enough to make use of the possibilities in practice.

We may also note that a majority also find that the m-learning solutions “increase the overall quality of the course arrangements”. Concerning “quality of learning outcomes” the answers show that, probably because the trial was carried out under simulated learning conditions, a majority find that it is difficult to answer the question.

Additional comments on the questionnaire:

The questionnaire ended with space for open answers and general comments and comments on functionality and user-friendliness. The following comments were received:

- *Very feasible as additional equipment.*
- *It was just as fun as expected and much easier than assumed.*
- *I certainly believe that these solutions would strengthen distance learning methodologically. It increases flexibility and the possibility of exploiting “all” free hours for study when you have access to the Internet.*
- *It was easy to navigate and to use the menus. It was just fine to read texts, but illustrations were a little too small. Very practical when you don’t want to bring a lot of books and read a course that contains texts/information/illustrations. Not all courses are perhaps suitable. I would not have the energy to read a lot of text at a time, but very suitable for repetitions etc. Very funny, clear and easy to use, fine as supplement.*
- *Course materials are not good on a PDA – readable, OK, but paper is best and PC is second. As I understand on the condition that mobile devices and solutions are supplements, this is necessary. The great advantage is increased flexibility related to cooperation, Forum discussions, e-mail and chat. Concerning multi-media, not good. Much of it becomes too small and transmission speed is important. Good multi-media elements are nevertheless very valuable.*

- *As a student I use books and other study materials. Personally, I find that it is more convenient to use a PDA than ordinary PC with keyboard. This gives more space on the table and better overview. Concerning taking a test or answering assignments for submission, I would prefer an ordinary PC with keyboard. Else I would say that I found reading course materials on the PDA were very convenient. Normally I print out pages to read. With a PDA I believe I would prefer to read more from the screen.*
- *The texts on graphical materials was difficult to read when the background was darker than the text. Normal reading with light background was surprisingly easy to read.*

The comments illustrates to some extent information given by ticking the questionnaire and during the trials. The mobile devices are seen as feasible additional equipment (in line with our assumptions for the developments). Some comments indicate differences in views on how attractive reading on the PDA screen really is. The comments also indicate that the m-learning solutions are suitable for reading, for communicating when on the move and for repetition of materials studied on ordinary equipment.

Summary and conclusions

This paper has described and discussed the functionality of an “always-online m-learning environment” including the quality of multi-media elements, text and communication via PDA with WLAN connection. The development of solutions was part of the EU Leonardo Project “Mobile learning: The next generation of learning”.

The assumptions of the NKI project are that the use of mobile learning devices is an addition to course access on ordinary PC equipment. The assumption was also that ideally the developments are mainly done on the server side to find solutions that make it possible to deliver all NKI online distance learning courses so that they can be studied with satisfactory quality on mobile devices by students on the move, and also so that other students not applying mobile solutions can participate in the same courses.

The trials were carried out as “laboratory tests” with mobile learning devices. The students were NKI employees all registered in the course “Sales and services”. We carried out 6 trials with an average of 3 students in each trial.

The test covered all aspects of an “always-online m-learning environment”:

- Logging in and navigation on the NKI Internet College personal page
- Navigating in the course
- Reading
- Submissions of assignments
- Multi-media (ordinary multi-media and multi-media specifically developed for m-learning)
- Reading in course Forum
- Writing messages to the Forum
- Synchronous communication (IP telephony and two versions of chat)

Concerning student user-friendliness of mobile learning in the context examined, nearly all the test persons found the equipment easy to use and also found that the experience was “fun”. Concerning the questions about whether they would like to take another m-learning course or recommend m-learning to others, the answers are, not surprisingly, somewhat more reserved,

as their experiences from the test situation probably is a little restricted to enable them to answer these questions firmly.

When it comes to didactic efficiency, we may conclude that after the m-learning experience, taken the assumed context of m-learning as a supplement to the distance online learning environment, the students believe that “m-learning increases quality, that objectives can be met by m-learning, that accessing course content and communication with the tutor was easy, and that m-learning is convenient for communication with other students.”

Most of the students found navigation easy. The test persons did not agree whether graphics and illustrations are necessary. More than half of the students was uncertain or actually disagreed with the statement that “graphics and illustrations are necessary for m-learning to be effective”. This opinion can partly be a result of the assumed context that the students would also have the possibility to study learning materials on standard equipment, and also to the fact that most of NKI learning programmes are quite theoretical and based on the study of text materials.

A majority agreed that evaluation and questioning was effective. But again some were uncertain or even negative. This is probably related to the fact that in the trial, some of the test and questioning materials were distributed with graphical materials, which still is far from perfectly presented on the PDA.

Most of the participants agree that m-learning increases access to learning. On the negative side is, of course, that access to technology is still lacking. We have previously shown that communication costs, even when communicating by mobile phone were acceptable. In these trials, we assumed that the learning could take place in an always-online environment with free access.

The students tried synchronous communication both by chat and IP telephony. Generally, it seemed that the test persons assume, that according to their experiences in the m-learning test, the chat function is similar in functionality with chatting on an ordinary PC. The majority also answered that they believed that the chat function could be useful in m-learning.

The test persons generally expressed that they were impressed by the quality of IP telephony on the PDAs. Most of the students also agreed with the statement that IP telephony could be very useful in mobile learning. The one person disagreeing probably held the position that synchronous communication generally is not useful in distance learning mainly based on asynchronous communication.

According to the students, sending and receiving e-mails, writing to the course forum, answering assignments with Word attachments and sending/receiving assignments functioned well. There are few responses on the negative side.

The students were generally very positive towards reading text on the PDA.

The students were generally positive concerning the quality of both human and synthetic sound on the PDA – all responding on the positive side of the scale. The opinions differed more concerning the functionality of the video. However, it seemed clear that the uncertain and negative responses concerning video were more related to the bothersome way of playing

the video rather than to the quality of the video itself. In fact, the students found the quality of the streamed video quite good.

The answers concerning the graphical materials support the impressions that presently graphical materials do not function satisfactorily on the PDA.

Although the majority of the students have responded quite positively to most of the questions concerning the m-learning environment, they do not find the solutions satisfactory for mobile access only. This is in line with our assumptions that m-learning in the NKI college is seen as an addition to increase access and flexibility of learning.

The students agree generally that the always-online mobile solutions increase the flexibility of e-learning. To a large extent they also agree that the m-learning solutions tried out increase the quality of course arrangements. More than half of the students are uncertain whether the solutions tried out actually increase the quality of learning outcomes. This is, of course, a very difficult question to answer based on the experiences from the test situation.

It was clear that some of the students with a technical background and working in IT-positions were less enthusiastic than the other participants. According to their statements during the trial they were less tolerant towards operations that were more complicated or taking longer time than on standard PC equipment. This could be seen as an indication that the technology still has to be developed further before it is attractive enough for a sufficient number of online learners. However, the research so far has demonstrated that developing solutions that make courses available in sufficient quality independent of devices on the user side seems to be a sound strategy.

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Appendix 1. QUESTIONNAIRE ON MOBILE LEARNING

PART 1

Section 1. Personal background

1. What is your occupation?

Manager
Employee non-technical
Employee technical
Teacher or trainer
Student
Unemployed
Other

2. What is your age grouping?

24 or younger
25-29
30-40
41-50
over 50

3. Gender?

Male
Female

4. What is your level of education?

High school matriculation
One to three years of post-secondary education
Four or more years of post-secondary education

5. Mobile device ownership – do you own?

A mobile phone?
A PDA (personal digital assistant), pocket PC or palmtop?

Section 2. Student user-friendliness

6. It was easy to use the equipment in this mobile learning course

Strongly agree
Agree
Uncertain
Disagree
Strongly disagree

7. This mobile learning experience was fun

Strongly agree
Agree
Uncertain
Disagree
Strongly disagree

8. According to my experience I would take another mobile learning course if relevant to my learning needs

Strongly agree
Agree
Uncertain
Disagree
Strongly disagree

9. I would recommend mobile learning as a method of study to others

Strongly agree
Agree
Uncertain
Disagree
Strongly disagree

10. Where did you study the mobile learning course?

At home
At the office or work
While travelling
Other

Section 3. Didactic efficiency

11. Mobile learning increases the quality of e-learning

Strongly agree
Agree
Uncertain
Disagree
Strongly disagree

12. Course learning objectives can be met by mobile learning

Strongly agree
Agree
Uncertain
Disagree
Strongly disagree

13. Accessing course content was easy

Strongly agree
Agree
Uncertain
Disagree
Strongly disagree

14. Communication with and feedback from the tutor in this course was easy

Strongly agree
Agree
Uncertain
Disagree
Strongly disagree

15. Mobile learning is convenient for communication with other course students

Strongly agree
Agree
Uncertain
Disagree
Strongly disagree

Section 4. Technical feasibility

16. Navigation through the mobile learning course was easy
Strongly agree
Agree
Uncertain
Disagree
Strongly disagree
17. For mobile learning to be effective it is necessary to use graphics and illustrations

Strongly agree
Agree
Uncertain
Disagree
Strongly disagree
18. Evaluation and questioning in the mobile learning course was effective

Strongly agree
Agree
Uncertain
Disagree
Strongly disagree

Section 5. Cost effectiveness

19. Mobile learning increases access to education and training

Strongly agree
Agree
Uncertain
Disagree
Strongly disagree
20. The cost of accessing the mobile course materials was acceptable

Strongly agree
Agree
Uncertain
Disagree
Strongly disagree

21. The cost of communicating in the mobile learning course with the tutor and other students was acceptable.

Strongly agree
Agree
Uncertain
Disagree
Strongly disagree

PART 2

In this mobile learning course the following functionalities were used on mobile devices in an always-online environment:

Synchronous communication:

Chat

22. Have you previous experiences using chat?

Yes, a lot
Yes, some
No, not at all

23. How do you view the user-friendliness of the chat function on PDA?

Better than on PC
Same as PC
Worse than PC

24. Chat in mobile learning can be very useful

Strongly agree
Agree
Uncertain
Disagree
Strongly disagree

IP telephony

25. Did you try IP telephony in connection with the mobile learning course?

Yes
No

26. IP telephony functions very well on the PDA

Strongly agree
Agree
Uncertain
Disagree
Strongly disagree

27. IP telephony in mobile learning can be very useful

Strongly agree
Agree
Uncertain
Disagree
Strongly disagree

Asynchronous communication:

E-mail

28. Communication with the tutor by e-mail functioned well

Strongly agree
Agree
Uncertain
Disagree
Strongly disagree

29. Communication with other students by e-mail functioned well

Strongly agree
Agree
Uncertain
Disagree
Strongly disagree

Discussion forum

30. Writing messages to the Forum functioned well

Strongly agree
Agree
Uncertain
Disagree
Strongly disagree

31. Answering assignments for submission applying the PDA functioned well

Strongly agree
Agree
Uncertain
Disagree
Strongly disagree

32. Sending assignments for submission to the tutor functioned well

Strongly agree
Agree
Uncertain
Disagree
Strongly disagree

Courseware:

Text

33. Accessing and reading text on the PDA functioned well

Strongly agree
Agree
Uncertain
Disagree
Strongly disagree

34. Making notes on the PDA functioned well

Strongly agree
Agree
Uncertain
Disagree
Strongly disagree

Multimedia:

Sound

35. Accessing and listening to sound materials functioned well

Strongly agree
Agree
Uncertain
Disagree
Strongly disagree

Video

36. Accessing and watching video materials functioned well

- Strongly agree
- Agree
- Uncertain
- Disagree
- Strongly disagree

Graphics

37. Accessing and perceiving graphical materials functioned well

- Strongly agree
- Agree
- Uncertain
- Disagree
- Strongly disagree

38. Activities/assignments involving manipulation of graphical materials functioned well

- Strongly agree
- Agree
- Uncertain
- Disagree
- Strongly disagree

The always-online environment

39. Overall, how do you view the always-online mobile environment compared with PC access and applications in studying this course?

- Much better
- Better
- Uncertain
- Worse
- Much worse

40. Would you find it acceptable to study this course with mobile access only?

- Absolutely
- Probably
- Uncertain
- Probably not
- Absolutely not

41. Always-online mobile access to the course as an addition to access on standard PC equipment increases the flexibility of e-learning

- Strongly agree
- Agree
- Uncertain
- Disagree
- Strongly disagree

42. Increased accessibility and flexibility of always-online mobile access to the course as an addition to access on standard PC equipment increases overall quality of the course arrangements

- Strongly agree
- Agree
- Uncertain
- Disagree
- Strongly disagree

43. Increased accessibility and flexibility of always-online mobile access to the course as an addition to access on standard PC equipment increases quality of learning outcomes

- Strongly agree
- Agree
- Uncertain
- Disagree
- Strongly disagree

PART 3

Comments:

Comments on equipment functionality and user-friendliness:

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Technical working paper 2005, NKI Distance Education
Exploring online services in an mobile environment – updated version of the paper from 2004

May 2005

This paper is written as a part of the project "Mobile Learning: The Next Generation of Learning" as a result of the research done at NKI Distance Education (NKI) for adapting SESAM (NKI's learning management system (LMS) to the mobile environment. The aim of this project was to develop and adapt courses for current and future mobile handsets where mobile learning is defined as the provision of training courses via wireless devices – Personal Digital Assistants (PDAs), smart phones and mobile telephones. These courses will be developed as part of a fully functional mobile Learning Management System (mLMS) and the courses will be tested and evaluated, and the results widely disseminated. The web page of the Leonardo project is found at: <http://learning.ericsson.net/mlearning2/index.shtml>.

This paper accounts for and discusses the challenges of adapting layout of the content from the traditional LMS to serve mobile clients such as a PDA or similar devices. Smart phones and mobile telephones are not discussed in this article as the screen is much smaller and has other limitations that need special attention. When the term "mobile device" is used it refers to a handheld device that is capable of displaying hypertext mark-up language (html). This paper deals with PDAs used as a mobile client accessing NKI's LMS, SESAM.

Summary

This technical working paper is written by developers at NKI in the EU Leonardo project "Mobile Learning: The Next Generation of Learning", and describes the work carried out in the second year of the project. We have enhanced our LMS to provide services and web pages for mobile clients with a built-in html compatible web browser. We have simulated the future, as we believe it might be, with a wireless always-online environment with five mobile users. We have also tested the course in a controlled environment with 18 people. The services we found interesting and useful were IP Telephony by the use of Skype and messaging services such as MSN Messenger (Skype also has this feature). We chose the Pocket Internet Explorer that comes with PDAs with the Windows Mobile operating system as our browser of choice. We are still looking forward to the development of Opera's Small-Screen Rendering™ browser for the PDA that hopefully will enhance the readability and screen rendering on small screens. Until then we have chosen to make use of Cascading Style Sheet (CSS) to make changes in the layout and providing the appropriate style sheets based on the clients accessing the page. Some of the most important findings were that if the structure of the document is good, the challenge of transforming content to the small screens or different layouts was actually requiring less effort than expected. We did experience difficulties with large illustrations that contained too much information for the small screens as well as large flash animations with fixed width. This is a problem we still have, but the work-around is to zoom in and scroll on the illustration that needs a certain size to be understood.

The need for adapting to mobile devices

To better serve the increasing demand for different formats as well as mobility we need to give the mobile user a better experience with existing web pages. The reason for targeting mobile devices at this point is because there are more and more users who acquire mobile devices and want to use them with our services. The market is still limited, but increasing for mobile users – this is why we needed to adapt the existing web pages and services to the mobile devices.

One of the biggest challenges concerning the mobile devices was to find acceptable solutions adapted to the small screen. There is simply not enough space for all the information found on a traditional web page on a small screen. Another problem was the limited data transfer rate and processing power found in mobile devices. When people use a mobile device with Internet connectivity, the connection speed is traditionally lower for instance via a mobile phone. This is why we have chosen to design for the future, as we believe it might be, with online high-speed access wherever you are. We want to provide the mobile users with the same information we provide for traditional clients, but with a different layout better suited to the small screen.

Always-online test environment

For this work package established a wireless, broadband community counting 5 users of mobile learning. At home and at work, these users are equipped with PDAs that have wireless access to ADSL (Asymmetric Digital Subscriber Line – a broadband technology). This environment allows the users to explore wireless applications we consider to be generally available in the future. We have developed and tested several applications and software that through this “always online” environment utilizes:

- **Synchronous communications, chat**
- **Mobile access to e-mail which might generate a quicker response**
- **High bandwidth gives fast downloading of course content and use of audio, video and advanced graphics.**
- **Use of Flash, Java etc due to high storage capacity in future PocketPC**
- **Access to the resources at the Internet at all time**
- **ADSL gives you control over cost**
- **Not dependent of synchronization with desktop pc**
- **Online assessments and assignments**
- **Opens for collaboration between mobile learners**

We are using a wireless 802.11b base station connected to a broadband Internet connection that provides the basic “always online” infrastructure. We have tested out the wireless technology at home and at work to see how it influenced with the way we utilized the Internet as a source for information as well as the benefits of studying wireless. We have also conducted a test with 18 people in a to see how they experienced the mobile environment. We used an iPAQ PDA with wireless connection as a terminal. The LMS used was NKI’s SESAM that serves all our students on a daily basis. We modified some code on the development server so that our web pages also would fit the small screen of the PDA (240x320). This was done mostly by CSS but some structural changes have also been made to make it easier to adapt the pages to the small screen.

Synchronous communications

To explore the possibilities with synchronous communication we have tested two very different and exciting applications. One of the most interesting and useful of these might be the use of instant messages from the PDA by using MSN Messenger (MSN). MSN is Microsoft's popular instant messaging client that allows users to communicate with each other in real-time. This client lets you keep your existing contacts wherever you are, and if you add new contacts they are saved to a server that is maintained by Microsoft. The benefit is that wherever you log on, being from a desktop computer using the traditional MSN Messenger client, the web-client or via the PDA Pocket Messenger, you have your contacts with you at all time. This is a great way to keep in touch with fellow students (and other contacts) without being logged in to the LMS. This is an application many students already utilize and therefore it might become the preferred way of communication (second to e-mail?) between students who wishes to cooperate. Numbers provided by the Norwegian MSN portal, states that there will be approximately 1.000.000 Norwegian user of MSN Messenger within 2005 (<http://www.digi.no/php/art.php?id=111280>).

We tested another form of communication using Skype, which is an IP telephony application that is available for Windows, Mac OS X and Linux. There is also a version that is named Pocket Skype that works with PDAs with the Windows Mobile operating system. This allows the users to make phone calls over the Internet to anyone with a Skype account and has the same cost as being online in any other way. It is recommendable with a broadband Internet connection to avoid too much delay between the parties conducting a conversation. This has been tested between two students as well as a group conversation between three people and works surprisingly well (even better than traditional phone conferences due to the fact that IP is duplex and phones are simplex). This might be a challenge to the long distance calls of today. Compared to MSN Messenger, Skype has not the same propagation as MSN, but the numbers of users are increasing (27th of April 2005, there were 2.514.168 Skype users online). The benefit of oral communication compared to typing is quite obvious. The possibility to have a conversation between fellow students even across countries is appealing to distance education, especially since the cost of the "always online" Internet connection known and fixed. Conversation also benefits students that are slow writers in a synchronous environment such as MSN. Another benefit by using Skype is the new possibility to make calls to non-Skype phones, meaning making calls from Skype to standard phones and mobile phones for a fraction of the cost the traditional providers charge. Calling from Norway to Ireland costs 1.7 Euro cents a minute (<http://skype.com/products/skypeout/rates/>) on 27th of April 2005. The new version of Skype (Skype 1.2) has a centralised contact list so you keep your contacts the same way as with MSN, which is a great improvement.

Using flash on the PDA

Development work with flash on the PDA has been interesting and we have had focus on the readability on all our flash applications. This is because low readability is much more noticeable on a small screen. Flash is authoring software developed by Macromedia, and is used for producing vector graphics-based animations. Flash makes it possible to develop various programs/features such as navigation interfaces, graphics illustrations, interactivity in a resizable file format that is small enough to stream across a normal modem connection. Flash is very suitable for use on the web due to the vector graphics ability to adapt and adjust to different display sizes and screen resolutions and it is designed for optimised delivery. The important thing to remember is not to use negative text and to be more focused on the readability of the colour combinations of the background and text. The choice of font is also important.

In this project we wanted to use flash for producing assignments mainly in the form of multiple choice and drag-and-drop. We have also developed parts of the courseware with the use of flash together with audio. This has been in a sort of pre-assignment or case as a basis for the real assignment that follows.

After experimenting with the course assignments developed in Flash, we adapted them to the PDA. The assignments have been adapted and further developed from the original version intended for use on a large screen to be used on the PDA with the Internet Explorer and the Flash player 6 plugin for PDA installed.

Screen format on the PDA

We found that 240 x 270 (width x height) pixels was the optimal size and filled the screen as much as possible (see picture 1).



Figure 1: Full size
(the red colour)

Using text in Flash

When starting our developments we found that the text we used in the assignments was too small and nearly impossible to read when presented on the PDA. We started to experiment with different font types and sizes. By default Flash uses anti-aliasing on the font and that makes the text a little blurring in the edges. To get the text more sharpen and easy to read on a small screen, we found that we could use an option in flash call “dynamic text”. This proved better concerning readability and solved our problem.

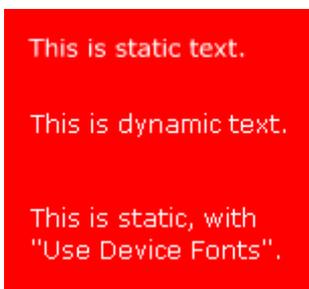


Figure 2: Different methods
with text, verdana 12 pix.

On figure 2, the font is 12 pixels, but the flash program shows different sizes using two different methods. We have no good answer why Flash do so, but that’s no special behaviour to PDA since this is how the program itself react. Later on, we also discovered we could keep the font static and use the options “Use Device Fonts” in flash. Flash uses device fonts to display certain text blocks, so that Flash does not embed the font for that text. This gave us the same output results as setting the text to “Dynamic” but we had more control over line breaking and text behaviour and it might also increase the file size.

We experienced a lot of difference in behaviour with the same flash file when using it on a PC versus the PDA. For instance we had textboxes that showed three lines on a PDA, could only shows two lines on a PC. We solved this by adjusting the size of the textboxes to fit the PDA.

We have also made a couple of assignments that use "drag and drop" functionality. This worked very well on the PDA, but we experienced the same issues here regarding text readability. One must also have in mind that some functions, like "onMouseOver", wouldn't work on the PDA since the PDA is equipped with a touch screen and a stylus and no mouse like on the pc.

Here are some screens shoots from these assignments made in Flash (in Norwegian):



Figure 3: Multiple Choice assignment



Figure 4: Drag and Drop assignment



Figure 5: Drag and Drop assignment

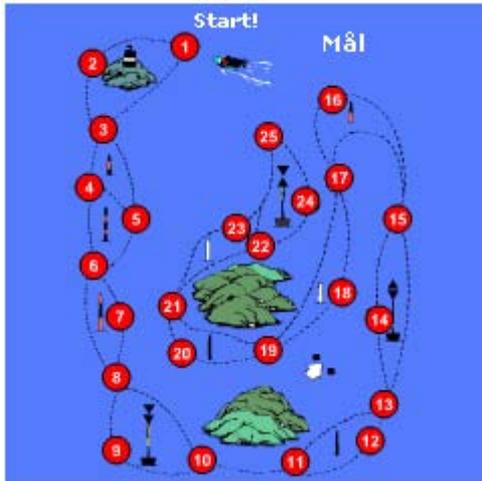


Figure 6: Boat Operators Certificate "Game".

- Take your boat through rough waters guided by the navigation marks and beacons



Figure 7: Boat Operators Certificate "Game".

- If you make a bad decision, you'll get an informative feedback telling you what you should have done to avoid an unpleasant encounter with shallow waters.



Figure 8: Screen shot from a video clip

Video on the PDA

We have also tried out the use of video on the PDA with small video clips showing a discussion between two persons in a learning situation. This has worked very well using the Windows Media Player and we had no problems with viewing the files with high quality both on picture and audio. This is of course also due to high capacity of the wireless broadband solution. We encountered problems when trying to stream video directly from the web browser. Unlike Internet Explorer (IE) for PC, the pocket version of IE is not capable of streaming video directly from the browser or start the Windows Media Player. This means that one have to copy the URL into the Media Player and watch the video from the Media Player. This works okay, but is a rather cumbersome method to watch a video.

Synthetic speech on the PDA

As a result of previous projects working with Universal Accessibility, we also tested out the use of synthetic speech on the PDA. We are very pleased with the results and the possibilities this technology gives us. We have implemented a technology that makes it possible to save the text on a web page as an mp3 file and have it "read" for you afterwards by the use of synthetic speech. We believe this could be a good way of reviewing course material.

Identify target devices

To ensure that the user/device receives a suitable web page, we need to know which devices we want to adjust our content to. The most basic question is; how many different devices do we want to pay special attention to? If the answer to this is none, everyone should get the same page, we have no need to identify the devices and everyone sees the same page. If we want to provide two different pages to different clients we could check for one property e.g. screen resolution (on the iPAQ: 240x320); if the width of the available page of the client is less than a specified size, then provide page a, else page b. This could be accomplished by the use of java script, but is limited to the clients supporting java script. Some user might also turn their browsers java scrip functionality off. The only reason for giving the users a choice between two versions of a web page could be in situations with limited access to high-speed bandwidth, for instance when using a mobile phone. If you would like to target more than two devices and/or give the choice to the server on which page to serve we need to know how to identify the wanted devices. This could be accomplished in different ways, but to ensure that we do it regardless of the device we want to have the server identify the client.

Identifying the client can be done by reading the http-header and provide a page based on the information retrieved. The http-header contains information about the user-agent among other information, but this is one of the possible variables we could use to distinguish between the pages we want to provide or base our layout on. If we do the testing on the server side, we know it will be adaptable to all types of clients, since the change is done on our server, and we know that if a client is to read pages from our server it needs to send a request and our server must send a response. This response could be based on the request and designed to fit the user-agent making the request for a page. We are using a browser-sniffer software called BrowserHawk that is installed on our web server, used for getting information about the client accessing the web page. This could help us identifying the mobile devices as well as helping with either redirection to another web page or changing the layout of the page to better fit the small screen.

The way we identify the client is the use of both BrowserHawk (to send the student or teacher to a specially designed start-page) and the use of css media-types. Media-types are used to choose which stylesheet to provide to the client. The media-type is transmitted when a client makes a request and by checking the device accessing we moved the course menu to the top instead of having it on the right hand side as we have for the traditional clients. This makes the page fit in the small screen better and you always have the menu on the top of the page.

Server or client based adaptation?

This is in our opinion one of the most basic and fundamental choices to make. In our case we could not base our layout on the clients and their ability to handle the layout. If one bases everything on the client, there is no need to change the code if, for instance, the mobile browser is satisfactory for use on traditional web pages. This is an option if it is not critical for a company to provide services and web pages to the mobile client. If it is critical for the business, it has to be done on the server side that is controlled by the provider. We do not know what type of clients our users have and cannot tell the users to install programs to access our pages. This is possible only if the mobile services are supplied in addition to the traditional services, and if the users are aware of this fact. Then they will probably find the service as a nice addition to the other services the company has to offer. However, if the company is to gain new customers from supplying services for this medium, there is a need for a more professional approach.

By identifying the client on the server-side, we have some different possibilities; we can provide a page different from the page provided to a traditional client or we can change the layout on the same page. We can provide a different stylesheet (which we do for the course pages to change the position of the menu) or strip away tables, or other elements, (also done on the course pages) to avoid sideways scrolling. By using the server as the identifying part we can assure that the web pages will work and do not have to take special precaution to users that for instance have disabled java script functionality in their browser.

Concluding remarks

We have tested some of the available browsers on the market today and are closely watching the developments taking place, specifically the development of the Opera browser for the PDA. There are still challenges to overcome in converting existing materials intentionally developed for large screens the small screen of the PDA or other mobile device. The optimal solution for the small screen is obviously to make the most of the space available, and the challenge is to do this globally on the server, not on every single web page. If the basic structure is basically good, there is already technology on the market, which solves the problem with small screens quite well.

There are still a number of challenges concerning the use of Flash and large images because of the reduced readability when shrinking the image. This has not yet been solved, but it is possible to zoom in and out an image to see the details. The work we have done with Flash, video, synthetic speech and different communication elements so far, demonstrates that there are great potentials built into in these small pocket computers that just wait to be released. Combined with a wireless, always online environment these online services could benefit both the online tutor and student in several ways. This is further described and discussed in two separate papers that discuss the testing and the experiences from our trails with students in a controlled environment.

Resources

Skype

<http://www.skype.com/>

BrowserHawk

<http://www.browserhawk.com/>

Opera

<http://www.opera.com>

MSN

<http://www.msn.no>

Media Queries:

<http://www.w3.org/TR/css3-mediaqueries/>

ThunderHawk:

<http://www.bitstream.com/wireless/?wireless-web>

The World Wide Web Consortium (W3C):

<http://www.w3.org/>

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Technical Overview

-of the mobile PDA environment at NKI Distance Education

September 2005

This overview is written as a part of the project "Mobile Learning: The Next Generation of Learning" as a result of the research done at NKI Distance Education (NKI) for adapting SESAM (NKI's learning management system (LMS) to the mobile environment. The aim of this project was to develop and adapt courses for current and future mobile handsets where mobile learning is defined as the provision of training courses via wireless devices – Personal Digital Assistants (PDAs), smart phones and mobile telephones. These courses will be developed as part of a fully functional mobile Learning Management System (mLMS) and the courses will be tested and evaluated, and the results widely disseminated. The web page of the Leonardo project is found at: <http://learning.ericsson.net/mlearning2/index.shtml>.

This technical overview summarizes the challenges of adapting layout of existing content from the traditional LMS to serve mobile clients such as a PDA or similar devices. Smart phones and mobile telephones are not discussed in this overview as the screen is much smaller and has other limitations that need special attention. Smart Phones which have a web browser that can render (x)html may use the same approach that is described here. When the term "mobile device" is used, it refers to a handheld device that is capable of displaying hypertext mark-up language (html) or xhtml (The Extensible HyperText Markup Language (xhtml) is a family of current and future document types and modules that reproduce, subset, and extend HTML, reformulated in XML.). This paper deals with PDAs used as a mobile client accessing NKI's LMS, SESAM.

This technical paper is written by developers at NKI in the EU Leonardo project "Mobile Learning: The Next Generation of Learning", and describes the work carried out in the second year of the project. We have enhanced our LMS to provide services and web pages for mobile clients with a built-in html compatible web browser.

The Pocket Internet Explorer that comes with PDAs with the Windows Mobile operating system is our browser. We are still looking forward to the development of Opera's Small-Screen Rendering™ browser for the PDA that hopefully will enhance the readability and screen rendering on small screens. Until then we have chosen to make use of Cascading Style Sheet (CSS) to make changes in the layout and providing the appropriate style sheets based on the clients accessing the page.

Some of the most important findings were that if the structure of the document is good, the challenge of transforming content to the small screens or different layouts was actually requiring less effort than expected. We did experience difficulties with large illustrations that contained too much information for the small screens as well as large flash animations with fixed width. This is a problem we still have, but the work-around is to zoom in and scroll on the illustration that needs a certain size to be understood.

The best approach to “mobilizing” an LMS in our opinion is to optimise the pages for layout by CSS, not by using tables that has been the tradition for a long period of time now. The time has come to using layout by CSS and div-tags in (x)html to control the layout. This will not only ease the “mobilization” of the content, but also improve the accessibility for other users that might have disabilities.

By laying out the pages by div-tags and CSS one separate, the content from the presentation, which always is a good idea. This enables one to for instance using one font-family for print, and another for screen, as well as changing the text-size and any other property of the page based on the target device. To do this we used a method in CSS known as media-types, which recognizes the device accessing the page and uses the appropriate style-sheet for that device (one still has to write this style-sheet though, but the content stays the same). This enables the designer to re-design a page for one device and not every device intended to access the page.

If one does not describe the images used as an illustration, blind users will not be able to “see” this information. There are, however, others who access the page, which also are “blind”. These are better known as spiders, or search-engine robots. These spiders indexes your page based on the textual information, and if the images are described this will benefit in the search-engines as well as serving blind users better. The description-tag may also be printed as text for the mobile device, and/or for the print version if it is an animation.

To have a reason for adapting for a mobile device, think rather of all the other benefits gained when structuring the pages well:

1. One might get a better rating in search-engines
 - a. This can generate more traffic to the website
2. One separate presentation from the data itself
 - a. Easier re-design and maintenance
 - b. Designers may re-design without touching the data or business logic
3. More users will be able to read and benefit from the pages
 - a. This means that the total marked for the page is larger
4. Accessibility is improved
 - a. Every user will benefit from a good structure
 - b. An accessible page is often easier to re-design
5. The page can be viewed on a mobile device

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Mobile Distance Learning with PDA – Development and Testing of an Always Online Multi Media Environment

**Paper presented to the conference “mLearning - The future of Mobile?”
Dun Lahoghaire, Co. Dublin, Ireland, September 9th 2005**

Summary

This paper builds on the presentation to the conference *mLearning: The Cutting Edge* arranged in November 2002 presenting experiences from to project *mLearning: the next generation of learning* (Rekkedal 2002) and on papers produced in the present project, *mLearning- the Next Generation of Learning*.

The paper discusses NKI basic philosophies of distance learning and their consequences for development of solutions for mobile learning.

During the present project NKI has designed and developed solutions for an “always online multi-media environment” for distance learners based on the use of PDA with access to wireless networks. During the project NKI first developed one specific course for mobile access with PDA. However, cost efficiency considerations require server side solutions that make access independent on devices on the user side. Thus, during the second year of the project NKI installed software and solutions that in principle make all online courses accessible independent on mobile devices.

One of the biggest challenges concerning the mobile devices was to find acceptable solutions adapted to the small screen. There is simply not enough space for all the information found on a traditional web page on a small screen. Another problem was the limited data transfer rate and processing power found in mobile devices. When people use a mobile device with Internet connectivity, the connection speed is traditionally lower for instance via a mobile phone. This is why we have chosen to design for the future, as we believe it might be, with online high-speed access wherever you are.

For the research, we have used a wireless 802.11b base station connected to a broadband Internet connection that provides the basic “always online” infrastructure. We have tested out the wireless technology at home and at work to see how it influenced with the way we utilized the Internet as a source for information as well as the benefits of studying wireless. We have also conducted a test with 18 people to see how they experienced the mobile environment. In general, the test group found the solutions acceptable or to a large extent of high quality, except for graphical materials that tend to be too small on handheld device screens.

Although it is difficult to foresee what will be the technical solutions for mobile devices in the years to come, there is no doubt that the research on mobile technology in online distance learning at NKI has inspired developments that increase the quality of our online distance learning in general and also make us better prepared to serve mobile students now and in the future independent of which technology the prefer to use when on the move.

Introduction

NKI Distance Education is the largest distance teaching institution in Norway, recruiting 7,000-10,000 students every year. NKI Distance Education is one unit in the NKI group, a non-governmental educational institution also offering full-time and part-time training on secondary and tertiary level.

NKI Distance Education was one of the first institutions worldwide to offer online distance education when we started the first trials on our in-house developed Learning Management System, *EKKO*, in 1987. Since then online education has continuously been offered to an increasing student population. In 2005 NKI has approximately 6,000 active online students, studying one of more than 60 study programmes or over 400 courses offered on the Internet/Web. During summer 2005 we passed 50,000 course enrolments to NKI online distance education since 1987. In 2001 we launched what we consider to be the 4th generation online distance education system at NKI when introducing the internally developed LMS *SESAM* (*Scalable Educational System for Administration and Management*) that totally integrates the web-based Learning Management System with the overall Student Administration System and a number of other applications for efficient operation and administration of the logistics and student support measures in online distance education.

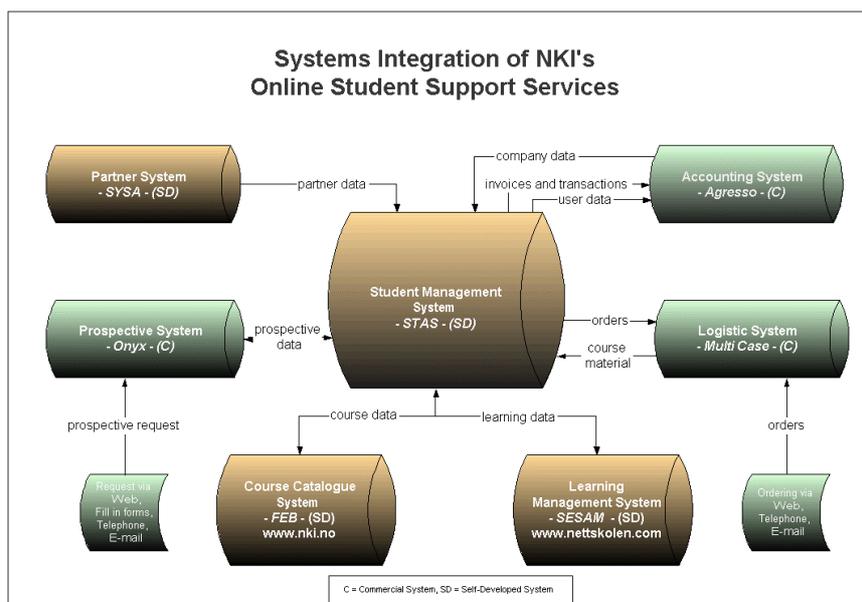


Figure 1. NKI's integrated systems for online administration and student support.

When engaging in the Leonardo m-learning projects the NKI Research and Development group was very decisive that our aims would be to develop solutions that would increase access and flexibility and refine the total distance learning environment to meet the needs of the “*mobile distance learner*”.

NKI basic philosophies concerning distance learning

Increasing the flexibility of distance education

A number of evaluation studies among distance and online learners at NKI have demonstrated that students emphasize flexibility (see e.g. Rekkedal 1990, 1998, 1999, Rekkedal & Paulsen 1997).

We have argued that distance education generally seems to develop in two quite different directions. The solution at one end of a flexibility continuum can be described as an individual, flexible solution allowing the student freedom to start at any time and follow his/her own progression according to personal needs for combining studies with work, family and social life – *‘the individual flexible teaching model’*. This model represents a generic development of the model of distance teaching institutions and applies normally media and technologies independent of time (and place), such as asynchronous computer communication, video, audio and printed materials. The model on the opposite end of the scale, *‘the extended classroom model’*, assumes that the students are organised into groups required to meet regularly at local study centres and applies technologies such as video conferencing, satellite distribution, radio and television (Gamlin 1995).

In this connection we have chosen the philosophy for the development of Internet based education at NKI: *Flexible and individual distance teaching with the student group as social and academic support for learning*. NKI recruits nearly 10,000 students to more than 600 courses and over 120 study programmes by correspondence based and Internet based distance teaching every year. These students may enrol to any course or programme or combination of courses at any day of the year and progress at their own pace. This flexibility does not exclude group-based solutions in cooperation with one single employer, trade organisation or local organiser, or that individual students on their own initiative or by the initiative of the tutor are collaborating on learning tasks. According to NKI philosophy on online learning as expressed in the strategic document (NKI 2005): *“NKI Distance Education facilitates individual freedom within a learning community in which online students serve as mutual resources without being dependent on each other.”*

Views on knowledge and learning

When starting the first discussions on m-learning and planning for the first m-learning development, it was for the NKI research group very clear that the learning aims, content and teaching/learning methods in the NKI online courses and programmes generally were far away from most e-learning courses (see e.g. Dichanz 2001).

To us, learning is a change in the student’s perception of reality related to the problem areas studied and increased competence in solving problems in a field, ability to differ between focal and more peripheral questions, analytical skills and competence in using the tools within a field in appropriate ways. This means that learning results are shown in a qualitative change in the student’s understanding, academic, social and technical competence. The learning is a result of active processing of learning material and solving problems individually and/or in groups. This view is different from what often we can find in many so-called e-learning programmes, where knowledge often is seen as a larger amount of information or ability to recall and reproduce facts. In addition to cost considerations, this is why NKI in general has put little emphasis on using fancy effects in a behaviouristic pedagogical tradition, programmed learning and knowledge transmission (see Marton et al. 1987, Marton et al. 1997, Morgan 1993 on students’ conceptions of learning, deep level and surface level approaches to learning). We also hold the view that learning is an individual process that can be supported by adequate interaction and/or collaboration in groups (Askeland 2001), as stated in the NKI strategic plan (2005). From the discussion of NKI philosophy of learning and views on knowledge and aims and objectives in formal studies we came to the conclusion of experimenting on mobile learning based on a more advanced technology than what was available mobile phones in 2001, the WAP and Smart phones. Thus, we found that the Compaq iPAQ PDA in combination with mobile phone communication was suitable for our

purposes. Our experiences and the experiences of other project partners (Fritsch 2002) during the first project resulted in interest in continuing the developments further in the present project.

Our main objective in the first m-learning project, *From e-learning to m-learning* (http://learning.ericsson.net/mlearning2/project_one/) was to extend the distribution of learning materials and communication to lighter equipment, specifically PDA and mobile phone. Already during the first project we understood that for NKI the longer term challenge would be to develop the system and server side to present materials in ways suitable for PDA and other mobile technology and to find acceptable solutions for *access to materials* and for *teacher-to-student/student-to-teacher and student-to-student communication*. We should also add that NKI parallel to the m-learning projects has been engaged in projects on developing *Universal accessibility* (Mortensen 2003) (<http://www.nettskolen.com/pub/artikkel.xsql?menyID=9>), which has similar consequences concerning server side solutions for making content available to anyone independent of physical handicaps or technology on the receiver side.

It was our aim in designing the environment for the mobile learner to extend and enhance (or restore) the flexibility of distance education, that to some extent took a step backwards when converting from paper based to online learning, where students largely were required to study at a place (and at a time) where a computer with access the Internet was available. This aim was still in focus during the second project, *Mobile learning: The next generation of learning* (<http://learning.ericsson.net/mlearning2/>).

Designing and Trying Out the Environment for Mobile Learners in Project 1

Design and Development

Studying online and offline

In line with the above discussions on learning and studying, most NKI courses are not designed to function as online interactive e-learning programmes, although some parts of the courses may imply such interaction with multi-media materials, tests and assignments. The courses normally involve intensive study, mainly of text based materials, solving problems, writing essays, submitting assignments and communicating with fellow students by e-mail or in the web based conferences. This means that most of the time the students will be offline when studying. From experience we also know that the students often download content for reading offline and often also print out content for reading on paper.

Technical solution

It should also be emphasized that we assume that the NKI Internet students normally will have access to a desktop or laptop computer with Internet connection. This means that the equipment and technologies used when mobile are additions to the students' equipment used when studying at home or at work. It should also be noted that our developments were based on the absolute assumption that mobile learners would study in the same group as students not having access to mobile technology. Thus, the design of the learning environment had to cater efficiently for both situations.

When planning for the m-learning environment of the first project the NKI project team had long discussions whether to develop the learning materials for online or offline study. Taken

the above experiences, and also cost considerations concerning mobile access to online learning materials, we concluded that the learning environment for the first course should include the following aspects (Fagerberg, Rekkedal and Russell 2002):

Technology:

- Pocket PC/PDA
- Mobile phone
- Portable keyboard

Learning content and communication:

- Learning content to be downloaded on the mobile device to be studied offline.
Downloaded content to include all course materials:
 - Content page
 - Preface
 - Introduction
 - All study units
 - Resources (articles on the web, references to other resource materials)
- Online access to the discussion forum with the possibility of as quick as possible access for reading in the Forum and writing contributions
- E-mail for individual communication with tutor and fellow students and for submitting assignments. Assignments may be submitted as text-based e-mail or as Word or Text attachments.

Students' and tutor's use of technology when mobile

When mobile – and using mobile technologies – we found that it was generally satisfactory for the student (and the tutor) to have the course content available to study on the PocketPC. In addition, the following communication possibilities were seen as necessary. When mobile, the student must be able to:

- Access the course forum archive to read messages (if necessary) (messages on the forum is also sent to participants as e-mails)
- Access the course forum to submit contributions to the discussions
- Send e-mail to fellow students, to the teacher and to the administration (study advisor)
- Receive e-mail from fellow students, from the tutor and from the administration
- Submit assignments by e-mail including attachments
- Receiving assignments corrected and commented on by the tutor including attachments.

To access e-mail and discussion forums, mobile phones with infrared connection to the PDA were used.

Trialling the 2 courses of Project 1

During the first project two courses were tried out with students using mobile phone and PDA. The two courses were:

1. *The tutor in distance education (Norwegian version)*
2. *SPICE 603 Online Teaching and Learning*

The first course was tried out in a simulated distance teaching setting with 9 students. The second course was tried out in a real setting with 3 students studying in a group with other students not using mobile technology – a context expected to the normal situation for mobile learning in the NKI distance education setting.

Main conclusions from Project 1 trials

We learned that downloading and synchronizing learning materials to the students' PDAs caused few (or rather no) problems. The learning content was delivered in two versions, HTML and Microsoft Reader e-book format. As the preference for the e-book format was so clear from the first trial, the second course applied e-book materials only. Illustrations were considered unacceptable on the PDA. Taking notes was found to be a problem, so for the second trial we found it necessary to equip the students with keyboards that actually solved the problem, including writing longer texts in connection with assignments etc. Communication via mobile phones for submitting assignments and writing messages to the course forums were found to be easy, with few problems and with acceptable costs on the condition that texts normally were produced offline.

Our main aim in designing solutions for mobile learners was to maximize student freedom and to support online learners who also are mobile when studying. This is also clear from all the participants in the pilot trials; the main advantage of m-learning as designed in these trials, is the *increased flexibility of online distance education*.

“Mobile Learning: the Next Generation of Learning” – Designing and Testing an Always-Online Environment for Mobile Learners

As a result of the experiences from the first project, NKI wished to continue research on m-learning based on the PDA solutions available in 2004-2005. After examining the different brands available, we decided to develop solutions for the follower of the previous devices, HP iPAQ Pocket PC 5500 series with built-in wireless network card. At the same time all developments were done with the main object to develop generic solutions independent on devices on the user side.

For NKI as a large-scale provider of flexible online distance learning, it is extremely important to deliver cost-effective solutions, i.e. for NKI it is of vital importance that we are able to find system solutions that allow learners who are users of mobile technology and wish to study also when on the move, that also allow other students to apply standard technology. The solutions must be designed in ways to allow both groups to participate in the same course. This means that we had to look for solutions that are optimal both for communication and for distributing content in courses, independent on whether the students and tutors apply mobile technology or standard PC and Internet connection for teaching or learning.

Already when planning the first m-learning project we considered online access to course content probably to be the best solution. However, 4 years ago this was seen as neither technologically nor economically possible. Since then, the technological developments have made it more attractive to start developing and experimentation with solutions based on the assumption that an “always-online environment” would be available for mobile learners. This is, in fact, close to reality today, and will most probably be the normal situation in the near future.

Provisional developments during year 1 of the project

In principle the NKI project team had undertaken to develop one course, the Norwegian version of *Sales and Services*, to an “always-online mobile learning environment” during the first year, and a second course, *Administration Systems and Support Services for Online Education*, during the second year.

The first course was developed with an additional version with specific materials for mobile learners. This version was produced on the server in a format adapted to the PDA screen and multi-media materials specifically developed to be accessed by the PDA. These developments were described by Dye et al. (2004).

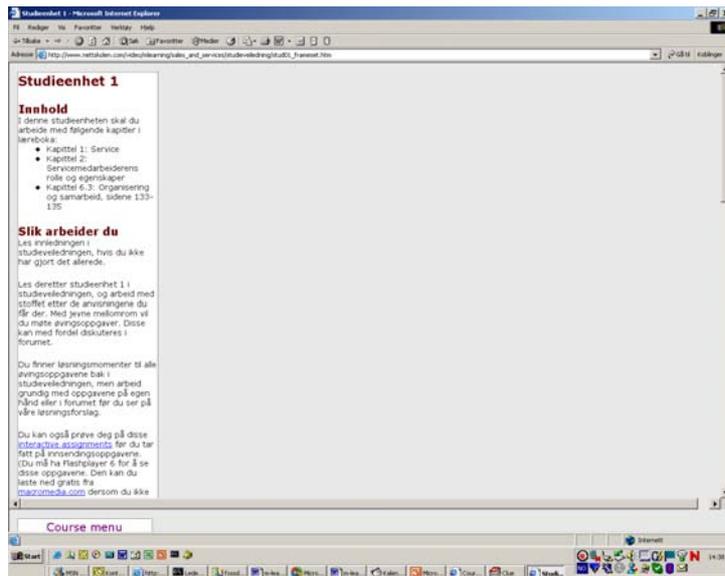


Figure 2. Screen shot from a PC of the specific version of *Sales and Services*.

On the PDA the text is perfectly adapted to the screen. The menu link is fixed at the bottom of the PDA screen to allow easy navigation. Multi-media elements were developed in Macromedia Flash and were also specifically developed for the PDA version. We tried different solutions to get the multi-media elements readable on the PDA without actually finding really good solutions. The conclusion both during development trials and testing with students was that most multi-media elements have details that are difficult to present in acceptable form on the PDA. It is important not to use negative text and to be more focused on the readability of the colour combinations of the background and text. The choice of font is also important. Below are two screens shoots from the PDA of these assignments (in Norwegian).

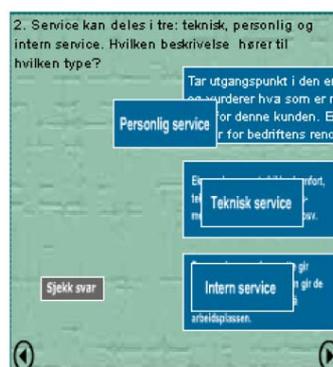
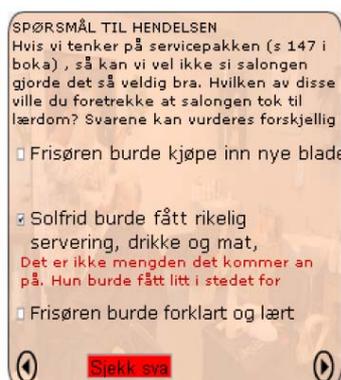


Figure 3. Screenshots from the PDA of multi-media multiple-choice question and “drag and drop” assignment.

It was clear during internal testing that the solutions functioned according to expectations and that the solutions allowed mobile learners and other online students to participate and communicate in the same course. However, as specific additional materials had to be developed for the mobile learners, the solutions could never be applied cost-effectively on a large scale.

Second year: Functionalities of the “always-online environment” developed by NKI in the project “Mobile learning: The Next Generation of Learning”

When planning for the present project, the NKI project team emphasized development of solutions for m-learning where students and tutors using PDA/PocketPC through wireless systems could benefit from teaching and learning in an “always-online” environment.

Although downloaded content gives access to the course at any time, this solution has some disadvantages, such as:

- Little incentive to log into the Internet College and take advantage of a learning community
- No possibility of taking advantage of interactive materials
- No (or slow) access to other Internet resources
- Restricted communication possibilities

During the planning process we described the following aspects of an always-online solution that would possibly increase the quality of the services for mobile learners:

- High bandwidth gives fast downloading of course content and use of audio, video and advanced graphics
- Independence of synchronization with desktop PC
- Access to resources on the Internet at all times
- Easy access to e-mail at all times
- Possibilities for online assessment and assignments
- Options for easier co-operation with fellow students
- Possibilities for synchronous communication, chat and IP telephony
- ADSL or free access to WLAN give control over costs

During the first phase of the present project an “ideal” description of requirements for a mobile learning management system (mLMS) for the NKI context was developed by Dye & Fagerberg (2004). The requirements were based on the assumption that the NKI Learning Management System, *SESAM*, would be further developed to accommodate the needs of mobile learners with priority to learners using PocketPC. A description of *SESAM* and functionalities have been given by Paulsen et al. (2003).

mLMS system requirements

The specifications proposed by Dye & Fagerberg (2004) are presented below with comments concerning the actual developments done as part of the present project. The specification is divided into six categories. The functionalities developed and tried out in the project as of August 2005 are marked by (*OK*):

Overall framework needs

- The mLMS must be a part of an LMS and support the mobile client as well as traditional clients. *(OK)*
- The mLMS should provide different types of content to different devices automatically. *(OK)*
- The mLMS must create a comfortable learning environment for students studying with mobile devices. *(OK)*

Course content

- The mLMS must be able to store course content in the system. *(OK)*
- The mLMS should provide easy navigation. *(OK)*
- The mLMS should provide a zoom function for illustrations and pictures. *(OK –not actually part of the mLMS but a function on the PDA)*

Access to courseware

- Access to resources, library, references, glossary and exam database. *(OK)*
- Access to course planning tools and calendar. *(Software (JSP) not yet available in the PDA)*
- Students must have the possibility for submitting assignments. *(OK, but students must presently use e-mail with attachments instead of the submission system available from PC, software not available)*
- Tutors must have the possibility to answer and return assignments. *(OK, same problem as above)*
- One must have access to a class list with tutor and student information. *(OK)*
- Students must have the possibility to answer using multiple choices, drag and drop test/exercises, etc. *(OK)*
- Text to speech possibilities would be very helpful. *(OK, texts are stored as synthetic speech on mp3-files)*
- The mLMS must support graphics, audio and video, moving image. *(OK, but the small screen gives some problems)*
- The mLMS must immediately provide answers and feedback on test/exercises to students. *(OK)*
- It would be useful to have searchable course content. *(Content in course pages are searchable, but yet no function for overall search in the materials)*

Communication

- One must have access to online synchronous communication such as chat. *(OK and also IP telephony)*
- One must have access to an asynchronous communication system such as e-mail. *(OK)*
- The mLMS could support Short Messages Service (SMS) between students and teachers for instance to notify the teacher that a student has just delivered a new assignment. The other way around, a student could get a notification that the teacher has just sent the answer to the assignment. Could also contain the score/grade. *(Not yet implemented)*
- The mLMS could support the use of Multimedia Messaging Service (MMS) *(Not presently planned for)*
- SMS between users of the mLMS and the mLMS to give reminders and other information as well as enrolling and signing up to exams and other arrangements. *(Not yet implemented)*
- Students and tutors must have access to course forums to read and write

messages. *(OK)*

- One must have access to a list with both tutor and student information. *(OK)*
- Message board. *(OK)*
- Announcements. *(OK)*

Administration of users

This is a feature that is meant for the administration of the institutions and is not actually a part of the end user system for the mobile student or tutor.

- The mLMS should give the possibility to register for an exams. *(Not yet implemented)*
- One must have access to student records. *(OK)*
- Student tracking. *(OK)*

Other

- The mLMS should give the possibility to enrol to a course (students enrol from a web page) *(Possible at present, but awkward)*
- Provide export features to have course access even when offline. *(Not available as constructed as always-online)*
- Adjustment of personal settings such as changing password or e-mail address. *(OK)*
- Access to frequently asked questions (FAQ). *(OK)*
- Access to contact information. *(OK)*
- Access to general study information such exams dates, student handbooks, regulations, etc. *(OK)*
- Access to a sitemap. *(OK)*
- A possibility to print from the device. *(OK, presently device dependent)*
- An area where you can upload and store personal files. *(Not yet)*
- Access to technical support services. *(OK)*

Features and functionalities tested in the NKI trials

Related to the requirements above NKI has during year 2 developed the SESAM LMS into a functioning mLMS. The trials were carried out during March 2005 with 18 test students registered in the course “Sales and services” (Rekkedal & Dye 2005). The functionalities tested is described below:

Introduction to the PDA and use of equipment

As the majority of the test persons were not users of a PDA, we started the test by describing the hypothetical real situation lying behind the developments and how to use the PDA.

Logging in and navigation on the NKI Internet College personal page

The students were asked to log into their pages on the Internet College and to navigate and examine their personal page as it is presented on the PDA.

Navigating in the course

After having been acquainted with the personal start page, the students had the opportunity to navigate around in the course.

Reading study unit 1

The students read the text of study Unit 1.

Submissions of assignment for Study Unit 1: “*What is your opinion of reading course texts on the PDA?*” Instead of answering the ordinary assignment for submission, the students

wrote an answer to the above question. Submission 1 involved using Pocket Word for writing the answer, storing the word document, opening e-mail programme, attaching document, sending and receiving e-mails. During the test the students received feedback from the tutor with comments.

Examining multi media (ordinary multi media in the course)

The following standard multi media elements in the course were examined:

- Sound
- Video
- Multimedia
- Multiple-choice questions
- Drag and drop exercises

In addition the test course included some multi media elements specifically developed for mobile learning:

- Sound
- Multimedia
- Multiple-choice questions
- Speaking course pages
- Drag and drop exercises
- Graphics
- Animations with and without sound
- Multiple-choice questions
- Drag and drop exercises
- Synthetic speech

Reading in course Forum

The functionality of reading in the course forum and writing messages to the forum was also tried out. The first message was written by the tutor. The test students received messages by e-mail onto the PDA and also read the same messages on the course pages.

Writing messages to the Forum

Writing messages to the forum may be done either by writing in Pocket Word and paste into the Forum text box, or by writing directly into the text box. The latter solution was applied in the tests.

More about navigation in the course

The students also examined the course functionality through reading presentations of other students and writing e-mail to fellow students, sending and receiving mails

Synchronous communication

Although NKI in general puts little emphasis on synchronous communication, as this project concerned a theoretical always-online environment, we took the opportunity to try some synchronous solutions such as chatting by MSN messenger and Skype. Skype offers primarily an IP telephony functionality, which was also tested in the trials. Thus, the students also had the opportunity of communicating orally with fellow students using the PDA and Internet telephony with Skype.

Conclusions from testing

User friendliness

Concerning student user-friendliness of mobile learning in the context examined, nearly all the test persons found the equipment easy to use and also found that the “*experience was fun*”. The answers to the questions whether they would like to take another m-learning course or recommend m-learning to others are, not surprisingly as their experiences from the test situation probably is a little restricted to enable them to answer these questions firmly, somewhat more reserved.

Didactic efficiency

When it comes to didactic efficiency, we may conclude that after the m-learning experience, taken the assumed context of m-learning as a supplement to the distance online learning environment, the test students believed that “*m-learning increases quality, that objectives can be met by m-learning, that accessing course content and communication with the tutor was easy, and that m-learning is convenient for communication with other students.*”

A majority agreed that evaluation and questioning was effective. But again some were uncertain or even negative. This is probably related to the fact that in the trial, some of the test and questioning materials were distributed with graphical materials, which still is far from perfectly presented on the PDA. The test students exposed both to graphical materials specifically developed for the PDA (part of year 1 developments) and the standard graphical course materials presented on the PDA. Both types had definitely clear, however different weaknesses.

Technical feasibility

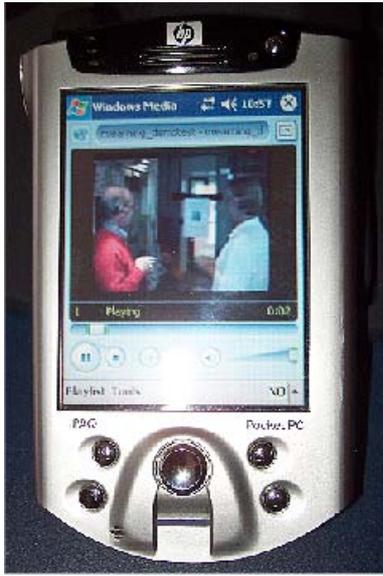
Most of the students found navigation easy. They did not agree whether graphics and illustrations are necessary. More than half of the test students were uncertain or actually disagreed with the statement that “graphics and illustrations are necessary for m-learning to be effective”. This opinion can partly be a result of the assumed context that the students would also have the possibility to study learning materials on standard equipment, and also to the fact that most of NKI learning programmes are quite theoretical and based mainly on the study of text materials.

Cost efficiency

Most of the participants agreed that m-learning increases access to learning. On the negative side is, of course, that access to technology is still lacking. Mobile phones with more PocketPC-like functionalities may solve this problem. We have previously shown that communication costs, even when communicating by mobile phone was acceptable. In these trials, we assumed that the learning could take place in an always-online environment with free access. For most users today, however, sending e-mails is probably easier via the mobile phone than setting up the PDA for sending e-mails through different network providers.

The test students tried synchronous communication both by chat and IP telephony. Generally, it seemed that the test persons assume, that according to their experiences in the m-learning test, the chat function is similar in functionality with chatting on an ordinary PC. The majority also answered that they believed that the chat function could be useful in m-learning.

Functionalities and quality



Video on the PDA with small video clips worked very well using the Windows Media Player and there were no problems viewing the files with high quality both on picture and audio. We encountered problems when trying to stream video directly from the web browser. Unlike Internet Explorer (IE) for PC, the pocket version of IE is not capable of streaming video directly from the browser or start the Windows Media Player. This means that one has to copy the URL into the Media Player and watch the video from the Media Player. This works okay, but is a rather cumbersome method to watch a video. The test students' opinions concerning the functionality of the video differed. However, it seemed clear that the uncertain and negative responses were more related to the difficulties of playing the video rather than to the quality of the video itself. In fact, the test students found the quality of the streamed video quite good.

Figure 4. Video on the PDA.

As a result of previous projects working with Universal Accessibility (Mortensen 2003), we also tested out the use of synthetic speech on the PDA. We have implemented a technology that makes it possible to save the text on a web page as an mp3 file and have it "read" afterwards by the use of synthetic speech. The test students were generally positive concerning the quality to both human and synthetic sound on the PDA – all responding on the positive side of the scale. The quality of both digital human voice and synthetic speech was found to be fully sufficient.

The test persons generally also expressed that they were impressed by the quality of IP telephony on the PDAs. Most of the students also agreed with the statement that IP telephony could be very useful in mobile learning. The one person disagreeing probably held the position that synchronous communication generally is not useful in distance learning mainly based on asynchronous communication, a statement in line with the NKI philosophy and strategy.

According to the students, sending and receiving e-mails, writing to the course forum, answering assignments with Word attachments and sending/receiving assignments functioned well. There were few responses on the negative side.

The test students were generally very positive towards reading text on the PDA.

The answers concerning quality of the graphical materials support the impressions that presently graphical materials do not function satisfactory on the PDA.

Although the majority of the students responded quite positively to most of the questions concerning the m-learning environment, they did not find the solutions of sufficient quality for mobile access only. This is in line with our assumptions that m-learning in the NKI online system is seen as an addition to increase access and flexibility of learning.

The students agreed that the always-online mobile solutions increase the flexibility of e-learning. To a large extent they also agreed that the m-learning solutions tried out increase the quality of course arrangements. More than half of the students were uncertain whether the solutions tried out actually increase the quality of learning outcomes. This is, of course, a very difficult question to answer based on the experiences from the test situation.

It was clear that some of the test students with a technical background and working in IT-positions were less enthusiastic than the other participants. According to their statements during the trial they were less tolerant towards operations that were more complicated or taking longer time than on standard PC equipment. This could be seen as an indication that the technology still has to be developed further before it is attractive enough for a sufficient number of online learners. However, the research so far has demonstrated that developing solutions that make courses available in sufficient quality independent of devices on the user side seems to be a sound strategy.

Conclusions

The NKI developments and research on mobile learning in connection with the two EU Leonardo projects have resulted in better solutions for serving distance online learners. We have learned that cost efficiency considerations do not allow for developing parallel versions of courses. Courses must be developed, presented and distributed in ways that allow both mobile and not mobile learners to participate in the same course and that course materials can be assessed both by standard and mobile technology with acceptable quality of all content elements. Interaction with course content and multi-media materials and communication with tutors and fellow students must also function adequately both through standard and mobile technology.

It is still a question of what the “ideal” device and solution for mobile learning really is. Probably is the answer a result of the learner’s individual preferences. That is why NKI has found it extremely important to experiment with different solutions that have inspired developments towards finding course design systems solutions that may serve the needs of the learner independent of the technology used by the students.

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M-Learning 1: From e-learning to m-learning



**Papers prepared for the EU Leonardo da Vinci Project:
“From e-learning to m-learning” IRL/00/B/F/PP-119-209**

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Designing and Trying Out a Learning Environment for Mobile Learners and Teachers

Sub-project of the EU Leonardo Project “From e-Learning to m-Learning”

December 2001

Summary

This paper summarises the work package carried out at NKI Distance Education during the year 2001 of the EU Leonardo Project, “*From e-Learning to m-Learning*”. The project is led by LM Ericsson, Dun Laoghaire, Ireland. Other project members are Distance Education International, Ireland, Università degli Studi di Roma III, Italy, and FernUniversität, Germany. The NKI work sub-project is carried out in close cooperation with the other partners, specifically LM Ericsson.

The concepts, distance education, e-learning and m-learning are discussed with reference to NKI Distance Education philosophies, views on learning and experiences in developing learning materials for distance education and online learning.

During 2001 NKI project team studied International experiences concerning m-learning, analysed technological solutions and pedagogic/didactic needs based on our internal practical experiences and results from previous surveys and evaluation studies among our distance students.

The technical solution chosen was to try out the use of Pocket PC/Personal Digital Assistant (PDA) in combination with mobile phone for distribution of learning content and communication between tutor and students, between students and for students’ communication with the learning material. As technologies develop so fast that the specific technology available changes from one week to the next, it was important that the solutions chosen had some generic basis, i.e. also that the specific brands of PCs, mobile phones and keyboards etc. should not constitute any substantial restrictions concerning generalisability of our experiences.

When we had to do make our choice late spring 2001, we found that after analysing functionality of different brands of PDA/Pocket PC, we chose to build our learning environment around the Compaq iPAQ 3630 and 3660. The mobile phones chosen were Ericsson T39 and Ericsson R580. This article describes the project work and decisions preparing for the first practical trials of the distance learning environment. The next steps for NKI Distance Education in the project will be to carry out the first experiment of a partly real and partly simulated distance learning setting including evaluation, carry out a survey among distance learners on aspects of mobility and plan and conduct a second experiment in a fully realistic setting.

The actual course chosen, ‘*The tutor in distance education*’ was chosen for the following reasons:

- It is a course in the pedagogy of distance teaching, and as such represents an ideal course for combining the research on media, methods and technology with the substance or content of the learning
- It is taught by internal NKI staff, also involved in the project, thus combining internal competence development with development work in the project
- The fact that same staff are involved in development and teaching in the practical try outs to be carried out opens for real field research during try out and also makes it easier to transfer the experiences and results from the experiments to further developments in the operations of the NKI Internet College
- Students taking the course are prospective online teachers in the NKI Distance Education system, their experiences as mobile learners are transferred to their teaching after completing the course

Distance education – flexibility and mobility

D-learning, e-learning and m-learning

'Distance education' and *'distance learning'* are well-established concepts (Keegan 1996). The *'distance learner'* is a person who, for some reason, will not or cannot take part in educational programmes that require presence at certain times or places. Recently terms such as *'e-learning'* and *'m-learning'* have entered the scene. To us, learning is an activity or process and shown as a change in a person's perceptions, attitudes or cognitive or physical skills. It cannot be *'electronic'* (if that is what e-learning is supposed to stand for (?)). The terms e-learning and d-learning deserve to be analysed. For instance, the term, e-learning, seems to be used to convince users that some supernatural things happens with your brain when you place yourself in front of a computer screen. This miracle is very unlikely to happen, as learning in the real world is mainly hard work. Most examples of so-called e-learning programmes seem to be extremely costly to develop and most often covers low-level knowledge and facts based on a simplistic view of what learning is (see e.g. Dichantz 2001 *"E-learning, a linguistic, psychological and pedagogical analysis of a misleading term"*). However, as the term seems to become part of accepted terminology, it is imperative for educational researchers and serious providers to define it and assign meaning that is in accordance with our views on teaching and learning. Seen from a university perspective, Dichantz, who is professor of education and the German FernUniversität ends his critical analysis of the term, e-learning with the following definition:

"E-learning is the collection of teaching – and information packages – in further education which is available at any time and any place and are delivered to learners electronically. They contain units of information, self-testing batteries and tests, which allow a quick self-evaluation for quick placement. E-learning offers more lower level learning goals. Higher order goals like understanding, reasoning and (moral) judging are more difficult to achieve. They require an individualised interactive discourse and can hardly be planned" (Dichantz 2001)

Even though we do not totally agree with Dichantz that higher level learning goals cannot be planned, we agree that such goals are much more difficult to plan, and that most so-called e-learning programmes do not demonstrate attention to higher level learning objectives.

Similar reflections can be raised concerning the term, *'mobile learning'*. Again, learning cannot be mobile. Learners are probably more and more mobile, and they use mobile technology. In connection with this project we would describe NKI's main objective *'to design and trial out a learning environment for mobile learners and teachers'* maintaining the flexibility of distance education for learners on the move. These reflections are in line with Sariola et al. (2001):

"The term 'mLearning' has lately emerged to be associated with the use of mobile technology in education. It seems, however, that it is used in commercial purposes rather than as an educational concept. We wonder if the term is a commercial trick to market technology and educational services or if it is an emerging concept that educationalists should take seriously." (Sariola et al. 2001, p 1)

It should be noted that, although m-learning is a new concept, serving mobile learners is not a new idea. Again, distance education has a history of more than 150 years, where institutions has offered high quality education to learners *'free of time and place'*. This means, that if we are willing to accept the concept m-learning, distance teaching institutions have provided m-learning since its invention. For example, the history of Hermods, once one of the worlds largest correspondence institutions, tells that the original idea that resulted in establishing the institution in 1898 came when Hermods as a local language teacher in Malmö started to support one of his students who moved to another city (Gaddén 1973).

Thus, distance education institutions have provided m-learning for many years. In fact, the *'correspondence courses'* of the first generation of distance education could be studied at any time anywhere. Actually, the introduction of the desktop computer (and other learning technologies), which required the student to study at a certain place, often also at a certain time, reduced flexibility of distance learning. It is the introduction of mobile electronic equipment and communications technologies, which reintroduces mobility to the distance learner (and teacher). Kjell Askeland (2000) goes even further, and points to the fact that, if we disregard the need for an institution to plan and conduct teaching, mobile learning started when the printing technique was invented, and students could learn without coming to schools and universities.

Again, if we accept the term *'mobile learning' = m-learning'*, what is it? Most definitions take technology as the starting point, e.g. Quinn (2000-2001): *"...(mLearning)? It's elearning through mobile computational devices: Palms, Windows CE machines, even your digital cell phone. Let's call them information appliances (IAs),..."*

Others define m-learning closely to distance education, Chabra & Figueiredo (undated): *"The ability to receive learning anytime, anywhere and on any device"*, while Harris (2001) combines technology and the flexibility concept of distance education in his definition: *"The point at which mobile computing and eLearning intersect to produce an anytime, anywhere learning experience"*.

Sariola et al. (Ibid.) discusses the concept, m-learning, from the perspective of educational theory, technology-based definition is obviously not sufficient, and also tries to include aspects of technology. They introduce the characteristics, *'portability'*, i.e. the equipment is so light that we can carry the devices that we call mobile, *'wireless'*, there are no wires in the equipment, and *'mobility'*, we are moving when using the technology. Sariola et al. notes that it is the mobility that is most interesting from an educational viewpoint. Concerning mobility,

they raise the question about 'who' is moving, 'why' and 'where'. If moving is not related to the learning activity as such, why a person is moving might be irrelevant from an educational viewpoint. However, it is the challenge of the educational institution to satisfy learning needs for people on the move (and we could add to support teachers who move to continue their tasks concerning student support). Sariola et al. notes that conducting educational activities while moving, might deal with *convenience*, e.g. rational time management or *expediency*, e.g. the person is moving to a place relevant for the subject studied. Both situations concern NKI when designing an effective and efficient learning environment for the distance learner, although convenience has been most focussed till now.

Flexible teaching or teaching in the 'extended classroom'

A number of evaluation studies among distance and online learners at NKI demonstrate that students emphasize flexibility (see e.g. Rekkedal 1990, 1998, 1999).

In our view, distance education seems to develop in two quite different directions. The solution at one end of a flexibility continuum can be described as an individual, flexible solution allowing the student freedom to start at any time and follow his/her own progression according to personal needs for combining studies with work, family and social life – *'the individual flexible teaching model'*. This model represents a generic development of the model of distance teaching institutions and applies normally media and technologies independent of time (and place), such as asynchronous computer communication, video, audio and printed materials. The model on the opposite end of the scale, *'the extended classroom model'*, assumes that the students are organised into groups required to meet regularly at local study centres and applies technologies such as video conferencing, satellite distribution, radio and television (Gamlin 1995).

In this connection we have chosen the philosophy for the development of Internet based education at NKI: *Flexible and individual distance teaching with the student group as social and academic support for learning*. NKI offers more than 400 courses and over 100 study programmes by correspondence based and Internet based distance teaching and recruits 10,000 students every year. These students may enrol to any course of programme or combination of courses at any day of the year and progress at their own pace. This flexibility does not exclude group-based solutions in cooperation with one single employer, trade organisation or local organiser.

It is also clear from NKI experiences that already many of our students and teachers have experience as mobile learners and teachers. Till now this has been restricted mainly to students and teachers carrying their laptops, possibly including communication via mobile phones.

Our main objective in this part of the project has been to extend the distribution of learning materials and communication to lighter equipment, specifically PDA and mobile phone. The challenge is then to develop the system and server side to present materials in ways suitable for PDA technology, find acceptable solutions for distribution of materials and for *administration to student, teacher to student/student to teacher and student to student communication*.

It is our aim in designing the environment for the mobile learner to extend and increase the flexibility of distance education, that to some extent took a step backwards when converting from paper based to online learning, where students largely were required to study at a place (and at a time) where a computer with access the Internet was available.

Views on knowledge and learning

For NKI it was clear that the learning aims, content and teaching/learning methods in our online courses and programmes generally are far away from most e-learning courses. Most examples of m-learning experiments concern e-learning on mobile devices, often WAP and/or 'smart-phones' (see e.g. Kynäslähti 2001, Kristiansen 2001).

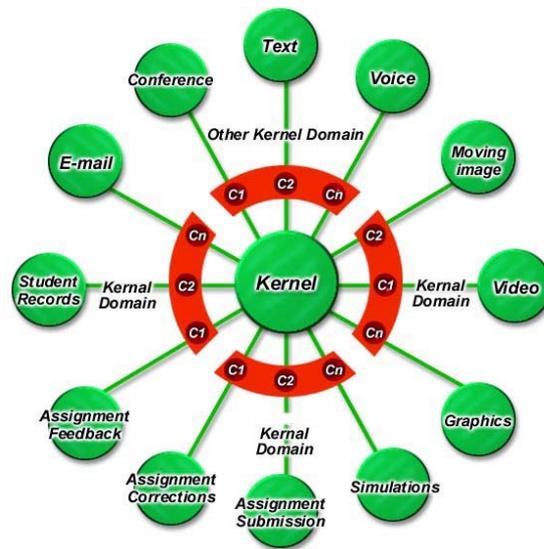
To us, learning is a change in the student's perception of reality related to the problem areas studied and increased competence in solving problems in a field, ability to differ between focal and more peripheral questions, analytical skills and competence in using the tools within a field in appropriate ways. This means that learning results are shown in a qualitative change in the student's understanding, academic, social and technical competence. The learning is a result of active processing of learning material and solving problems individually and/or in groups. This view is often different from what we can find in many so-called e-learning programmes, where knowledge often is seen as a larger amount of information or ability to recall and reproduce facts. In addition to cost considerations, this is why NKI in general has put little emphasis on using fancy effects in a behaviouristic pedagogical tradition, programmed learning and knowledge transmission (see Marton et al 1987, 1997, Morgan 1993 on students' conceptions of learning, deep level and surface level approaches to learning). We also hold the view that learning is an individual process that can be supported by adequate interaction and/or collaboration in groups (Askeland 2001). With these considerations in mind the NKI solution for designing and trying out a new learning environment for online learners applying PDA and mobile communication seemed to be a sensible one. Our considerations and decisions are discussed below.

Internet based education at NKI today

NKI was probably the first European online college, and it has offered distance education online every day since 1987. Few - if any - online colleges in the world has been longer in continuous operation.

NKI Distance Education has today well above 200 courses and more than 60 complete study programmes on the Internet. October 2001 we had 3,000 registered active students. There will be more than 6,000 new course enrolments this year (2001). Contrary to many other educational providers where the Internet is used as a supplement to face-to-face teaching or other forms of distance education, we have followed the philosophy that in principle all communication can be taken care of through the Internet, and ideally no obligatory physical meetings should be required. (This does not mean that the students are not free to communicate by post, phone or fax or that study materials may include print, audio or video technologies.)

In connection with a previous EU Leonardo projects managed by LM Ericsson we described the programme and distribution system in Internet based learning as a '*Multimedia World Wide Web Kernel for Distance Education*' (<http://www.nki.no/eeileo/>) with the following elements:



Model of the Multi Media Kernel for Distance Education.

In designing the learning environment with the mobile learner in mind, all these aspects and functionalities have to be taken into account. However, in this first pilot experiment we have not focussed on multi-media materials. Extending the functionalities to more multi-media content adapted to the PDA should be a main objective for another project.

Development and Design of the Environment for the Mobile Learner Applying the Compaq iPAQ

As mentioned above, the aim for the NKI project team was to adapt a course so that it could be used on a wireless handheld device, in our case the Compaq iPAQ Pocket PC. After some discussions we have chose the course *'The Tutor in Distance Education'* for this project. In addition, we also put some effort into adapting the course *Spice 601, Specialization Program in International Online Education*, to the Pocket PC. This was mainly done to demonstrate a course in English for the Leonardo project team.

These courses were already developed and distributed as courses from the NKI Internet College. The challenge was to design a solution to try out for mobile learners.

Some background information on the Compaq iPAQ

This device is a handheld pocket PC that puts the power of a desktop PC in a sleek little to-go box that gives access to Microsoft Pocket applications like Internet Explorer, Outlook, Word and Excel. Among this software is also Microsoft Reader with Clear Type, which is one of the technologies that we wish to try out in the project. It is also possible to install third party software. One can synchronize the device with one's desktop PC to read e-mail, view attachments, update the calendar and the device can easily connect to a mobile phone via cable, infrared or bluetooth (3870 version) for online browsing. (See <http://www.compaq.com/products/handhelds/index.html> for more details.) The screen keyboard is acceptable for short notes. However, many users would prefer to connect to Pocket PC with a foldable keyboard for more efficient writing. At the time of writing (December 2001) available keyboards are far from ideal concerning supporting Norwegian characters.

Studying online and offline

In line with the above discussions on learning and studying, most NKI courses are not designed to function as online interactive e-learning programmes, although some parts of the courses may imply such interaction with multi-media materials, tests and assignments. The courses normally involves intensive study, mainly of text based materials, solving problems, writing essays, submitting assignments and communicating with fellow students by e-mail or in the web based conferences. This means that most of the time the students will be offline when studying. From experience we know that the students often download content for reading offline and often also print out content for reading on paper.

It should also be emphasized that we assume that the NKI Internet students normally will have access to a desktop or laptop computer with Internet connection. This means that the equipment and technologies used when mobile are additions to the students' equipment used when studying at home or at work.

When planning for the m-learning environment the NKI project team had long discussions whether to develop the learning materials for online or offline study. Taken the above experiences and also cost considerations concerning mobile access to online learning materials, we concluded that the learning environment should include the following aspects:

Technology:

- Pocket PC
- Mobile phone
- Portable keyboard



NKI distance student reading comments from his tutor in the garden of his hotel on business in Rome using PocketPC, portable keyboard and mobile phone.

Learning content and communication:

- Learning content to be downloaded on the mobile device to be studied offline.
Downloaded content to include all course materials:
 - Content page
 - Preface
 - Introduction
 - All study units
 - Resources (articles on the web, references to other resource materials)
- Online access to the discussion forum with the possibility of as quick as possible access for reading in the Forum and writing contributions
- E-mail for individual communication with tutor and fellow students and for submitting assignments. Assignments may be submitted as text-based e-mail or as Word or Text attachments.

Before taking the decision on distribution of course content to students via the Pocket PC, we analysed three alternative solutions that were discussed in depth. The discussions also included viewpoints on which materials and study activities were suited for offline or online work.

3 alternative solutions for distribution of course content

The 3 main solutions for distributing content were:

4. **The AvantGo Mobile Internet service**
5. **Online access via mobile telephone to the entire course**
6. **'Download-on-demand' version**

Solution 1: The AvantGo Mobile Internet service

Technically we could choose the solution were the student easily could download the entire course content through 'The AvantGo Mobile Internet Service'. From the AvantGo website:

"The AvantGo Mobile Internet service provides free interactive and personalized content and applications to your handheld device or Internet-enabled mobile phone real-time via wireless connection or desktop synchronization. With AvantGo you can seamlessly transition between wireless and offline modes to browse your favorite websites on your mobile device or select from our more than 1500 brand-name content and application channels for up-to-date news, financial, travel, entertainment, sports information and much more.

The AvantGo Service allows the user to subscribe to a large number of channels of different categories. AvantGo offers a range of products for the synchronizing of PDAs. Including a range of hosting services. Unfortunately the hosting services are only suitable for the delivering of typical news channel information such as CNN headlines or stock quotes. These services are priced according to how many users use the service each day. AvantGo then uses advertising and revenue from the information provider to generate income. It is up to the information supplier to generate their own income based on these services. The hosted services also do not cover NKI Distance Education needs of personalized content and user interaction.

To be able to deliver content to PDAs via AvantGo we will be required to install our own AvantGo server, and then deliver content via this server to PDAs. AvantGo call their server Mbusiness server. The server is capable of being connected to our current web application (SESAM). And allow us to use our own database of user names and passwords, via a

connection to our LDAP server for authenticating users. This would allow NKI to deliver customized content to each user. When using the Mbusiness server it is also possible to cater for user interactions. In that case a user could write a submission to the forum system and the next time the PDA was synchronized, the submission would be uploaded to our server

The Mbusiness server is available for many operating systems, including MS-Windows, Linux and SUN Solaris. All communication with the server is encrypted for security.

AvantGo's pricing policy is based on the value the server product will add to the purchasing enterprise. So the price is highly variable. It is not possible to get a 'definitive' price for the Mbusiness server without AvantGo evaluating how much 'value' the server will add to our organization. However, we were able to get a general guideline. The Mbusiness server would typically costs around 75,000 euros for a 250-user intranet. These are costs that would not be acceptable for use with NKI Internet students.

Solution 2: Online access via mobile telephone to the entire course

This is perhaps in principle the preferred solution. However, it requires higher speed and lower prices than we could find in Norway in 2000. It is also the most complex solution. An online version requires that we would have to redesign the entire site to fit the Pocket PC format. Before doing this we would have to make a cost-benefit analysis in front to see if the solution really is worth the effort. The other important issue is the availability of mobile communication technology and pricing. In this project we are using the Ericsson R520 and Ericsson T39 mobile phones connected with the PocketPC. These phone supports GPRS, General Packet Radio Services, and HSCSD (high-speed circuit switched data). So far in the project our experience with this technology is mixed. It proved quite difficult to set up and connect via GPRS, and the pricing policy chosen by our Norwegian GPRS providers makes it all to expensive to use. One pays no subscription fees, however, the amount paid Mb of information transferred is presently not acceptable. For data up to 1Mb one pays 0.10 NKR pr. Kb and 0.025 NKR pr. Kb for data exceeding 1Mb.

Solution 3: 'Download-on-demand' version

We have developed two different "download-on-demand" versions. The first one consists of a set of zipped HTML files, which one may download to the desktop PC, unzip and synchronize with the PocketPC. The second consists of a set of ready to use Microsoft Reader files, which also are synchronized to the PocketPC. These files are available from within the web course.

At this stage of the project we focused on this alternative. The HTML version is using *Internet Explorer* to browse the course material offline. The other version is also an offline version, using the software, *Microsoft Reader with ClearType*.

The choice of solution 3 was partly a result of limited time and resources available at this stage of the project. Solution 1 needs more research to explore opportunities, limitations and cost/benefit. Solution 2 would perhaps be *'the most ideal'* solution for the future, i.e. to offer a complete PDA adapted version based on the same learning materials available in the web course for standard PCs. The principle of *'one file many versions'* (html, pdf, reader, etc.) is achievable trough the use of XML). Presently, through our preliminary analyses we found that there were too many limitations in mobile technology regarding transfer capacity vs. cost to be able to carry out the experiments that we wished to do. Solution 2 would also, as mentioned above, require a complete site redesign of the NKI Distance Education website.

The reason for supplying two alternatives of content is that we as part of the empirical testing are interested in examining attractiveness and user friendliness of the different solutions for the student. The student can manipulate the Microsoft Reader content by the possibility of *bookmarking, adding highlights, notes and drawings and look up words directly in the PocketPC Dictionary*. This means that the students can use the materials actively in ways that we recognise from students' use of print materials and their personal notes. The student is, in other words, able to 'make the materials his own' while studying. It is reason to believe that these functionalities may help students organising the materials cognitively and support learning and remembering.

The decision to go for the choice of downloading content for offline study was based on previous experiences and also the following considerations: NKI Internet students study mainly offline. Communication concerns discussion with fellow students in the academic forums, cooperation on projects and group assignments, and individual communication with other students – and, most important, according to our evaluations (see e.g. Rekkedal & Paulsen 1997), communication with the tutor including submission of assignments with correction and feedback. All our analyses concluded that the students will have all these possibilities available on their desktop or laptop PCs, including online interaction with the learning materials.

When mobile – and using mobile technologies – it is generally satisfactory for the student (and the tutor) to have the course content available to study on the PocketPC. In addition, the following communication possibilities are necessary. When mobile, the student must be able to:

- Access the course forum to read messages
- Access the course forum to submit contributions to the discussions
- Send e-mail to fellow students, to the teacher and to administration (study advisor)
- Receive e-mail from fellow students, from the tutor and from the administration
- Submit assignments by e-mail including attachments
- Receiving assignments corrected and commented on by the tutor including attachments

To access e-mail and discussion forums, mobile phones will be used. We plan that in future versions it will be possible to synchronize discussions via the student's desktop or laptop PC.

This software/technologies chosen are described in more detail below.

Development of courseware and the software applied

We chose a course previously developed for Internet/web based learning, '*The Tutor in Distance Education*' as courseware for this project. This course is one of our many ongoing Internet courses and therefore already available in a HTML version. Thus it was relatively easy to adapt the existing version of the course to the iPAQ since MS Internet Explorer is the browsing tool used. The main part of the adaptation was to create directories and file structures that insured that all content were present and worked as intended. Some modifications had to be done, e.g. the table of content had to be changed, so that all links to introductions, study units, articles etc. could be placed on one page. The Content Page also contains links to examples of course pages such as class list, forum page, the student's personal NKI college page and others. Students can also a link to the presentation of their tutor with contact information. The course includes reference links to many external

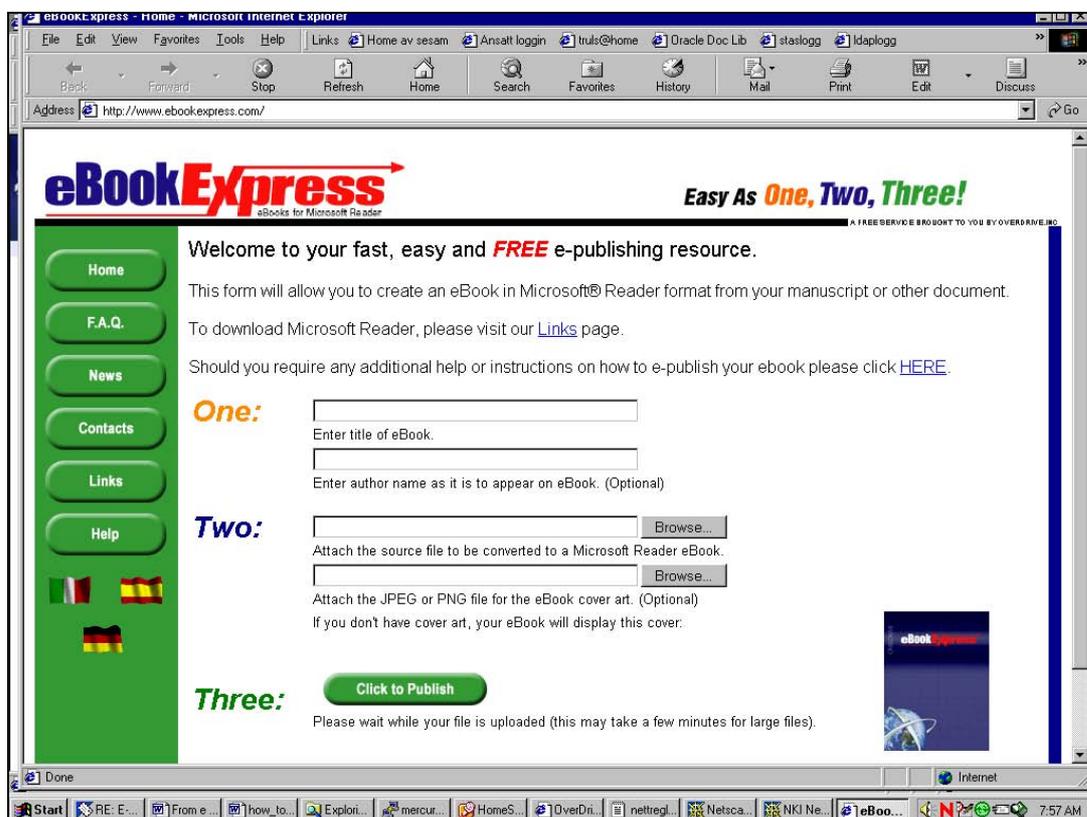
resources, which also are available on the PocketPC, but accessible only when online through the mobile phone. The course also includes a number of articles available at the NKI Internet College Pages. We chose to include the whole library of distance education research reports, articles, conference papers etc. available on the NKI pages. This was done mainly because the course content concerns distance education pedagogy and didactics, thus as the storing capabilities of the iPAQ was sufficient, we considered this as an extra academic service.

As mentioned, the HTML version applies Microsoft Pocket Internet Explorer that is a web browser with far less functionality than the full scale PC version.

The other version developed for the project uses Microsoft Reader on the Pocket PC as 'browsing' tool.

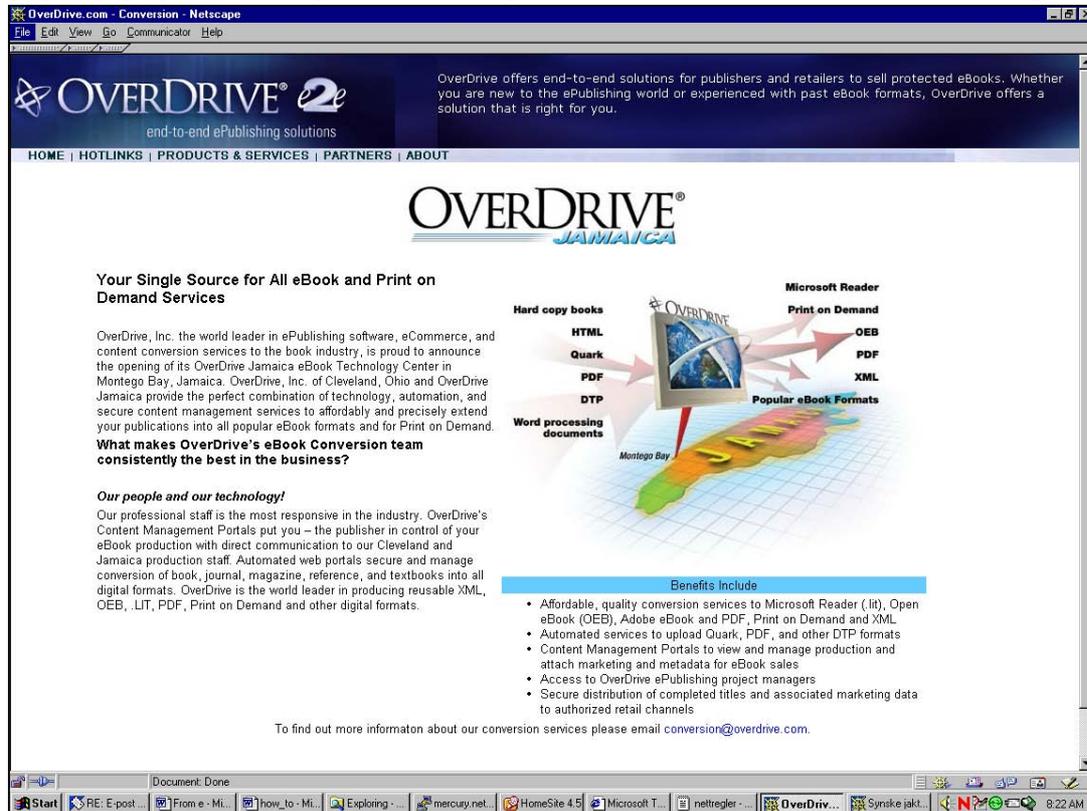
Microsoft Reader with ClearType is one of the programmes available to read e-books or content in the *.lit file format (MS Reader file format). Microsoft has developed Microsoft Reader with ClearType that enhances display resolution by as much as 300 percent by improving letter shapes and character spacing, making them appear more detailed, more finely crafted, and more like printed fonts. This gives powerful digital advantages like integrated dictionary support and electronic annotations, while honouring the best traditions of typography to ensure proper kerning and leading, correct margins, and line justification, to name a few. The software also gives the opportunity to read e-books, Pocket Dictionaries etc. to downloaded from the Internet and synchronized to the PocketPC via the PC.

There are several methods to produce materials in the Microsoft Reader format. One may create on-the-fly Reader files via publishing websites like eBookExpress:



The eBook Express Home Page.

It is possible to outsource the entire or parts of the converting process. Several e-book consulting and content conversion services are available and offering services ranging from document conversion to complete e-commerce solutions. Overdrive is one example of a firm that offer ePublishing solutions, <http://www.overdrive.com/>. The software builds the e-book, page-by-page, according to individual preferences to suit the device one is using.



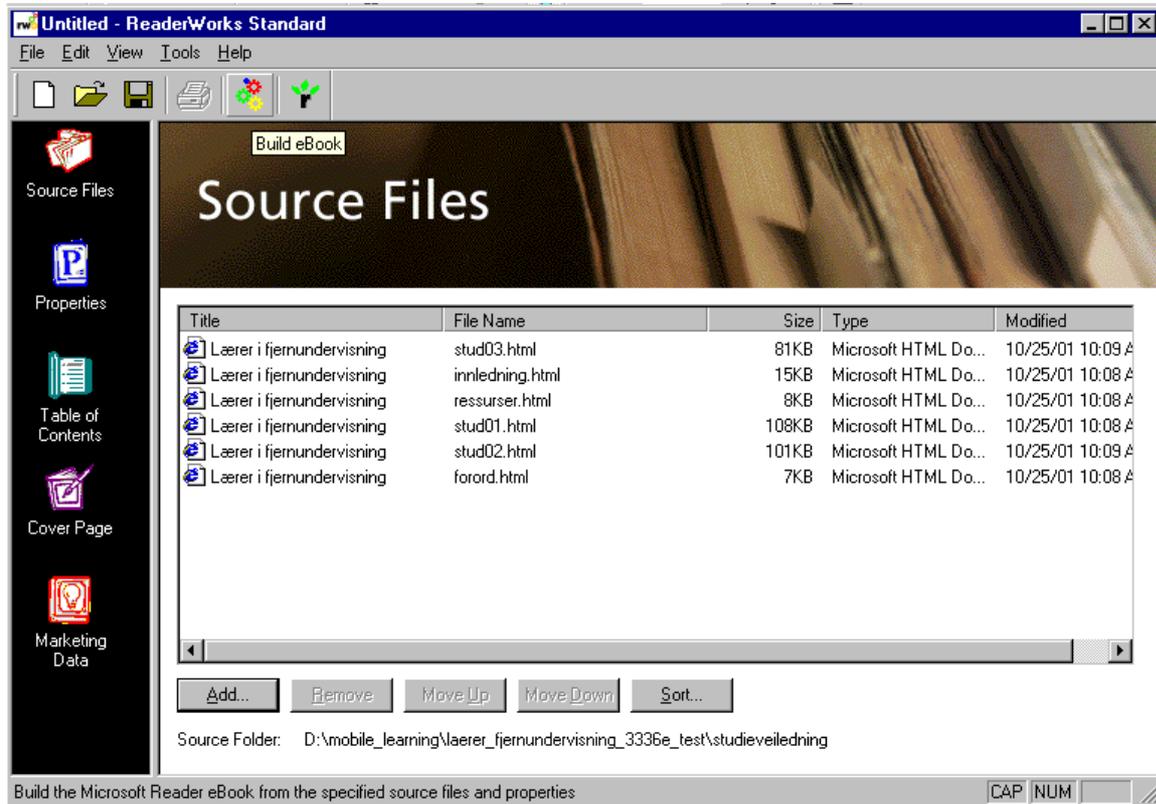
Overdrive ePublishing Home Page.

One may also download software that converts publications into Reader files/e-books according to individual preferences. One of these is ReaderWorks. This is a third-party software recommended by Microsoft developed by OverDrive Inc. ReaderWorks is available in three versions, Standard, Publisher and Professional. The Standard version is freeware with less functionality than the Publisher and Professional versions. OverDrive and Microsoft also provides a software development kit (SDK) that software developers can use to build tools that generate Micorosoft Readerfiles. Microsoft also offers an add-in functionality for Microsoft Word that makes it possible to convert a Word document to Reader format.

We have in the project produced a version of the learning materials for Microsoft Reader using the Standard version of ReaderWorks from OverDrive Inc. This version is a freeware application with some limitations regarding commercial sale and distribution. It also lacks the opportunity to provide cover pages and marketing information.

ReaderWorks Standard includes tools to convert html, text and image files to Reader format. It also allow for making a table of content based on heading formatting of HTML documents. Our experience so far is that this is a very well functional tool that also is quite easy to use. It has an intuitive user interface with many different options and functions. We had some

problems with empty meta-tags that made the conversion fail. The software also showed some problems with documents containing internal style-sheets and script language. These errors caused the conversion to fail. The HTML code causing these errors had to be manually corrected. The software supplied good reports on what kind of errors arising and where they occurred.



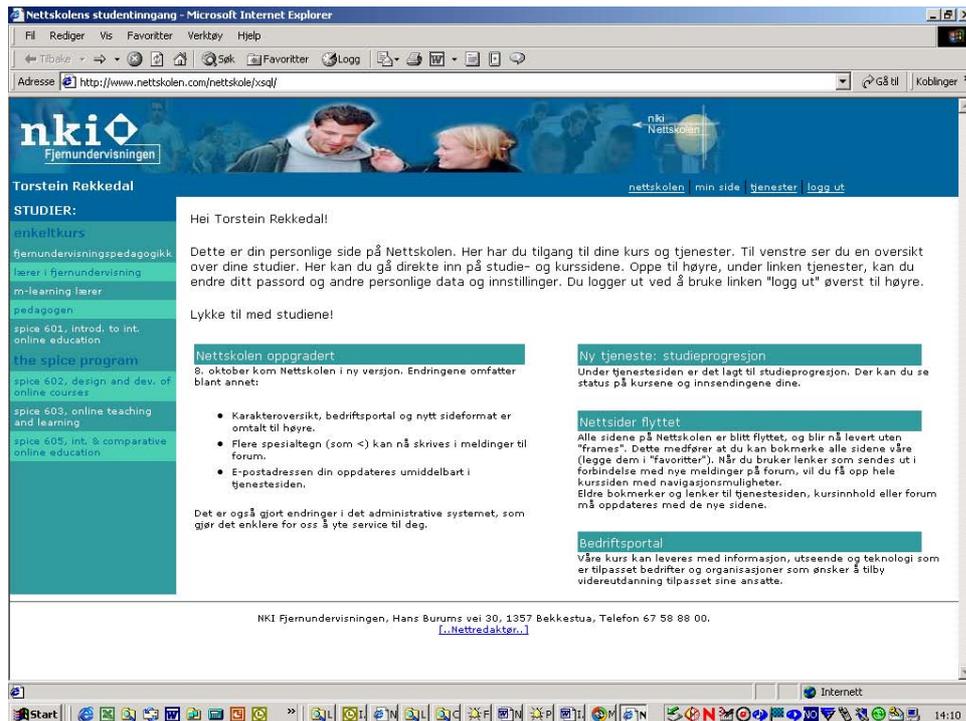
Screen shot from ReaderWorks software.

The Solutions Exemplified

Learning materials accessed from the PC

As described before all NKI Internet students, whether studying a course with a mobile supplement or not, will access the course materials and communication solutions via their ordinary PC at home, at the workplace or elsewhere. Course content for the mobile supplement is downloaded to the PC and synchronized to the PocketPC, while all the communication activities can be carried out through the PocketPC and the mobile phone when on the move.

Below we shall illustrate the practical solutions through a number of screen shots of the course as it looks on the PC and on the Compaq iPAQ.



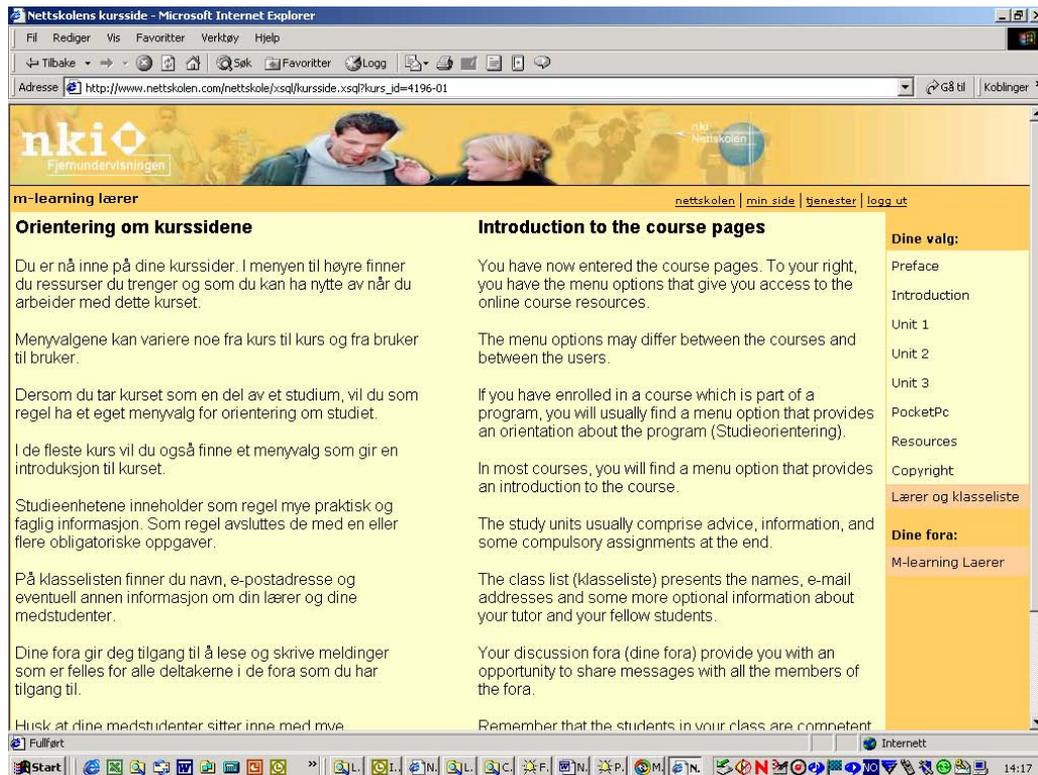
Screen shot of the tutor's 'Personal page' as it looks on the PC.

After logging into the NKI Internet College with user name and password, the user (tutor or student) opens the person's individual 'Personal page'. This page contains general information and lists the courses and programmes the person has access to. On the screen above the tutor has access to '*m-learning lærer*', which is the course developed and to be tried out during the first phase of the project. The course title links to the Course Front Page.

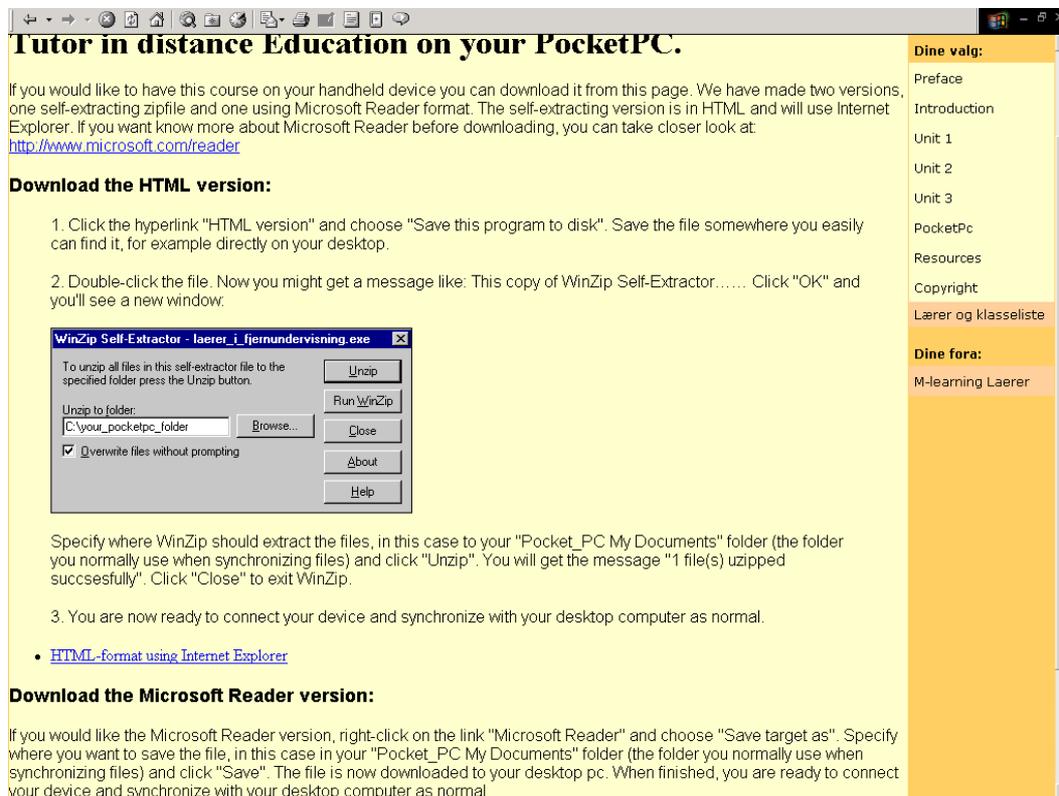
The course front page links to:

- The course content on the server
 - Preface
 - Introduction
 - Study Unit 1
 - Study Unit 2
 - Study Unit 3
 - Resources
- Information about copyrights
- Tutor and class list
- The course forum

In addition the m-learning version has a link named '*Pocket PC*', which links to a page containing all necessary information for downloading the content in the two versions, HTML format and Microsoft Reader format.



Course Front Page with the PocketPC link on the menu.



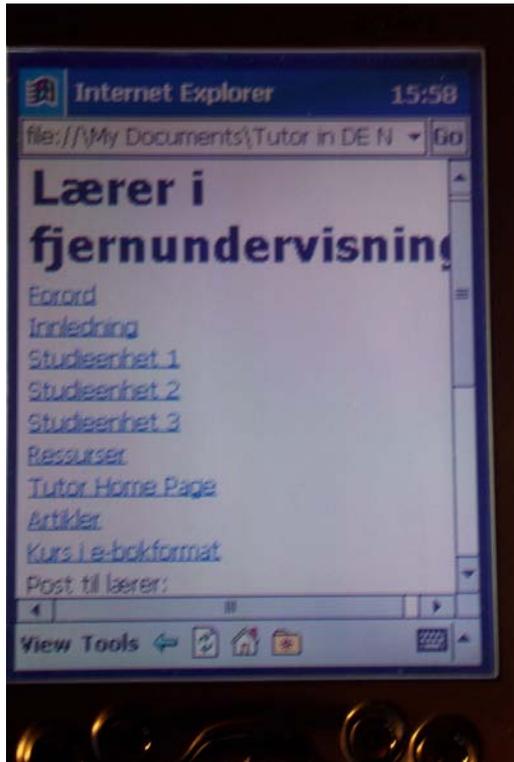
Page for downloading course materials to the PocketPC.

Learning materials and communication on the PocketPC

The learning materials downloaded and synchronized to the PocketPC are presented as complete HTML files, and are, according to our subjective opinion, satisfactory for reading on the PocketPC screen. This will be evaluated during the try out.

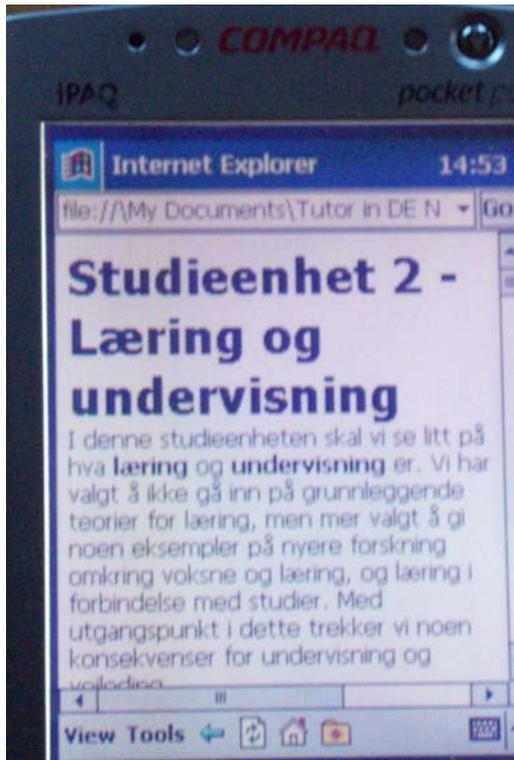
The screen shots of the PocketPC are photographed using a digital camera. The results are not perfect, but give a reasonably good impression of how they look.

Below is presented the course content files as they appear downloaded in the HTML version:

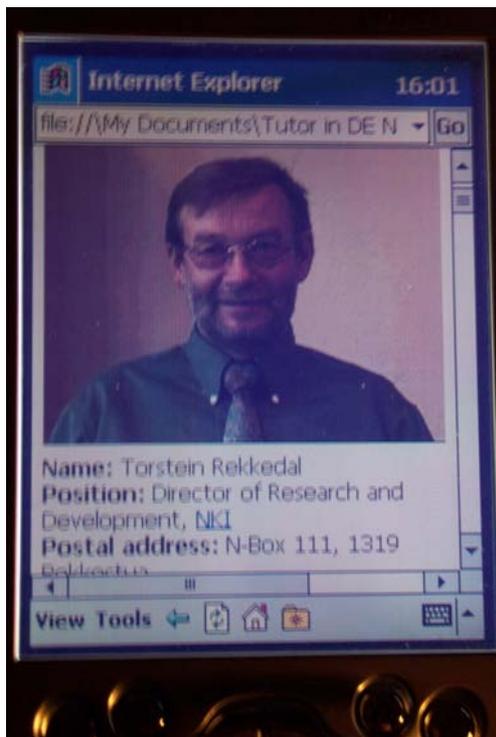


The Table of Content Page on the PocketPC.

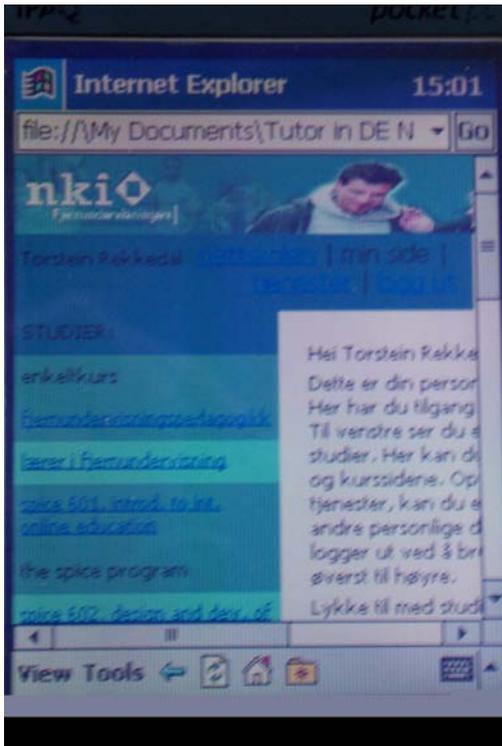
The hyperlinks brings the student to the course content files. The last link seen at the screen, '*Kurs i e-bokformat*' (*Course in e-book format*) opens the Microsoft Reader with a second full version of the course. The Content Page also has links (not seen on the screen) that opens the PocketPC e-mail programme or connects directly to the course online for reading and contributing to the course forum.



Screen shot of the first page of Study Unit 2.



Tutor Presentation (Tutor's Home Page) as accessed online with the PocketPC or downloaded and synchronized to the PocketPC.



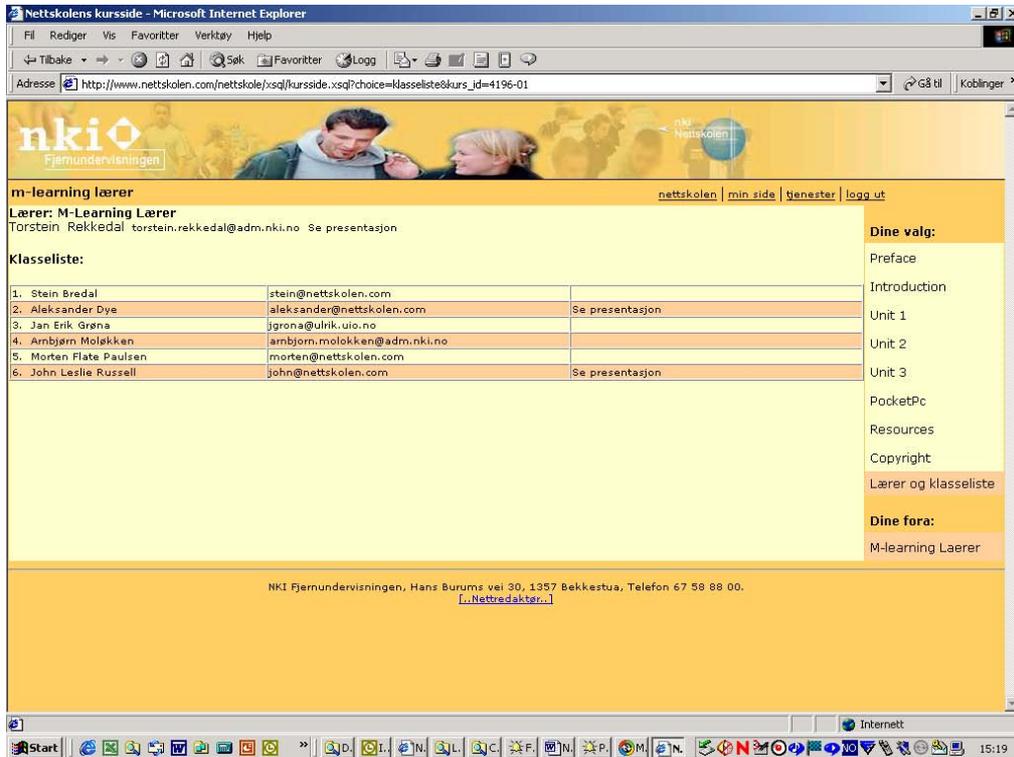
The tutor's personal page as accessed online with the PocketPC or downloaded and synchronized to the PocketPC.



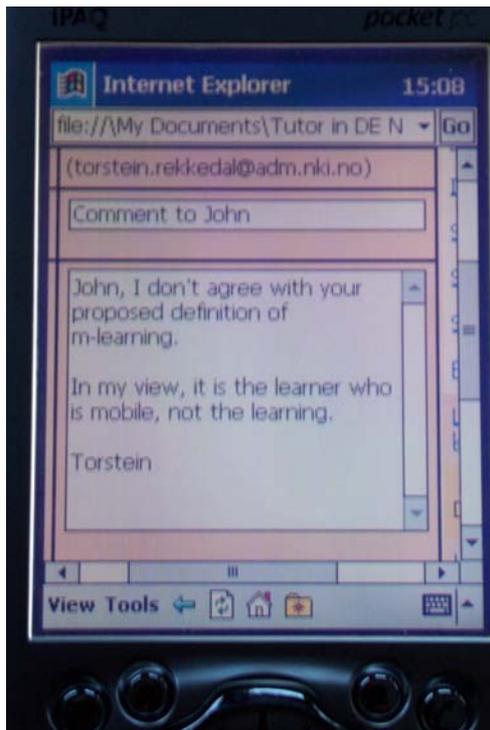
The Class List as accessed online with the PocketPC or downloaded and synchronized to the PocketPC.

While the course content is presented in formats adapted to the screen of the PockePC, the pages above are shown as they appear with the present solution (without having redesigned the materials on the server to fit the PocketPC). However, with some scrolling the pages are readable.

Below is illustrated how the Class List looks when accessing the materials from an ordinary PC:

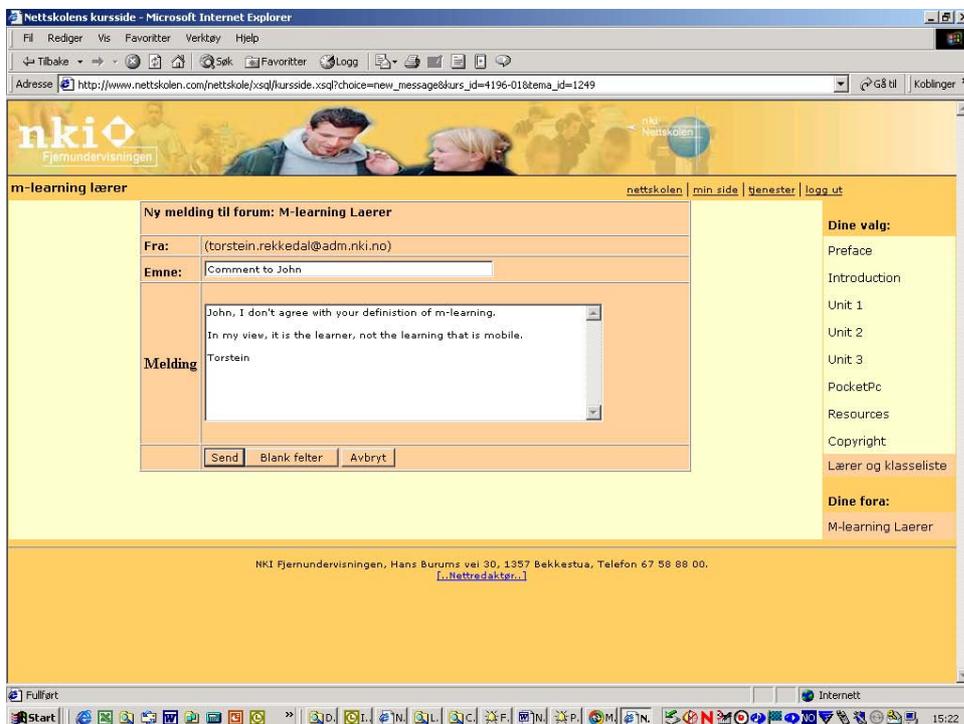


As we have discussed above online studying in this version is mainly related to communication including participation in Forum discussions. The picture below illustrates how the page for Forum contribution appears on the PocketPC.



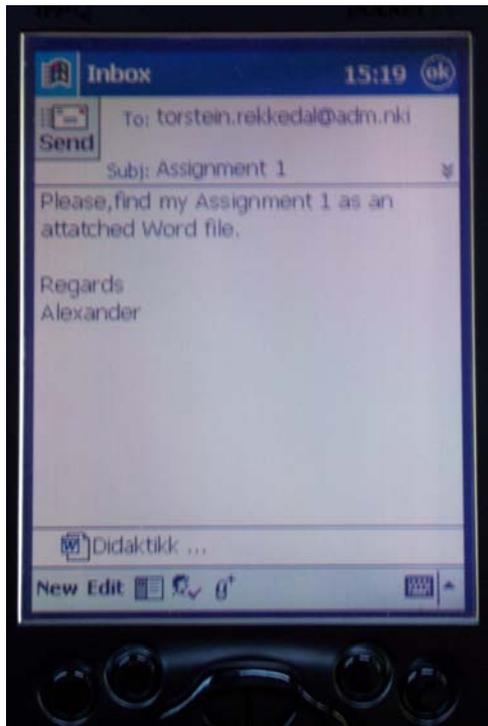
Comment for submissions to the Forum from the tutor to a student contribution as appearing when online from the PocketPC.

Below is shown how the page for constructing a contribution to the Forum appears when accessing the NKI Internet course pages from a PC:

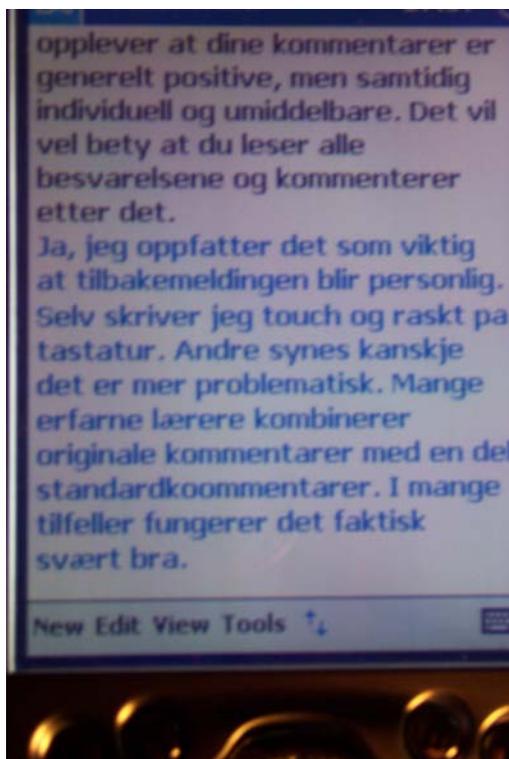


Comment for submissions to the Forum from the tutor to a student contribution as appearing when online from the PocketPC.

The Content Page also contains a hyperlink that opens the e-mail programme and prepares an e-mail to the tutor.



E-mail with an Assignment submission as attached Word document.



Student assignment written in Word with the tutor's comments in blue as appearing on the PocketPC. (Letter size can easily be changed.)

Conclusion course presentation and communication

At the present stage and with present technological limitations the NKI project team decided that we had found an acceptable solution for presentation of course content and facilities for studying the learning materials, for solving assignments and submission of assignments to the tutor. Sending and receiving e-mails also functions satisfactory.

It is the empirical try out that hopefully will give answers to how our solutions actually are accepted in practice. In connection with the second phase of the project, we will parallel to the empirical research look at possible solutions for redesigning the site to make the learning materials better adapted for online access and interaction from mobile equipment.

Summary and Conclusions

In this paper we have described the preparatory work, internal discussion and analyses and the development work concerning preparing for trying out a learning environment for mobile learners within the teaching and learning system of NKI Distance Education. The NKI Internet College is defined as the total system for Internet based distance education courses. The work during 2001 is carried out in close cooperation with the other partners in the project.

The solution is based on the assumption that students defined as *'mobile learners'* have access to the NKI Internet College through a standard PC and Internet connection, and that the mobile part is seen as a supplement for students when on the move. Our technical requirements was that the mobile learning platform had to allow more advanced presentation and communication possibilities than possible through the WAP phone, concerning storing capabilities, use of colours and graphics and size of files. The decision was taken to develop learning materials, i.e. complete courses for handheld PDAs/PocketPC and mobile phone for connection to the Internet. The solutions are supposed to be generic and based on state of the art technology and also representing technologies that would give experiences of value for future assumed probable developments in software and hardware. The actual equipment used as basis and trials during development was Compaq iPAQ and Ericsson T39 and R580.

One course, *'The tutor in distance education'* was chosen as the first practical case in developing materials and communication solutions for the mobile learner. Before starting actual try outs, the project group feels that the technical solutions chosen constitute a good basis for experimenting and evaluating an environment for mobile learners in NKI Distance Education.

Planning the Try Out

We plan to try out the solution from early January 2002. Originally we wished to try out the course among ordinary students at NKI. We have found that access to equipment among our ordinary students for the time being is too limited. Thus, the first trial will be carried out in a partly real and partly simulated situation where one member of the project team will teach the course to an internal group of NKI employees, some members of the project team and some participants working in other projects and related areas. For the try out we have purchased 10 PDAs and a few mobile phones.

We will evaluate the results through the process applying qualitative research methods, such as diaries, interviews and discussions in the academic Forum focussing on the aspects of the mobile learning environment. Aspects to be evaluated are:

Technical problems concerning downloading, synchronization, communication with forum and e-mail

Studying on the move with the learning materials on mobile equipment (PDA and mobile phone)

Use of learning materials, usefulness of HTML solutions and e-book

Technology, such as use of screen and portable keyboards

The participants will be required to log experiences from the first experiences with the PDA and downloading till end of course, to study the materials and communicate with fellow students and participating in forum discussions via mobile equipment.

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Technical working paper 2002, NKI Distance Education **Development of courseware and the software applied year 2002.**

September 2002

This paper describes the technical work package carried out at NKI Distance Education during the year 2002 of the EU Leonardo Project, *“From e-Learning to m-Learning”*. We have based our technical work during this second year on our work and experiences from 2001. This work is described in detail in our report *“Designing and Trying Out a Learning Environment for Mobile Learners and Teachers”* (Fagerberg et al. 2001) (<http://www.nettskolen.com/forskning/55/NKI2001m-learning2.html>).

Summary 2001

The technical solution chosen was to try out the use of Pocket PC/Personal Digital Assistant (PDA) in combination with mobile phone for distribution of learning content and communication between tutor and students, between students and for students' communication with the learning material.

We chose to build our learning environment around the Compaq iPAQ 3630 and 3660. The mobile phones chosen were Ericsson T39 and Ericsson R580. The next steps for NKI Distance Education in the project were to carry out the first experiment of a partly real and partly simulated distance learning setting including evaluation, carry out a survey among distance learners on aspects of mobility and plan and conduct a second experiment in a fully realistic setting.

To distribute our course content we analyzed three different solutions. They were:

- **The AvantGo Mobile Internet service**
- **Online access via mobile telephone to the entire course**
- **‘Download-on-demand’ version**

For more details, see *“Designing and Trying Out a Learning Environment for Mobile Learners and Teachers”* (Fagerberg et al. 2001)

The *“Download-on-demand”* version was chosen and the development work was concentrated around an off-line Norwegian version of the course *“Tutor in Distance Education”*.

Development of courseware

In the 2001 experiment we supplied our students with two optional versions of the course, one in HTML and one in the Microsoft Reader (*.lit) file format. Based upon our evaluation results and experiences with Microsoft Reader from 2001, we decided to offer the 2002 course in the Microsoft Reader format only.

Microsoft Reader is a program for reading e-books or content in the *.lit file format (MS Reader file format). Microsoft has developed Microsoft Reader with ClearType that enhances

display resolution and improved reading qualities. This also gives powerful digital advantages like integrated dictionary support and electronic annotations, while honoring the best traditions of typography to ensure proper kerning and leading, correct margins, and line justification, to name a few. The software also gives the opportunity to read e-books, Pocket Dictionaries etc. download from the Internet and synchronize to the PocketPC via the PC.

For the 2002 trial, have chosen to adapt one of the courses in the SPICE program, SPICE 603 Online Teaching and Learning. The Specialization Program in International Online Education (SPICE) comprises five six-credit (ECTS) courses about online education delivered internationally via the Internet. Successful completion of all five courses and exams qualifies for the Specialization Program in International Online Education Certificate (SPICE) which is awarded by NKI.

Producing e-books

In this second year we are using the same tools and technology used in year one, but we have upgraded our version of “ReaderWorks” to ReaderWorks Standard version 2.0.2.0215 and the PocketPC operating system(OS) to PocketPC 2002. Upgrading the PocketPC gave us better functionality regarding viewing tables in a document. On the old OS some tables in documents were not displayed properly. The new OS displayed it perfectly.

All our source files were originally produced in html format except one pdf – file that we had to convert to html because Reader Works can only handle html, word or plain text files as source files.

Microsoft Reader, e-book format, gives very limited options concerning layout and design features compared to word processors and html. Our html source files commonly use frames, tables and illustrations as design elements. All frames had to be removed by re-building all documents, and all tables used as design elements were removed. Tables used as “ordinary” tables or as markings around text were kept when possible, otherwise they were rebuilt or split to fit the screen size at the PocketPC. One interesting point to note, is that Reader for PocketPC handles large tables over several pages quite well, while Reader for desktop PC does not. We have experienced that on a desktop PC long tables tend to disappear at the bottom of a page.

Design elements such as illustrations were kept if they added value to the e-book, otherwise they were removed. Some illustrations were removed because they were too large to be displayed at the PDA and therefore added little or no value. Text attributes (font, style) and colors were converted without problems and kept as they were in the original documents.

All html source files have been cleaned up and edited to create one “look and feel”. ReaderWorks use the heading tags to generate table of content(TOC) so all heading tags were checked and edited if necessary. The title tag < TITLE >A title</TITLE> were completely removed from the html source files because it generated an error when we produced the TOC. If the title tag was not removed, it included it self on the beginning/top of TOC. We have created our own style based on template styles for TOC to make it more readable and user-friendly for the PDA.

We also had to remove all tags in the head tag, <HEAD></HEAD>in each html file. This included not just the title tag, but also all meta tags because they generated errors when creating the Reader files and the process was not able to finish.

After completing all clean-up and adjustments , we were ready to produce our own e-book version of SPICE 603. ReaderWorks gives one the option of either creating files directly to the reading device, PocketPC, using synchronizing that stores the files directly into the <Pocket_PC My Documents> folder, or one could store them directly on to the desktop PC and chose were to store the files. We could not see any differences in these files whether stored on PocketPC or desktop PC.

It is imperative to produce a project file, ReaderWorks Project File (*.rwp). If one afterwards needs to edit the e-books, this project file will contain all materials such as original source files, setup files for table of content, properties, cover etc.

In this project we have made use of a limited freeware version of ReaderWorks called "ReaderWorks Standard". ReaderWorks is available in other versions with more advanced features. Vendor OverDrive, Inc. also provides an online service converting documents into e-book format. A ReaderWorks SDK(Software Development Kit) is also available. This SDK allows for instance to add a "Save As Microsoft Reader" component to software applications.

More information can be found at: <http://www.overdrive.com/readerworks/>

Course distribution

All NKI Internet students, whether studying a course with a mobile learning supplement or not, will access the course materials and communication solutions via their ordinary PC at home, at the workplace or elsewhere. Course content for the mobile supplement is downloaded to the PC and synchronized to the PocketPC, while all the communication activities can be carried out through the PocketPC and the mobile phone when on the move. After logging into the NKI Internet College with user name and password, the user (tutor or student) opens the person's individual 'Personal page'.

The screenshot shows the 'Personal page' for Truls Fagerberg on the NKI Nettskolen website. The page has a blue header with the NKI logo and navigation links. The main content area is divided into several sections:

- STUDIER:** A sidebar on the left lists various courses like 'enkeltkurs', 'lærer i fjernundervisning', and 'the spice program'.
- Hei Truls Fagerberg!** A personalized greeting at the top of the main content area.
- Dette er din personlige side på Nettskolen.** A paragraph explaining the user's access to courses and services.
- Lykke til med studiene!** A message of encouragement.
- Oppgradering av SESAM** A section with a bulleted list of updates:
 - En animert flash-demonstrasjon av web-tjenestene som inngår i et typisk kurs.
 - Web-sider som viser lærerne hvor mye lønn de har tjent.
 - Forbedringer av forumsystemet.
 - Relansering av vårt elektroniske læreværrelse, Pedagogen.
 - En funksjon som forbedrer utskriftsmuligheter for våre web-sider.
 - Et bedre system for personlig presentasjon av brukerne .
 - Karakteroversikt, bedriftsportal og nytt sideformat er omtalt til høyre.
- Ny tjeneste: studieprogresjon** A section stating that study progress is now tracked on the course page.
- Nettsider flyttet** A section announcing that all website pages have been moved to new frames.
- Bedriftsportal** A section mentioning that courses can be delivered with information, technology, and tailored for employees.

At the bottom, there is a footer with contact information for NKI Fjernundervisningen and a link to the printer-friendly version.

Figure 2. Screen shot of the 'Personal page' as it looks on the PC

This personal page contains general information and lists the courses and programmes the person has access to. The course title links to the Course Front Page and gives access to the following page:

The screenshot shows the Course Front Page for 'spice 603, online teaching and learning'. The page has a yellow header with the nki logo and navigation links: 'nettskolen', 'min_side', 'tjenester', and 'logg_ut'. The main content is divided into two columns. The left column is titled 'Orientering om kursssidene' and contains several paragraphs of text. The right column is titled 'Introduction to the course pages' and also contains several paragraphs of text. On the far right, there is a vertical menu with the heading 'Dine valg:'. The menu items are: 'SMARTFORCE' (highlighted with a black box), 'Studieorientering', 'Introduction', 'Unit 1', 'Unit 2', 'Unit 3', 'Unit 4', 'Unit 5', 'Glossaries', 'Online resources', 'SPICE registration', 'Board of Professors', 'Copyright', 'PocketPC', and 'Lærer og klasseliste'. Below the menu, there is another section titled 'Dine fora:' with the following items: 'SPICE 603, Online Teaching and Learning 01'.

Figure 3. Course Front Page with the PocketPC link on the menu.

All courses have a menu that gives access to study units, glossaries, resources etc. The menu may differ according to specific requirements for each course. In addition the m-learning version has a link named 'Pocket PC', which links to a page containing all necessary information for downloading the course. This is available from the standard version of SPICE 603 and can be taken advantage of by anyone with access to mobile equipment.

Download page

This page contains downloading instructions and is divided into five separate downloading alternatives. The first section is called "Spice 603 Online Teaching and Learning" and contains the entire course except required readings for unit 1 - 4 (unit 5 does not have any required readings) and glossaries.

Required readings are divided into units, that are downloadable one-by-one. Students can decide for themselves if they prefer to download all content to their PocketPC or only those parts they need for the unit they are currently working on.

This course also contains a set of recommendations for further readings. They are however not offered as Reader files. Students will have to use their mobile telephone to log on to the Internet and download these further readings provided in html format directly to their PDA.

nki
Fjernundervisningen

spice 603, online teaching and learning

nettskolen | min_side | tjenester | logg ut

SPICE 603 for PocketPC with Microsoft Reader

To download the Microsoft Reader version, right-click on the link (course content) you prefer and choose "Save target as". Specify where you want to save the file, in this case in your "Pocket_PC My Documents" folder (the folder you normally use when synchronizing files) and click "Save". The file is now downloaded to your desktop pc. When finished, you are ready to connect your device and synchronize with your desktop computer as normal.

We have divided this section into five separate downloading alternatives. The first section is called "Spice 603 Online Teaching and Learning" and contains the entire course except required readings for unit 1 - 4 (unit 5 does not have any required readings) and glossaries. Required readings are divided into units, 1- 4, that you may download one-by-one. You can decide for yourself if you prefer to download all content to your PocketPC or only those parts you need for the unit you are currently working with.

- [Spice 603 Online Teaching and Learning](#)
- **Required reading unit 1**
 - [Meeting the Needs of Adult Learners in Developing Courses for the Internet](#)
 - [Courses on the WWW - Student Experiences and Attitudes Towards WWW Courses - II](#)
 - [Persistence in Distance Education](#)
- **Required reading unit 2**
 - [Definitions of Pivotal Terms for Online Teaching](#)
 - [The Online Report on Pedagogical Techniques for Computer-Mediated Communication](#)
- **Required reading unit 3**
 - [The Role of the Online Instructor/Facilitator](#)
 - [Moderating Discussions in the Electronic Classroom](#)
 - [Playing Croquet with Flamingos: A Guide to Moderating Online Conferences](#)
 - [Effectively Using Electronic Conferencing](#)
- **Required reading unit 4**
 - [Designing an assessment system](#)

Dine valg:
SMARTFORCE

Studieorientering

Introduction

Unit 1

Unit 2

Unit 3

Unit 4

Unit 5

Glossaries

Online resources

SPICE registration

Board of Professors

Copyright

PocketPC

Lærer og klasseliste

Dine fora:
SPICE 603, Online Teaching and Learning 01

Figure 4. Page for downloading course materials to the PocketPC

From this course page one also has access to a discussion forum. For this second year experiment we have made some adjustment to the forum setup compared to year one. In year one we had just two main discussion areas called "administrative information" and "academic discussion". This produced a quite long list of threads and, it was not easy to figure out which threads belonging to which study unit. To help out on this we have now made several enhancements to the discussion forum.

Each study units were assigned their own main thread and we also added threads for support and general discussion on m-learning.

spice 603, online teaching and learning				nettskolen	min_side	tenester	logg_ut
Forum: SPICE 603, Online Teaching and Learning 01							
Administrative questions and information	Antall meldinger	Siste melding		Nytt innlegg			
Are all connected?	1	19. Aug 2002					
Velkommen!	0	10. Jun 2002					
Discussion on m-learning possibilities, problems and challenges	Antall meldinger	Siste melding		Nytt innlegg			
Testing and sending from abroad	2	04. Sep 2002					
Missing linebreaks	1	31. Jul 2002					
Connecting	4	31. Jul 2002					
Dispatch of equipment	1	12. Jun 2002					
Velkommen!	0	10. Jun 2002					
Support on m-learning	Antall meldinger	Siste melding		Nytt innlegg			
Have you received the equipment?	4	01. Jul 2002					
Velkommen!	0	10. Jun 2002					
Unit 1 discussion	Antall meldinger	Siste melding		Nytt innlegg			
Introductory comment to SPICE 603	12	19. Sep 2002					
Online Journal of Distance Learning Administration	1	19. Sep 2002					
DEOS	1	12. Sep 2002					
Velkommen!	0	10. Jun 2002					
Unit 2 discussion	Antall meldinger	Siste melding		Nytt innlegg			
Velkommen!	0	10. Jun 2002					
Unit 3 discussion	Antall meldinger	Siste melding		Nytt innlegg			
Velkommen!	0	10. Jun 2002					
Unit 4 discussion	Antall meldinger	Siste melding		Nytt innlegg			
Velkommen!	0	10. Jun 2002					
Unit 5 discussion	Antall meldinger	Siste melding		Nytt innlegg			

Dine valg:
SMARTFORCE

Dine valg:
 Studieorientering
 Introduction
 Unit 1
 Unit 2
 Unit 3
 Unit 4
 Unit 5
 Glossaries
 Online resources
 SPICE registration
 Board of Professors
 Copyright
 PocketPC
 Lærer og klasseliste
Dine fora:
 SPICE 603, Online Teaching and Learning 01

Figure 5. Forum page

Some results



Figure 6. Library page on the PocketPC

After downloading the necessary material and synchronised, the course is available using the Microsoft Reader application on their PocketPC.

When starting Microsoft Reader one begins with a Library page that gives an overview menu of all Reader files on our PocketPC. This start-up page also gives access to various features such as help, settings and sort.

“Settings” allows for adjusting font size, annotations etc. “Sort” offer different ways to organise the e-books, by title, by author, by size etc.

One drawback is that one can have only one library. We miss the option to have multiple libraries when enrolled to more than one course or course materials are very comprehensive. It would have been helpful to create one’s own library to place course material in the correct place.

Below is shown a screenshot of the introduction the SPICE 603 on the PocketPC:

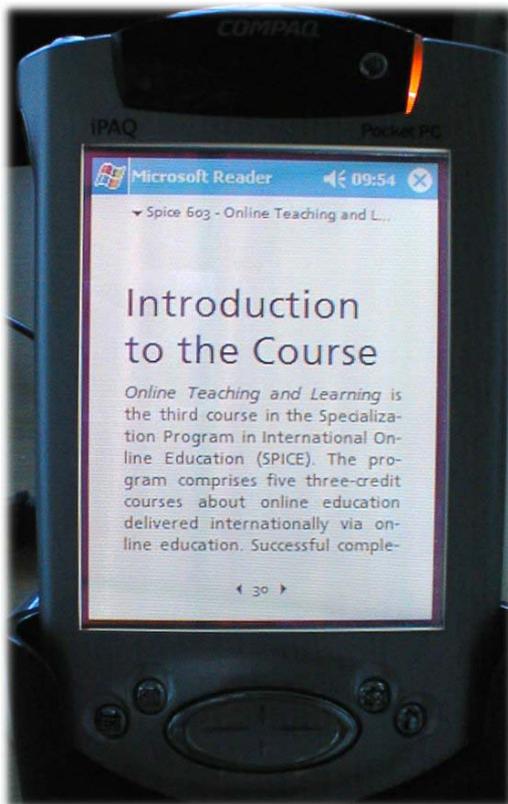


Figure 6. Screen shot of course page

During 2002 experiment 3 “real” students and tutor in the course SPICE 603 were equipped with mobile phones, PDA and portable keyboards. Additional students were enrolled in the course during the experiment period. From a technical point of view, our chosen methods of distribution, support and technology seems to have worked very well in a small scale environment. Student evaluations will be available and we will hopefully be able to gather views and experiences that will found a basis for future development.

From a developers point of view, it has been quite time consuming to convert all html files for a comprehensive course such SPICE 603. Other methods/techniques will have to be considered when(if) doing this on a large scale with many courses. ReaderWorks has shown to be an intuitive and effective converting tool easy to use and with quite good functionality provided even tough in the freeware version used in this project.

As a vague conclusion we might say that it is easy to generate e-books if one have “clean” source files that doesn’t need much editing and is without graphics etc. Microsoft Reader presents text with acceptable good readability, useful functions such as highlighting of text and the possibility to add bookmarks and notes. We consider Microsoft Reader on a PocketPC to be a good solution and it seems to work well for our students and tutors.

References

Truls Fagerberg, Torstein Rekkedal and John Russell: *“Designing and Trying Out a Learning Environment for Mobile Learners and Teachers”*.

Department for Research & Development, NKI Distance Education, January 2002

(<http://www.nettskolen.com/forskning/55/NKI2001m-learning2.html>).

Appendix

Cleaned-up source file for the SPICE 603 introduction page, ready to be converted into the e-book format.

```
<html>
<head>
</head>
<body>
<h1 id="_RWTOC-1"><a name="_Toc466344001">Introduction to the Course</a></h1>

<p><em>Online Teaching and Learning</em> is the third course in the Specialization Program in International Online Education (SPICE). The program comprises five three-credit courses about online education delivered internationally via online education. Successful completion of all five courses and exams qualifies for the Specialization Program in International Online Education Certificate that is awarded by NKI.</p>

<h2 id="_RWTOC-2"><a name="_Toc466344002">Overview of the Course</a></h2>

<p>The course consists of the following five study units: </p>

<p>Unit 1 - <em>Online Learners</em> discusses the characteristics of online learners and their special needs. It further presents student experiences of and attitudes towards online education. Finally, it discusses online students' results with regard to course completion and grades.</p>

<p>Unit 2 - <em>Online Teaching Methods, Techniques, and Devices</em> discusses the four online teaching methods: one-online, one-to-one, one-to-many, and many-to-many. We shall also be looking at a number of recommended teaching techniques and devices.</p>

<p>Unit 3 - <em>Teaching Functions and Facilitation Techniques</em> looks at the organizational, social, intellectual, and assessment functions of teachers. It further discusses issues that influence teaching style, and finally, it presents some recommended moderation and facilitation techniques.</p>

<p>Unit 4 - <em>Assignments and Assessment</em> discusses the implications of various types of assignments and assessment in online education. We shall be discussing and comparing self-assessment, computer assessment, tutor assessment, and peer assessment.</p>

<p>Unit 5 - <em>Teaching Incentives and Barriers</em> discusses what motivates
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online teachers and the problems they encounter when they teach online. The unit focuses on the teachers' proactive and interactive workload, how the teachers perceive the workload, and alternative strategies to reduce the workload.

Course Objectives

After completing the course, you should be able to:

- identify the fundamental issues with regard to online learners;
- distinguish between and assess various online teaching methods, techniques, and devices;
- analyze a teachers' social, administrative, intellectual, and assessment functions;
- understand the implications of including individual and group assignments;
- consider the implications of self-assessment, peer-assessment, computer-based assessment, and tutor assessment;
- identify incentives and barriers for online teaching;
- discuss teacher workload and strategies to reduce the workload.

Readings

In each of the study units, you should first print out and study the introductory reading. Then, you should print out and read the articles that are chosen as required unit readings. In addition, some articles are suggested for further reading for those who are especially interested in the topic discussed in the study unit. Finally, the SPICE program presents you with a host of online resources that should be consulted during the course.

Online Resources

There are a number of online resources that are of special value to this course. They are compiled, categorized, and described on a separate web page that you can access via the course menu.

Activities

Activities are included throughout this course to help you search for information that is relevant to the course and to give you an opportunity to practice some of the theory discussed in the course. You are encouraged to collaborate and share your results with your peer students.

Questions for Reflection

In each study unit there is a number of questions for reflection. The questions are meant for individual reflection, self-assessment, and reinforcement, but they can also be discussed in small groups or in the class forum.

The Course Assignments

For the course assignments and activities, you are required to study the teaching activities in an online course. In the course of your choice, you may have the

role as a teacher, a guest lecturer, a student, or just an observer. You are responsible for finding and accessing the course yourself. You may consult online course catalogues and peer students to find a course that suits your interests. Your teaching or observation of other online teachers will provide the basis for your analyses in the course assignments. </p>

<p>The assignments for submission in this course are essay-style assignments that describe and analyze one or more online courses. There is one such assignment in each of the study units. You could choose to do them alone, but you are encouraged to collaborate with one or two peer students.</p>

<h3 id="_RWTOC-9">The Final Report</h3>

<p>At the end of the course, you must compile and refine the essays you wrote at the end of each unit into a fairly comprehensive report about online teaching and learning. The report will be presented online to the class. The final report must be written as an individual report. </p>

<h3 id="_RWTOC-10">Participation in Class</h3>

<p>You are required to collaborate with other students in the course and to contribute to the class activities. At the end of the course, you are required to assess your participation in class and give yourself a grade for this work. You must submit a short report that justifies the grade. </p>

<h2 id="_RWTOC-11">The Grades</h2>

<p>The course requires you to complete successfully all course assignments listed in the table below. Your final grade is based on all course assignments, on the final report and on the report on participation in class, according to the percentages listed in the table. Students who choose not to submit the reports, will not be assigned grades. After the final assignment, they will receive documentation to show that the course has been completed. </p>

The course assignments	Percentage of final grade
Unit 1	8%
Unit 2	8%
Unit 3	8%

Unit 4	8%
Unit 5	8%
Final report	40%
Report on participation in class	20%

The grading system is based on the European Course Credit Transfer System (ECTS), that was developed by the Commission of the European Communities in order to provide common procedures to guarantee academic recognition of studies abroad.

Grades	Percentage of successful students normally achieving the grade	Definition
A	10	EXCELLENT - outstanding performance with only minor errors
B	25	VERY GOOD -above average standard but with some errors
C	30	GOOD - generally sound work with a number of notable errors
D	25	SATISFACTORY - fair but with significant shortcomings

```
<td>E</td>
<td>10</td>
<td>SUFFICIENT - performance meets the minimum criteria</td>
</tr>
<tr align="center">
<td>FX</td>
<td>-</td>
<td>FAIL - some more work required before the credit can be awarded </td>
</tr>
<tr align="center">
<td>F</td>
<td>-</td>
<td>FAIL - considerably more work is required </td>
</tr>
</table>
```

<p>I hope you will enjoy this course, and find it useful in your future work.
Welcome to SPICE 603.</p>

<p>Morten Flate Paulsen
The NKI Internet College</p>

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</body>
</html>
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Torstein Rekkedal, Director of R & D, NKI Distance Education

Trying Out a Learning Environment for Mobile Learners Evaluation of the course “*The Tutor in Distance Education*” – Phase 1 of the NKI sub-project of the EU Leonardo Project “*From e- learning to m-learning*”

July 2002

Summary

This article represents the evaluation of the first try out of a course presented for mobile learners at NKI Distance Education. This evaluation study is part of the EU supported project ‘From e-learning to m-learning’ (<http://learning.ericsson.net/leonardo/index.html>).

NKI Distance Education gives main emphasis and priority to student autonomy, flexibility and freedom to choose where and when to study in designing the environment for distance learners. Our main aim in designing solutions for mobile learners is to maximize this freedom to support online learners who also are mobile when studying. This is also clear from all the participants in this pilot trial; the main advantage of m-learning is the *increased flexibility of online distance education*.

The NKI project team decided to develop one of the more than 300 NKI web based courses so that it could be studied by learners using mobile phone and Pocket PC (PDA) in addition to their desktop of laptop PC. For reasons of costs and lack of access to the necessary technology among the NKI ordinary distance students, the course was tested in a semi real situation. 9 students participated in the try out, and the evaluation was carried out as a process evaluation study where aspects such as downloading of learning materials, communication with tutor and fellow students, submitting assignments and communication with the course Forum via the PDA browser were examined. The trial was completed with a quantitative questionnaire on the same aspects, see Appendix 1.

Our pilot trial showed that the technology functioned according to our expectations. The participants were generally satisfied with the technological and didactical solutions. The participants differed somewhat in their acceptance. Some were quite enthusiastic; others were a little more reserved. The differences could partly be related to different learning styles and study preferences, such as preference for note taking on paper and/or general reluctance towards reading longer texts from (any) screen.

In the NKI system it will be a challenge to design solutions for learners who are users of mobile technology and have a need to study also when on the move, and that other students, who prefer to use standard technology can do that, and that both groups may participate in the same course. This means that we have to look for solutions that are optimal for distributing content and communication in courses, independent on whether the students and tutors apply mobile technology or standard PC and Internet connection for teaching or learning.

The next trial will take place from summer 2002 with a few real students in the course 'SPICE 603 – Online Teaching and Learning'. In the next trial course materials for PDA will be presented in e-book format, the tutor and students will use Compaq iPaq (3630, 3660, 3870) and Ericsson mobile phones T39m and R580, portable keyboards and both IR and bluetooth connection. The results from this first trial will be taken into account in the design and the teaching/learning process.

Introduction

This paper accounts for the experiences in the first try out of an Internet based course at NKI specifically adapted to satisfy the needs of mobile learners – i.e. distance learners who for some reason need or prefer maximum flexibility of space and time in their studies. We have previously argued that we do not fully accept either the term 'e-learning' or 'm-learning' (Fagerberg, Rekkedal & Russell 2002, Rekkedal 2001). We shall not repeat all the arguments here; only make some few comments on the terms in question.

'Distance education' and 'distance learning' are well-established concepts (Keegan 1996). Keegan (2000, p 18.) has also argued "*that web based education is best regarded as a subset of distance education...that the literature of the field of educational research known as distance education, is of value for those embarking on training on the web*". The 'distance learner' is a person who, for some reason, will not or cannot take part in educational programmes that require presence at certain times or places. It has always been one of the most important arguments for distance study that 'one may study whatever course wherever and whenever one wishes'. In fact, it was the introduction of the computer (and many other technologies) as well as teaching and learning methods that required presence at a certain place at certain times, which reduced the flexibility of distance learning. The introduction of mobile technologies has reintroduced flexibility and returned power to the distance learner. Thus we see the main challenges to be able to 'design learning environments for the mobile distance learner and support learners on the move'. Other writers have also been sceptical to accept the term, m-learning. E.g. Tommy Strandvall (2002) in a Norwegian online seminar on the pedagogy and didactics of net based distance learning suggested that as terms related to technology changes so often with new terms continuously being introduced, we could just as well agree on the term 'x-learning'. Still, for practical reasons in this project, when we use the term m-learning, it means 'distance learning with mobile technology'.

During 2001 the NKI project team studied International experiences concerning m-learning, analysed technological solutions and pedagogic/didactic needs based on our internal practical experiences and results from previous surveys and evaluation studies among our distance students.

The technical solution chosen was to try out the use of a Pocket PC/Personal Digital Assistant (PDA) in combination with a mobile phone for distribution of learning content and communication between tutor and students, between students and for students' communication with the learning material. When we had to make our choice in late spring 2001, we found that after analysing the functionality of different brands of PDA/Pocket PC, we chose to build our learning environment around the Compaq iPAQ 3630 and 3660. The mobile phones chosen were Ericsson T39 and Ericsson R580. The actual work in adapting the course for mobile learners has been presented in an earlier article ((Fagerberg, Rekkedal & Russell 2002). This article presents tutor and student experiences during the first practical trials of the course, 'The tutor in distance education' (Norwegian version). To get the full understanding of the evaluation presented here the above-mentioned article should be

consulted. This pilot try out is mainly to be seen as a simulated distance learning setting. During the next phase of the project we plan to carry out a second experiment in a fully realistic setting. When this article is written (June 2002), the planning of this second trial is nearly finished. In this planning we have tried to take results and experiences from the first trial into account.

The course chosen for the first pilot evaluation, *'The tutor in distance education'* was chosen for the following reasons:

- It is a course in the pedagogy of distance teaching, and as such represents an ideal course for combining the research on media, methods and technology with the substance or content of the learning
- It is taught by internal NKI staff, also involved in the project, thus combining internal competence development with development work in the project
- The fact that same staff are involved in development and teaching in the practical try outs to be carried out opens the possibility for real field research during try out and also makes it easier to transfer the experiences and results from the experiments to further developments in the operations of the NKI Internet College
- Students taking the course are prospective online teachers in the NKI Distance Education system, their experiences as mobile learners are transferred to their teaching after completing the course

NKI Distance Education and Online Learning

NKI was probably the first European online college, and it has offered distance education online every day since 1987. Few - if any - online colleges in the world has been longer in continuous operation offering distance education based on computer-mediated communication.

If one logs into the NKI Distance Education Computer College (Nettskolen) today (July 12th 2002) one will see that 346 courses (and in fact more than 60 complete study programmes) are offered on the Internet and that there are 3,818 active students registered. Last year we enrolled more that 6,000 new students taking Internet based distance courses.

NKI has chosen the philosophy for the development of Internet based education at NKI: *Flexible and individual distance teaching with the student group as social and academic support for learning.* Till last year, when we embarked on this project, many NKI tutors and students have had experience as mobile learners and teachers. However, till now this has been restricted mainly to students and teachers carrying their laptops, possibly including communication via mobile phones.

In this project our main objective has been to extend the distribution of learning materials and communication to lighter equipment, specifically PDA and mobile phone. The challenge has been how to develop the system and server side to present materials in ways suitable for PDA technology and to find acceptable solutions for distribution of materials and for organising *administration-to-student, teacher-to-student/student-to-teacher and student-to-student communication.* It was our aim in designing the environment for the mobile learner to extend and increase the flexibility of distance education, that to some extent took a step backwards when converting from paper based to online learning, where students largely were required to study at a place (and at a time) where a computer with access the Internet was available.

The Course

The course *'The tutor in distance education'* represents NKI's mandatory training programme for prospective NKI tutors. When it was launched in 1977 it was probably the first distance training course for distance tutors in the world. It was adapted to online teaching in 1990 and was taught on the first generation system for online distance education in NKI, the EKKO-system (see Paulsen & Rekkedal 1996, Rekkedal 1999, Rekkedal 2001). It was developed for distribution and teaching/learning on the Internet from 1996. The course contains 3 study units and according to the Norwegian system for classifying course workload, it is equivalent to 3 ECTS Credits. The course contains mainly text, some few illustrations, and internal and external links to resources. The students may submit the three assignments individually or in groups. A discussion forum is available for asynchronous communication. The students are requested to submit a minimum of 3 contributions to the discussion forum.

The Technical Solution

The technical solution has been described and explained in detail by Fagerberg, Rekkedal and Russell (2002). The learning environment included the following aspects:

Technology:

- Pocket PC
- Mobile phone
- Portable keyboard

Learning content and communication:

- Learning content to be downloaded on the mobile device to be studied offline.
Downloaded content to include all course materials:
 - Content page
 - Preface
 - Introduction
 - All study units
 - Resources (articles on the web, references to other resource materials)
- Online access to the discussion forum with the possibility of as quick as possible access for reading in the Forum and writing contributions
- E-mail for individual communication with tutor and fellow students and for submitting assignments. Assignments may be submitted as text-based e-mail or as Word or Text attachments.

In addition it was assumed that the NKI Internet students normally would have access to a desktop or laptop computer with Internet connection. This means that the equipment and technologies used when mobile are additions to the students' equipment used when studying at home or at work.

3 alternative solutions for distribution of course content were examined:

1. The AvantGo Mobile Internet service
2. Online access via mobile telephone to the entire course
3. 'Download-on-demand' version

When we decided to adopt solution 3, it was partly a result of limited time and resources available. However, our experiences during the try out have confirmed that with today's technology and pricing of software, services and communication, this solution is acceptable and probably better for both students and institution. Course content was provided in two versions *HTML* and *Microsoft Reader*.

The reason for supplying two alternatives of content is that we as part of the empirical testing are interested in examining attractiveness and user friendliness of the different solutions for the student. The student can manipulate the Microsoft Reader content by the possibility of *bookmarking, adding highlights, notes and drawings and look up words directly in the PocketPC Dictionary*. This means that the students can use the materials actively in ways that we recognise from students' use of print materials and their personal notes. The student is, in other words, able to 'make the materials his own' while studying. There is reason to believe that these functionalities may help students organising the materials cognitively and support learning and remembering.

When mobile – and using mobile technologies – it is generally satisfactory for the student (and the tutor) to have the course content available to study on the PocketPC. In addition, the following communication possibilities are necessary. When mobile, the student must be able to:

- Access the course forum to read messages
- Access the course forum to submit contributions to the discussions
- Send e-mail to fellow students, to the teacher and to administration (study advisor)
- Receive e-mail from fellow students, from the tutor and from the administration
- Submit assignments by e-mail including attachments
- Receiving assignments corrected and commented on by the tutor including attachments.

To access e-mail and discussion forums, mobile phones were used.

Screen shots of the course pages on the PC and the PDA were presented by Fagerberg, Rekkedal and Russell (2002). The course is fully presented for use on the student's PC. In addition the m-learning version had a link named '*Pocket PC*', which links to a page containing all necessary information for downloading the content in the two versions, HTML format and Microsoft Reader format.

At the present stage and with present technological limitations the NKI project team decided that we had found an acceptable solution for presentation of course content and facilities for studying the learning materials, for solving assignments and submission of assignments to the tutor. Sending and receiving e-mails also functioned satisfactory.

During the empirical try out we wished to explore whether our solutions actually functioned and were accepted in practice.

Participants in the pilot trial and evaluation

The Tutor

The author functioned as tutor during the trial. He has wide experience from distance education research and development and has published extensively on distance education research and evaluation. He was also author of the course. He has taught the course from its start as correspondence education, during the first phase of online delivery with computer conferencing and also on the Internet since 1996. He has for more than 4 years tutored in a mobile setting using laptop PC and mobile phone on holidays and on travel in Norway and abroad. During the try out he also tutored students in two other courses, *Distance education*

Pedagogy (12 ECTS credits) and Organisation, Administration and Support Systems for Online Education (6 ECTS credits). He is often on travel and has during the try out been on travel nationally and internationally. During travel he also communicated with students in the two other courses via his PDA and mobile phone. Also the real students in the other two courses received comments on assignments received, commented on and returned via mobile technology. Thus, the tutor's experiences covered both the project try out in the simulated setting as well as real students in ordinary online distance education courses.

The 'Students'

'Students' is written in inverted commas, as the pilot study of mobile learning in the NKI sub-project took place in a simulated distance learning setting with mobile technology, and the participation took place with evaluation of the m-learning system and not real learning of course content as the main goal of the activity. It should also be noted that all the 'students' had specific interest in technology for distance teaching and learning from different perspectives.

The educational background of the 9 participating students varied from two years college/university education up to Ph. D. in education, age varied from 24 to 56. One was a graduate student from the University of Oslo planning to write a thesis on mobile learning, one was a third year student of the Norwegian School of Information Technology working part time in NKI Distance Education as programmer, two participants were employed in the central NKI IT department as manager and network coordinator, one participant is employed as academic staff in information technology, the other 4 are working with the development of Internet based education at NKI. These 'students' are generally well qualified in information technology, some also in pedagogy; and they have all specific interests connected to the development of systems, design and methods of distance teaching and learning. They are not representative of the population of distance and Internet students at NKI. However, their attention to the practice of distance education may make them well qualified for the assessment of user friendliness, didactic efficiency, technical feasibility and cost effectiveness of the environment created for m-learning in the pilot study. Their involvement in this field-testing also puts them in a good position for further development of m-learning from their individual perspective.

Evaluation Methods and Procedures

All the students and the tutor in the trial were equipped with a Compaq iPaq PDA (3650 and 3660 with 32 and 64 mb memory) and were expected to use the PDA for ordinary office work including the main programmes such as e-mail, tasks, calendar, contacts and file synchronization before the pilot m-learning trial was carried out. Three Ericsson mobile phones were purchased (T39 and R520). Some of the students had their own mobile phone. The purchased telephones were used by the tutor and 'students' by turns when needed. Two of the students also tried successfully to use a wireless LAN card with their PDA at home and at the office for receiving and sending e-mails.

The course was made available on the server for downloading and synchronization to the mobile equipment 7th January 2002, and the final data collection was finished 4 months later 30th of April.

We decided to evaluate the m-learning environment primarily by a qualitative process related field research model applying the technology to be tested. Thus, the tutor used the course forum for testing many-to-many communication by giving questions to the students related to

course evaluation rather than course content. E-mails were exchanged between students and the tutor and to some extent between 'students'. The students were required to submit assignments also related to m-learning evaluation and experiences, and the tutor commented on assignments as ordinary assignments via the PDA and mobile phone, both from Norway (also on travel) and when travelling abroad (Germany). The first response to the process related evaluation was submitted to the course forum 8th January and the last 30th of April. The evaluation questions and answers were distributed as contributions to the Forum, which means that all entries are sent as e-mail to the participants and that they also are archived and can be read on the course pages on the PC or on the PDA when connected to the Internet. This means that all the participants had access to other participants' evaluation responses during the trial.

When the trial was finished, a quantitative questionnaire for summative student course evaluation was distributed 23rd April with 1st May as the final date for response. It is this author's view that a quantitative evaluation instrument gives little meaning in a study of experiences and attitudes of 9 subjects. However, we agreed to include a quantitative element, as there are evaluations taking place in different settings and countries, with different courses, content and technology but with similar questions. There might be some advantages in combining and comparing these data for presenting a total picture of the overall project. (The project questionnaire is presented in Appendix 1.)

Results

The process evaluation

The collection of information about the students' experiences and attitudes was carried out during January till end of April 2002. The tutor conducted the evaluation process through questions put to the students in the discussion Forum, via e-mail. The procedure required the students to answer using e-mail, contribute to the Forum and through submitting responses as assignment answers in the course. During the trial the participants used both PC's connected to the Internet via LAN at work, via modems, ISDN or broadband at home and their PDAs communicating via mobile phone, synchronization and wireless LAN. All participants were required to contribute to the Forum and send e-mail via mobile technology. For evaluation purposes most reading took place on the PDA.

One of the students suggested that questions and answers were given in English to make reporting to the project more efficient. This was generally accepted with the exception of two participants who preferred to give their answers in Norwegian.

Downloading and synchronizing course materials to the PDA

Question:

Can you all, please, during the next few days download the course in both versions (HTML and Microsoft Reader) to your PC and synchronize with your PDA? It would be preferable if those who can, download through their home connection. Answer the following questions on the Forum as responses to this entry:

1. Which type of connection have you used when downloading (internal network, modem, ISDN, broadband)?
2. How long did it take to download the HTML version?
3. How long did it take to download the e-book version?
4. Possible problems in downloading?
5. Possible problems in unzipping the files?
6. Possible problems in storing and synchronizing to the PDA?

Send your answers as soon as the task is carried out.

Answers:

3 participants answered that they tried to download the materials via telephone line and modem from home. 2 of these stated that they had technical difficulties and ended up in downloading via the office network. The third participant downloaded without problems via his home telephone line and modem and gave **24 minutes for downloading the HTML version and 1 minute and 45 seconds for downloading the e-book version**. The tutor and 1 student downloaded at home via ISDN connection. 1 student reported that the e-book version was downloading in the office, and the **HTML version at home via modem in 18 minutes**. This took in both cases **12 minutes for the HTML version** and approximately **40 seconds for the e-book version**. 1 of the participants reported that he had downloaded the **HTML version at the office in 6 seconds (and spent in total 10 minutes for the whole process of downloading to the PC and synchronizing with the PDA (synchronizing taking most of the time))**. This student also reported that he had downloaded **the e-book version on his laptop PC via infrared connection to Ericsson R580 mobile phone in “a little more than 4 minutes, being online for 6 minutes and 37 seconds”**. The others, who downloaded via office LAN reported generally from 6 seconds to a little more than one minute for downloading the HTML version and 1-2 (max=6) seconds for the e-book version.

The e-book version contained only the basic course materials (296 kb), while the HTML version in addition included a large collection of resource materials, mainly research articles (5097 kb).

Problems: Very few problems were reported, except the two who mentioned difficulties in downloading via modem. The third student, who downloaded via modem at home reported: ”I had no difficulties using Internet Explorer but Netscape 4.76 would open the file content directly in the browser, so I got one extremely long page with meaningless characters. This problem should be looked further into”

In fact, the answers indicate that all participants (tutor and students) would support this statement from one of the respondents: “The whole process was easier than I expected, and I did not experience any real problems. The most time consuming part was actually the synchronization between the laptop and the PDA.”

Conclusion

The participants in the trial used different ways of downloading the materials: Modem, ISDN, broadband home connection, office LAN and mobile telephone. All solutions were acceptable in time and costs. Very few problems in downloading and synchronizing to the PDA were reported, except 2 students who had technical problems in downloading via modem. (Reasons for these difficulties are not known.)

The participants study situation (and some early experiences)

Question:

This question is to be answered using your PDA and mobile phone.

(This means that you have to prepare your PDA for mobile communication.)

1. Where and under which circumstances would you potentially study?

At home?

At the office?

On travel (while mobile)?

Other???

2. In this experimental trial, what equipment and type of connection do you apply?
At home?
At the office?
On travel (while mobile)?

I will also answer this question - as teacher.

Answers:

Answer from the tutor:

As teacher I work with my course and students mainly from home, where I am connected to the Internet via ISDN line.

Now and then I also log into the course or communicate with the forum and individual students from my laptop (same as home) via local network.

Before I had the PDA I often used my laptop and mobile phone for teaching when on the move. After getting the Compaq iPaq I have generally not brought my PC but only the PDA when on the move.

Answers from students:

The student, who also was studying at the University of Oslo, comments that in his University studies he mainly reads textbooks, and does not use his laptop when travelling. He further comments that his experiences with the PDA has made him reflect on the advantages of using a the PDA combined with mobile telephone for communicating, "... I clearly see the advantages of study being connected with PDA and mobile phone, and also study offline with materials downloaded and synchronized to the PDA." He further comments that at home he studies with a desktop and ISDN line and has chosen to receive all messages in the trial course Forum as e-mail. Since his software was not fully compatible with the PDA software, he decided to upgrade the computer and software.

The other student/part-time worker at NKI answered this question by his PDA and WLAN at NKI: "As student I study at school, at home and on holidays. On holidays until now I have brought my laptop. But I imagine with this little wonder (the PDA) this is enough, at least for shorter time periods. Now in this course I read from the PDA on the bus and go straight to write my answers when I get home."

Some other answers:

"I would like to study from home, from work, from my mountain cabin, and when I travel. Sometimes I will bring my laptop, sometimes not.

I will use my laptop, my PDA, and my mobile phone. At home I will use ISDN and at work I will use an Ethernet connection.

PS. This took me 10 minutes online to do..."

The final comment means that this answer was written on the PDA connected to the Internet and written in the PDA's browser – which demonstrates that the technology functions for small messages given on the PDA screen keyboard and transmitted through the mobile phone. (Experiences during the trial demonstrated that writing on the foldable keyboard beforehand and copying the text into the answering field is much more efficient and can be done in 2-3 minutes.)

"I normally study at home, but because of slow communication (modem) I use the PC at work for communication and downloading larger files. With the PDA I see much greater flexibility in where to study. It is small and light, but this also has drawbacks, illustrations are difficult to 'read' and without extra keyboard it is practically impossible to make notes. These disadvantages make it

necessary to put certain requirements to the design of courses meant for mobile learning with this technology.

I use the same laptop both on work and at home. On travel, till now I mostly work offline."

Another answer:

"Normally I would study at home using my PC with ISDN connection, and using the PDA while away from home for reading texts.

At home I use a normal PC and a portable PC, both with ISDN, and while away the PDA and a mobile phone with infrared port."

In general, both the tutor and the students in the trial work from home, from the office and on travel. This question was answered only a few days after the study had started. It is clear that the participants already had discovered positive and negative sides of the functionality, such as increased flexibility in using lightweight equipment, but also need for extra keyboard, that the screen was small for some content such as illustrations etc.

Reading and studying on the PDA

To assess the quality and acceptability of the downloaded materials for study, we delivered two versions, the complete course in HTML to be read in the PDA browser, and the main course in Microsoft Reader e-book format.

HTML materials

Question:

About three weeks after the trial had started the following questions were sent to the Forum via PDA and mobile phone:

Dear friends and colleague students of the m-learning project.

Now we approach the first discussions around the course itself. However, again it is the questions around m-learning that is central. Thus, the first task for you all is to read the html-version of STUDY UNIT 1 from the beginning until 'Utvikling av fjernundervisning i Norge'. (You are, of course free to read also the 'Preface' and the 'Introduction').

Answer the following questions:

Look at yourself as an ordinary student:

What is your experience of studying subject matter on the PDA? (Is it convenient? Does it work? Could you read quite extensive course matter on the PDA? Would you make notes while reading? If making notes, would you make notes on paper or do you see possibilities using the PDA for study notes? Etc.?)

Please, answer this question by response to this entry on the Forum. You are requested to submit your answer by communicating with the PDA and mobile phone!!!!!!

You may write your answer by writing on the PDA screen keyboard, by using portable keyboard or you may write your answer on your PC and synchronize to the PDA. You may write your answer online or offline.

Answers:

The students are only partly satisfied with reading subject matter in HTML format on the PDA. Generally, they accept reading small quantities of texts and they accept that it is acceptable on travel and when commuting, when they look at benefits (lightweight equipment and large amounts of materials available) relative to the drawbacks or difficulties (getting an overview of the materials to study, small screen etc.) At this time the students had already acquainted themselves with the Microsoft Reader and compare the two solutions. It seems

that the students generally prefer the e-book solution, the object of the next evaluation question.

Some example answers:

"In this assignment we were asked to read the HTML version of study unit 1 and after doing this my feelings for this HTML version are mixed. When reading this version the first thing I missed was the opportunity to make notes. This would have been very convenient both to highlight matters I considered important and if I found things I would like to ask my tutor about. I would prefer to use the PDA for making notes.

Reading on the PDA is easy and works quite well. I believe that the fonts and font spacing used in Microsoft Reader is more pleasant for my eyes to read and would make a difference on extensive course material. I also do miss the opportunity to search within the course material in the HTML version.

Overall experience studying subject matter on the PDA is that it is easy to use, reading onscreen is okay and I have all my course materials in my back pocket. When equipped with a mobile telephone I find this tool/PDA very helpful both in communicating with my tutor and classmates and it also gives me the ability to use external resources wherever I might be. I have not taken telephone cost considerations into account in this answer."

One other student writes:

"To read the HTML text on the PDA is reasonable, but I would prefer to work on my "normal" PC if I should read an extensive amount of text. However, for studying a few pages (say up to 10-15) while travelling or commuting, the PDA is satisfactory. It is okay to mark text, but to take notes with the screen keyboard is slow and cumbersome. I prefer to mark text, and to make my notes with pen and paper. Back at my PC I rewrite my notes. So the PDA is okay for studying while travelling, but in all other situations I prefer my PC."

And another:

"In the HTML version I would use MS Pocket Word for notes and maybe if I was at home. I would use pen and paper for notes. On the PDA away from home I would copy parts of text into a word document and comment it there, as well as copying text I find useful to keep for summaries. I do believe I would read the study units on the PDA, maybe take some notes, copy some text into Word and when I got home I would elaborate on the notes and do the assignments. To use the PDA for writing I would need a foldable keyboard. (This answer was copied from a word file written on my work PC and transmitted on mobile from the PDA.)"

The pictures are not useful for me, I had to look at them on my desktop PC at work to understand them. (Is there a good solution to this problem?)

It is not hard to read this kind of text, but it is very much easier to use the Microsoft Reader version for extensive reading.

Many mention the problem of note taking. It is clear that a keyboard is considered to be necessary. The screen keyboard is not acceptable for writing more than a few short words. The students do not appreciate making notes on paper for later copying to the PDA or PC. The students also complain that the illustrations are unacceptable. (In this first trial version no specific measures were taken to solve this problem. It was considered that as the students had all the materials also on their PCs, the illustrations in the PDA text version only indicated and reminded of the original graphics. This should be solved in further courses to be developed for NKI m-learning).

Reading and note taking with Microsoft e-book reader

As mentioned the answers on the HTML solution demonstrated that the participants already had found that the e-book solution in many ways was better, mainly because of possibilities of active note taking, highlighting and other functionalities.

Question:

"The last question was related to reading and studying on the PDA using the html version of the course. This question relates to the use of Microsoft Reader with the functionalities of making:

Bookmarks

Drawings

Highlights

Notes

Copying text

Searching (Find)

It is also a good idea to install the Dictionary (if you have storing capabilities for it).

TASK:

Read Study Unit 2 from the beginning until "Hukommelse og glemsel". And use at least 4 of the functions above.

1. What is your view of using the PDA for studying the course? Use your own words without looking too much about what the others have answered.
2. Explain the usefulness of the 'text manipulation' functions that you used for study purposes.
3. Can you use the copying text function for note taking and for instance copy to Notes or Word for using for repetition purposes? Try it and give your views.

Answers:

"I found using the PDA as a study tool very convenient. This time I actually was in laid-back modus, using the PDA while sitting/laying on the couch. While reading, I tried to figure out what kind of notes would be most effective for my use. I highlighted the text regarding elements I wanted to save for further use in later repetition. I also tried to use the note function, though it took me a couple of minutes to master the "back" button on the PDA to shift from Microsoft Reader to Notes. After reading the text, I went to the index containing my highlighted elements. Therefore, concerning the note taking, I found that the highlighted text most is an organizer for text-bindings in the study-unit. When I wanted to repeat the text, the highlights is in an easy to use interface, and contained a list of all my highlighted text.

Using notes, I found it necessary to save the notes in the PDA and later sync it with my pc. When sync., the notes automatically popped up as a Word file. This is therefore a nice method to work with the text later as a repetition or for other purposes. I did not take notes on paper, since I wanted to test the most "lightweight" method possible, with extra paper etc. as little as possible. The size of the screen or the text font did not give me any problems reading/studying.

When reading a more extensive material, I think the PDA would be more a supplement to traditionally studying with ordinary books, and not as a primary tool for studying. One have to change the way one study and other habits in order to fully use the PDA as the primary tool."

The respondent above is clearly quite positive towards using the PDA and e-book as a medium for study. The following answer supports this view:

"I find studying on the PDA using Microsoft Reader more convenient than reading the HTML version. My overall view is that studying on a PDA combined with a mobile phone is easy, portable and very handy using the Reader version with all the notes, bookmarks, etc. functions that exists. Of course, with large course materials perhaps containing much graphics, the PDA is not very suitable. In such case I would use it as "add-on" product if I need to bring certain pieces of the course on a travel etc. I find the text/fonts easy to read and the built-in functions easy to use.

I have tried all the text manipulation functions and found the 'Bookmark', 'Highlight' and 'Note' functions very useful. 'Find text' and 'Find' functions also functioned well, but I have not used these functions as much as those mentioned above. The drawing function is a 'nice to have' function but no need for me to use it so far. I would use these built-in functions rather than pen and paper when studying on the PDA, because I provides all functions I need (perhaps I'm on the beach and all my paper would be gone with wind).

If I use a HTML version of a course then pen and paper will be used to a greater extent due to the lack of functions in this version. Of course, you could use the copy and paste to a word document but that is more inconvenient.

At the beginning of section "Hvordan ser studentene på læring?" we were told that it could be useful to go back and repeat the learning definition. Having this in mind when developing a course for the PDA, it would have been useful if we were told something like: "please make a bookmark here, you will need it for later repetitions". I guess this is one option, another is to use the 'Find' function. What I really try to say is that it is not that easy to navigate in a large document on the PDA.

Concerning copying of texts to Notes or Word, of course you can do that, but I find the 'Add note' function suitable enough. If you need a larger piece of text or need to distribute or print the materials, copying to Word/Notes and sync with your desktop PC is a good (if print, only option?) options."

The answers above are to some extent representative. The students are generally quite positive, but they agree that they would not be happy with an m-course requiring that all texts and learning materials were presented on the PDA. As with other Internet students in NKI, they seem to prefer reading longer texts on paper. One of the students replied:

I found using the PDA as a study tool very convenient. This time I actually was in laid-back modus, using the PDA while sitting/laying on the couch. While reading, I tried to figure out what kind of notes would be most effective for my use. I highlighted the text regarding elements I wanted to save for further use in later repetition. I also tried to use the note function, though it took me a couple of minutes to master the 'back' button on the PDA to shift from Microsoft Reader to Notes. After reading the text, I went to the index containing my highlighted elements.

Therefore, concerning the note taking, I found that the highlighted text most is an organizer for text-bindings in the study-unit. When I wanted to repeat the text, the highlights are in an easy to use interface, and contained a list of all my highlighted text.

Using notes, I found it necessary to save the notes in the PDA and later sync it with my pc. When sync., the notes automatically popped up as a Word file. This is therefore a nice method to work with the text later as a repetition or for other purposes. I did not take notes on paper, since I wanted to test the most 'lightweight method possible, with extra paper etc. as little as possible. The size of the screen or the text font did not give me any problems reading/studying. When reading a more extensive material, I think the PDA would be more a supplement to traditionally studying with ordinary books, and not as a primary tool for studying. One has to change the way one study and other habits in order to fully use the PDA as the primary tool."

It also seems that there are individual differences between the students concerning preference for writing 'electronically' or on paper:

The text manipulation functions are for me more or less a set of toys. When I study, I learn thru my fingers, so I have to take 'manual' notes on paper, then write a summary of my notes on an ordinary PC."

Conclusion

It was quite clear that the students preferred the e-book version to the HTML version. They found some positive aspects of the text manipulation functions of the e-book format, but differed in their views of how useful these functions were.

They agree that reading long texts on the PDA is not highly appreciated (in many ways these viewpoints do not differ much from student's viewpoints on reading long texts on large computer screens).

Contribution to Forum via PDA and mobile phone

While the trial course presented the study materials as zip-files to be downloaded and studied offline, sending and receiving messages and reading Forum archive entries and contributing to the Forum had to take place online.

Question:

The following question was distributed to the Forum only a few days after course start:

1. Did you have any problems setting up your PDA for connecting to the Internet via mobile phone?
2. Describe how you solved the assignment of writing and sending to the Forum?
3. Approximately how long time were you connected?
4. Did you have any problems in the process?

Answers:

Very few problems were detected. Different brands and types of mobile telephones were used, Nokia and Ericsson. The PDAs were set up according to specifications with few if any problems. Those who used the phones abroad, had some difficulties. It took some time before we understood how to set up for international calls, and when in Germany it was experienced that some networks did not seem to accept our Norwegian data subscription (possible explanation)(?). When the tutor was at Spitsbergen, it proved impossible to connect to the server in Norway. The network provider explained this with problems concerning direct connection to the server via satellite communication.

The tutor answered the question himself with the following:

"My solution is the following:

- a. I copy the questions into a word document on the PDA and answer questions by writing in the word document. When writing longer passages, I always use the 'Targus Stowaway portable keyboard. The only problem with the keyboard is that Norwegian characters are set up in ways that disturbs other characters (no complete Norwegian version keyboard is available at present (mid-January 2002). In my view this is a serious drawback.)
- b. I have stored the Forum page (print friendly version as 'mobile favourite').
- c. After dialling and connecting to the server I click the favourite (Forum page) and is automatically connected.
- d. When online, I only have to go through the password page to access the Forum.
- e. When in the Forum the entry is copied into the text field for contribution.

The total connection time is less than 2 minutes for this operation."

One student reports that he has written his contribution when connected online:

This assignment was written directly on the PDA using the touch screen keyboard and pocket Word. It was not so time consuming as expected due to the auto completion function that Word (Windows) offer. I used a mobile telephone with infrared connection. I was connected totally 5 minutes."

It should be noted that his message contained 91 words and 504 characters written in approximately 5 minutes connection time.

Conclusion

Setting up the PDA for mobile communication was easily done with the correct information at hand. Setting up for international calls proved somewhat more difficult. Communication online with the Forum functioned well and could be organised within a few minutes connection time. It is important that the Forum is linked directly, so that the page does not open as a frame on the PDA screen, as the text field then becomes very, very small.

Assignment for submission via mobile technology

E-mail communication including submitting assignments for the tutor to comment on and return to the student is an important aspect in most distance education systems. In this trial many e-mails were exchanged between the students and the tutor. Only one assignment for submission was mandatory in the trial. Instead of answering one of the standard assignments of the course, the tutor asked the students to submit answers to an assignment for submission with 3 questions on *'mobile learning'*. The students were supposed to answer the questions and submit the answers using their PDA and mobile phone. The assignment was to be answered in the format of text in an ordinary e-mail and the full answer should also be attached as a word document.

The solution chosen resulted that *the assignment for submission in this case functioned both as the subject of evaluation and a means for evaluation.*

The tutor/evaluator gave this task:

This is the next task for all the 'students' in the m-learning course: All NKI online courses contain a certain number of assignments for submission. So also in your course. Instead of answering the questions in the course, you are expected to answer this assignment as your assignment for submission.

Your answer is to be sent as an e-mail to your tutor. You are supposed to send your answer using the PDA and mobile phone. The answer is to be sent as pure text in the e-mail. Copy the same text into a word document, which you attach to the e-mail.

Question:

1. In your view, how can m-learning as designed in this experiment increase the quality of e-learning?
2. Which additional problems may the student experience?
3. What increased benefits may the student experience?

You may answer as short or long as you wish. Truls and I meet the project group on Friday 15th March, and would like to have your answers before then.

5 students did the task and submitted their answers to the evaluator within the date mentioned. There were no real difficulties in this communication. It should be mentioned that the answers were received just before the tutor/evaluator embarked on the travel to the project meeting in Hagen 15th March 2002. 4 of the 5 assignments were commented on using the portable keyboard while flying from Oslo to Copenhagen and Copenhagen to Düsseldorf. The commented assignments were returned to the students via mobile phone while on the train between Düsseldorf and Hagen. When connected on the train, the 5th assignment was received. This was returned with comments from the hotel in Hagen. (See assignment example with comments, Appendix 2.) (The answers to the three questions are included when accounting for open answers in the questionnaire.)

Summary of experiences on assignment submission

Comments from the tutor

(Written on the PDA and portable keyboard and transmitting via mobile phone to the course Forum in as e-mail to all the participants in the course.)

This is an account on some experiences of answering to student assignments and sending and receiving messages when on travel abroad.

1. Comments to 4 student assignments were written on the plane from Oslo to Düsseldorf. As commented in the letters the comments were written in a height of 10,000 meters in a SAS plane.

2. We had some difficulties setting up the PDA for ringing from abroad. This problem was solved successfully on the intercity train between Düsseldorf Airport and Bochum.

3. On the train between Bochum and Hagen to the Leonardo m-learning project meeting 4 student answers with the tutor's comment were sent. All these had word documents attached to them.

When sending the e-mails, three mails were received, one of them with a word attachment.

3. Connection time

The connection was perfect and the total connection time was around 3 minutes.

4. Comments to student answers in other distance courses.

When in the Hotel outside Hagen comments to 5 other students were done, 1 in the m-learning project, one in the ordinary 'Tutor in distance education course' and 3 in the course 'Distance education didactics'

5. Connection from the hotel

The hotel Hochsrichter was far out from Hagen and connection with all networks was far from ideal. There were difficulties sending, and only 1 of the 5 e-mails was successfully sent.

6. The rest of the e-mails (4) was sent without problems when on the railway station, Wuppertal Oberbarmen, when changing train on the travel from Hagen to Düsseldorf.

7. This e-mail is written and sent from 175 meters height in the restaurant of the 'himmel'-tower of Düsseldorf.

Best regards

The NKI Leonardo project

Truls Fagerberg and Torstein Rekkedal



The tutor/evaluator writing and sending e-mails to the students from Düsseldorf 'Himmelturm'.

Conclusions concerning e-mail communication for assignments with attachments

The conclusion from the above e-mail is that communicating through the mobile technology and networks functions generally without problems – also abroad. There is some lack of compatibility between PDA Microsoft software and PC software. E.g. word documents received from students and synchronized to the PDA and returned with comments via the PDA and mobile phone cannot be read by the Microsoft software on the PC, i.e. 'Pocket Word' are not readable for students with ordinary Microsoft Word on their PC. However, when the documents are both received and returned on the PDA, there does not seem to be any problems.

Otherwise – communication is efficient at acceptable speed and costs. We had from time to time some difficulties in receiving and transmitting e-mails. Problems seem mainly to be that when connection to the mobile network was weak, the transmission failed. But we managed to transmit all e-mail messages before leaving Germany.

Final evaluation

Open answers on assignment questions

1. In your view, how can m-learning as designed in this experiment increase the quality of e-learning?

5 students answered the question. Main viewpoints were:

The students generally stressed the aspect emphasised by NKI that distance education should satisfy the adult learner's need for flexibility. This point was mentioned by all and it is referred to both the continuous availability of learning materials and the possibility of communication anytime and anywhere:

"In my opinion m-learning is a great asset for e-learning, it gives the students and teachers a lot more freedom in where they want to study or correct assignments. Students may send an email to their teacher from the cottage and get help from there, he or she may also access online material if he/she is stuck and needs some resources. From my point of view the most practical thing is to have access to online material whenever and the freedom to read wherever one feels like it. You can have an entire course (or more) on the PDA and still not be overloaded with books and other material. This is progress: New technology put to good use."

Some mention the advantage of being able to study in accidental free moments, such as when waiting for the bus or commuting with train or bus. One student also comments that studying under such conditions is not necessarily ideal:

"... I have a strong feeling that in a real study situation, I would need to find a couple of hours to concentrate on the readings and the assignments. Then, I'm pretty sure that I would prefer to read from paper printouts and write in front of a real PC."

It was also mentioned that m-learning might lead to more frequent communication (and collaboration) between students and also more frequent communication with the tutor:

"Students may in the future also collaborate more since the PPC2002 supports MSN which is an instant messaging service so people can see when you are online. Think of the possibilities this gives when it comes to online collaboration between students and teachers if they want to give their online status to help the students if they are online at the same time. Maybe the student sends an answer to a teacher and he or she just needs clarification on one or two points."

The student absolutely has a point here. With services, such as GPRS, students could be continuously online and send and receive messages. Whether this is a functionality that would be acceptable in practice remains to be seen. For tutors it is obviously a heavy strain if they were expected to be available continuously on their mobile equipment (see for instance Paulsen 1998) on teachers' perception of their workload in online education

It seems clear from our experiences that there are certain limits in the technology at present; however, after some experience some find that the technology functions quite well:

"Some would perhaps doubt if it is possible to use this technology on an extensive course, but I'm convinced it's possible after participating in this project. In an earlier assignment I said that the PocketPC perhaps worked best as supplement to desktop pc but now I'm not so sure, it works nice as a standalone unit as well."

Some of the students were not equipped with an extra portable keyboard. **It was generally agreed that the portable keyboard is necessary for applying the PDA for mobile learning. It is too tedious to write more than short notices on the screen keyboard.**

2. Which additional problems may the student experience (When learning with mobile technology)?

The students agreed that there are some problems concerning the technology; e.g.:

"... the most important problem is probably related to communication via mobile telephones. This is difficult and expensive compared to traditional use of e-mail and web. The configuration of the communication software is not easy - many prospective users will not manage to do it. Further, the number of e-mails people receive could easily discourage mobile users to use the mobile equipment if other options are available."

"Students may experience problems concerning new learning methods and time to adjust to new

formats both in reading, taking notes and writing. Other problems could be differences in kind of equipment and the lack of standardization."

It should be noted that in this experiment all participants had to get acquainted with the technology to take part in the trial study. In a real situation we must assume that the students participate in m-learning courses partly because they already have the technology available and wish to use it for extending their access to materials and communication in the learning situation. Then problems related to the technology itself would probably be minimal.

3. What increased benefits may the student experience?

Again, it is the increased flexibility that is mentioned, both concerning the accessibility of learning materials (content) and resource persons (fellow students and the tutor).

"More freedom of where and when they want to study. They could read (as I do) on the subway, bus or other transportation when on their way to something. This is a good way of getting the time to pass and use it to something useful. Students would always be able to show their assignments if they need help from someone, they may just interpret the text wrong and need a second opinion. The same goes to if they need someone to proofread their answers."

"The one and only real benefit of a mobile course designed as we have experienced here, is the fact that the users have access to the learning material and the learning environment wherever they are. In my opinion, this is not enough to justify the present limitations with the technology. If m-learning should succeed in the future, we need more user-friendly gadgets and technological solutions as well as additional services and content that are specially designed for mobile equipment."

Open comments on the questionnaire

General comments

It was commented by some that at present there are lacking functionalities in the technology, e.g. one missed that bluetooth technology was not installed in the PDAs used. Bluetooth would make the equipment easier to use. Faster and cheaper communication is also necessary for m-learning to be satisfactory. As it is now, one is more concerned with technology related problems that the methodology of teaching and learning in m-learning. The students also commented (as was our assumption of the design for m-learning) that the availability of and ordinary PC is necessary for being satisfied with m-learning:

"M-learning might be a supplement to ordinary courses on the Internet, but courses offered only as m-learning is not for me."

Comments on equipment functionality and user friendliness

One student commented:

"One possible scenario is that mobile equipment will be most useful at home, at work and in public places in which wireless broadband access will be available. We may also find that they become much more useful when Bluetooth technology makes it easy to attach better input and output devices."

Again it was commented by most that portable keyboard is necessary and that the screen is not suitable for reading longer texts, and there is no doubt that the screen is not acceptable for the time being for browsing web pages that are not designed to be read on an PDA.

The questionnaire answers

As mentioned, tables of questionnaire answers are presented mainly for a possible future combination with answers from students in the other pilot trials of the project.

Table 1. Questionnaire section 1. Personal background

	n	%	n	%	n	%	n	%	n	%	N
1. Occupation	Manager		Technical		Teacher/trainer		Student				9
	1	11	5	56	2	22	1	11			
2. Age grouping	>24 years		25-29 years		30-40 years		41-50 years		> 50 years		9
	1	11	-	-	4	44	2	22	2	22	
3. Gender	Male		Female								9
	9	100	-	-							
4. Level of education	High school		1-3 years p.s		4 ore more p.s.						9
	1	11-	1	11	7	78					
5.Mobile device ownership	Mobile phone		PDA		Both *						9
	-	-	-	-	9	100					
10. Where did you study? **	At home		At work		Both home/w		On travel***				9
	2	22	-	-	2	22	5	56			

*All the participants had got their PDA in connection with the project.

** In the questionnaire this question was put under ‘user friendliness

*** No one ticked only “when travelling”, 2 ticked all three alternatives, 2 ticked “at home and when travelling and 1 ticked at work and when travelling

All the participants of the pilot trial had some connection to the NKI research and IT/educational development. This background made them both open for and critical to new technology and present ‘state of the art’. All were men in age from 24 to 56 years. All had a mobile phone before the trial started, experience in using PDA ranged from a 1 month up to 1 year. 5 of the respondents (plus the tutor/evaluator not included in the questionnaire) used the technology on travel during the trial.

Table 2. Questionnaire section 2. Student user friendliness

	Strongly Agree		Agree		Uncertain		Disagree		Strongly disagree		N
	n	%	n	%	n	%	n	%	n	%	
Equipment easy to use	-	-	7	78	1	11	1	11	-	-	9
The mobile learning exp. was fun	3	33	3	33	2	22	1	11	-	-	9
I could take another m-learning course	2	22	3	33	3	33	1	11	-	-	9
I would recommend m-learning	1	11	3	33	4	44	1	11	-	-	9

One of the participants is consistently on the negative side. He was the oldest person and naturally also one of the least active participants during study. He also clearly commented that he preferred pencil and paper both for note taking and reading. It also seems clear that the younger participants are the most positive ones on all questions; the two most positive on all aspects were the two students who also are real students in other settings during the trial.

Table 3. Questionnaire section 3. Didactic efficiency

	Strongly Agree		Agree		Uncertain		Disagree		Strongly disagree		N
	n	%	n	%	n	%	n	%	n	%	
11. M-learning increases quality	1	11	1	11	5	56	2	22	-	-	9
12. Learning obj. can be met by m-l.	-	-	3	33	4	44	2	22	-	-	9
13. Downl. course content was easy	-	-	4	44	4	44	1	11	-	-	9
14. Communication w. tutor was easy	-	-	7	78	1	11	1	11	-	-	9
15. M-l conven. for comm. w. students	-	-	4	44	3	33	1	11	1	11	9

Concerning quality, the students are uncertain whether m-learning increases quality of e-learning. This is because the technology at present is lacking in functionality relative to online learning based on ordinary PCs and Internet connection, difficulties in reading on the small PDA screen and the need for a keyboard for writing. They do not agree whether (all?) objectives can be met by m-learning. It should be noted that they found communication with the tutor easy, but are more reserved whether m-learning is convenient for communication with fellow students.

Table 4. Questionnaire Section 4. Technical feasibility

	Strongly Agree		Agree		Uncertain		Disagree		Strongly disagree		N
	n	%	n	%	n	%	n	%	n	%	
16. Navigation was easy	1	11	7	78	-	-	1	11	-	-	9
17. Graphics and illustr. necessary	2	22	3	33	2	22	2	22	-	-	9
18. Eval. and quest. was effective	-	-	5	56	3	33	1	11	-	-	9

Most of the students found navigation easy. They do not agree whether graphics and illustrations are necessary. A majority agreed that evaluation and questioning was effective.

Table 5. Questionnaire Section 5. Cost effectiveness

	Strongly Agree		Agree		Uncertain		Disagree		Strongly disagree		N
	n	%	n	%	n	%	n	%	n	%	
19. M-learning increases access	2	22	5	56	1	11	1	11	-	-	9
20. Cost of downl. was acceptable	3	33	4	44	1	11	1	11	-	-	9
21. Cost of comm. was acceptable	-	-	4	44	1	11	2	22	1	11	9

Most of the participants agree that m-learning increases access to learning. On the negative side is, of course, that access to technology is lacking at present. The majority found that cost for downloading the course materials was acceptable, but it is not surprising that some find the cost for communication unacceptable (at present).

Discussion and Conclusion

The course *'The tutor in distance education'* was adapted for m-learning, assuming that both tutor and students would use a standard state of the art (2001/2002) PDA and mobile phone for study of learning materials and for communication one-to-one and many-to-many **when on the move**. The assumption was also that the m-learning should be part of a distance education setting based on the Internet and WWW as the main medium for learning, and also that participants should apply ordinary PCs (desktop or laptop) when studying at home or at work.

The participants in the trial were equipped with a Compaq iPaq PDA 3630 or 3660 and mobile phones. Some of the students had to borrow mobile phones and keyboard when needed. All participants had had the possibility of getting acquainted with the technology for other office and study applications before the trial started.

As the students were recruited for the course for assessment of m-learning problems and challenges, more that actually for studying the course, they are seen as pilot trial students

rather than real students. Still, we see that the results are valid for decisions about future developments of solutions for mobile distance students in the NKI distance education system.

Downloading and synchronizing learning materials

There were practically no problems experienced in downloading the materials to the PC and synchronizing with the PDA. Two students had difficulties downloading through their modems, while a third student had no difficulties. The downloading could be done at acceptable time and costs through all the different connection solutions used.

Technical solution and problems

The Compaq iPaq operating system is unstable. All participants experienced the need for soft restart at numerous occasions when the system broke down. The soft restart is quickly and easily done, but it is irritating that the technology breaks down so often. (We have later installed PocketPC 2002 on 3660 and 3870.)

All participants agreed that in order to use the PDA for effective studies and writing more than a few words, the screen keyboard is not sufficient. One needs a portable keyboard (which increases the equipment to carry, and the question arises whether a small laptop is a better solution when mobile). Presently (June 2002) we cannot get a Norwegian keyboard. However, there is software on the market (example Sunnysoft <http://www.sunnysoft.cz/>).

Connection to the Internet through infrared ports is acceptable when using the screen keyboard, but if using the portable keyboard to connect the ports, one has to make some improvised solutions to support the phone on the top of the PDA. With bluetooth technology connecting phone and Pocket PC is much better solved.

The PDA for studying

The participants seem to agree that it is acceptable to read from the small PDA screen. Some are enthusiastic when they look at the advantage of being able to carry course materials and read on the move and at occasional situations. This advantage seems to compensate for the difficulties reading from the screen. Some comment that they do not like reading from the small screen (in fact they dislike reading also from ordinary computer screens) more than very short texts.

It seems that the Microsoft e-book format is preferred to the HTML format. Thus, in the following trial with real students we will produce the learning materials in e-book format only.

At present, it seems that the HTML format makes it easier to provide links within the materials and organise the materials in separate files in logical order with content list with links etc.

We had had difficulties presenting illustrations in readable form on the PDA. Graphics are not easily transferred to the PDA, and in this trial we accepted that full understanding of illustrations were only possible on the PC. This problem must be solved if the technology should be acceptable for courses with more emphasis on graphical illustrations.

Note taking

The participants were asked whether the PDA was suitable for active note taking when studying. Related to the preference for reading in the e-book format, the students also found

that using the functions of making notes, bookmarks, highlighting etc. One comments that he prefers taking notes on paper, and all agree that the portable keyboard is a necessary additional equipment to use the PDA actively for note taking.

Sending and receiving e-mails

Setting up Internet connection and e-mail service on the PDA was not easy, but with the purchaser's manual it functioned well. We also had some difficulties finding the correct settings for connection to the Internet from abroad, but after some trial and error we succeeded. If one normally receives many and heavy e-mails, it is important to set the mail to receive only headers and afterwards decide which e-mails to download. When the settings are correctly installed, the mail system functioned to our full satisfaction. We had no difficulties with attachments. The tutor may comment in the students' assignments using separate colours or text types. This functioned also quite well, although changing fonts is more time consuming and needs more steps than on an ordinary keyboard using macros.

Reading and writing online through the browser

Reading the NKI Internet college pages online through the PDA browser is generally not acceptable. The pages are not designed for browsing on the PDA. However, the only need to be online to the NKI Internet College in this pilot trial was for contributing to the course discussion Forum. Writing contributions to the Forum has to be done online by writing in the text field in the browser. The best solution is to write the text offline in Notes or Word and copy the text into the text field. This procedure could be done easily and in short time.

Conclusion

NKI Distance Education gives main emphasis and priority to student autonomy, flexibility and freedom to choose where and when to study in designing the environment for distance learners. Our main aim in designing solutions for mobile learners is to maximize this freedom to support online learners who also are mobile when studying. This is also clear from all the participants in this pilot trial; the main advantage of m-learning is the ***increased flexibility of online distance education.***

Our pilot trial with mobile technology (PDA and mobile phone) showed that the technology functioned according to our expectations. The participants were generally satisfied with the technological and didactical solutions. The participants differed somewhat in their acceptance. Some were quite enthusiastic; others were a little more reserved. The differences could partly be related to different learning styles and study preferences, such as preference for note taking on paper and/or general reluctance towards reading longer texts from (any screen).

In the NKI system it will be a challenge to design solutions for learners who are users of mobile technology and have a need to study also when on the move, and that other students, who prefer to use standard technology can do that, and that both groups may participate in the same course. This means that we have to look for solutions that are optimal for distributing content and communication in courses, independent on whether the students and tutors apply mobile technology or standard PC and Internet connection for teaching or learning.

The next trial will take place from summer 2002 with a few real students in the course '*SPICE 603 – Online Teaching and Learning*'. In the next trial course materials for PDA will be presented in e-book format, the tutor and students will use Compaq iPaq (3630, 3660, 3870) and Ericsson mobile phones T39m and R580, portable keyboards and both IR and bluetooth

connection. The results from this trial will be taken into account in the design and the teaching/learning process.

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Appendix 1: QUESTIONNAIRE ON MOBILE LEARNING

Section 1. Personal background

22. What is your occupation?
Manager
Technical
Teacher or trainer
Student
Unemployed
23. What is your age grouping?
less than 24
25-29
30-40
41-50
over 50
24. Gender?
Male
Female
25. What is your level of education?
High school matriculation
One to three years of post-secondary education
Four or more years of post-secondary education
26. Mobile device ownership
Do you own a mobile phone?
Do you own a PDA (personal digital assistant), pocket PC or palmtop?
Do you own both a mobile phone and a PDA?

Section 2. Student user friendliness

27. It was easy to use the equipment in this mobile learning course
Strongly agree
Agree
Uncertain
Disagree
Strongly disagree
28. This mobile learning experience was fun
Strongly agree
Agree
Uncertain
Disagree
Strongly disagree

29. According to my experience I would take another mobile learning course if relevant to my learning needs
Strongly agree
Agree
Uncertain
Disagree
Strongly disagree
30. I would recommend mobile learning as a method of study to others
Strongly agree
Agree
Uncertain
Disagree
Strongly disagree
31. Where did you study the mobile learning course?
At home
At the office or work
While travelling
Other

Section 3. Didactic efficiency

32. Mobile learning increases the quality of e-learning
Strongly agree
Agree
Uncertain
Disagree
Strongly disagree
33. Course learning objectives can be met by mobile learning
Strongly agree
Agree
Uncertain
Disagree
Strongly disagree
34. Downloading course content was easy
Strongly agree
Agree
Uncertain
Disagree
Strongly disagree

35. Communication with and feedback from the tutor in this course was easy
Strongly agree
Agree
Uncertain
Disagree
Strongly disagree
36. Mobile learning is convenient for communication with other course students
Strongly agree
Agree
Uncertain
Disagree
Strongly disagree

Section 4. Technical feasibility

37. Navigation through the mobile learning course was easy
Strongly agree
Agree
Uncertain
Disagree
Strongly disagree
38. For mobile learning to be effective it is necessary to use graphics and illustrations
Strongly agree
Agree
Uncertain
Disagree
Strongly disagree
39. Evaluation and questioning in the mobile learning course was effective
Strongly agree
Agree
Uncertain
Disagree
Strongly disagree

Section 5. Cost effectiveness

40. Mobile learning increases access to education and training
Strongly agree
Agree
Uncertain
Disagree
Strongly disagree

41. The cost of downloading the mobile course materials was acceptable
Strongly agree
Agree
Uncertain
Disagree
Strongly disagree
42. The cost of communicating in the mobile learning course with the tutor and other students was acceptable.
Strongly agree
Agree
Uncertain
Disagree
Strongly disagree

Comments:

Comments on equipment functionality and user friendliness:

Appendix 2: Commented assignment on mobile learning (both subject and means of evaluation)

Aleksander, here are my comments to your assignment

Question:

1. In your view, how can m-learning as designed in this experiment increase the quality of e-learning?

In my opinion m-learning is a great asset for e-learning, it gives the students and teachers a lot more freedom in where they want to study or correct assignments. Students may send an email to their teacher from the cottage and get help from there, he or she may also access online material if he/she is stuck and needs some resources. From my point of view the most practical thing is to have access to online material whenever and the freedom to read wherever one feels like it. You can have an entire course (or more) on the PDA and still not be overloaded with books and other material. This is progress: New technology put to good use. There are two things I am missing with my PDA. 1: A keyboard and 2: More disk space, I currently only have 32MB. Increased space also gives the possibility of an MP3 player and more advanced features.

Agree with your views. I understand that you point to both access issues concerning time and space, and also to practical issues such as storing and retrieving materials. I agree completely with your views on the need for keyboard. Storage is also a problem. Both problems can easily be solved.

Students may in the future also collaborate more since (from what I heard) the PPC2002 supports MSN which is an instant messaging service so people can see when you are online. Think of the possibilities this gives when it comes to online collaboration between students and teachers if they want to give their online status to help the students if they are online at the same time. Maybe the student sends an answer to a teacher and he or she just needs clarification on one or two points.

2. Which additional problems may the student experience?

There may be technical problems and students may lose their work because of forgetting the charger... This is something they only do once and it is nothing that could not happen with an ordinary PC

Obviously technical difficulties are making problems for the time being. This is as it was for most participants in the early days of computer mediated communication in distance education. I believe that these problems will become much less in the future. Agree?

3. Which increased benefits may the student experience?

More freedom of where and when they want to study. They could read (as I do) on the subway, bus or other transportation when on their way to something. This is a good way of getting the time to pass and use it to something useful. Students would always be able to show their assignments if they need help from someone, they may just interpret the text wrong and need a second opinion. The same goes to if they need someone to proofread their answers.

Final comment:

Thanks for answering so rapidly. And thanks for your valuable viewpoints so far.

Best regards from 10,000 meters height.

Torstein

Torstein Rekkedal

Trying Out a Learning Environment for Mobile Learners II **Evaluation of the course “Online Teaching and Learning” – Phase 2 of the NKI** **sub-project of the EU Leonardo Project “From e-learning to m-learning”**

December 2002

Introduction

This evaluation report presents the results from the second trial of m-learning among Norwegian students at NKI.

During the project period two courses have been tried out with students using mobile phone and PDA. The two courses were:

3. *The tutor in distance education (Norwegian version)*
4. *SPICE 603 Online Teaching and Learning*

The first course was tried out from January until end of April 2002. The second course was launched for mobile access at the end of June 2002. When writing this evaluation report the second course is still running in its trial version. However, as the period of the formal project ends November 30 2002, the evaluation of student experiences with m-learning was completed by distributing the final questionnaires at this date.

The first course that was tried out as part of the Norwegian sub-project was ‘*The tutor in distance education*’. Results from this trial were presented by Rekkedal (2002a, 2002b). The second course tried out was “*Online Teaching and Learning*”. The course is one of 5 courses in the programme “*Specialization Programme in International Online Education*”. It constitutes 6 ECTS Credits. It has 5 mandatory assignments for group or individual submission.

Experimental conditions in the two trials

Trial 1

The first course try out took place in a simulated distance learning setting with mobile technology, and the ‘students’ participated on the condition that *evaluation of the m-learning system* and not *real learning of course content* was the main goal of the activity. It should also be noted that all the ‘students’ had specific interest in technology for distance teaching and learning from different perspectives. (Students’ is written in inverted commas because the participants were more evaluators and observers than real learners of course content.)

Trial 2

The second course was tried out in a real situation. Actually, one of the ‘students’ from the first trial tutors the second course. During the trial the course had 5 registered active students, 4 in Norway and 1 in California. 3 of the 4 Norwegian students were using mobile technology. During the experiment one of the three experimental students stayed for some weeks in Tanzania, and one has travelled and communicated from the USA and European countries. The 3 mobile learners are 1 man (age 32, bachelor in computer science) and 2

women (age 55, Pd.D in chemistry and working as web master and age 35, bachelor of education, director of studies at a technical research centre).

In a future real situation we assume that mobile learners have access to and experience with the necessary technology before actually applying the technology for learning. This was not really the case in this experiment, as only one of the three experimental students owned the technology and was an experienced user before embarking on the course. (He was also one of the 'students' in the first course trial, but was enrolled as an ordinary student in the second course.) The two other experimental students were equipped with the technology when starting on the course. Thus, they met some minor introductory problems of setting up the PDA for communicating with the mobile phone, which one would not expect with future experienced users of the technology. (To some extent these problems were similar to those we experienced when online learning was introduced 15 years ago.)

The technical solutions were the same in both trials, except that as we learned from the first course that course content in Microsoft Reader format was preferred before HTML-format, we only supplied Reader files for the SPICE course. During the first trial only the tutor and one student was supplied with portable keyboard. Keyboard was seen as a necessary functionality, thus during the second trial all three students and the tutor were supplied with keyboards to be used with their PDAs. During the second trial the PDAs had the 2002 operating system installed. This gave better presentation of graphics and tables.

Evaluation methods and procedures

The experimental students and the tutor in both trials were equipped with a Compaq iPaq PDA (3650, 3660 and 3870 with 32 and 64 mb memory). The second course was made available for mobile equipment end of June 2002. However, with one exception the students did not really start their studies before mid September.

We decided to evaluate the m-learning environment primarily by a qualitative process related to a field research model applying the technology to be tested. The evaluation questions and answers were distributed as contributions to the Forum, which means that all entries were sent as e-mail to the participants, but also that they also are archived and can be read on the course pages on the PC or on the PDA when connected to the Internet. This means that all the participants had access to other participants' evaluation responses during the trial.

The second trial was reasonably realistic as the experimental students were real students studying the course. All three experimental students planned to complete the whole 30 ECTS Credit programme. Thus, the evaluation process was carried out parallel to the teaching-learning process by this author as evaluator. (Regrettably, the teaching-learning process of the second course will not be finished during the project period. When this final evaluation is written, the students are still active studying in the course.

Results

The participant's study situation

As in the first trial, both the tutor and the students worked from home, from the office and on travel. It clearly seems that the participants find that the mobile equipment functions satisfactory for reading and communicating when travelling. Connection time becomes very expensive when abroad, e.g. connection time from Tanzania was over 4 Euro per minute.

Concerning where study took place one of the students answered:

“As I am taking this course through work, most of my studying online takes place at work. (I am given time during work hours and employer is paying for the course). My daily work consists of a lot of time in front of the computer and thus it is easy for me to study whilst being connected anyway. In periods I work out of the office - running residential courses - and in these periods I do not study during work hours at all.

At home I would study in the evening after kids bedtime (21h) as well as sometimes at weekends. Mostly I use programmes like word and Microsoft Reader at home - writing assignments.

I also would study during travel – in evenings at hotel rooms, on the plane/train as well as out in the field when collecting data for projects. I have already used the equipment/course in Tanzania, which worked well.”

One of the other students replied:

“The main part of my study will take place in my home and when travelling both abroad and in Norway. If I took the bus or train to work I would certainly have used that spare time to study.

I would also consider studying a little bit when I'm on vacation since the equipment is easy to bring with me and I have all I need of readings etc on the PDA.

At home I use an old pc with 56k modem. It is possible to use it for synchronization but I prefer to use my computer at work for this purpose. At work I have a LAN connection and my computer is a PIII 900 mhz with 256 ram.”

It is perhaps interesting to note that two of the three students (the two women) both informed that they did not have access to an ordinary computer at home. Thus, actually the mobile equipment made it possible also to study at home. Earlier, they had to study in the office where they usually worked at the computer.

Downloading and synchronizing learning content

Generally, the participants experienced few problems in downloading and synchronizing learning materials to their PDA. During the first trial some few problems in downloading the html materials were reported. During the second trial all study materials were distributed in the Microsoft Reader format. Downloading was fast and easy. One of the students had difficulties setting up the PDA for communication. She actually came physically to NKI to get support. The other student, who also had received the equipment because of the trial, also had some difficulties. However, these were solved locally with the support of technical staff at her workplace.

Reading and studying on the PDA

All three students agreed that reading and studying the learning materials in Microsoft Reader format on the PDA was quite acceptable, specifically related to the ease of carrying the equipment when on the move.

One student wrote:

“In terms of size of the equipment this has been a major advantage compared to for example carrying a laptop around. When travelling to Africa I brought a small makeup bag containing the PDA, Stowaway keyboard and mobile phone. I could fit it in my handbag, which is very convenient. I wished the adapter for phone and PDA was the same to avoid bringing two, but this is of course a minor issue.”

2 of the 3 students point out that the PDA has been very practical as a study tool. They both have used it for note taking and also used the text manipulation functions of the Microsoft Reader software.

Contribution to Forum via PDA and mobile phone

While the course presented the study materials to be downloaded and studied offline, sending and receiving messages and reading Forum archive entries and contributing to the Forum had to take place online. Very few problems were detected concerning setting up the PDAs for connection to the Internet via mobile phone.

The conclusion is that communicating through the mobile technology and networks functions generally without problems at acceptable speed and costs.

Answers to the final questionnaire

(Seen in isolation a quantitative questionnaire answered by 3 students is absurd. However, as this evaluation is part of a European with a quite large number of experimental students from 6 courses in 4 countries, the project team agreed that the results also would be presented as a whole, as all the students answered the same questions.)

Table 1. Questionnaire section 1. Personal background

	n	%	n	%	n	%	n	%	n	%	N
1. Occupation	Manager		Technical		Teacher/trainer		Student				3
	-	-	2	67	1	33	-	-			
2. Age grouping	>24 years		25-29 years		30-40 years		41-50 years		> 50 years		3
	-	-	-	-	2	67	-	-	1	33	
3. Gender	Male		Female								3
	1	33	2	67							
4. Level of education	High school		1-3 years p.s		4 ore more p.s.						3
	-	-	1	33	2	67					
5.Mobile device ownership	Mobile phone		PDA		Both *						3
	-	-	-	-	3	100					
10. Where did you study? **	At home		At work		Both home/w		On travel***				9
	-	-	-	-	1	33	2	67			

*Two of the students were equipped with the PDA for this experiment.

** In the questionnaire this question was put under ‘user friendliness

*** No one ticked only “when travelling”, 1 ticked all three alternatives, 1 ticked “at home and when travelling and 1 ticked at work and at home.

One of the students said that she very seldom travelled. However, as she did not have access to a PC at home, the mobile equipment was used for study at home. The two other students clearly expressed that they travelled, and that the equipment and solutions for m-learning were appreciated.

Table 2. Questionnaire section 2. Student user friendliness

	Strongly Agree		Agree		Uncertain		Disagree		Strongly disagree		N
	n	%	n	%	n	%	n	%	n	%	
Equipment easy to use	-	-	3	100	-	-	-	-	-	-	3
The mobile learning exp. was fun	2	67	1	33	-	-	-	-	-	-	3
I could take another m-learning course	1	33	2	67	-	-	-	-	-	-	3
I would recommend m-learning	1	33	2	67	-	-	-	-	-	-	3

All the participants are consistently on the positive side. They find the equipment easy to use, they found the experience to be ‘fun’ and they would be willing to take another m-learning course, and they would also recommend others to take an m-learning course. During the first trial we found that one participant, man between 50 and 60 years, to be quite negative. In this second trial we had one woman at the same age, who was far more positive.

Table 3. Questionnaire section 3. Didactic efficiency

	Strongly Agree		Agree		Uncertain		Disagree		Strongly disagree		N
	n	%	n	%	n	%	n	%	n	%	
11. M-learning increases quality	-	-	2	67	1	33	-	-	-	-	3
12. Learning obj. can be met by m-l.	1	33	2	67	-	-	-	-	-	-	3
13. Downl. course content was easy	1	33	1	33	1	33	-	-	-	-	3
14. Communication w. tutor was easy	1	33	1	33	1	33	-	-	-	-	3
15. M-l conven. for comm. w. students	-	-	3	100	-	-	-	-	-	-	3

One of the three students is uncertain whether m-learning increases quality of e-learning. The same student is also uncertain whether downloading was easy and whether communication with the tutor was easy. From the whole evaluation process it was clear that this student had some difficulties. From conversations with the student these difficulties seemed to be more related to external factors, time stress and an accident causing sickness absence for a long period during the trial. Generally, the three students in this second trial were somewhat more positive also concerning didactic efficiency.

Table 4. Questionnaire Section 4. Technical feasibility

	Strongly Agree		Agree		Uncertain		Disagree		Strongly disagree		N
	n	%	n	%	n	%	n	%	n	%	
16. Navigation was easy	2	67	1	33	-	-	-	-	-	-	3
17. Graphics and illustr. necessary	-	-	1	33	-	-	2	67	-	-	3
18. Eval. and quest. was effective	-	-	1	50	1	50	-	-	-	-	2

The students found navigation easy. They do not agree whether graphics and illustrations are necessary. Concerning evaluation and questioning, one did not answer and one is uncertain. We would ascribe this uncertainty to the fact that when the final questionnaire was distributed, they had studied only part of the course and not submitted more than 1 or 2 of the 5 assignments in the course.

Table 5. Questionnaire Section 5. Cost effectiveness

	Strongly Agree		Agree		Uncertain		Disagree		Strongly disagree		N
	n	%	n	%	n	%	n	%	n	%	
19. M-learning increases access	2	67	1	33	-	-	-	-	-	-	3
20. Cost of downl. was acceptable	1	33	1	33	1	33	-	-	-	-	3
21. Cost of comm. was acceptable	1	33	1	33	1	33	-	-	-	-	3

The students agree that m-learning increases access to learning. Concerning costs, this was not a real situation for the students, as their mobile communication bills were covered by the project. However, they have experienced that the connection time can be kept reasonably low, and they have probably assessed whether costs would be acceptable if they were to pay themselves. It should also be noted that all three students have their course paid by their employer. It is, of course a question whether their employer also would cover the costs of mobile communication.

Open answers to the questionnaire

Student 1:

“Comments on equipment functionality and user-friendliness:

I found the equipment quite functional and easy to use, except one thing I experienced when I suddenly fell sick. On return to my office after several weeks’ quite serious illness, I discovered all my software had disappeared from my pocket PC. This can cause a trouble in communication and hamper successful participation when, due to unforeseen circumstances, a battery just runs empty. This will require extra time and effort to restore all necessary information in this device and if the cost for this is too high, one might be discouraged to continue.

There’s one more factor of concern: security issues. Even I myself didn’t suffer from any kind of Spyware intruders, I’m aware (and everyone should be) about the problems a frequent use of such equipment might bring about. Technological solutions to do away with this kind of uncertainty are on their way but the system is not safe yet”

It is worth noting this student’s experience of loosing the data on the PDA when batteries get empty. This experience caused a lot of frustration for the student. From distance education in general we know that unexpected incidents like this may cause drop out from study. The incident is probably mainly due to the fact that the equipment was new to the student.

This student also expresses some worry concerning the safety of mobile communication – although we would not expect this problem to be of a very sensitive nature in education.

Student 2:

Comments:

The 'mobility' of the course using the PDA acts as an extension to the general (traditional) online learning programmes. In my case it has been particularly useful when travelling. The slowness of the phone has made me choose to use internet/e-mail with the PDA as little as possible and only when travelling. It may be worth mentioning that I do not have a computer at home, thus the PDA has been useful both for studying materials as well as writing assignments.

Using the PDA as a personal organiser (calendar, book of contacts), has meant that I have carried it around everywhere. Thus it has always been possible to take notes and write down ideas that may have come to my mind at any time and being able to file it in a document called 'notes for the course'.

Comments on equipment functionality and user-friendliness:

As I started using the equipment at the same time as the course started, there were definitely frustrations and difficulties in setting it up and a lot of time and help from computer specialist was needed. Having come passed the hurdle of the set-up it has been easy enough to use the equipment. At times I have had problems connecting to the Internet, but I have always managed in the end, even from Tanzania. The PDA itself is easy and I find using Microsoft Reader useful both in terms of being able to highlight texts and insert bookmarks as well as copying quotes and references directly from the text to a document I was writing.

As mentioned above, the slow connection together with difficulties in connecting at all, made me avoid login on to Internet through the PDA. As the discussion group for this course has not been active, this has not been a problem. On the other hand, I have spent less time online due to this than in other online training. Having used IR to mobile phone for connecting I have considered buying a cable to make connection faster, but never got around to this.”

Conclusions

The second trial was supposed to be as real as possible. Except that two of the students were equipped with the technology specifically for the trial, and thus not real and experience users before taking the course, and that bills for mobile communication were paid by the educational organisation, the study situation was completely real.

As far as we can judge from the process evaluation, including formal questions and answers in the course Forum on m-learning, telephone contacts with the students and answers to the final questionnaire, the students were generally positive. In fact, although comparisons between small groups are difficult to make, the evaluations give the impressions that the students in trial two are more positive than the participants in the first trial. This might be a result of the higher degree of realism in the second trial.

It was very clear that the two students, who really were on the move, and travelled also abroad during the experiment, were more positive than the one student who actually had not been on the move during the experiment.

NKI Distance Education gives main emphasis and priority to student autonomy, flexibility and freedom to choose where and when to study in designing the environment for distance learners. Our main aim in designing solutions for mobile learners is to maximize this freedom to support online learners who also are mobile when studying. This is also clear from all the participants in the pilot trials; the main advantage of m-learning as designed in these trials, is the ***increased flexibility of online distance education.***

Our pilot trials with mobile technology (PDA and mobile phone) have demonstrated that the technology functioned according to our expectations. The participants were generally satisfied with the technological and didactical solutions. The participants differed somewhat in their acceptance. Some were quite enthusiastic; others were a little more reserved. The differences could partly be related to different learning styles and study preferences, such as preference

for note taking on paper and/or general reluctance towards reading longer texts from (any) screen.

In the NKI system it will be a challenge to design solutions for learners who are users of mobile technology and wish to study also when on the move, that also allow other students to apply standard technology. The solutions must be designed in ways to allow both groups to participate in the same course. This means that we have to look for solutions that are optimal for distributing content and communication in courses, independent on whether the students and tutors apply mobile technology or standard PC and Internet connection for teaching or learning.

During our two trials and experiences with the technology over nearly two years, we have met some technical problems. We have learned that a portable keyboard is necessary to fully exploit the possibilities of the PDA for learning. It also seems that both the number and severity of problems continuously are decreasing as the hardware and software technology develop.

There is no doubt that NKI Distance Education faces a large challenge in further developing server side solutions and teaching methodology that include the use of mobile technology for serving our mobile distance learners more efficiently. We really look forward to continue the developments and experiments.

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Enhancing the Flexibility of Distance Education – Experiences with a Learning Environment for Mobile Distance Learners

Paper presented at the Conference “M-learning: The Cutting edge”, final conference of the EU Leonardo Project “From e-learning to m-learning”

November 2002

Summary

NKI Distance Education is Norway’s largest distance teaching institution offering a large number of courses and programmes in a wide range of subjects on different levels.

This paper presents NKI experiences concerning the development of solutions for m-learning applying Pocket PC and mobile phones for distribution of content and communication in distance learning. During the project period 2001 and 2002 NKI Distance Education developed solutions for m-learning for two courses and tried out the solutions with students. In the first course, ‘*The Tutor in Distance Education*’ the experimental students consisted of employees at NKI Distance Education who tried the solutions in a partly real study situation. The second trial with the course, ‘*Online Teaching and Learning*’ was carried out with real students. At the time of writing this paper the second trial is not completed.

Thus, the conclusions here relate more to the first trial than to the second. However, so far it seems that there is no large difference in opinions and experiences from the two evaluation studies.

NKI Distance Education gives main emphasis and priority to student autonomy, flexibility and freedom to choose where and when to study in designing the environment for distance learners. Our main aim in designing solutions for mobile learners is to maximize this freedom to support online learners (and teachers) who also are on the move. This is also clear from all the participants in the pilot trials; the main advantage of m-learning as designed in these trials, is the ***increased flexibility of online distance education.***

Our pilot trials with mobile technology (PDA and mobile phone) have demonstrated that the technology functioned according to our expectations. The participants were generally satisfied with the technological and didactical solutions. NKI solutions for mobile learners must be designed in ways that allow students using stationary equipment only can study without difficulties together with mobile distance learners. During the second trial, both students with mobile equipment and other students are participating in the same group. This means that we have to look for solutions that are optimal for distributing content and communication in the courses, independent on whether the students and tutors apply mobile technology or standard PC and Internet connection for teaching or learning.

Technology develops fast. We have experienced many different problems during the trials. However, difficulties are continuously decreasing. Our experiences have made us optimistic that mobile technology will increase the quality for distance learners concerning the possibility to study what, where and when you want.

Introduction

NKI Distance Education is the largest distance teaching institution in Norway, recruiting 7,000-10,000 students every year. NKI Distance Education is one unit in the NKI group, a non-governmental educational institution also offering full-time and part-time training on secondary and tertiary level.

NKI Distance Education was one of the first institutions worldwide to offer online distance education when we started the first trials on our in-house developed Learning Management System, *EKKO*, in 1987. Since then online education has continuously been offered to a increasing student population. November 2002 NKI has approximately 4,500 active online students, studying one of more than 60 study programmes or nearly 400 courses offered on the Internet/Web. March 2001 year we launched what we consider to be the 4th generation online distance education system at NKI when introducing the internally developed LMS *SESAM (Scalable Educational System for Administration and Management)* that totally integrates the web-based Learning Management System with the overall Student Administration System.

When engaging in the project “*From e-learning to m-learning*” the NKI Research and Development group was very decisive that our part of the project should be used for refining the total distance learning environment to meet the needs of the “*mobile distance learner*”.

NKI basic philosophies concerning distance learning

Increasing the flexibility of distance education

A number of evaluation studies among distance and online learners at NKI demonstrate that students emphasize flexibility (see e.g. Rekkedal 1990, 1998, 1999, Rekkedal & Paulsen 1997).

In our view, distance education generally seems to develop in two quite different directions. The solution at one end of a flexibility continuum can be described as an individual, flexible solution allowing the student freedom to start at any time and follow his/her own progression according to personal needs for combining studies with work, family and social life – *‘the individual flexible teaching model’*. This model represents a generic development of the model of distance teaching institutions and applies normally media and technologies independent of time (and place), such as asynchronous computer communication, video, audio and printed materials. The model on the opposite end of the scale, *‘the extended classroom model’*, assumes that the students are organised into groups required to meet regularly at local study centres and applies technologies such as video conferencing, satellite distribution, radio and television (Gamlin 1995).

In this connection we have chosen the philosophy for the development of Internet based education at NKI: *Flexible and individual distance teaching with the student group as social and academic support for learning*. NKI offers more than 400 courses and over 100 study programmes by correspondence based and Internet based distance teaching and recruits 10,000 students every year. These students may enrol to any course of programme or

combination of courses at any day of the year and progress at their own pace. This flexibility does not exclude group-based solutions in cooperation with one single employer, trade organisation or local organiser, or that individual students on their own initiative or by the initiative of the tutor are collaborating on learning tasks.

It is also clear from NKI experiences that already many of our students and teachers have experience as mobile learners and teachers. Until the last couple of years this has been restricted mainly to students and teachers carrying their laptops, possibly including communication via mobile phones.

Our main objective in this the project has been to extend the distribution of learning materials and communication to lighter equipment, specifically PDA and mobile phone. The challenge is then to develop the system and server side to present materials in ways suitable for PDA technology and to find acceptable solutions for *distribution of materials* and for *teacher to student/student to teacher and student-to-student communication*. We should also add that NKI parallel to this project is engaged in a project on *Universal accessibility* (<http://vega.nettskolen.com/ekstern/universell/>), which has similar consequences concerning server side solutions for making content available to anyone independent of physical handicaps or technology on the receiver side.

It was our aim in designing the environment for the mobile learner to extend and increase the flexibility of distance education, that to some extent took a step backwards when converting from paper based to online learning, where students largely were required to study at a place (and at a time) where a computer with access the Internet was available.

Views on knowledge and learning

For NKI it was clear that the learning aims, content and teaching/learning methods in our online courses and programmes generally are far away from most e-learning courses (see e.g. Dichanz 2001). Most examples of m-learning experiments concern e-learning on mobile devices, often WAP and/or 'smart-phones' (see e.g. Kynäslähti 2001, Kristiansen 2001).

To us, learning is a change in the student's perception of reality related to the problem areas studied and increased competence in solving problems in a field, ability to differ between focal and more peripheral questions, analytical skills and competence in using the tools within a field in appropriate ways. This means that learning results are shown in a qualitative change in the student's understanding, academic, social and technical competence. The learning is a result of active processing of learning material and solving problems individually and/or in groups. This view is often different from what we can find in many so-called e-learning programmes, where knowledge often is seen as a larger amount of information or ability to recall and reproduce facts. In addition to cost considerations, this is why NKI in general has put little emphasis on using fancy effects in a behaviouristic pedagogical tradition, programmed learning and knowledge transmission (see Marton et al. 1987, 1997, Morgan 1993 on students' conceptions of learning, deep level and surface level approaches to learning). We also hold the view that learning is an individual process that can be supported by adequate interaction and/or collaboration in groups (Askeland 2001).

Designing the Environment for Mobile Learners

With these considerations in mind, presently mobile learning using mobile phones alone did not make much sense to us. On the other hand, we found that designing and trying out a new

learning environment for online learners applying PDA and mobile communication seemed to be a sensible one. Our considerations and decisions are presented below.

Studying online and offline

In line with the above discussions on learning and studying, most NKI courses are not designed to function as online interactive e-learning programmes, although some parts of the courses may imply such interaction with multi-media materials, tests and assignments. The courses normally involves intensive study, mainly of text based materials, solving problems, writing essays, submitting assignments and communicating with fellow students by e-mail or in the web based conferences. This means that most of the time the students will be offline when studying. From experience we know that the students often download content for reading offline and often also print out content for reading on paper.

Technical solution

It should also be emphasized that we assume that the NKI Internet students normally will have access to a desktop or laptop computer with Internet connection. This means that the equipment and technologies used when mobile are additions to the students' equipment used when studying at home or at work. It should also be noted that our developments were based on the absolute assumption that mobile learners would study in the same group as students not having access to mobile technology. Thus, the design of the learning environment had to cater efficiently for both situations.

When planning for the m-learning environment the NKI project team had long discussions whether to develop the learning materials for online or offline study. Taken the above experiences, and also cost considerations concerning mobile access to online learning materials, we concluded that the learning environment for the first course should include the following aspects (Fagerberg, Rekkedal and Russell 2002):

Technology:

- Pocket PC/PDA
- Mobile phone
- Portable keyboard

Learning content and communication:

- Learning content to be downloaded on the mobile device to be studied offline.
Downloaded content to include all course materials:
 - Content page
 - Preface
 - Introduction
 - All study units
 - Resources (articles on the web, references to other resource materials)
- Online access to the discussion forum with the possibility of as quick as possible access for reading in the Forum and writing contributions
- E-mail for individual communication with tutor and fellow students and for submitting assignments. Assignments may be submitted as text-based e-mail or as Word or Text attachments.

More detailed description of the analyses and decisions behind and the development of the technical solutions is presented by (Fagerberg 2002a, 2002b).

Students' and tutor's use of technology when mobile

When mobile – and using mobile technologies – we have found that it is generally satisfactory for the student (and the tutor) to have the course content available to study on the PocketPC. In addition, the following communication possibilities are necessary. When mobile, the student must be able to:

- Access the course forum archive to read messages (if necessary) (messages on the forum is also sent to participants as e-mails)
- Access the course forum to submit contributions to the discussions
- Send e-mail to fellow students, to the teacher and to administration (study advisor)
- Receive e-mail from fellow students, from the tutor and from the administration
- Submit assignments by e-mail including attachments
- Receiving assignments corrected and commented on by the tutor including attachments.

To access e-mail and discussion forums, mobile phones were used.

The Trials

The courses

During the project period two courses have been tried out with students using mobile phone and PDA. The two courses were:

5. *The tutor in distance education (Norwegian version)*
6. *SPICE 603 Online Teaching and Learning*

The first course was tried out from January until end of April 2002. The second course was launched for mobile access at the end of June 2002. When writing this paper the second course is still running in its trial version.

The tutor in distance education

The course *'The tutor in distance education'* represents NKI's mandatory training programme for prospective NKI tutors. When it was launched in 1977 it was probably the first distance training course for distance tutors in the world. It was adapted to online teaching in 1990 and was taught on the first generation system for online distance education in NKI, the EKKO-system (see Paulsen & Rekkedal 1996, Rekkedal 1999, Rekkedal 2001). It was developed for distribution and teaching/learning on the Internet from 1996. The course contains 3 study units and according to the Norwegian system for classifying course workload, it is equivalent to 3 ECTS Credits. The course contains mainly text, some few illustrations, and internal and external links to resources. The students may submit the three assignments individually or in groups. A discussion forum is available for asynchronous communication. The students are requested to submit a minimum of 3 contributions to the discussion forum.

SPICE 603 Online Teaching and Learning

The course *"Online Teaching and Learning"* is one of 5 courses in the programme *"Specialization Programme in International Online Education"* and constitute 6 ECTS Credits. It has 5 mandatory assignments for group or individual submission.

More detailed description of experimental conditions

Trial 1

The author of this paper, who also is NKI's project manager, functioned as tutor and evaluator during the trial of the first course. He was also author of the course. He has taught the course from its start as correspondence education, during the first phase of online delivery with computer conferencing and also on the Internet/web since 1996. He has for more than 4 years tutored in a mobile setting using laptop PC and mobile phone on holidays and on travel in Norway and abroad. During the try out he also tutored students in two other courses, *Distance education Pedagogy (12 ECTS credits)* and *Organisation, Administration and Support Systems for Online Education (6 ECTS credits)*. He is often on travel and was during the try out on travel nationally and internationally. During travel he also communicated with students in the two other courses via his PDA and mobile phone. Also the real students in the other two courses received comments on assignments written on PDA with portable keyboard and returned via mobile technology. Thus, the tutor's experiences covered both the project try out in the simulated setting as well as real students in ordinary online distance education courses.

The first course try out took place in a simulated distance learning setting with mobile technology, and the 'students' participated on the condition that *evaluation of the m-learning system* and not *real learning of course content* was the main goal of the activity. It should also be noted that all the 'students' had specific interest in technology for distance teaching and learning from different perspectives. (Students' is written in inverted commas because the participants were more evaluators and observers than real learners of course content.)

The educational background of the 9 participating students varied from two years college/university education up to Ph. D. in education, age varied from 24 to 56. One was a graduate student from the University of Oslo planning to write a thesis on mobile learning, one was a third year student of the Norwegian School of Information Technology working part time in NKI Distance Education as programmer, two participants were employed in the central NKI IT department as manager and network coordinator, one participant is employed as academic staff in information technology, the other 4 are working with the development of Internet based education at NKI. These 'students' are generally well qualified in information technology, some also in pedagogy; and they have all specific interests connected to the development of systems, design and methods of distance teaching and learning. They are not representative of the population of distance and Internet students at NKI. However, their attention to the practice of distance education may make them well qualified for the assessment of user friendliness, didactic efficiency, technical feasibility and cost effectiveness of the environment created for m-learning in the pilot study. Their involvement in this field-testing also puts them in a good position for further development of m-learning from their individual perspective.

Trial 2

The second course was to be tried out in a real situation. Actually, one of the 'students' from the first trial tutors the second course. During the trial the course has 5 registered active students, 4 in Norway and 1 in California. 3 of the 4 Norwegian students are using mobile technology. During the experiment one of the three experimental students stayed for some weeks in Tanzania, and one has travelled and communicated from the USA and European countries. The 3 mobile learners are 1 man (age 32, bachelor in computer science) and 2 women (age 55, Pd.D in chemistry and working as web master and age 35, bachelor of education, director of studies at a research centre).

In a future real situation we assume that mobile learners have access to and experience with the necessary technology before actually applying the technology for learning. This was not really the case in this experiment, as only one of the three experiment students owned the technology and was an experienced user before embarking on the course. (He was also one of the 'students' in the first course trial, but was enrolled as an ordinary student in the second course.) The two other experimental students were equipped with the technology when starting on the course. Thus, they met some minor introductory problems of setting up the PDA for communicating with the mobile phone, which one would not expect with future experienced users of the technology. (To some extent these problems were similar to those we experienced when online learning was introduced 15 years ago.)

The technical solutions were the same in both trials, except that as we learned from the first course that course content in Microsoft Reader format was preferred before HTML-format, we only supplied Reader files for the SPICE course. During the first trial only the tutor and one student was supplied with portable keyboard. Keyboard was seen as a necessary functionality, thus during the second trial all three students and the tutor were supplied with keyboards to be used with their PDAs. During the second trial the PDAs had the 2002 operating system installed. This gave better presentation of graphics and tables.

Evaluation Methods and Procedures

All the students and the tutors in both trials were equipped with a Compaq iPaq PDA (3650, 3660 and 3870 with 32 and 64 mb memory). During the first trial the participants had made themselves acquainted with the use the PDA for ordinary office work including the main programmes such as e-mail, tasks, calendar, contacts and file synchronization before the pilot m-learning trial was carried out. In total five Ericsson mobile phones were purchased (T39 and R520). Two of the students in the first trial (and the tutor in the second trial) also tried successfully to use a wireless LAN card with their PDA at home and at the office for receiving and sending e-mails.

The first course was made available on the server for downloading and synchronization to the mobile equipment 7th January 2002, and the final data collection was finished 4 months later 30th of April. The second course was made available for mobile equipment end of June 2002. However, with one exception the students did not really start their studies before mid September.

We decided to evaluate the m-learning environment primarily by a qualitative process related to a field research model applying the technology to be tested. Thus, during the first trial the tutor (who was also the evaluator) used the course forum for testing many-to-many communication by giving questions to the students related to course evaluation rather than course content. E-mails were exchanged between students and the tutor and to some extent between 'students'. The students were required to submit assignments also related to the m-learning evaluation and experiences rather than on course content, and the tutor commented on assignments as ordinary assignments via the PDA and mobile phone, both from Norway (also on travel) and when travelling abroad (Germany). The first response to the process related evaluation was submitted to the course forum 8th January and the last 30th of April. The evaluation questions and answers were distributed as contributions to the Forum, which means that all entries are sent as e-mail to the participants and that they also are archived and can be read on the course pages on the PC or on the PDA when connected to the Internet. This

means that all the participants had access to other participants' evaluation responses during the trial.

When the first trial was finished, a quantitative questionnaire for summative student course evaluation was distributed 23rd April with 1st May as the final date for response.

As mentioned, the second trial followed the same procedures, except that the situation was more realistic as students were real students studying the course. All three experimental students planned to complete the whole 30 ECTS Credit programme. Thus, the evaluation was carried out as a completely different process parallel to the teaching-learning process by this author as evaluator only, not involved in the course itself. (Regrettably, the teaching-learning process of the second course will not be finished during the process period. Thus, the evaluation is not finished at the time of this conference.)

Results

The participant's study situation

(Results from the first trial have been published in a separate article before (Rekkedal, T. 2002). <http://learning.ericsson.net/leonardo/NKI2001m-learningevaluationFinal.doc>)

In general, both the tutor and the students in both trials worked from home, from the office and on travel. It clearly seems that the participants find that the mobile equipment functions satisfactory for reading and communicating when travelling. Connection time becomes very expensive when abroad, e.g. connection time from Tanzania was over 4 Euro per minute.

Typical answer:

"As student I study at school, at home and on holidays. On holidays until now I have brought my laptop. But I imagine with this little wonder (the PDA) this is enough, at least for shorter time periods. Now in this course I read from the PDA on the bus and go straight to write my answers when I get home."

Some other answers:

"I would like to study from home, from work, from my mountain cabin, and when I travel. Sometimes I will bring my laptop, sometimes not. "

"I will use my laptop, my PDA, and my mobile phone. At home I will use ISDN and at work I will use an Ethernet connection."

During the second trial one of the students answered:

"As I am taking this course through work, most of my studying online takes place at work. (I am given time during work hours and employer is paying for the course). My daily work consists of a lot of time in front of the computer and thus it is easy for me to study whilst being connected anyway. In periods I work out of the office - running residential courses - and in these periods I do not study during work hours at all.

At home I would study in the evening after kids bedtime (21h) as well as sometimes at weekends. Mostly I use programmes like word and Microsoft Reader at home - writing assignments.

I also would study during travel – in evenings at hotel rooms, on the plane/train as well as out in the field when collecting data for projects. I have already used the equipment/course in Tanzania, which worked well."

One of the other students in the second trial replied:

"The main part of my study will take place in my home and when travelling both abroad and in Norway. If I took the bus or train to work I would certainly have used that spare time to study.

I would also consider studying a little bit when I'm on vacation since the equipment is easy to bring with me and I have all I need of readings etc on the PDA.

At home I use an old pc with 56k modem. It is possible to use it for synchronization but I prefer to use my computer at work for this purpose. At work I have a LAN connection and my computer is a PIII 900 mhz with 256 ram."

Downloading and synchronizing learning content

Generally, the participants experienced few problems in downloading and synchronizing learning materials to their PDA. For the first course the files were supplied as on self-extracting zip-file and one Microsoft Reader file. Two participants during the first trial did not manage to download the content via their modems at home, reasons not found. A third student, however, had no difficulties, and spent 24 minutes downloading the extensive HTML version of the first course. It seems that most participants will easily and cheaply be able to download the learning materials. In fact, the answers indicate that all participants (tutor and students) would support this statement from one of the respondents: "The whole process was easier than I expected, and I did not experience any real problems. The most time consuming part was actually the synchronization between the laptop and the PDA."

Downloading the Microsoft Reader versions was very fast and easy in both trials.

The participants in the two trials used different ways of downloading the materials: Modem and ISDN connections, broadband home connection, office LAN and mobile telephone. All solutions were considered to be acceptable in time and costs.

Reading and studying on the PDA

As mentioned, to assess the quality and acceptability of the downloaded materials for study, in the first trial we delivered two versions, the complete course in HTML to be read in the PDA browser, and the main course in Microsoft Reader e-book format.

The students in the first trial were only partly satisfied with reading subject matter in HTML format on the PDA. Generally, they accepted reading small quantities of texts and they found it acceptable on travel and when commuting, when they look at benefits (lightweight equipment and large amounts of materials available) relative to the drawbacks or difficulties (getting an overview of the materials to study, small screen etc.) During the first trial it seemed that the students generally preferred the Microsoft Reader e-book solution. This was the reason for supplying this solution only for the second trial.

The problem of note taking was generally mentioned. During the first trial it became clear that a keyboard was considered to be necessary for efficient study. The screen keyboard was not considered acceptable for writing more than a few short words. The students did not appreciate making notes on paper for later copying to the PDA or PC. The students also complained that the illustrations were unacceptable. (No specific measures were taken to solve this problem. It was considered that as the students had all the materials also on their PCs, the illustrations in the PDA text version only indicated and reminded of the original graphics.) This should be solved in further courses to be developed for NKI m-learning. One of the 'students' in the first trial (an over 50 years old man with a masters degree in engineering) stated that he generally was reluctant reading from the screen. He preferred to print materials on paper, and, of course, reading from the PDA screen was not seen to acceptable.

It was quite clear that the students preferred the e-book version to the HTML version. They found some positive aspects of the text manipulation functions of the e-book format, but differed in their views of how useful these functions were.

They agree that reading long texts on the PDA is not highly appreciated (in many ways these viewpoints do not differ much from student's viewpoints on reading long texts on large computer screens).

Contribution to Forum via PDA and mobile phone

While both trial courses presented the study materials to be downloaded and studied offline, sending and receiving messages and reading Forum archive entries and contributing to the Forum had to take place online. We asked the students whether they had met problems setting up their PDAs for connection to the Internet via mobile phone, how they solved the activity of writing and sending to the Forum, how long they were connected and whether they met any problems during the process.

Very few problems were detected. Different brands and types of mobile telephones were used, Nokia and Ericsson. The PDAs were set up according to specifications with few if any problems. Those, who used the phones from abroad, had some difficulties. It took some time before we understood how to set up for international calls, and when in Germany it was experienced that some networks did not seem to accept our Norwegian data subscription (possible explanation)(?). When the tutor in the first trial was at Spitsbergen, it proved impossible to connect to the server in Norway. The network provider explained this with problems concerning direct connection to the server via satellite communication.

Setting up the PDA for mobile communication was easily done with the correct information at hand. Setting up for international calls proved somewhat more difficult. Communication online with the Forum functioned well and could be organised within a few minutes connection time. It is important that the Forum is linked by a 'mobile favourite' directly (preferably to the 'printer friendly' version of the page), so that the page does not open as a frame on the PDA screen, as the text field then becomes very, very small. Most participants prepared their entry offline and copied the message into the text field before sending to the Forum.

Assignment for submission via mobile technology

E-mail communication including submitting assignments for the tutor to comment on and return to the student is an important aspect in most distance education systems. In both trials many e-mails were exchanged between the students and the tutor. Also assignments were submitted via the PDA and mobile phone. During the trial for test purposes the assignments were to be answered both in the format of text in an ordinary e-mail and with the same answer attached as a word document.

There seemed to be no real difficulties in writing answers to assignments and sending receiving. It should be mentioned that during the first trial 4 answers to an assignments were received just before the tutor/evaluator embarked the plane to travel to a project meeting in Hagen 15th March 2002. These assignments were commented on using the portable keyboard while flying from Oslo to Copenhagen and Copenhagen to Düsseldorf. The commented assignments were returned to the students via mobile phone while on the train between Düsseldorf and Hagen. When connected on the train, a 5th assignment was received. This was

returned with comments from the hotel in Hagen. (See assignment example with comments, Appendix 1.)

The conclusion is that communicating through the mobile technology and networks functions generally without problems at acceptable speed and costs. There is some lack of compatibility between PDA Microsoft software and PC software.

Conclusion

When completing this paper for the final project conference (November 2002) the second trial was not concluded. Thus, the conclusions relate more to the first trial than to the second. However, so far it seems that there is no large difference in opinions and experiences from the two evaluation studies.

As pointed out, NKI Distance Education gives main emphasis and priority to student autonomy, flexibility and freedom to choose where and when to study in designing the environment for distance learners. Our main aim in designing solutions for mobile learners is to maximize this freedom to support online learners who also are mobile when studying. This is also clear from all the participants in the pilot trials; the main advantage of m-learning as designed in these trials, is the *increased flexibility of online distance education*.

Our pilot trials with mobile technology (PDA and mobile phone) have demonstrated that the technology functioned according to our expectations. The participants were generally satisfied with the technological and didactical solutions. The participants differed somewhat in their acceptance. Some were quite enthusiastic; others were a little more reserved. The differences could partly be related to different learning styles and study preferences, such as preference for note taking on paper and/or general reluctance towards reading longer texts from (any) screen.

In the NKI system it will be a challenge to design solutions for learners who are users of mobile technology and wish to study also when on the move, that also allow other students to apply standard technology. The solutions must be designed in ways to allow both groups to participate in the same course. This means that we have to look for solutions that are optimal for distributing content and communication in courses, independent on whether the students and tutors apply mobile technology or standard PC and Internet connection for teaching or learning.

During our two trials and experiences with the technology over nearly two years, we have met some technical problems. E.g. this author have experienced that word documents received as attachment to e-mails and synchronized to the PDA, commented on and returned via mobile technology could not be opened by the student. (This problem seems to have been solved by Sunnysoft Interwrite (<http://www.sunnysoft.cz/>), which also has solved our problems concerning Norwegian characters on the portable keyboard.) Also Microsoft Pocket PC 2002 software has better functionality and stability than previous versions. We have learned that a portable keyboard is necessary to fully exploit the possibilities of the PDA for learning.

There is no doubt that NKI Distance Education faces a large challenge in further developing server side solutions and methodology that include the use of mobile technology for serving our mobile distance learners more efficiently. We really look forward to continue the developments and experiments.

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Appendix 1: Commented assignment on mobile learning during the first trial (both subject and means of evaluation)

Aleksander, here are my comments to your assignment

Question:

1. In your view, how can m-learning as designed in this experiment increase the quality of e-learning?

In my opinion m-learning is a great asset for e-learning, it gives the students and teachers a lot more freedom in where they want to study or correct assignments. Students may send an email to their teacher from the cottage and get help from there, he or she may also access online material if he/she is stuck and needs some resources. From my point of view the most practical thing is to have access to online material whenever and the freedom to read wherever one feels like it. You can have an entire course (or more) on the PDA and still not be overloaded with books and other material. This is progress: New technology put to good use. There are two things I am missing with my PDA. 1: A keyboard and 2: More disk space, I currently only have 32MB. Increased space also gives the possibility of an MP3 player and more advanced features.

Agree with your views. I understand that you point to both access issues concerning time and space, and also to practical issues such as storing and retrieving materials. I agree completely with your views on the need for keyboard. Storage is also a problem. Both problems can easily be solved.

Students may in the future also collaborate more since (from what I heard) the PPC2002 supports MSN, which is an instant messaging service so people can see when you are online. Think of the possibilities this gives when it comes to online collaboration between students and teachers if they want to give their online status to help the students if they are online at the same time. Maybe the student sends an answer to a teacher and he or she just needs clarification on one or two points.

2. Which additional problems may the student experience?

There may be technical problems and students may lose their work because of forgetting the charger... This is something they only do once and it is nothing that could not happen with an ordinary PC

Obviously technical difficulties are making problems for the time being. This is as it was for most participants in the early days of computer-mediated communication in distance education. I believe that these problems will become much less in the future. Agree?

3. Which increased benefits may the student experience?

More freedom of where and when they want to study. They could read (as I do) on the subway, buss or other transportation when on their way to something. This is a good way of getting the time to pass and use it to something useful. Students would always be able to show their assignments if they need help from someone, they may just interpret the text wrong and need a second opinion. The same goes to if they need someone to proofread their answers.

Final comment:

Thanks for answering so rapidly. And thanks for your valuable viewpoints so far.

Best regards from 10,000 meters height.

Torstein

Truls Fagerberg (truls.fagerberg@nki.no)

Torstein Rekkedal, (torstein.rekkedal@nki.no)

Enhancing the Flexibility of Distance Education – Designing and Trying out a Learning Environment for Mobile Distance Learners

**Paper presented at the 21st ICDE World conference on Open Learning &
distance education, Hong Kong, 18-21 February 2004**

NKI Distance Education

Norway

Summary

The paper presents NKI experiences concerning the development of solutions for m-learning applying Pocket PCs and mobile phones for presenting content and for communication in distance learning. The developments were carried out as part of the EU Leonardo project '*From e-learning to m-learning*'. The concepts of distance learning, e-learning and m-learning are discussed.

Flexible models of teaching allowing students to study at any time and any place have traditionally characterized distance education. Some of this flexibility was lost when new technology was introduced. Specifically, online education excluded learners without access to computers, and often also required the students to study at a fixed place and sometimes at fixed times. Our main aim in designing solutions for mobile learners was to maximize student freedom by designing an environment supporting online learners (and also teachers) who are on the move.

In the project NKI redesigned two online courses to allow students and tutors to apply mobile technology (PocketPC/PDA and mobile phone) in their studies. The paper presents the analyses and decisions behind the solutions for distribution of content, forum discussions and assignment submission. The solutions chosen were based on our basic philosophies concerning knowledge, student learning in general, and distance learning and e-learning.

The paper also presents and discusses experiences from two pilot trials of the two courses. Our pilot trials demonstrated that the technology functioned according to our expectations, i.e. the participants were generally satisfied with the technological and didactical solutions. The participants differed, however, somewhat in their acceptance. Some were quite enthusiastic; others were more reserved. The differences could partly be related to different learning styles and study preferences, such as preference for note taking on paper and/or general reluctance towards reading longer texts from a small screen.

For NKI it will be a major challenge to design solutions for users of mobile technology who wish to study also when on the move. The solutions must be designed in ways to allow both users and non-users of mobile technology to participate in the same course. This means that we have to look for solutions that are optimal for distributing content and communication in courses, independent on whether the students and tutors apply mobile technology or standard PC and Internet connection for teaching or learning.

Technical problems were continuously reduced as technology developed during the project. Based on our experiences we are really not certain whether solutions for mobile learning in the future will be based on technology that combines mobile phone and PDA (as in our research), by some hybrid technology integrating the two, by lightweight laptop with mobile communication or by some other technology. But we are certain that solutions applying mobile technology may increase the perceived quality of distance learning for students who value independence and maximum flexibility.

Distance education – flexibility and mobility

D-learning, e-learning and m-learning

'Distance education' and 'distance learning' are well-established concepts (Keegan 1996). The 'distance learner' is a person who, for some reason, will not or cannot take part in educational programmes that require presence at certain times or places. Recently terms such as 'e-learning' and 'm-learning' have entered the scene. To us, learning is an activity or process and shown as a change in a person's perceptions, attitudes or cognitive or physical skills. It cannot be 'electronic' (if that is what e-learning is supposed to stand for (?)). The terms e-learning and d-learning deserve to be analysed. For instance, the term, e-learning, seems to be used to convince users that some supernatural things happens with your brain when you place yourself in front of a computer screen. This miracle is very unlikely as learning (included distance learning) in the real world is mainly hard work. Most examples of so-called e-learning programmes seem to be extremely costly to develop and most often covers low-level knowledge and facts based on a simplistic view of what learning is (see e.g. Dichanz 2001 "*E-learning, a linguistic, psychological and pedagogical analysis of a misleading term*"). However, as the term seems to become part of accepted terminology, it is imperative for educational researchers and serious providers to define it and assign meaning that is in accordance with our views on teaching and learning. Seen from a university perspective, Dichanz, in a presentation to the 20th ICDE World Conference ended a critical analysis of the term, e-learning with the following definition:

"E-learning is the collection of teaching – and information packages – in further education which is available at any time and any place and are delivered to learners electronically. They contain units of information, self-testing batteries and tests, which allow a quick self-evaluation for quick placement. E-learning offers more lower level learning goals. Higher order goals like understanding, reasoning and (moral) judging are more difficult to achieve. They require an individualised interactive discourse and can hardly be planned" (Dichanz 2001)

Even though we do not totally agree with Dichanz that higher level learning goals cannot be planned, we agree that such goals are much more difficult to plan, and that most so-called e-learning programmes do not demonstrate attention to higher level learning objectives.

Similar reflections can be raised concerning the term, 'mobile learning'. Again, learning cannot be mobile. Learners are probably more and more mobile, and they use mobile technology. In connection with this project we would describe NKI's main objective 'to design and trial out a learning environment for mobile learners and teachers' maintaining the flexibility of distance education for learners on the move. These reflections are in line with Sariola et al. (2001):

"The term 'mLearning' has lately emerged to be associated with the use of mobile technology in education. It seems, however, that it is used in commercial purposes rather than as an

educational concept. We wonder if the term is a commercial trick to market technology and educational services or if it is an emerging concept that educationalists should take seriously." (Sariola et al. 2001, p 1)

It should be noted that, although m-learning is a new concept, serving mobile learners is not a new idea. Again, distance education has a history of more than 150 years, where institutions has offered high quality education to learners '*free of time and place*'. This means, that if we are willing to accept the concept m-learning, distance teaching institutions have provided m-learning since its invention. For example, the history of Hermods, once one of the worlds largest correspondence institutions, tells that the original idea that resulted in establishing the institution in 1898 came when Hermods as a local language teacher in Malmö started to support one of his students who moved to another city (Gaddén 1973).

Actually, the introduction of the desktop computer (and other learning technologies), which required the student to study at a certain place, often also at a certain time, reduced flexibility of distance learning. It is the introduction of mobile electronic equipment and communications technologies, which reintroduces mobility to the distance learner (and teacher). Again, if we accept the term '*mobile learning*' = *m-learning*', what is it? Most definitions take technology as the starting point, e.g. Quinn (2000-2001): "*...(mLearning)? It's elearning through mobile computational devices: Palms, Windows CE machines, even your digital cell phone. Let's call them information appliances (IAs),...*".

Sariola et al. (Ibid.) discuss the concept, m-learning, from the perspective of educational theory, technology-based definition is obviously not sufficient, and also tries to include aspects of technology. They introduce the characteristics, '*portability*', i.e. the equipment is so light that we can carry the devices that we call mobile, '*wireless*', there are no wires in the equipment, and '*mobility*', we are moving when using the technology. Sariola et al. note that it is the mobility that is most interesting from an educational viewpoint. Concerning mobility, they raise the question about '*who*' is moving, '*why*' and '*where*'. If moving is not related to the learning activity as such, why a person is moving might be irrelevant from an educational viewpoint. However, it is the challenge of the educational institution to satisfy learning needs for people on the move (and we could add to support teachers who move to continue their tasks concerning student support). Sariola et al. note that conducting educational activities while moving, might deal with *convenience*, e.g. rational time management or *expediency*, e.g. the person is moving to a place relevant for the subject studied. Both situations concern NKI when designing an effective and efficient learning environment for the distance learner, although convenience has been most focussed till now.

Flexible teaching or teaching in the 'extended classroom'

A number of evaluation studies among distance and online learners at NKI demonstrate that students emphasize flexibility (see e.g. Rekkedal 1990, 1998, 1999, Rekkedal & Paulsen 1997).

In our view, distance education seems to develop in two quite different directions. The solution at one end of a flexibility continuum can be described as an individual, flexible solution allowing the student freedom to start at any time and follow his/her own progression according to personal needs for combining studies with work, family and social life – '*the individual flexible teaching model*'. This model represents a generic development of the model of distance teaching institutions and applies normally media and technologies independent of time (and place), such as asynchronous computer communication, video,

audio and printed materials. The model on the opposite end of the scale, '*the extended classroom model*', assumes that the students are organised into groups required to meet regularly at local study centres and applies technologies such as video conferencing, satellite distribution, radio and television (Gamlin 1995).

In this connection we have chosen the philosophy for the development of Internet based education at NKI: *Flexible and individual distance teaching with the student group as social and academic support for learning*. NKI offers more than 400 courses and over 100 study programmes by correspondence based and Internet based distance teaching and recruits 10,000 students every year. These students may enrol to any course of programme or combination of courses at any day of the year and progress at their own pace. This flexibility does not exclude group-based solutions in cooperation with one single employer, trade organisation or local organiser.

It is also clear from NKI experiences that already many of our students and teachers have experience as mobile learners and teachers. Till now this has been restricted mainly to students and teachers carrying their laptops, possibly including communication via mobile phones.

NKI's main objective in the '*m-learning project*' has been to extend the distribution of learning materials and communication to lighter equipment, specifically PDA and mobile phone. The challenge was to develop the system and server side to present materials in ways suitable for PDA technology, find acceptable solutions for distribution of materials and for *administration to student, teacher to student/student to teacher and student-to-student communication*. **When designing the environment for the mobile learner we wished to extend and increase the flexibility of distance education, that to some extent took a step backwards when converting from paper based to online learning, where students largely were required to study at a place (and at a time) where a computer with access the Internet was available.**

Views on knowledge and learning

For NKI it was clear that the learning aims, content and teaching/learning methods in our online courses and programmes generally are far away from most e-learning courses. Most examples of m-learning experiments concern e-learning on mobile devices, often WAP and/or '*smart-phones*' (see e.g. Kynäslähti 2001, Kristiansen 2001).

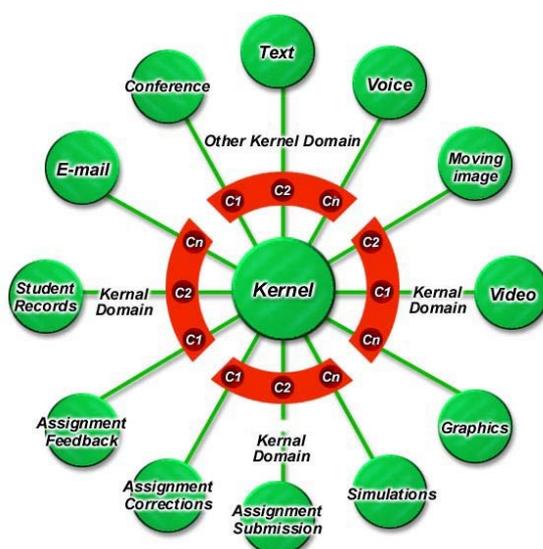
To us, learning is a change in the student's perception of reality related to the problem areas studied and increased competence in solving problems in a field, ability to differ between focal and more peripheral questions, analytical skills and competence in using the tools within a field in appropriate ways. This means that learning results are shown in a qualitative change in the student's understanding, academic, social and technical competence. The learning is a result of active processing of learning material and solving problems individually and/or in groups. This view is often different from what we can find in many so-called e-learning programmes, where knowledge often is seen as a larger amount of information or ability to recall and reproduce facts. In addition to cost considerations, this is why NKI in general has put little emphasis on using fancy effects in a behaviouristic pedagogical tradition, programmed learning and knowledge transmission (see Marton et al. 1987, 1997, Morgan 1993 on students' conceptions of learning, deep level and surface level approaches to learning). We also hold the view that learning is an individual process that can be supported by adequate interaction and/or collaboration in groups (Askeland 2001).

Mobile learning using mobile phones alone did not make much sense to us. On the other hand, we found that designing and trying out a new learning environment for online learners applying PDA and mobile communication seemed to be a sensible one. These considerations were clearly supported by the research at the FernUniversität in the project (Fritsch 2002) Our considerations and decisions are presented below.

Internet based education at NKI today

NKI was probably the first European online college, and it has offered distance education online every day since 1987. Few - if any - online colleges in the world has been longer in continuous operation.

NKI Distance Education has today well above 300 courses and more than 60 complete study programmes on the Internet. February 2003 we had over 4,500 active online students. In connection with an earlier EU Leonardo projects we described the programme and distribution system in Internet based learning as a 'Multimedia World Wide Web Kernel for Distance Education' (<http://www.nki.no/eeileo/>) with the following elements:



Model of the Multi Media Kernel for Distance Education.

In designing the learning environment with the mobile learner in mind, all these aspects and functionalities have to be taken into account.

Designing the Environment for Mobile Learners

Studying online and offline

In line with the above discussions on learning and studying, most NKI courses are not designed to function as online interactive e-learning programmes, although some parts of the courses may imply such interaction with multi-media materials, tests and assignments. The courses normally involve intensive study, mainly of text based materials, solving problems, writing essays, submitting assignments and communicating with fellow students by e-mail or in the web based conferences, which means that most of the time the students will be offline when studying.

Technical solution

It should also be emphasized that we assume that the NKI Internet students normally will have access to a desktop or laptop computer with Internet connection. The equipment used when mobile are additions to the technology used when studying at home or at work. It should also be noted that our developments were based on the absolute assumption that mobile learners would study in the same group as students not having access to mobile technology. Thus, the design of the learning environment had to cater efficiently for both situations.

When planning for the m-learning environment the NKI project team had long discussions whether to develop the learning materials for online or offline study. Also taking costs of mobile access to online learning materials into consideration, we concluded that the learning environment for the NKI m-learning courses should include the following aspects (Fagerberg 2002, Fagerberg, Rekkedal and Russell 2002, Fagerberg & Bredal 2002):

Technology:

- Pocket PC/PDA
- Mobile phone
- Portable keyboard

Learning content and communication:

- Learning content to be downloaded on the mobile device to be studied offline.

Downloaded content to include all course materials:

- Content page
- Preface
- Introduction
- All study units
- Resources (articles on the web, references to other resource materials)
- Online access to the discussion forum with the possibility of as quick as possible access for reading in the Forum and writing contributions
- E-mail for individual communication with tutor and fellow students and for submitting assignments. Assignments may be submitted as text-based e-mail or as Word or Text attachments.



Students' and tutors' use of technology when mobile

When mobile – and using mobile technologies – we have found that it is generally satisfactory for the student (and the tutor) to have the course content available to study on the PocketPC. In addition, the following communication possibilities are necessary. When mobile, the student must be able to:

- Access the course forum archive to read messages (if necessary) (messages on the forum is also sent to participants as e-mails)
- Access the course forum to submit contributions to the discussions
- Send e-mail to fellow students, to the teacher and to administration (study advisor)
- Receive e-mail from fellow students, from the tutor and from the administration
- Submit assignments by e-mail including attachments
- Receiving assignments corrected and commented on by the tutor including attachments.

To access e-mail and discussion forums, mobile phones were used.

The Trials

The courses

During the project period two courses have been tried out with students using mobile phone and PDA. The two courses were:

7. *The tutor in distance education (Norwegian version)*
8. *SPICE 603 Online Teaching and Learning*

The first course was tried out from January until end of April 2002 with 9 students. The second course was launched for mobile access at the end of June 2002 with 3 experimental students.

Evaluation Methods and Procedures

All the students and the tutors in both trials were equipped with a Compaq iPaq PDA (3650, 3660 and 3870 with 32 and 64 mb memory). During the first trial the participants had made themselves acquainted with the use the PDA for ordinary office work including the main programmes such as e-mail, tasks, calendar, contacts and file synchronization before the pilot m-learning trial was carried out. In total five Ericsson mobile phones were purchased (T39 and R520). Two of the students in the first trial (and the tutor in the second trial) also tried successfully to use a wireless LAN card with their PDA at home and at the office for receiving and sending e-mails. The first trial took place in a kind of simulated distance learning, as evaluation of the m-learning system and not real learning of course content was the main goal of the activity for both tutor and 'students'. The trial of the second course took place in a real setting with real students.

We decided to evaluate the m-learning environment primarily by a qualitative process related to a field research model applying the technology to be tested. Thus, during the first trial the tutor (who was also the evaluator and one of the authors of this paper) used the course forum for testing many-to-many communication by giving questions to the students related to course evaluation rather than course content. E-mails were exchanged between students and the tutor and to some extent between 'students'. The students were required to submit assignments also related to the m-learning evaluation and experiences rather than on course content, and the tutor commented on assignments as ordinary assignments via the PDA and mobile phone, both from Norway (also on travel) and when travelling abroad (Germany). The evaluation questions and answers were distributed as contributions to the course forum, i.e. all evaluation responses were available to all participants during the trial.

The second trial followed the same procedures, except that the situation was more realistic as students were real students studying the course. All three experimental students planned to complete the whole 30 ECTS Credit programme. Thus, the evaluation was carried out as a completely different process parallel to the teaching-learning process by the same author as evaluator, not involved in the course itself.

Results

The participant's study situation

Results from the first trial have been published in a separate article (Rekkedal, T. 2002).

In general, both the tutors and the students in both trials worked from home, from the office and on travel. It clearly seems that the participants found that the mobile

equipment functions satisfactory for reading and communicating when travelling.

Connection time can become very expensive, especially when abroad, e.g. on student experienced connection cost from Tanzania to be over 4 Euro per minute.

Typical answer:

“As student I study at school, at home and on holidays. On holidays until now I have brought my laptop. But I imagine with this little wonder (the PDA) this is enough, at least for shorter time periods. Now in this course I read from the PDA on the bus and go straight to write my answers when I get home.”

Downloading and synchronizing learning content

Generally, the participants experienced few problems in downloading and synchronizing learning materials to their PDA: *“The whole process was easier than I expected, and I did not experience any real problems. The most time consuming part was actually the synchronization between the laptop and the PDA.”* The course files were supplied as self-extracting zip-files (HTML course version) and Microsoft Reader files. Downloading the learning materials, especially the Microsoft Reader version, was very fast and easy in both trials.

The participants in the two trials used different ways of downloading the materials: Modem and ISDN connections, broadband home connection, office LAN and mobile telephone. All solutions were considered to be acceptable in time and costs.

Reading and studying on the PDA

As mentioned, to assess the quality and acceptability of the downloaded materials for study, we delivered two versions, the complete course in HTML (first trial) to be read in the PDA browser, and the main course in Microsoft Reader e-book format (both trials).

The students were only partly satisfied with reading subject matter in HTML format on the PDA. Generally, they accepted reading small quantities of texts and they found it acceptable on travel and when commuting, when they look at benefits (lightweight equipment and large amounts of materials available) relative to the drawbacks or difficulties (getting an overview of the materials to study, small screen etc.) During the first trial it seemed that the students preferred the Microsoft Reader e-book solution, which was chosen as the only solution for the second trial.

The problem of note taking was generally mentioned. The screen keyboard was not considered acceptable for writing more than a few short words. The students did not appreciate making notes on paper for later copying to the PDA or PC. The students found some positive aspects of the text manipulation functions of the e-book format, but differed in their views of how useful these functions were. They agree that reading long texts on the PDA is not highly appreciated (in many ways these viewpoints do not differ much from student's viewpoints on reading long texts on large computer screens). It became clear that foldable/portable keyboard is necessary for the mobile learners to fully exploit the potential of the technology.

Contribution to Forum via PDA and mobile phone

While both trial courses presented the study materials to be downloaded and studied offline, sending and receiving messages and reading Forum archive entries and contributing to the Forum had to take place online. Very few problems were detected. Setting up the PDA for

mobile communication was easily done with the correct information at hand. Communication online with the Forum functioned well and could be organised within a few minutes connection time. Most participants prepared their entry offline and copied the message into the text field before sending to the Forum.

Assignment for submission via mobile technology

E-mail communication including submitting assignments for the tutor to comment on and return to the student is, of course, an important aspect in most distance education systems. In both trials many e-mails were exchanged between the students and the tutor. Also assignments were submitted via the PDA and mobile phone. The assignments were answered both in the format of text in an ordinary e-mail and as word document attachments. There seemed to be no real difficulties in writing answers to assignments and sending receiving. Generally, communicating through the mobile technology and networks functioned with few difficulties at acceptable speed and costs.

Conclusion

Our main aim in designing solutions for mobile learners was to maximize student freedom and to support online learners who also are mobile when studying. This was also made clear from all the participants in the pilot trials; the main advantage of m-learning as designed in these trials, was the *increased flexibility of online distance education*.

Our pilot trials with mobile technology (PDA and mobile phone) have demonstrated that the technology functioned according to our expectations. The participants were generally satisfied with the technological and didactical solutions. The participants differed somewhat in their acceptance. Some were quite enthusiastic; others were a little more reserved. The differences could partly be related to different learning styles and study preferences, such as preference for note taking on paper and/or general reluctance towards reading longer texts from (any) screen.

In the NKI system it will be a challenge to design solutions for learners who are users of mobile technology and wish to study also when on the move, that also allow other students to apply standard technology. The solutions must be designed in ways to allow both groups to participate in the same course. This means that we have to look for solutions that are optimal for distributing content and communication in courses, independent on whether the students and tutors apply mobile technology or standard PC and Internet connection for teaching or learning.

There is no doubt that NKI Distance Education faces a large challenge in further developing server side solutions and methodology that include the use of mobile technology for serving our mobile distance learners more efficiently.

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