

Note Taking and Sharing with Digital Pen and Paper.

Designing for Practice Based Teacher Education.

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Problem Description

Note taking is recognized as a critical activity in learning contexts. Notes are essential for recalling what has been heard or seen, and can promote reflection afterwards. Different ICT solutions have been proposed to support note taking, but most of the existing tools are focusing on note taking in the context of traditional classroom education. This task aims at designing support for practice-based education, with focus on teacher education. The task will build on a previous project to understand the needs of students and the usage of digital writing systems for supporting note taking.

The main goal of the task is the design of a digital writing system supporting the pedagogical needs of practice-based teacher education

Assignment given: 01. February 2006
Supervisor: Monica Divitini, IDI

Abstract

Note taking in education is recognized as a critical component of the learning process [1]. While there have been done much research on note taking support with digital systems, the focus has been on lecture based education. Practice based educations impose other needs for a digital note taking system.

This thesis is a continuation on my previous project work, “Supporting Notetaking with Digital Writing System: the case of teacher education” [2]. Through observations and empirical data the students note taking and sharing habits were mapped. A digital note taking system was also tested to find its potential for further customization for the PPE students.

The main goal of this thesis is to design a customized digital pen and paper based note taking system for the practice based teacher education. The requirements for this system was based on the previous work, the pedagogical objectives of PPE and deployment scenarios.

The system proposed in this thesis extends the systems that was used in autumn 2005, the Logitech io2 system [3], to take advantage of the updated software, which include new and enhanced functionalities. An important new feature is the ioTags, a method to invoke actions on parts of notes on a page. The thesis extensions include a new ioTag action to handle archiving of notes and a specialized paper design.

The system was evaluated by experts and users. The valuable feedbacks are presented to inform possible further work with this system.

Preface

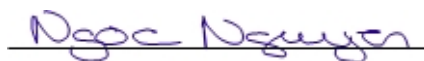
This thesis is part of the MOTUS 2 (Mobil Teknologi I Undervisnings Sammenheng) project, lead by prof. Monica Divitini, at the Department of Computer and Information Science (IDI), Norwegian University of Science and Technology (NTNU) in Trondheim, Norway.

The author of this report is Software Engineering Group (SU) student Ngoc Phan Hong Nguyen at IDI, NTNU. The thesis ran from February to June 2006.

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Trondheim, June 28th, 2006

A handwritten signature in purple ink that reads "Ngoc Nguyen". The signature is written in a cursive style and is positioned above a horizontal line.

Ngoc Phan Hong Nguyen

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Chapter 1

Introduction

1.1 Motivation

Note taking in education is perceived as a major component in the learning process [1]. Students mainly use notes to capture information during lectures and research for usage in assessments. But taking notes is useful for learning also. Vygotsky said:

“Thought is not merely expressed in words, it comes into existence through them” [4]

Hoel takes it further and claims that taking notes, individually or in collaboration, promotes the ability to reflect and is therefore an activity that enhance learning [1].

The value of taking notes has been discussed in several works [5, 6, 7], and much research has been done on digital support for note taking in education to take advantage of the digital properties provided by digital devices, such as digital storing, editing and sharing [8, 9, 10, 11]. However, the focus of these researches has been on supporting lecture based note taking. Practice based studies impose other demands on note taking support because the note taking needs extends beyond the lecture halls.

The teacher education at NTNU, the Pedagogical-Practical Education, hence forth PPE, is a study that combines both theory learning in lectures and practical experience as teacher in real schools. The practice situation puts other demands on digital note taking support because the learning environment are more mobile and complex [12].

A customized, light weight digital note taking system can increase the efficiency of situated note taking and sharing of these notes. This can contribute to enhanced note taking and sharing experiences and therefore stimulate to more note taking and sharing among the students.

1.2 Project context

This thesis is done in context with the MOTUS 2 (Mobil Teknologi I Undervisnings Sammenheng) project lead by Monica Divitini at IDI, NTNU. The goal of MOTUS 2 is to “investigate the potential and impact of mobile applications for supporting new forms of cooperation in the educational settings, independent of the participants’ location” [13].

MOTUS 2 has an ongoing collaboration with the Program for teacher education (PTE) who is responsible for organizing the practical part of the Pedagogical-Practical education (PPE) at NTNU [12].

The aim is to enhance learning in mobile situations by introducing new technologies. Considered technologies are blog [14], ambient display [15] and digital pen [2].

This thesis is continuing the collaboration with PTE to design a digital note taking system for PPE students with the digital pen.

1.3 Thesis goal

A digital note taking system has the possibility to promote more note taking and sharing among students, because it can provide enhanced handling and sharing of notes through digital means.

The students in PPE are facing a different note taking and sharing environment than students in traditional lecture based educations. The note taking and sharing environment are more mobile and varied while the students are in practice. Facilitating these students with a digital note taking and sharing system that is customized to their needs, can enhance the experience of taking and sharing notes, and therefore promote more note taking and sharing of those notes among the students.

The main goal of this thesis is therefore to *design a customized digital pen and paper based note taking and sharing system for the practice based teacher education, PPE.*

The main customization focus will be on the handling of notes and sharing of them.

1.4 Research method

This thesis continues the work from my previous project in autumn 2005. In the autumn project most of the focus lied on the PPE students, their note taking environment and what they might need from a digital note taking system.

For the design of a suitable note taking system more research needs to be done on PPE as a study and PTE's interest for their students, to identify the pedagogical objectives. This can be done in the form of literature review of the PPE's study model and other research connected to PPE.

Together with the previous research, this new research will contribute to the identifying of requirements for the customized note taking system.

Further literature review on state of the art works will provide an overview of what technologies are available and show the potentials of digital pen and paper based systems.

The chosen technology for the autumn project, Logitech io2 Digital Writing System, will continue to be the base for the customized note taking system.

The system extensions will be designed based on the identified main functionalities. Some of these functionalities will be implemented to illustrate the possibilities of such a system. Then an evaluation by both experts and users will be performed to inform possible further development of the proposed system.

Some scenarios will be developed to further illustrate the deployment of the system.

The system will then be evaluated by experts, those who have in dept knowledge of PPE and their students, and users, students from previous project. They will evaluate the system based on the scenarios developed and then give feedback on the suitability of these functionalities in the scenarios. The feedback can be a valuable source for further work with the proposed system.

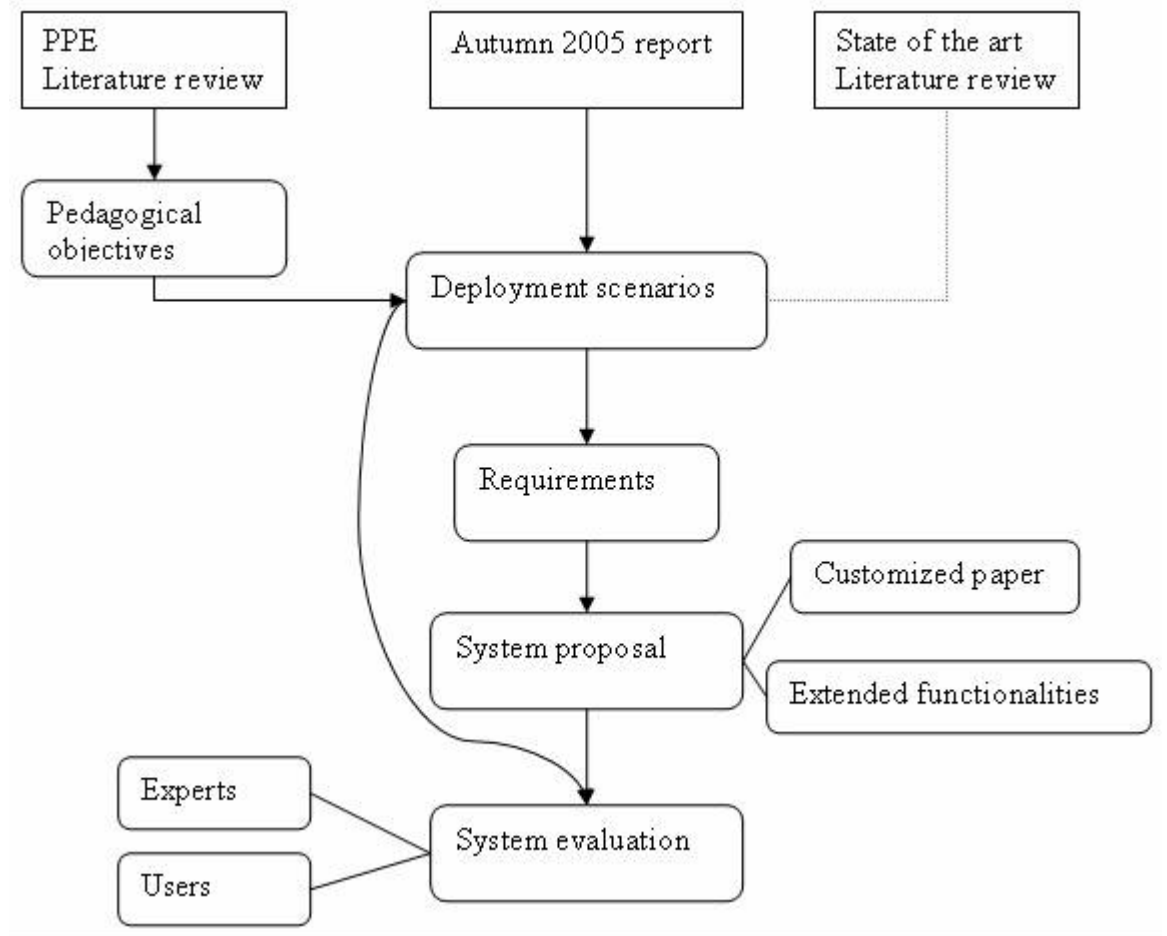


Figure 1.1: Research methods model

Figure 1.1 shows the course of the research methods done in this thesis.

1.5 Expected contributions

Expected contribution will be a customized system design proposal for note taking and sharing support:

- Deployment scenarios
- Requirements
- New customized paper design
- Extended functionalities to cater for more effective archiving and sharing of notes

- Expert and user evaluation of the system

1.6 Structure of the report

This section presents an overview of the structure of the report.

Chapter 2 In this chapter I will present some state-of-the art work before I present a short summary of the relevant data found in my previous work. Then I will focus the task and then present the research questions for this thesis work.

Chapter 3 This chapter will present the literature review done on PPE, and then present the pedagogical objectives derived from the literature review.

Chapter 4 This chapter will compare the pedagogical objectives with the summary of my previous work to establish what needs should be focused on when designing the customized digital note taking system.

Chapter 5 This chapter will present four scenarios derived to illustrate the deployment possibilities of such a system in PPE.

Chapter 6 This chapter will present the system requirements derived based on the previous chapters.

Chapter 7 This chapter will present the deployed system in this thesis and also shortly comments on other possible systems.

Chapter 8 This chapter will present the development technologies needed for the system development.

Chapter 9 This chapter will present the overall system design with its extension. It will also elaborate some on the assumptions made for this system and discuss the pro and cons of the two main features that can be used to provide solution for the extensions.

Chapter 10 This chapter will present the feedback and discussion from the evaluations made by experts and users.

Chapter 11 This chapter will present the overall evaluation of this thesis work.

Chapter 12 This chapter will conclude the thesis work and suggest possible further work.

Chapter 2

Problem elaboration

This chapter aims to give an overview of the state of the art in pen-based digital note taking systems, and then recap my previous work done in autumn 2005 (see Appendix A) to inform on the areas that will contribute to this thesis work.

2.1 State of the art

The field of pen-based digital note taking systems is moving fast forward to provide note taking systems that combines the advantages of both the paper world and the digital world.

2.1.1 Pen and paper based digital note taking and collaboration systems

Technology from Anoto [16] enables the digitizing of handwritten notes using digital pen and augmented paper. Several researches have utilized this technology to develop systems that merge the digital and the paper world. These systems provide enhanced support for dealing with handwritten notes in a digital world without losing the physical affordances of pen and paper [17].

PADDs: Paper Augmented Digital Documents

Paper Augmented Digital Documents, PADDs, are digital documents that can be manipulated either on a computer screen or on paper. The PADD system[18] utilizes Anoto technology to bridge the gap between normal paper and digital documents.

PADDs are primarily digital documents, but when the paper affordances are needed, the documents can be printed on augmented paper and annotated with digital pen to be able to digitize the new data on the documents. Using an application, "Stroke Collector", the new data on the printed paper can be merged together with the digital version of the document. A database will keep track of the changes. This system thus enables the users to choose their preferred medium to manipulate their documents on.

PapierCraft

PapierCraft [19] is a gesture-based command system for interactive paper. It uses the Anoto technology as a user interface to interact with digital documents.

The system enables users to annotate a printout or draw a command gesture to indicate operations such as copying and pasting a document area, or create a link. When the digital pen is synchronized with the PapierCraft application, the annotations, document areas and links will be associated with the digital document.

ButterflyNet

The ButterflyNet system [20] has used the command infrastructure of the PapierCraft work to develop a system that supports field biology research. In addition to Anoto technology, the system also utilizes a smart camera to enable mobile capture and access of heterogeneous field research data.

The system enables the field scientists to capture, organize, and share their data, including handwritten notes and digital photos.

The use of Anoto pen with Bluetooth and a smart camera enable on-the-spot annotations of photos. The smart camera also communicates wirelessly with the pen, offering a real-time visual and audio feedback for in-the-field interaction.

The field research data in the note book is merged together with the digital photos in the ButterflyNet application. In addition to provide digital notes and photos in one place, the application also provides other metadata such as time stamps to better organize the heterogeneous data.

The system lack the internet connection ability that are provided by PDA systems [21], but as a note taking device it provides larger 'screen' size, infinite display time in addition to digital editing, sharing and storing, making the system more suitable for field work.

iDeas learning ecology

The iDeas learning ecology [22] is a system that adapts the ButterflyNet system into the design education context. In design the students are dependent on their design notebook to sketch ideas, take notes and collect ideas from other media, in the same time the students are also depended on delivering works in digital formats. The iDeas learning ecology provides the possibility to digitally capture their work in their notebook for easier re-use and sharing.

In addition to the functionalities provided by ButterflyNet, the iDeas application also provide a timeline tab with flags to represent course milestones and provide links to course web pages.

Paper Collaborator

The Paper Collaborator [23] is also a system that employs the ButterflyNet system. But unlike the iDeas system, Paper Collaborator utilizes ButterflyNet to offer the benefit of physical affordances to digital files.

The system aims to enhance collaborative work in design projects, by incorporating a pen and paper based interface to a wall display that facilitates access, sharing and organization of digital documents in the physical world.

By mapping specific documents to paper icons, it enables the students to pick one and have it displayed on the shared LCD screen next to the icons.

This system is meant for face-to-face collaborations, where a physical sharing of documents on a common display stimulates conversations and interactions, without abandoning the digital benefits.

2.1.2 Augmented paper as user interface

The Anoto technology has not only been employed for note taking systems, but several researches have also realized the potential of the technology as an interface to other systems.

Computing technology is becoming more and more common in everyday life, but the user interface to these computing infrastructure are not always as intuitive to understand for all users. Pen and paper based user interface provides a familiar and easy interaction with this infrastructure.

UbiComp Scrapbook

The UbiComp Scrapbook [24] is part of the Nightingale multimodal context-aware computing project [25]. The system incorporates different media and a Virtual Personal Server Space (VPSS) to promote reminiscence and communication activities among elders. It support natural interaction with the

computing infrastructure through invisible and adaptive interfaces, by allowing users to draw a box and fill it in with a command word as needed.

The system produces a physical scrapbook with a corresponding digital scrapbook augmented with images and sounds from the multi-modal, multi-device ubiquitous computing system.

Controlling Appliances with Pen and Paper

In Kolberg et. al work's [26] the Anoto pen and paper system is proposed as a suitable interface for networked appliances. This system provides pre-printed functionality boxes that can be chosen by the user to invoke actions on their appliances on the network.

The system uses the augmented paper to identify the application needed, and the pen to identify the user. Then using Bluetooth to connect the pen to a mobile network, the data can be transferred to a service provider where the data is processed and sent to the user's home.

This system offers a single point of control to execute the requests to appliances inside the home, without the user needing to deal with a PC interface.

2.1.3 Audio augmented digital note taking

While the above mentioned systems have used Anoto technology to capture the handwriting, other systems have utilized other technologies, and sought to provide more than just digitizing of notes and merging of digital and paper documents.

Audio augmented note taking systems have been developed to enable both speech record and note taking to better facilitate information capture during lectures and meetings, where the participants have to divide their attention between listening and taking notes.

Dynomite

Dynomite [27] is a portable electronic notebook that aims to connect users' handwritten notes with audio notes.

This system is intended to be run on mobile devices such as PDAs or Tablet PCs. This system enables pen-based free-form input. The notes are stored as image because the handwriting recognition technology was still inaccurate at the time.

In addition to enable digital manipulation of the handwritten notes, the system also provides explicit audio highlighting, allowing the system to make

intelligent decisions about storage management and allowing users to visually navigate through important audio segments.

Speech pen

The Speech pen [28], is a multimodal input system (microphone and Tablet PC) that assist digital writing during lectures or presentations with background speech and handwriting recognition.

The Speech pen incorporates predictive handwriting based on ambient multimodal recognition, meaning that it recognizes speech and handwriting in the background and provides the instructor with predictions for further writing to speed it up and make it less tedious for the instructor to write. The result of the instructor's speech recognition is then sent to the audience to support their own note taking.

Audio Notebook

The Audio Notebook [29] is a pen and paper based note taking system that combine note taking and audio recording in the same device.

This system consists of simple digital ink pen, normal paper and a digitizing pad with audio recording and playing elements. This enables the users to take notes as with normal pen and paper, and still be able to digitize their notes to get the digital affordances. The audio feature enables the user to link every pen stroke to a different part of the audio recording, making it easy to connect the right audio part with the right note.

2.1.4 Combining paper and digital documents

PADDs has been mentioned as a way to combine paper and digital documents using Anoto technology, but following is another example of a system aiming to combine paper and digital documents in document intensive environments.

PaperSpace

PaperSpace [30] is a computer vision based document management system.

This document management system allows users to manage digital and paper documents simultaneously. It provides a method for sharing, locating, filing and associating documents through either the paper or the digital copies.

The digital documents are printed with a 2D tracker code in the margins of each page of the document. The paper document is also printed with a command bar, including commands to Annotate, Open, Email, Information

and Link. A web camera tracks the papers around the user's desk. Capturing and parsing gestural operations performed on the command bar. Other modules are: a database, tracking code generator and a user interface.

2.1.5 Discussion

As seen in this section, there are increasing number of works that utilizes digital pen and augmented paper. Systems that are based on the PADDs, PapierCrafts and ButterflyNet have focused on the capturing of handwritten notes and merge this together with other digital media. And others systems have focused on the ability of using augmented paper as an interface. These systems have shown the strength of utilizing Anoto technology to enable the usage of pen and paper to interact with digital systems.

The systems that combines note taking with audio recording seem very useful for taking notes in lectures and meetings. But these systems are dependent on a third device beside pen and paper, and therefore makes it less mobile than systems that only need pen and paper for the note taking needs.

The PaperSpace system has been included to show the possibilities of using another type of augmented paper that is not based on Anoto technology. But this system is mainly for tracking documents in paper dense locations, such as offices, and it only enables a few commands through the command bar. Since the command bar icons are small and the detector is a web camera, the commands can be accidentally invoked. It seems like the systems most useful functionality is to organize for a cluttered workspace.

This literature review has strengthened the motivation for utilizing the Logitech io2 system that is based on Anoto technology, in this thesis work. The ButterflyNet system is utilizing many of the functionalities provided by Logitech io2 system in addition to enabling merging of notes and digital media from paper level. However, the system does not provide other enhanced note handling and sharing from paper level and the capturing and of merging of notes and photos do not seem relevant for the scope of thesis.

2.2 PreviousWork

In my project work from autumn 2005 [2], I have investigated the possibilities for introducing a digital pen and paper based system to support note taking in the practice based teacher education, PPE.

I studied 8 students' note taking pattern and situation while they were in their practice period. I also conducted a literature survey on note taking

technologies to find a suitable technology for supporting note taking in PPE. A digital pen solution, Logitech io2 Digital writing system (see Appendix A), was employed by 4 of the students to investigate the potential of such a system to cover the note taking needs of PPE students. The students were to employ the system whenever it felt natural during the 6 weeks of practice at their practice school, Ole Vig vgs.

2.2.1 The main focus of the project work

The main focus of my project work was to discover the note types the students took and in what situations the students took these notes in. Figure 2.1 shows the main type of ‘situations’ the students take notes for and the type of note they take in each situation.

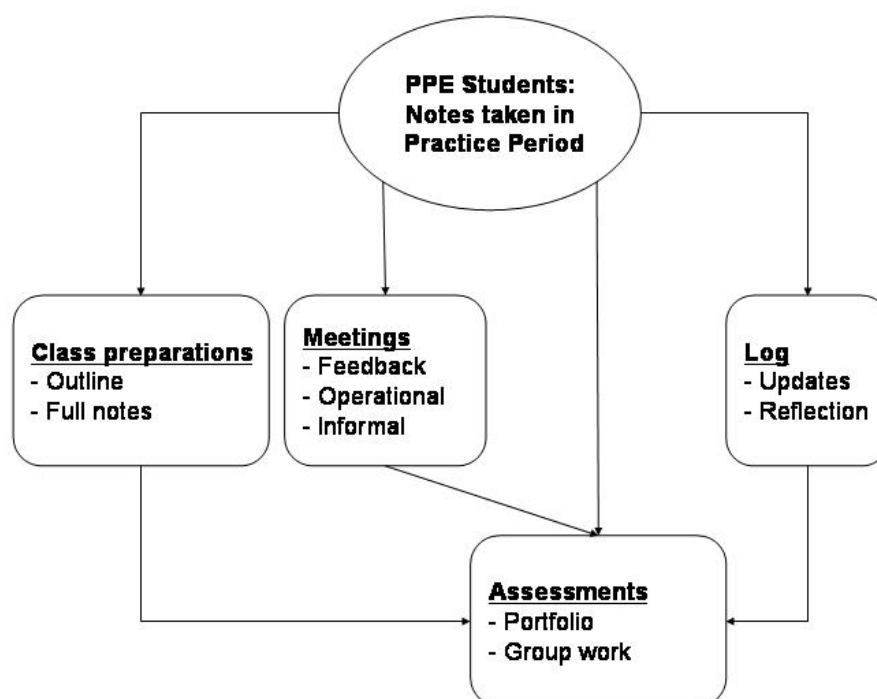


Figure 2.1: Students note taking in PPE

The work studied both the note taking and the collaboration in PPE, trying to suggest a note taking system that can take advantage of the digital properties to also promote sharing with the system.

Note situations and types

As seen in figure 2.1, there are four main situations the students takes notes in, or should take note in.

Class preparation Preparing for classes was the number one situation students took notes for. Preparation notes in form of short outlines and full notes, was basically done by every students. The amount of notes taken varied among the students, but the most note intensive student finished at least one notebook in the practice period, which lasted for 6 weeks.

Meetings The practice period included various meetings, such as operational and informal group meetings, and individual meetings, where students got feedback from their tutor or observation teacher about their work.

Log The students were encouraged by PPE staff to make regular log during their practice period. This was not implemented by all the students. Some because they did not believe in the effect of log, and others because they thought the new experiences were so memorable that it would be hard to forget. The log note had updated information about what has happened and the students' reflection on the topic. From the observation, it seems like this type of note was often kept short and could be taken on various different type of paper format.

Assessments The students had collaboration with their base group, were they had to write a text and the others have to comment on it. This group work was not limited to the practice period only, but could be done during the practice period also. The students also had to complete an exam portfolio to be delivered at the end of the study. The portfolio works were both theoretical and reflective texts and some was to be based on experiences from the practice period.

Preference of note taking utilities

From the empirical data collected, the normal pen and paper was the most used note taking artifacts. Even students that preferred writing on their

computer, often took small notes with pen and paper, but these notes were thrown after the intended usage, explaining it with bad handwritings or to specific or to bad notes that they have no re-use value.

Usage of notes

The empirical data showed that the preparation notes for classes were the most frequent type of notes taken by the students. The main usage of this type of notes is to prepare for class and use it as a reminder while in class. The quality of this type of note varied a lot, and depended on the quality, the notes were either thrown right after class or kept for a possible re-use in the future.

The other types of notes were not often taken by most students, but those who did tend to keep these notes. However, the organization of these notes varied from chaotic storage to the super organized student who archived them into folders once a week.

The potentials of a digital pen solution for PPE students

In addition to store the handwritten notes digitally the system also enabled the students to save their handwritten notes and then send them as attachment in emails and put into word documents.

There was also a handwriting conversion program in the system which enabled conversion of handwritten text to machine fonts. But this was only available in English and therefore not expected to be used by the students. I assumed they would be taking notes in Norwegian, the local language.

As part of the usability investigation of this system, the students' collaboration pattern was also checked, because the shareability of the system can enhance the students' note taking experience. The students had collaboration with others; and most of it was done face-to-face. There was little sharing of personal notes among the students. The recipients of shared notes were typically their basic group and their tutor or other relevant teachers.

Conclusion from this research was that a digital writing system has the potential to improve note taking and sharing experiences among the students in PPE. But the digital writing system deployed in the research as it is was not good enough. Note taking habits among the observed students were quite different and the system seemed to best fit students that are used to take notes with ordinary pen and paper, or rather don't have a preference to do all their writing on the computer.

2.2.2 Lessons learned from the system deployment

Physical drawbacks

The Logitech io2 Digital writing system function well for the digital storage and other functionalities of the handwritten notes, but the physical sizes of the digital pen and the hard-cover notebook got some negative feedback. The digital pen is larger than normal pen and is tedious to use for longer periods, while the hard-cover notebook took a lot of space when it was open.

Functionality drawbacks

Storing The system did give perfect copies of the students' handwritten notes and enabled them to store and send them as images attached to email. But the storing feature only enabled the students to store every page as an own file. Notes that went over multiple pages had to be manually "binded" together in the system application. This is not a difficult activity, but can be tedious if the students waited until the pen was full before transferring the pen files to the computer.

Also the storage of whole pages in one file made it a little problematic when they took several types of short notes in one file. They could manually mark and store each part as an own file, but this is laborious work that does not give any extra value to the students and none of the students did this.

The pen files were named 'Untitled - time and date', making it difficult to easily see what the notes are about until it is marked for preview. The students had the opportunity to fill in a file name in a 'Subject' text field, but the text field was small and hard to write in and the students often skipped this possibility.

Sharing The sharing of notes as images of handwriting was not seen as a very useful functionality. The students liked the idea of having their paper notes captured, but the idea of sharing their handwriting with others was not popular. They argued that their handwriting was often sloppy and can be hard to read by others, so they preferred to send neatly types text to others.

Functionality level The students expressed that they prefer to have functionalities that can be invoked while taking notes on the paper. The system application did provide editing and other functionalities, but if they had to spend time a lot of time on the computer anyway, then they rather use text applications, such as Word, from the start.

Handwriting recognition and conversion Even though this functionality was not promoted, the students saw great value in this. They did not try it in every day use, but they imagined that this will possibly be the main advantage of this system.

2.2.3 Guidelines and ideas for a note taking system

The students deployment of the io2 system inspired these guidelines:

- Fixed function boxes need customization. The chosen direction of how to customize must be dependent on the specific needs of the students. It is not possible to pre-customize to all, therefore the system should either provide the possibility of self configuration or incorporate the most popular functionalities.
- Introduce freestanding commands will make the system more flexible.
- Storing of notes should be improved. Binding of note pages and archiving to pre defined folders should be made possible at note taking time.
- The system should customize for note types that are identified as enhancing reflection and learning

In addition to support and promote note taking, the digital note taking system can also take advantage of its digital affordances to promote sharing and collaboration. By being able to send to external system, the system can act as an interface to groupware on remote systems. Following are some guidelines for making the digital note taking system compatible with external systems.

- Choose a familiar and easy to use system to make compatible. Students do not like to learn to use new complex systems.
- Sending of notes to the external system should be done in as few steps as possible
- Students should be able to decide whom they will share with and how many they want to share with.

2.3 Focusing the task

The previous work has presented the students note taking pattern and environment while in the practice period, and shown the potentials of a digital pen and paper based note taking system. The drawbacks found and the guidelines from my previous work will contribute to the deriving of requirements and system design.

But beside the previous work on the students in PPE, the pedagogical objectives of PPE and the deployment technology should be researched further

to better inform the requirements and system design. To better illustrate the possibilities with such a system, deployment scenarios will be derived, these scenarios can act as both a base for the requirements and the evaluations of the proposed system in this work.

2.3.1 Pedagogical objectives

This thesis will look closer on PPE's pedagogical objectives and see if this is coherent with the students note taking (and sharing) pattern while in their practice period. Based on this I can suggest functionalities that cater for the PPE students to better achieve the study's pedagogical objectives. Since this is study consisting of many different types of students and classes, the functionalities will be focused on the note handling and sharing support.

2.3.2 Deployment system

The Logitech io2 Digital writing system was chosen as the experiment system because it was commercial available, had a complete application to handle handwritten notes and offered the possibility of user extensions of the system.

Even though the physical aspects of the system did get some negative feedback, but since last time the io2 application has been improved to open for free form command at note taking time. Therefore, the Logitech io2 system will continue to be the chosen system for this thesis work.

2.4 Research questions

The main goal of this thesis is to:

Design a customized digital pen and paper based note taking system for the practice based teacher education, PPE.

The system is intended to support and promote note taking and sharing among the students. By catering for students' needs and the study's pedagogical objective, a customized system can enhance the students note taking and sharing experiences and therefore promote them to take and share more of their notes.

To reach the goal, this thesis aims to answer the following research questions:

Research questions	
RQ-1	What are PPE's pedagogical objectives for their students?
RQ-2	How does the students note taking and sharing pattern in their practice period correspond with the pedagogical objectives?
RQ-3	How can a digital note taking system promote the pedagogical objectives?
RQ-4	What extensions are needed for a customized system for the PPE students?
RQ-5	How should these extensions be implemented to give the PPE students good usability?

Table 2.1: List of research questions

Chapter 3

Pedagogical objectives of PPE

This chapter aims at giving a more in dept information of PPE's study model and PTE's interest for their students. And then based on this information identify the pedagogical objectives, which will help identify functionalities in a customized digital writing system.

3.1 PPE

Practical-pedagogical education, hence fort PPE, is a part of a teaching education offered at NTNU. For bachelor and master students, the PPE can be attended as a built on full-time-course that last for one year, and is a combination of pedagogic, subject didactic and practice and it will certify students for teaching in elementary schools [course handbook].

This course aims at giving the students the possibility to exercise their pedagogical theory in practice. In each semester, the students have a 6–7 weeks of practice period where they are placed at a local high school in which they are to practice teaching. This practice is organized by Program for Teacher Education, hence fort PTE.

3.1.1 Reflection: Connecting theory and practice

An important aspect of learning with practice work is that students are given the opportunity to connect their theory with their practice[7]. The connecting process is done through reflection, both on individual and collective level. Reflection is an important premise to be able to learn and improve the students own knowledge of teaching [7]. PPE is promoting reflection among their students by following an education model that make possible for reflection through both oral and written and both individual and in collaboration.

3.2 The partnership model

The chosen education model at PPE is called the partnership model[7]. This model was started at NTNU in 1998 and it has been subject for improvement since. The model base on the assumption that theory and practice are equally important for a teacher education and it is through mutual binding collaboration between the different contributors; the university, the practice schools and the students, that the course can be an arena for reflection and renewal.

The organization

The PPE course is organized into 6 partnerships. Each partnership consists of the following:

- 5 schools with each own tutor
- ca 30 students
- 3-5 teacher educators with different types of qualifications/skills
- 1 administration staff

Each partnership is then divided into base groups consisting of 4-5 students, which functions a both professional and social support [12]. The base groups also have tasks which demand the student to collaborate, evaluate and discuss each others written works.

Model components

In [7], there is a list of activity components that have been added to improve the partnership model for all the involved partners. This thesis is focusing on the teacher students, and will therefore only go into aspects that have direct influence on the teacher students. Following are the activity components:

1. Practice
2. Practice supervising/tutoring
3. Seminar
4. Supervising of the teacher students documentation work
5. Evaluation of the teacher students teaching capability and fitness as teachers

6. Greetings of new students: Graduated students are used in this activity. This greeting happens in partnership basis and also involves tutors and other staff.
7. School take-over
8. Web-pages: Each partnership has developed its own web-site for both professional and social purposes.

Other measures during the course time

To support the students or give them the basis for enhancing their learning based on the education model, the students are also offered these activities during their course[31]:

- Writing course
- Reflection course
- Log writing
- Writing of teacher profiles
- Development conversations
- Ongoing evaluation

This shows that the teacher education is emphasizing the importance of reflection and writing in the study.

3.3 Portfolio assessment

The PPE course has chosen portfolio as assessment method for the students [6]. This method has been chosen to establish a closer link between the learning process and the methods of examination. The students are now encouraged to do more systematically work on written texts as a strategy for learning. When accompanied by responses to their draft offered by the course tutors, it gives the students yet another base for doing several levels of reflection in their course period.

The definition of portfolio is:

[A portfolio] is a purposeful collection of student work that exhibits the student's efforts, progress, and achievements in one or more areas. The collection must induce student participation in selecting contents, the criteria for selection, the criteria for judging merit, the evidence of student self-reflection [6]

The PPE course further implies these points:

- that the texts are produced over a relatively long period of time
- that the work on the texts includes student cooperation in the process of giving feedback and judging the quality of the text
- reflection both as an individual and a collective phenomenon

All three elements are important because the portfolio is intended as a part of the learning process. The process of making portfolio to include a student cooperation, see 3.4, in bigger extend has not yet been realized for all subjects in PPE. 3.4

3.3.1 Portfolio text requirements

The student portfolio is required to have 9 texts, mostly reflective, that are or can be strongly connected to the practice period. These are the text that must be included in the delivery:

1. Observation report - choose a topic and observe for it during the practice period, analyze and discuss what the observation means
2. Practice summery - Summary of the practice period with context, success, problems and further work
3. Teaching plan - Report of deployment of the teaching plan
4. School political theme - Discuss a chosen political theme put in a context, and based on theory
5. Seminar contribution - Contribution to the student managed seminar
6. Progress document - Addition to text 2, further progress
7. Integrated task - Multidisciplinary task, discuss a case based on theory from multiple subjects
8. Text about a chosen topic - Chose a topic that is central for you and use theory or own experiences from practice period

9. Personal text - Free choice of topics and genre, but needs to be connected to the teacher profession

For further description of these texts see appendix B

3.4 Reflection and collaboration experiments

The partnership model is constantly under improvement, and many activity components have been added to make the course better and to better support the students in their learning. There have been experimented with more activities to elevate the students' reflection level on their practice and the connected theory.

Three examples are enhancing reflection by a one-on-one e-mail tutoring [1], response groups (basis groups) as learning resources when working with portfolios [6] and blog to support learning in the field [14]. These experiments emphasize that critical reflections on the practice period have major influence on the students learning.

The first experiment only involved one-to-one relation between a student and a supervisor/tutor, while the other experiment involved a limited group of students, where they are trying to utilize the resources that are among the students, this way the students get more feedback and supervising/tutoring without adding more staff resources. The last one tried to involve all students in the partnership to share their experiences.

The two first experiments have shown great impact on the students' reflection level and their end grade can be a good indicator for how well this focus on reflection and collaboration is for the students learning. The last experiment was a fiasco, but still it did not contradict that reflection and sharing of experiences enhance learning. Rather it indicates that activities that include a high amount of student can be thought to implement. Time and introduction method also seems to play an important role in the fiasco of the project.

3.5 The pedagogical objectives

Thus far this chapter has shown that enhanced learning through reflection is the teacher education main pedagogical objective for their students. The portfolio tasks are making the students connecting their theory and practice, and the other activities such as response group work and the courses emphasizing writing and reflection.

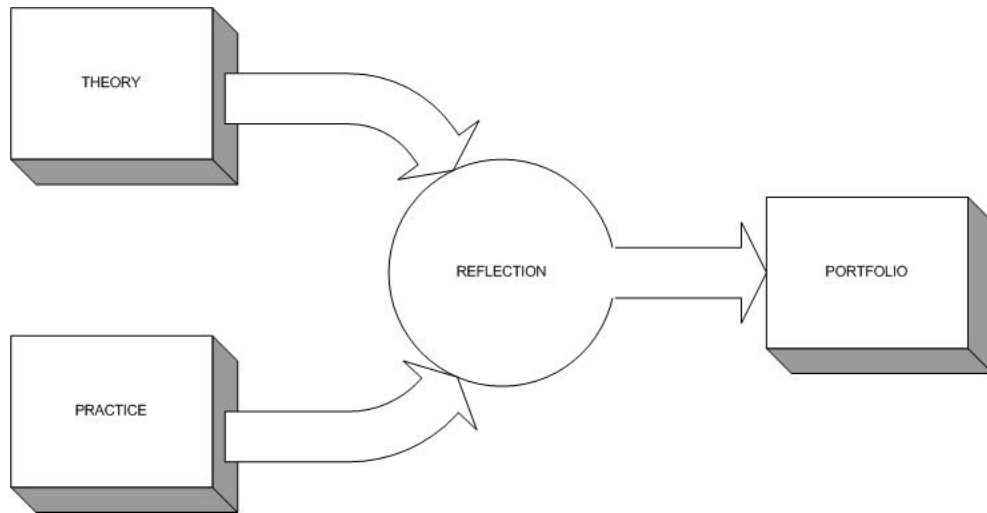


Figure 3.1: Connecting theory and practice

As seen in figure 3.1, the students reflection is the connection point of theory and practice, and it is shown as learned lessons/knowledge in the portfolio deliveries. The course organization 3.2, the course components 3.2 and the assessment method 3.3 are all for promoting this connection of theory and practice and critical reflection of this connection.

The student reflection is not limited to only individual reflection. As implied by the experiments in 3.4, reflection in groups is also an important aspect of learning through reflection. Therefore collaboration is also an important pedagogical objective, because through collaboration the students can perform multiple aspects of reflection.

The pedagogical objectives of PPE can be seen as follows:

Main pedagogical objective

PO-1 Make the students connect theory and practice in the teacher education

Sub pedagogical objectives

PO-1.1 Promote critical reflection

PO-1.2 Promote collaboration

Table 3.1: PPE's pedagogical objectives

PO1 is achieved by the course organization, the composition of theory and practice during the course. PO2 is promoted by the portfolio assessment and the several points in the activity components, such as practice documentation and tutoring from course lecturers and other staff. In addition,

PPE has also put note taking and log making as important components in achieving this objective. PO3 is promoted the organization of the course, the partnership model, with is basic group, is providing an environment that promotes collaboration among the students.

Chapter 4

Pedagogical objectives vs. Students in practice

This chapter aims to discuss the situation in PPE to see how well the students note taking and sharing pattern in their practice period corresponds to the pedagogical objectives. And then suggest possible solutions for bridging the gap between the students' action in practice and the pedagogical objectives, with a digital note taking and sharing system.

4.1 Note taking

In chapter 2.2 I have shown that the students in PPE do take many types of notes. The partnership model, see chapter 3.2, provides many situations for the students to take notes and do critical reflection, and the identified types of notes the students took in their practice period, see figure 2.1, match well with the pedagogical objectives, see table 3.1.

But there are still many students that do not take many notes. From my observations, I saw very few taking notes in meetings. There tend to be less note taking in group meetings than in individual meetings where students got personal feedback. From the empirical data and the work shop held with the PPE students, these are the main arguments for not taking notes:

1. They see no value in taking notes, they rely on their memory.
2. It does not seem natural to take notes in certain situations. Some students are not used to take notes while having discussions with others, and they don't take notes after the fact either because they rely on their memory.

3. Bad handwriting. They can have problems reading their own notes afterwards.
4. Chaotic organization of notes, it is hard to make use of it later because the notes are hard to find.

These reasons make the students less motivated to take notes in the various situations to help them remember and reflect. Reason 1 is hard to cater for with only a digital note taking system, but as experienced in my previous work [2], some students do change their mind after a reflective discussion about the topic. For the other reasons, a digital note taking system can address these problems, and provide another mechanism to promote more note taking among the PPE students.

4.2 Sharing

The PPE's partnership model, see chapter 3.2 opens for tight collaboration in the following groups: Student - Tutor/Teacher, Practice partners, Response group/basic group. However, the students in practice (see Appendix A) showed little note sharing during the practice period. They mainly had email contact with their tutor, and face-to-face contact with the other groups.

This area has the potential for improvements to reach PPE's goal, the pedagogical objective PO3.

The students are comfortable with discussing face-to-face, but the information shared in this context is more informal and might not be taken serious. While discussion based on texts might promote more critical reflection, it can also act as an information bank for information retrieval for the assessment work.

Tutors and Teachers The sharing contents here are documents such as 'Supervising document'¹ and other feedback notes, Orientation and organizational notes.

Practice partners They mainly share their preparation notes. Not so often in a permanent way, but more in a loan and see matter.

Response groups These groups are mainly to comment and help each other on deliverable texts. They are suppose to comment and annotate on others texts and then send to each other.

¹Veiledningsdokument

All There are no organized sharing to all as it is during the last research, but a lot of information's are conveyed between many people, and these information's can be of interest to publicize to all. Notes that can be of relevance for these groups are: meeting notes (minutes, recap/outline, important issues, and organizational data), experiences, questions and answers

4.3 Summary

The pedagogical objectives of PPE are to make the students connect theory with practice, by doing critical reflection and collaboration. The partnership model provides opportunities for students to do this by allocating groups and tutors to promote collaboration, both oral and written. By using portfolio as assessment method, the PPE study requires the students to do a lot of critical reflection; therefore they also encourage their students to take more notes and logs to train their reflective ability.

The study on the students note taking and sharing pattern shows that some students do react to PPE's encouragement. They take notes and logs in the various situations that occur during the practice period, but there are still many students who do not. The main reasons identified in the autumn project 2005 are: 'Wrong' attitude towards note taking (reason 1 and 2), bad handwriting and chaotic organization of notes.

The partnership model provides several natural sharing partners, but the empirical data showed little sharing of notes and the tutor was the one getting most of the shared notes. The notes are often also typed into the computer and sent by email. The students expressed that they did not prefer to send their handwritten notes to others.

A customized digital note taking system can attend to the above mentioned issues and be provided to the students as a mechanism to promote more note taking and sharing.

Chapter 5

Scenarios for deployment

This chapter aims to illustrate how the customized digital note taking system can be deployed by the students to ease their note taking organization and sharing.

5.1 Deployment possibilities

The following scenarios are possible situations to deploy the customized digital note taking system. They address the archiving and sharing possibilities in different situations.

The scenarios are:

1. Question to tutor at start-up with portfolio work
2. Archiving of class preparation notes
3. Sharing of thoughts to a common blog site
4. Basis group collaboration.

5.1.1 S1: Question to tutor at startup with portfolio work

Tom is sitting in the common work room at the practice school, and was just starting with his portfolio work, using his digital pen and paper. He has chosen to start with his ‘Observation’ report (see Appendix B), and starts with a small brainstorming.

Jotting down the requirements for the report, he comes up with a problem focus and wonders if it is good enough. He thinks that it might be smart to

ask his tutor at NTNU about this, having him approve the problem focus and maybe even give some literature tips.

Tom marks the problem focus for sending as email, and also adds the question about the literature tips. He provides the subject and email address connected to the note, and continues with his work. Knowing that his questions will be sent to his tutor the next time he downloads the digital pen.

At the end of the day he puts the pen into the common downloading dock at the practice school. The download starts automatically and the application starts up. An email composition window pops up. Tom sees that his handwritten note to his tutor has been converted and put into the email as typed text; he had almost forgotten the email during the day. He reviewed it a final time and clicks send.

5.1.2 S2: Archiving of class preparation notes

Lise is preparing for her biology class, and she uses her digital pen and paper. She likes to bring her preparation note with her to class, as a reminder, so it is better to use pen and paper rather than her laptop.

She writes the outline, deciding that this version is fine enough, and then marks it to be archived into the specified folder. She adds the subject and the folder name, Biology.

Right before her class, Lise tears out her class outline and brings it to class. She holds the paper note in her hand to make sure that she covers every point.

After class she throws the paper away, knowing that she has the digital copy that will be archived to the right folder without any fuzz at next download. She knows she will probably not use the note again, but on the other hand it is good to have it in case she needs inspiration when she starts working as a teacher.

5.1.3 S3: Sharing of thoughts to a common blog site

Merete is writing on her log with her digital pen and paper. She has had a rough day with a problem pupil in one of her classes. The boy kept interfering and made other students restless too. She tried to reason with him, but that did not help much.

After class she discussed the problem with two of her basic group members. They gave their opinions, but neither has experience such a situation yet. Now sitting at home by herself, she is wondering how other would react,

or have reacted. She thought that this would be a good entry to the course's blog site.

She does not have an internet connection at home, but she figures she could use the digital pen and paper. That way she would not lose her impulsive thoughts. She writes a short description of the situation and asks if any other has experienced the same. She marks it to be sent to the blog site. Then she continues with logging the rest of her day.

The next morning at the practice school she downloads the pen files at the common docking station. And the blog entry appears; she approves it and sends it away, hoping that her entry will get some comments soon.

5.1.4 S4: Response group collaboration

Håkon is working with a response group collaboration text. The text is written by Silje in his group, and the rest of the group, including him, have to read the text and give feedback to Silje.

Håkon likes to read on normal A4 papers, so he prints the text out, and brings it to his work place.

While he reads, he is noting his comments with his digital pen and paper. After he is done going through the text, he adds some extra comment to his note, and then he marks it to be sent to the basic group.

The next time the digital pen contents are downloaded, the note is sent to everyone in the basic group.

Chapter 6

Requirements

This chapter elaborates on the previous chapters 2, 3, 4 and 5, to establish a set of requirements for the extensions of the Logitech io2 Digital writing system, the system chosen for the design of a customized digital note taking system for the PPE students.

6.1 Main goals of the system

As discussed in previous chapter 3 the pedagogical objectives require the system to:

1. Promote critical reflection
2. Promote collaboration

A digital note taking system can only provide support for critical reflection and collaboration in forms of the handling of notes and the sharing of them.

The main goals of this system are therefore to support handling of digital notes and sharing possibilities of these notes. The system requirements will therefore focus on these goals.

6.2 System functionalities

My discussion on previous work in chapter 2.2 and the scenarios developed in chapter 5, has motivated several system functionalities.

6.2.1 Functionalities invoked at note taking time

Even though the system application provides a rich set of functionalities to edit and share the digital notes, the students have expressed that it is not appealing, because if they were to spend time on the computer they rather utilize a system they are familiar with, for example Word. Therefore, to make this system more appealing to the students, the new system functionalities should be focused on being available from note taking time. That means that the actions can be invoked from paper level, while the students are taking their notes.

Separation and extraction of different note types on same page

Chapter 2.2.1 shows that the students have several different types of notes that must be supported by this system. In addition to be used as intended for the note type, these notes can also be used to support the students' assessment work. To make it easier to find notes taken on the same page as other notes, the system should support the separation or extraction of the different types of notes and store them as separate files, as illustrated in Scenario 2 (see chapter 5.1.2)

This gives the students more flexibility in how to take notes and should be a high priority requirement.

Archiving of notes

In chapter 4, the students also expressed that poor organizing can be demotivate note taking. The system should therefore also make it easier for 'un-organized' students to organize their notes. By being able to archive a note into specified folders will make it easy for students to retrieve their notes afterwards and re-use them in assessment work or in their future teaching job.

To support good archiving of notes, the system should enable the students to decide the note's file name and where to store it at note taking time, as illustrated in Scenario 2, This avoids extra work after download to computer, which was one of the drawbacks of the previous system (see chapter 2.2.2). But it should also give the students the flexibility to decide the file name and destination later if they prefer it. So the digital note must work either it has been given a file name and folder destination at note taking time or not.

This should be a high priority requirement.

Binding of notes

Another drawback of the previous system was that each note page was stored as a new digital file. Notes that covered multiple pages were stored as multiple files. The student had the opportunity to manually bind the note pages together into one common file. But this can be laborious if the note, for example full preparation notes, covers many pages. Also if the students wait until the pen memory is full before they download, they will get a lot of files they will have to go through to decide which to bind.

A functionality to make this possible from paper level will save the students a lot of time and also ease the archiving of the notes.

This should be a high priority requirement.

Sharing to specific single and multiple recipients

In chapter 4.2 I identified four main sharing groups: Tutor/Teacher, Basic/Response group, Practice partner and 'All'. The previous system provided sharing ability with an E-mail action box on the augmented paper. The student could write in a subject and e-mail address in the text fields and then tick on the box for sending. But entering handwritten e-mail addresses can be a bit tedious if it is an address that is often used.

The tutor and the response group was identified as the most possible group to be shared to and scenario 1 and 4 illustrate the situations that this system can be used to share to these groups.

The practice partner did not receive many notes, and it seems like the students are content with face-to-face sharing when it comes to the practice partner, because they see each other quite often.

The group 'All' means the rest of the PPE students. The students experience a lot of new situations, and like in Scenario 3, a blog or a similar common area system where students can share with all, can support students learning and stimulate to more collaboration.

Therefore a functionality that enables the student to pre-configure the most used e-mail addresses and to invoke this at note taking time will ease their sharing and might stimulate more sharing.

This should be a high priority requirement.

6.2.2 Other functionalities

Handwriting recognition and conversion in local language

The handwriting recognition and conversion in Norwegian was not available during the student experiment in autumn 2005, so the student could not

use this feature in the experiment. However, the students expressed that they perceive this as a valuable functionality that will make the system more useful. In chapter 4, some students expressed that they were not motivated to take much notes because of their bad handwriting. A system with good handwriting recognition can motivate these students to take more notes. Other students said they preferred neatly typed text for sharing purposes and handwriting recognition can cater for this need. The students will not need to transcribe their handwritten notes into the computer; this can be done without minimal effort with Norwegian handwriting recognition and conversion functionality in the system.

This should be a high priority requirement; however, this is not a functionality that will be done in this thesis work. It will rather be assumed that this functionality will be available from commercial actors in the near future.

6.3 Non-functional aspects

In chapter 4, I identified four reasons for why students are not motivated to take more notes during their practice period. Reason 1 and 2 were about students' attitude about taking notes. Some of these students might have changed their mind, as happened in my experiment (see Appendix A), by involving them in critical reflection about the value of note taking. The digital note taking system can contribute to more provide more focus on note taking. However, it is not enough for the system to provide good functionalities, it must also be perceived as a value added system to persuade students that are not taking a lot of notes to make use of this system. In addition to useful functionalities the system should also fulfill the following non-functional aspects:

6.3.1 General aspects

Usability

Usability is important for users of a new system. In this case, the digital note taking system is trying to support note taking in the students practice period. Normal pen and paper has been the preferred artifacts for note taking until now, and for the digital note taking system to have a chance to be employed by the students, the system has to be easy to learn how to use, effective and easy to use.

If the usability of the system is not as good as normal pen and paper or better, the students will probably not bother to explore the advantages of the system, making it a failure from the start.

This should be a high priority requirement for the system.

Mobility

System mobility is vital because it is meant to be employed by students in a mobile learning environment. Students' mobility should be minimally restrained by deployment of this system. They should be able to use this system any where and any time.

Mobility should therefore be set as a high priority requirement for the system.

Flexibility

Normal pen and paper is a flexible note taking system for the students. It provides choices in pen and paper formats and the students can take note on whole pages or just on a corner of the paper and still be able to make use of it later.

The new system should also provide flexibility both in the physical aspect and the digital aspect to give the system extra added value, making it more attractive to the students. This should be a high priority requirement for the system.

Availability

The availability of system resources should also be considered as an important requirement of this system. Students have limited resources and the fact that normal pen and paper are so cheap and easy to attain are motivations for providing a system that provides easy and cheap access to system resources. Also the system is meant as a note taking promoting system and therefore one must assume that the system resources, the pen and paper, will need to be re-filled.

This is an important aspect if it wants to give better note taking support than normal pen and paper.

This should be a high priority requirement for the system.

Extensibility

The system proposed in this thesis work has focused on the main note taking and sharing needs of the PPE students as a whole, but note taking and sharing needs can be better customized to individual classes in the PPE study. The system should therefore be extendable to open for better customization.

Extendibility should be a high priority requirement.

Multiplatform friendly

The PPE study has a very diverse student mass, and we can not assume that students that have their own computer all have the same computer platform. The popular platforms are Windows, MAC OS and UNIX or Linux. A system meant for such a diverse student mass should also be able to run on the students own computer platform. However, this thesis work is in an early stage and has chosen the Windows based system, Logitech io2 to make use of its advantages.

This is set as a low priority requirement.

If future developer wants to develop a more customized note taking system from scratch, this requirement can be set as a higher priority.

Connectability to external system

Chapter 2.1 shows that a pen and paper based digital note taking system can also be used as an interface to other systems. The students in PPE have to use the e-learning system 'It's Learning' during their study and a connection to this system from the system can be valuable to the students. However, 'It's Learning' is a very complex system and little research have been done on how much and how the students actually use the system.

This should be a medium priority requirement because it is still uncertain how much added value it will provide this system.

Connectability to other mobile devices

To make this system even more mobile, the system should be compatible to other mobile devices, such as mobile phones. This ability can open for students to share their notes when they want too.

However, the chosen technology does not provide this compatibility with the provided functionalities and my previous work does not indicate a urgent need for providing wireless connection to other devices. This aspect is therefore set as a low requirement for this system.

6.3.2 Specific aspects

The above mentioned aspects are general aspects that should be followed by most mobile systems. Following are some specific aspects that have been identified in my previous work and should be implemented in this system.

Enhance ‘Subject’ and ‘To’ text fields

An identified usability problem from the previous system (see chapter 2.2.2) was the input text fields: ‘Subject’ and ‘To’. These fields were perceived as too restrictive and hard to write normal in. These fields should be made more usable in form of more input friendly text fields.

This is important for the sharing and archiving functionality and should be set as a high priority requirement.

Connectability to Blog

The scenario, S3 in chapter 5.1.3, motivates the requirement for the connectability of this system to a common blog site. PPE does not yet have a common blog site for the students, but previous work with incorporating Blog in PPE [14] shows that Blog is an interesting external system that might be used in PPE in the future.

Even though connectability to external systems is set to medium priority, enabling connectivity to a Blog site from the system will better illustrate the possibilities in this aspect. Therefore is this requirement set to high priority.

Bluetooth enabled digital pen

To make this system connectable to other mobile devices, the digital pen should have the wireless connection possibility. The Bluetooth technology is incorporated in many mobile devices, such as mobile phones, PDAs and laptops.

The general requirement for connectability to mobile devices is set as a low priority requirement, so this specific requirement is also set to low priority.

6.4 Requirements list

Functional Requirements		Priority
FR-1	Separation and extraction of notes on same page at note taking time	High
FR-2	Archiving of notes at note taking time	High
FR-3	Binding of notes at note taking time	High
FR-4	Sharing to specific recipients	High
FR-5	Handwriting recognition in Norwegian	High
General Non-functional Requirements		
GNR-1	Usability	High
GNR-2	Mobility	High
GNR-3	Flexibility	High
GNR-4	Availability	High
GNR-5	Extensibility	High
GNR-6	Multiplatform friendly	Low
GNR-7	Connectability to other mobile devices	Low
GNR-8	Connectability to external system	Medium
Specific Non-functional Requirements		
SNR-1	Enhance 'Subject' and 'To' text fields	High
SNR-2	Connectability to common Blog site	High
SNR-3	Bluetooth enabled digital pen	Low

Table 6.1: Table of requirements

Chapter 7

Chosen system

This chapter will shortly argument for the focus on pen and paper based note taking systems, then it will presents the chosen system, Logitech io2 Digital writing system, for deployment in this thesis work, and also shortly introduce similar technologies available in the commercial marked.

7.1 Paper and pen: preferred note taking utilities

In my previous work I have considered different types of digital writing technology for note taking support in PPE. System with PDA's and Tablet PC's gave the digital advantage but did not provide many of the regular pen and paper affordances. Pen and paper are preferred to PDA and TPC because of usability issues, such as: writing comfort, readability, true mobility; meaning that pen and paper are not limited to low battery time and it can be used any where at any time without disturbing the environment, flexibility; any paper can be used with any pen and the paper can be folded and manipulated in ways and still works. But normal pen and paper in itself can not provide the digital advantages, such as virtually no occupation of storage space , easy recovering from huge amount of documents, digital editing and manipulations, interaction with other programs, and digital sharing. In short normal pen and paper miss out on all the digital advantages a computer can provide.

More and more students are using pc and laptop for their essay writing and sharing needs, but for many this means that they write it once with pen and paper and then type it into the computer to utilize the digital advantages. A digital pen and paper system can be the technology to bridge this gap between traditional pen and paper and the computer.

7.2 Chosen system: Logitech io2 digital writing system

The Logitech io2 system is based on Anoto technology [16]. Following is a short introduction of the Anoto technology.

7.2.1 Anoto technology

The digital writing system from Anoto is based on augmented paper, dots pattern printed on normal paper, as seen in figure 7.1(a), and an ink pen with a digital camera/optical sensor and built inn flash memory, as seen in figure 7.1(b). Together it records the pen's movement over the augmented paper surface. The dots pattern functions as coordinates code and action code. When transferred to a computer, an application can process and interpret the recorded dots pattern and provide an exact image of the handwritten notes and execute any action chosen on the paper.

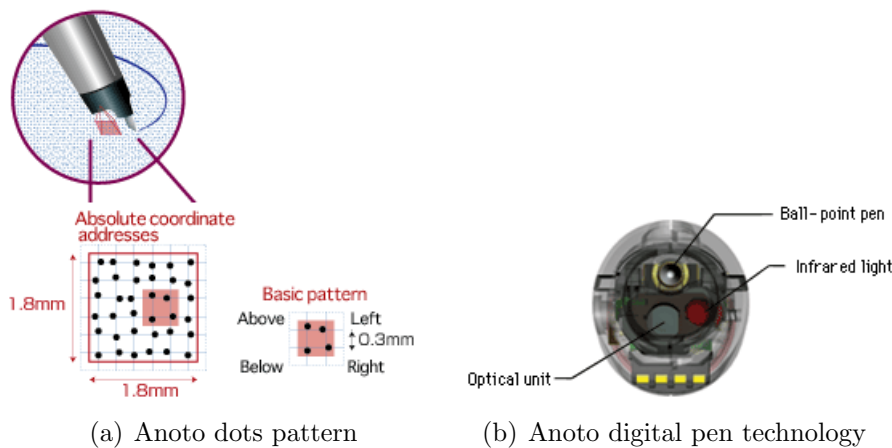


Figure 7.1: Anoto digital writing technology

Anoto is behind the pen and paper technology, but only provides the pattern license and a software kit for users to develop their own digital writing solutions, including paper and software. The commercial digital pen and paper are sold by licensed partners of Anoto. Logitech is one of Anoto's digital pen system partners.

7.2.2 Logitech io2

Logitech provides a digital writing package deal, the io2 Digital Writing system [3], which include io2 digital pen, augmented notebook, USB docking cradle and io2 software.

As mentioned earlier, this package was chosen for testing with PPE students in autumn 2005 A. Since then the io2 software has been updated to version 4.10, which include a new feature called ioTags. ioTags enables users to send portions of their handwritten notes directly to their email application or Word, among others, by using written shortcuts. These shortcuts are symbols that the user prefixes the notes with. For example can a letter E with a circle around it identify that the following text is to be converted to digital text and imported to an e-mail ¹; the letter W with a circle around it identify that the following text is to be converted and opened in Word. The conversion of handwritten notes to typed text is possible through a add on application called MyScript Notes, see section 7.5

In addition, all the handwritten notes, regardless of ioTag or other chosen actions, are stored as a digital pen file. ioTag also comes with a plug-in for Google Desktop Search. This allows the user to search for handwritten notes with Google Desktop Search, which is much faster than searching around MS Outlook or the Inbox.

The io2 system is also compatible with a wide range of different augmented paper formats. In addition it opens for user-developed functionality extensions by providing a plug-in toolkit, where users can develop own functionalities and have it implemented into the whole io2 program as a plug-in. This way, the new functionalities will work seamlessly with the rest of the io2 program. New paper designs can also be included as compatible with the io2 software, but the paper must be developed with Anoto technology. These are the reasons for continuing to choose Logitech io2 digital writing system for designing a customized note taking system for the PPE students.

7.2.3 Previous Software version 3.5

This system was tried out by 4 students in the autumn 2005 project [2]. And it had mixed receptions A. However it did show some potential with students that like to take notes by hand or students that ‘easily’ can be persuaded to do more note taking. The size and the limited functionality on paper level were major drawbacks. While the digital storage possibility was mentioned as useful for future re-use of the notes and for good organization.

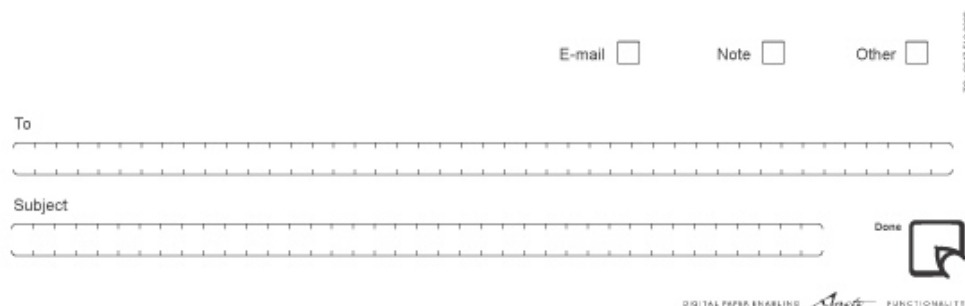
¹The old version only attached the note as a JPEG to the email

7.2. CHOSEN SYSTEM: LOGITECH IO2 DIGITAL WRITING SYSTEM⁴³

The main functionalities of the software, or the perceived most useful for the students was **the email functionality**; a drawback was that the note was only attached as an image (JPEG file), **the export to Word** functionality; the note was also put into word as image blocks, and the most useful but not promoted for use was **the conversion** of handwritten text to typed text; this function worked for English, Swedish and some other languages, but not Norwegian, so it was not useful for most PPE students. Still the students believed that this will be the main advantage of having a digital writing system, that they can edit and copy their notes and re-use it without typing it in again.

Paper functionalities

The above mentioned functionalities can be performed at paper level by ticking ‘action boxes’ and fill in text fields that are fixed on every page, as seen in figure 7.2.



The image shows a user interface for the Logitech IO2 digital writing system. At the top, there are three checkboxes labeled 'E-mail', 'Note', and 'Other'. Below these are two long horizontal text input fields labeled 'To' and 'Subject'. To the right of the 'Subject' field is a 'Done' button with a checkmark icon. At the bottom right, there is a logo for 'DIGITAL PAPER ENABLING' and 'FUNCTIONALITY'. A vertical text 'TC: 2011-510082' is visible on the right side of the interface.

Figure 7.2: Action boxes and text fields in Logitech note book

Choosing the ‘E-mail’ box, will at file download automatically open an email and attach the note on the page as a JPEG file. If the ‘Subject’ and ‘To’ fields are filled, the email will contain the subject and the email address specified in these fields respectively.

The ‘Note’ box will export the notes on the page as image to Word and the ‘Other’ box will execute a pre-configured action. This action can be chosen from a list in the software, including activities as Open as Image, Convert handwriting to Text and external application specific activities such as open in Lotus Note².

²io2 software is compatible with several other applications, but the user must have it installed to use these options.

io2 software functionalities

The functionalities can also be performed when the application is opened, so the students have the flexibility to change their mind or just postpone the decision on what to do with the note until later. The software opens for more editing of the digital note, but the experiment showed that the students seldom use this functionality and therefore I will not give it any more attention.

Since all the pages are stored as an individual file, the application enables for gathering several files and make it into one, this process is called ‘Binding’. When this is done the student can organize their files into dedicated folders.

There is also a search function in the software that opens for searching after specified subject/keywords that was inputted on the paper and the file title. But the searching technology could not ‘read’ the handwritten notes and therefore not search inside files that has not been converted.

7.2.4 Software version 4.10

Since the student experiment took place in autumn 2005, Logitech has updated its io2 software to include a feature called *ioTag*, Google Desktop Search and improved handwriting recognition (see chapter 7.2.2 and 7.5). This section will to deeper into how the ioTags feature work.

ioTags

The ioTags feature makes it possible for easy sharing and re-use of students notes. With this feature the students can choose what part of their notes they want to send as e-mail (see figure 7.3), converted and put into Word for re-use (see figure 7.4) or generated as an image (see figure 7.5). Giving them the flexibility of mixing in several types of notes in one page, and only performs actions on desired parts.

The included ioTags can be found in table 7.1.

-
1. Convert handwriting and send to Word: Subject
 2. Convert and open in new e-mail: Subject; To
 3. Save as an image
 4. Create a new pen document: Subject
-

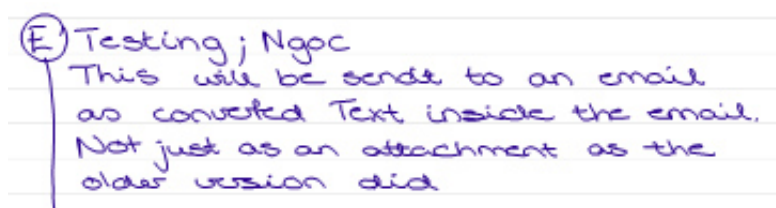
Table 7.1: List of ioTags

These ioTags actions are activated on paper level by writing a pre-defined prefix to their note. A chosen letter and a circle around it define the action.

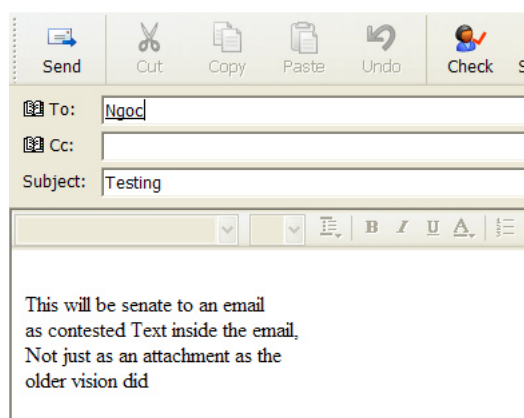
7.2. CHOSEN SYSTEM: LOGITECH IO2 DIGITAL WRITING SYSTEM45

Then a straight line from the circle and to the end of the text part on the left hand side will mark the chosen part included in the action.

Examples



(a) ioTag Email

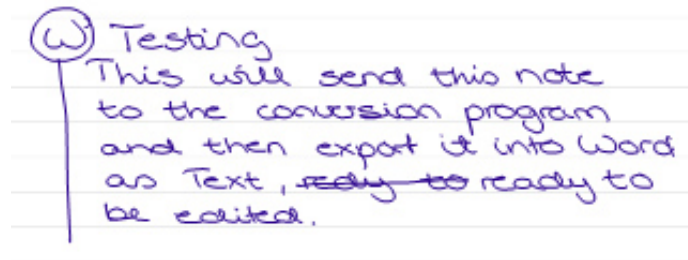


(b) Sendt to email

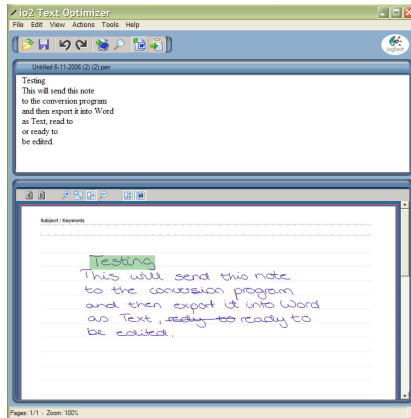
Figure 7.3: Sending email with ioTags

Figure 7.3 shows how the ioTag E (email) is used. At downloading time, the note will be opened inside an email ready to be edited and extended before sending. This example shows that email nick names can also be used instead whole email addresses, though it requires that the recipient already has been set a nick in the email application.

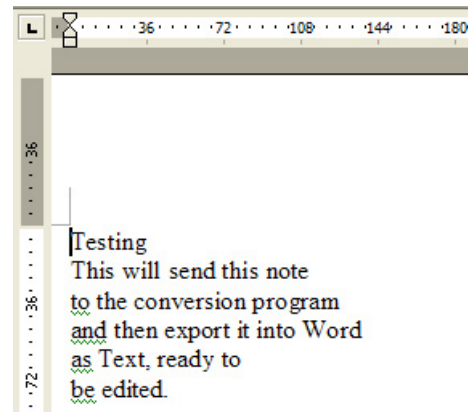
The example also shows that the handwriting recognition program is not flawless; 'converted' has been recognized as 'contested', but the user has the chance to fix this spelling error before sending, and the handwriting recognition and conversion program can be trained and optimized for better performance.



(a) ioTag Word



(b) Converted text for optimizing



(c) Exported to Word

Figure 7.4: Export to Word with ioTags

Figure 7.4 shows the process from using ioTag W (Word) to have the note in Word. At download the note is sent to the io2 Text Optimizer. Sub figure 7.4(b) shows the display of the text optimizer, the suggested conversion is showed over the digital note. As seen in this figure, the striking of words is not recognized as a correction from the user, rather the application tries to make a word of it anyway. The user can compare his or her note and correct the errors before pressing the button for exporting to Word.

7.2. CHOSEN SYSTEM: LOGITECH IO2 DIGITAL WRITING SYSTEM47

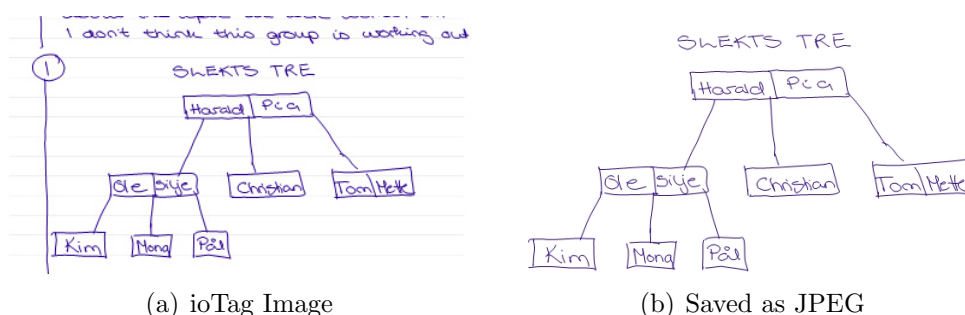


Figure 7.5: Saving as image with ioTags

Figure 7.5 shows how to save a drawing as an image file. The image will only include what's within the ioTag boundaries. At download the image file will be generated automatically and saved as a JPEG file. This file can not be opened in the io2 software, but it is saved in the user configured folder, the default folder is MyIoDocuments, and can be opened from there.

7.2.5 Original System Requirements Compliance

The original system, the Logitech io2 system before extension, comply with the following requirements as seen in table 7.2.

The chosen system, Logitech io2, complies well with all the general non-functional requirements that have high priority status. However, GNR-6, GNR-7 are not complied but these are low priorities and are therefore not essential to comply.

The functional requirements, FR-#, and the specific non-functional requirements, SNR-#, were not fulfilled by the old system, and are still not fulfilled by the new software version of Logitech io2. So these requirements still stand for the system extension.

General Non-functional Requirements		Compliance
GNR-1	Usability	+ The digital pen and paper provide the same usability as normal pen and paper - The pens physical size is bigger than normal pen and can be strenuous to use for long notes
GNR-2	Mobility	+ The students can use this system anywhere and anytime without disturbing the environment - The digital pen uses battery and the memory has also a limit. The capacities are relatively good, but it still requires the users to download and recharge at regular intervals
GNR-3	Flexibility	+ The system provides flexibility in both digital and physical aspect by be providing both paper level functionalities and software functionalities, and it is also compatible with different paper formats - The paper level functionalities are still limited to just a few functionalities
GNR-4	Availability	+ The system is less expensive than other mobile digital note taking devices such as PDAs and Table PCs - The commercial augmented paper is more expensive than normal paper and it is not sold everywhere such as normal paper
GNR-5	Extensibility	+ The system can be extended by the plug-in development kit by Logitech - There is little support from Logitech for the plug-in development
GNR-6	Multiplatform friendly	- Logitech is only supporting Windows platforms
GNR-7	Connectability to other mobile devices	- This system can only connect to other devices via USB cable
GNR-8	Connectability to external system	+ This system enables automatic sending external applications on the computer, such as to e-mail applications and MS Word - It has not connectability to system external to the computer

Table 7.2: Basic system requirements compliance

7.3 Other commercial systems

7.3.1 Anoto based

There are other digital pen systems that also utilize the Anoto technology, i.e. are Anoto partners are: Nokia and Maxell. HP is also a company that offered an identical system, but they are not mentioned as partner of Anoto.

7.3.2 Nokia Digital Pen

The Nokia Digital Pen package includes digital pen SU-1B, USB docking station, travel charger, augmented notepad (A5) and laminated MMS and Calendar/Contac cards which are reusable, and pc application.

Nokia's Digital Pen SU-1B works in the same way as Logitech's io2 digital pen, the pen shape is a bit different, see figure 7.6(b), but as table 7.3 shows, the size and weight are approximately the same. An advantage with the SU-1B digital pen is that it has integrated Bluetooth technology, which enables connectivity to Bluetooth mobile phones, but the transfer to pc still has to be done through the USB docking station.

The pc application that follows is the Nokia Digital Pen Application Suite 2, last updated in 23-Jan-2004. It lets the user view, edit and rearrange the digital notes. Shortcuts for copying the digital note to Word, PowerPoint and MS are enabled.

The paper sold with Nokia is from Esselte and they only carry two formats, A5 and B7. The paper functionalities include: Send to PC or Mobile Phone, edit pen stroke appearance on pc (color and thickness) choose message size.

The Nokia digital pen SU-1b supports the usage of compatible third party services and can be implemented with user developed application using Anoto Technology.

7.3.3 Maxell 'Penit'

Maxell's 'Penit' digital pen DP-201 is a slimmer digital pen than the above mentioned ones, see table 7.3 and figure 7.6(c). This pen has both Bluetooth and USB connectivity that can be synchronized to both pc and mobile phones³.

Maxell promote the pen as

³Possible through user developed application or third party applications

high technology interface/device that converts handwritten analog information created using 'pen and paper' into digital data, enabling the data to be utilized in various applications. [32]

This pen is the only digital writing product offered by Maxell. For compatible pc applications and paper the user must use Anoto SDK or other third party products as those mentioned on Anoto's site. Because of this, this product is actually only targeting companies that are willing to spend more on already third-party-developed application or have the resources to build their own application.

The system only enables the digital data to be utilized in various applications. Once stored in the pen memory the information can easily be transferred to a PC or other IT devices, mobile phones, via a Bluetooth or USB interface over networks, and used in a variety of applications.

7.3.4 HP Digital Pen

The HP Digital Pen 250 is a very similar pen to Logitech io2 digital pen, see figure 7.6(d). Their docking station is also identical. But HP is promoting this as their own technology and as a part of Forms Automation Systems. FAS is a complete solution for companies who wish to implement a system to digitally handle forms, such as hospitals. HP no longer provide the service of FAS, but has as Anoto licensed the technology to other partner companies [33].

The Forms Automation System [34] include beside the digital pen; HP licensed dots pattern, form development kit, software development kit and HP color jet laser printer, which can print the developed forms on site. The different companies also provide the developing service. Meaning this product is targeting big companies with a lot of forms that need automation.

7.4 Pen comparison



Figure 7.6: Anoto compatible digital pens

	Anoto Partner	Dimensions (mm)⁴	Weight (gr)	Inc. SW
Logitech	Yes	148.2 x 17.8 x 22	37.5	Yes
Nokia	Yes	147 x 22 x 20	38	Yes
Maxell	Yes	153 x 19 x 17	30	No ⁵
HP	No	148 x 22	36.2	No ⁶

Table 7.3: Anoto compatible digital pens comparison

These pens have built in rechargeable battery and most are recharged through the USB connection.

⁴Dimensions is without pen cap

⁵Compatible software can be developed with Anoto SDK

⁶The pen is a part of the Forms Automation System Solution Provider Program [35]

7.4.1 Non-Anoto based

Presently there are two other systems that also enable capturing of handwritten notes by utilizing pen and paper. These systems are: Pegasus Mobile NoteTaker and ACECAD DigiMemo (see Appendix C) .

These systems enable users to utilize normal paper for their note taking needs, by providing a third component to handle the digitization of the handwritten notes.

7.5 Handwriting recognition and conversion

All the systems mentioned above capture handwritten notes and provide an exact digital copy for use on the computer. Even though it is an easier way to transfer paper notes into computer, the usage is still limited to view, store and edit the notes as an image. Handwriting recognition and conversion programs take it a step further and provide users with automated transcribing into digital text. MyScript Notes is such an application and are compatible with all the above mentioned digital writing systems.

MyScript Notes

MyScript Notes is developed by Vision Objects [36]. This application converts handwritten notes to typed text in the computer. In the new version, MyScript Notes 2.0, the handwriting recognition is improved, providing users with the opportunity to add new words to the dictionary for better recognition and conversion rate. Shape recognition has also been included, though it only handles the most basic shape types. The language database has also been expanded to include 14 languages, most of the western language and Japanese and simplified Chinese. All the Nordic country language is represented but Norwegian.

Vision Objects also provides a development version called MyScript Builder, the latest version 4.1 does include Norwegian in its language database. This probably means that Norwegian will be included in the next official version release of MyScript Notes.

MyScript Notes was included as Logitech io2 digital writing software bundle when the system was bought for the student experiment in autumn 2005. But it now seems like the MyScript Notes no longer is offered as part of the Logitech package, but as a stand alone application (with a 30 days trial period).

7.6 Discussion

This chapter has looked at 3 different types of digital writing technologies:

1. Anoto: Optical digital pen and augmented paper
2. Pegasus: Ultrasonic digital pen and clip on receiver
3. ACECAD: Simple digital pen and an electromagnetic pad

These technologies have advantages over PDA and tablet PC because it enables normal note taking situations and are less expensive. The user can take notes any where at any time with these systems and still get a digital copy of their notes. With the handwriting recognition and conversion application, these digital notes can be made into digital text in a moment. These systems bridge the gap between the preferred way of taking notes and the preferred way of handling notes (digitally editing and sending).

Still these systems are not perfect. The Anoto system requires the usage of special augmented paper to work. The augmented paper is at the moment sold at a higher price than ordinary paper. This makes the system quite expensive to use in the long run. But the price is compared to normal paper. Compared to using tablet PC for example, it is still an inexpensive solution to get both handwritten notes and a digital copy.

The Pegasus and ACECAD systems have the advantage of providing digital notes from normal paper, making the system less expensive than Anoto in the long run. On the other hand, both the Mobile NoteTaker and the DigiMemo require an extra device in addition to digital pen and paper. As seen from the products dimensions and weight (table C.2, table C.1 and table 7.3) the Anoto system gives the user less to carry on, both in weight, units and dimensions. Even though the Anoto digital pens are bigger than the other two, the Maxell digital pen version (see figure 7.6(c)) seems to suggest that the digital pen can be developed even smaller in the future.

Anoto's digital writing system has a major advantage over the other two. It provides the users with paper level action commands, either in the form of an action box, or ioTags in the Logitech io2 system. This automates much functionality such as sending mail, send to Word, convert the note to digital text etc. Another advantage is the Bluetooth compatibility, which makes it possible to send to other Bluetooth devices, such as mobile phones.

The Anoto system also provides a software development kit, and in Logitech's cases a plug-in kit, making it possible for users to extend the system to fit their needs. While Pegasus and ACECAD are open for user specified developments, they have not provided any software development kit for the

normal user. This gives an edge to the Anoto system, because of the availability; it makes it easier to develop user functionalities, which can be added to Anoto's system as an add-on application or integrated part of the systems software.

These are technologies that are in development, and it will be interesting to see what can be achieved with this kind of technology in the future. It will probably not take over the PC's functionality, but it can be an important integrated part of the digital society, as the pc has become.

Chapter 8

Development

This chapter will give a brief account of the technology that was used during the design and development of the PPU customized system extension.

8.1 Augmented Paper design and development

The development of new specialized paper requires the following components. Its is important to use the latest version of every component, because the Anoto Form Design Kit is not backward compatible with all the other components.

Figure 8.1 illustrate the process and the needed components for designing and developing augmented paper.

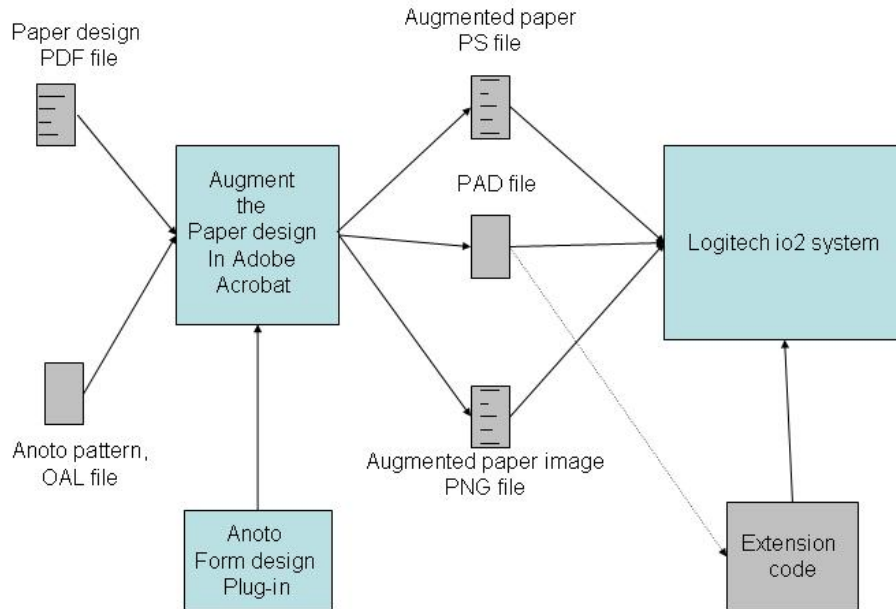


Figure 8.1: System development process

8.1.1 Anoto licensed pattern

This is the dot pattern mentioned in 7.2.1 and as seen in figure 7.1(a).

The licensed pattern is delivered in the form of an OAL file.

8.1.2 Anoto Form Design Kit 2.1.1

This kit contained the Anoto plug-in and documentations. The plug-in enables the merging of the licensed pattern with the designed form, and the activation of action boxes and text fields.

It will generate the PAD file needed for functionality implementations and PS (post script) file of the augmented paper for printing.

8.1.3 Adobe Acrobat Professional 7.0

Form development must be done in Adobe Acrobat Professional 6.0 or 7.0 with the Anoto Form Design Kit plug-in installed.

8.1.4 Ghostscript 8.53

This is needed for the conversion of the PDF file, the specialized paper that is developed with the Anoto Form Design Kit, to a PS file. The PS file gives better printer properties and the Anoto Form Design Kit uses Ghostscript to convert the PDF file in Acrobat. The Anoto licensed pattern is actually merged with the paper design at the file conversion.

8.1.5 GSview 4.8

This program is practical for pre-viewing PS files to print them.

8.1.6 HP Laser jet printer

To print the augmented paper, the licensed pattern is needed to be printed with normal black toner, which has carbon in it. The optical pen will read the carbon print as the licensed pattern. But if the paper design has larger areas with covered print, this print needs to be in carbon free toner for the digital pen to be able to read the dot pattern underneath.

8.1.7 MS Word

The customized paper form was designed in Word and then converted to PDF for use with the Anoto FDK. Other programs can be used for this purpose, most other paper design compatible with Logitech are designed with QuarkExpress.

8.2 Plug-in development

8.2.1 Logitech plug-in tool kit

This tool kit provides plug-in examples, documentations and API. It is provided at Logitech's site [3]

8.2.2 C#

The programming language used in the plug-in examples was C# and I continued to develop the extension in the same language. It is also possible to develop in other .Net compatible programming languages, such as Visual Basic and C++.

8.2.3 MS Visual Studio .Net 2003

MS Visual Studio .Net 2003 is the development environment needed to run, develop and install the plug-ins.

Chapter 9

Overall design

This thesis aims to take the existing Logitech io2 Digital writing system and extend it to better fit the needs of students in PPE. The extensions are meant to increase the systems usability and functionality according to the issues elaborated on in chapter 6 Requirements.

This chapter presents the proposed extensions for the Logitech io2 system and some assumptions, and then show the implementations made of some of the proposals.

9.1 System with extensions overview

The figure 9.1 presents the design of the proposed system based on Logitech io2. It includes the extended functionalities proposed for the PPE students. These are all automated functionalities that can be chosen at note taking time. The colored boxes are the extended functionalities.

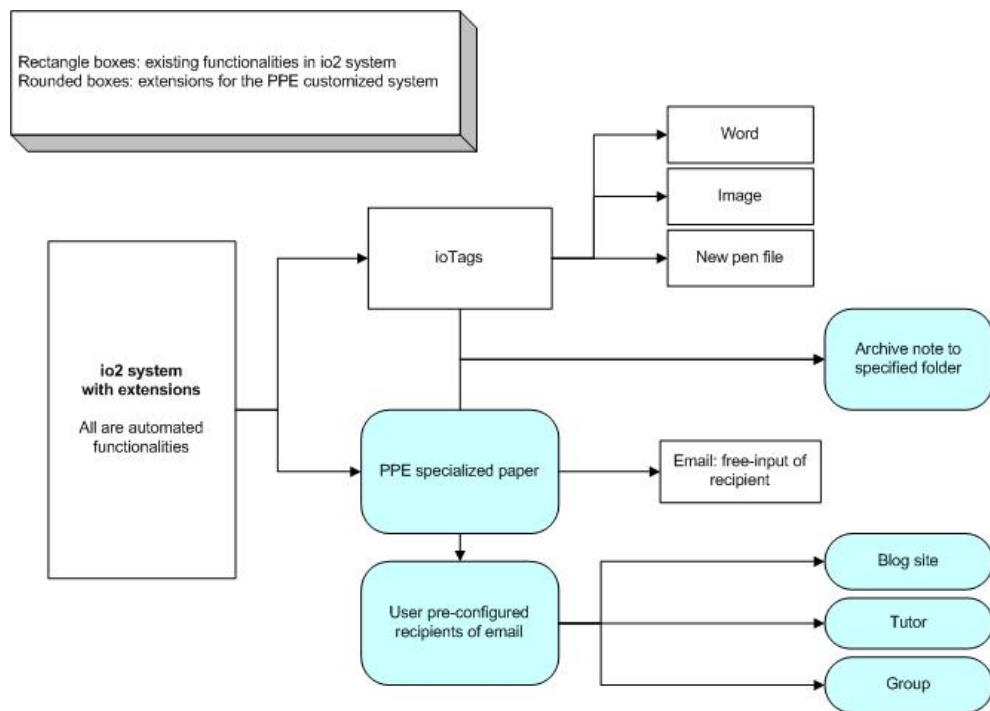


Figure 9.1: Extended io2 system

9.2 Extensions

This section presents the customized extensions proposed for the Logitech io2 system. They are based on the requirements set for the system, that are not fulfilled by the original system (see chapter 7.2.5), meaning the functional requirements and the specific non-functional requirements in table 6.4.

9.2.1 Extensions based on functional requirements

The functional requirements for this system are:

- FR-1 Separation and extraction of notes on same page at note taking time
- FR-2 Archiving of notes at note taking time
- FR-3 Binding of notes at note taking time
- FR-4 Sharing to specific recipients
- FR-5 Handwriting recognition in Norwegian

FR-1 – fulfilled

FR-1 is already fulfilled with the new Logitech io2 software version. The main function of ioTags is to enable users the possibility to separate and extract portion of notes on one page.

While ioTags: ‘Image’, ‘Word’ and ‘Email’ provide a combination of actions on the marked note portion, the ioTag ‘New Pen file’ provides the possibility to only extract a portion of notes without triggering any other actions. This gives the users full flexibility to handle their notes as they need too.

FR-2 – extension proposal

Archiving of notes at note taking time in the original system is limited to only saving the file with the name filled in the ‘Subject’ text field. This file is then stored in a common folder where the user has to manually move it to a specific folder.

Also, the ioTags functionalities do not store the files with the name in subject header as the file name and therefore it will be stored as ‘Untitled’ plus either creation date or page number as the file name.

To improve this, the system can incorporate two methods:

- New ioTag that takes two headers: ‘Subject’ and ‘To’, which will be set as the file name and the destination folder respectively. This will automatically send the digital note part to the specified folder at downloading, providing easy organization with minimal fuzz.
- Providing an action box called ‘Folder’ which will take the input in the ‘To’ text field as the destination folder. This will then store the whole page as a file with the name in the ‘Subject’ text field into the specified folder.

FR-3 – not fulfilled

The binding of notes seems to be a complex function that needs further study into how students ‘bind’ their notes in the real world. Notes that belong together are often notes that follow in the next pages, but it can also be that a student can take other types of notes in between. A possibility is to provide a ‘bind-all-files-with-same-subject’ functionality, but this might introduce a problem with different notes being named the same subject name. Especially if this functionality is going to be as effortless as possible, the binding of files with the same subject can cause even more chaotic organization of notes if different types of notes are binded together.

This requirement should be given more time to find a good solution for easy binding of coherent notes at note taking time.

FR-4 – extension proposal

Sharing of small notes is easily done with the ioTag email. The only drawback is that the user has to enter the email address or nick (providing they have a specified nick in their email application). To share with groups that are often shared with, a action box will make this sharing even more effortless.

The students are identified to share with these groups: Tutor, Group (as in response or basic group). So these should have own action boxes on the paper design to enable easy sharing of notes between these groups.

FR-5 – not fulfilled

This requirement is not fulfilled by the original system at present. But there is progress in this field and this requirement will probably fulfilled in the near future (see section 7.5).

9.2.2 Extensions based on specific non-functional requirements

The specific non-functional requirements for this system are:

- SNR-1 Enhance ‘Subject’ and ‘To’ text fields
- SNR-2 Connectability to common Blog site
- SNR-3 Bluetooth enabled digital pen

SNR-1 – extension proposal

To enhance the ‘Subject’ and ‘To’ text field, the fields can be designed bigger without any restrictive borders for each letter. But this requires that the user should write clearly inside the text field to enhance the recognition rate. These fields should be filled with capital letters to ensure the names are recognized correctly and the size of the text field should take this into account when deciding on the size.

SNR-2 – extension proposal

The system can also promote more sharing among students by providing another sharing group, the Blog group, which will be an informal sharing environment for all PPE students.

The system can become ‘connected’ to the blog site by using a blog site plug-in that enables user posting by email ¹. This way the note taking system can send blog postings to the blog email address. In this case the connectability can be supported with an action box called ‘Blog’.

SNR-3 – not fulfilled

Since the Logitech io2 system chosen in this work does not have compatibility between Bluetooth enabled digital pens and the io2 software, this requirement is not fulfilled.

¹Possible with Serendipity [37] which is employed in another MOTUS project [38]

9.2.3 Extended System Requirements Compliance

Functional Requirements		Compliance
FR-1	Separation and extraction of notes on same page at note taking time	Yes by using ioTags
FR-2	Archiving of notes at note taking time	Yes by providing new ioTag: Archive to Folder
FR-3	Binding of notes at note taking time	No, missing a good method, need more research
FR-4	Sharing to specific recipients	Yes, the providing these action boxes: Tutor and Group in addition to Email
FR-5	Handwriting recognition in Norwegian	No, but can assume it will be provided by commercial products in the near future
Specific Non-Functional Requirements		Compliance
SNR-1	Enhance 'Subject' and 'To' text fields	- Yes by making the fields larger and without letter borders
SNR-2	Connectability to common blogsite	- Yes by providing the action box: Blog
SNR-3	Bluetooth enabled digital pen	No, the Logitech io2 application does not support Bluetooth, but Logitech has a Bluetooth enabled digital pen and it might be incorporated into the system in the future

Table 9.1: Extended system requirements compliance

9.3 The proposed customized system

9.3.1 Specialized Paper design

Both archiving and sharing can easily be done on paper level with a customized paper form for the PPE students. I have designed a PPE specific paper form, as seen figure 9.3.1, the included paper elements are: ‘Subject’ and ‘To’ fields, the action boxes Email, Group, Tutor, Blog and Folder, and the magic box New Page.

New Page

This is a so called ‘Magic box’, which is already defined by Anoto. When a user ticks this box, the pen will be informed that the user has started on a new page.

This box is needed because of the license pattern type. The pattern type used in this thesis work is a page copied pattern. This means that every page has the same pattern, therefore if the ‘New Page’ is not ticked the pen will interpret the new notes as being on the same page as the last one.

Another license pattern type is unique pattern, which provides each page with a unique pattern, making it impossible for the digital pen to mix pages together. But this was not offered in the development kit provided for this thesis.

This form proposed here can be used in mass production, but the students must always remember to tick the ‘New Page’ box whenever starting on a new page.

Action boxes: Email, Group, Tutor, Blog and Folder

The email action box is provided to not limit the students sharing possibilities, in case they want to send to others than the identified sharing groups.

The action boxes: Group, Tutor and Blog, are according to the extension proposals discussed in the previous section, 9.2. These action boxes can be implemented as customized emails. While email requires the students to fill in the email address, can these action boxes together with a configuration panel in the software enable students to fill in the emails addresses to be associated with these action boxes. This way the students only need to fill in the emails once.

Text fields: ‘Subject’ and ‘To’

The text fields are also made bigger to ease the subject and folder name/email address as according to the extension proposals in section 9.2.2.

9.3.2 ioTags

The ioTags feature can function independently of paper design. The student can choose to do their actions with ioTags on all types of paper, as long as it is Anoto enabled paper.

Archiving to Folder

In connection to the extension proposal for requirement FR-2 in section 9.2.1, an ioTag functionality called: ‘Archive to Folder’ has been implemented.

This ioTag takes two headers: ‘Subject’ and ‘To’. As the email ioTag, the headers are divided with a ‘;’ to let the software know when the next header begins. When this ioTag is processed by the io2 software, the subject will be set as the file name, and to as the name of destination folder. Providing that the folder exists, the file will automatically be stored to the specified folder without more user involvement.

Other ioTags: Email, Word, Image and New pen file

These ioTags are already provided by the original io2 system.

Together with the new implemented ‘Archive to Folder’, these ioTags will provide a complete note handling system for small notes.

The students can write emails in their notebook, and then get their handwriting converted to typed text in Word, a JPEG file of their drawing, extract and save portion of notes in new pen, or easily organize their notes with the archiving functionality.

9.4 Assumptions

The following assumptions have been made in order to allow for natural progression of designing the system. They represent requirements that are expected to be met within the next few years (if not already) and as such will make the system more useful for the PPE students.

9.4.1 Handwriting recognition and conversion in local language, Norwegian

The students in PPE naturally take their notes in their local language, Norwegian. This language has not yet been supported by the handwriting recognition program, MyScript Notes, which is compatible with Logitech io2. However the Norwegian language has been included in a development version of MyScript's handwriting recognition, MyScript Builder, and there should not be to long before a new version of MyScript Notes will include Norwegian also.

So the extensions will be discussed with the assumption of Norwegian as already a part of the handwriting system compatible with Logitech, and that it is a natural part of Logitech.

9.4.2 Common Blog site

Blog has been experimented with as a collaboration and sharing arena for the PPE students, see chapter 3.4, with little success. But the potential for Blog as a mechanism to enhance collaboration is still there. Therefore I have included the Blog action box in the paper design as a illustration of how the paper can act as an interface to other systems. Therefore I am assuming that a common Blog site will be set up for the PPE students in the future.

9.5 Specialized Paper vs. ioTags

As seen in the sections above, section9.3 and section9.3.2, both specialized paper and ioTags can be used to solve the same issues. This section aims to set up the pro and cons of specialized paper and ioTags, compare the two and then elaborate on why I have chosen to incorporate both in my system proposal.

9.5.1 Pro and cons of specialized paper

Specialized paper means a customized designed paper form, which is developed with special fixed paper functionalities.

Pros	Cons
One tick functionality activation	Must always remember to tick the 'New Page' box (if using copied pattern)
No need for remembering commands	Can not use multiple functions on the same page, the last recorded tick applies
Easy to see what commands are available and been used	Limited space for action boxes on page, i.e. limits number of functionalities.
Learnability: Easy to understand by new users	Cuts down on note taking space
Activation for whole page (long notes)	Activation for whole page (short notes and different types of notes on same page)
Less vulnerable for user errors	

Table 9.2: Pros and cons of specialized paper

9.5.2 Pros and cons of ioTags

Pros	Cons
User flexibility: - Choosing which portion of the page to send - Choosing what functionality to use - Combining several functionalities in one page or note part No limits on number of functionalities that can be used/developed with ioTags Visibility/Traceability: the user sees where a function has been used, to where it has been sent etc. New files without the ioTag present, only the marked note	Uses extra space for declaring the ioTag and its header(s) The user has to remember the ioTag prefix and what header it takes Not optimal for long notes such as whole pages Handwriting conversion error might appear: sending to wrong email address or folder Some might find it messy Produces redundant files, the original page files and the ioTag file

Table 9.3: Pros and cons of ioTags

9.5.3 Specialized paper vs. ioTags

As seen in table 9.2 and table 9.3, both specialized paper and ioTags have their advantages and disadvantages. Following, I will discuss some of the main differences between specialized paper and ioTags.

Number of functionalities

The main advantage of using specialized paper is the visibility of available functionalities, making the learnability factor higher than for ioTags, which requires the users to remember the predefined prefixes and the headings for the various ioTags. However, this is mainly an issue when the functionalities becomes many, which in turn means that it will be hard to place the dedicated action boxes on the paper and still provide enough space for taking notes on

the paper. For small number of functionalities, the paper space will not pose a problem, and most probably neither will the issue of remembering ioTags.

The ioTags feature does give an advantage to enable much functionality. The user is free to choose which functionality to use and a bigger number of functionalities available gives the user the possibility to choose which functionalities to use. It means that the users do not need to remember more ioTags than they will use.

Parts of notes

The main difference between specialized paper and ioTags is that they provide efficient actions on whole pages and parts of pages respectively.

The action boxes are superior for storing long notes. The observation of the students in the autumn project showed that some students took a lot (long) note for their class preparations, often many pages long. The action boxes will be the optimal way to invoke action for example the whole preparation note, instead of having to mark whole pages with a vertical line such as required with ioTags.

ioTags, however, is more fit for extracting small parts of notes or drawing. In the autumn project, the students were also registered to take several types of notes on the same page. With ioTags, they can separate these notes and archive them into their own dedicated folders, making ‘chaotic’ notes organized at note taking time. Or if the student want make a drawing on the same page as other notes, ioTags enable the student to just saving the drawing as picture, not needing to show the rest of the notes (see figure 7.5), and also if they want to send a small email to someone, ioTag will only send the email portion and not the whole page.

User errors

The specialized paper makes it easier for the user to see what functionalities they can use, but on the same time limits the user to only one functionality action per page. Only the last tick will count, giving the user the possibility to change their minds, but it can trick the user to falsely think that they have activated two functionalities on the same page (example from the notebook: saving as image as the same time as sending to email). This will most probably not be a major issue with the users as long as they are informed, because the ticking leaves a mark on the page and the user can see if an action has been chosen before. Beside the specialized paper is less vulnerable for user errors.

The ioTags feature is depended on the handwriting recognition to process

the prefix and headers. Sloppy handwriting can pose a problem, causing the ioTag to not be recognized, the subject and to are converted wrong; giving the wrong name of recipients or folder. Or if the user makes a mistake in the headings, the user must start the ioTag over to ensure that it will work properly. However, these issues are not conceived as major problems. The user can still perform all the functionalities from the io2 software.

To replicate the ioTags' 'note extraction', the user can use the edit functionality in io2 software to mark, cut and paste the note portion to the desired destination. Of course, this might cause user irritation because they are feeling that they are doing the same work twice and the system might not promote note taking and sharing. The ioTag conversion problem will probably be less of an issue when the handwriting conversion program upgrades to improved versions.

9.5.4 Combining for flexibility

As we can see from the above discussion, the specialized paper and ioTags are filling their specific functions. To only include one of these will make the system less flexible and valuable. One of the main disadvantages of specialized paper is the limitation of functionalities on paper and only one action performed on the whole page, do restrict the usability of the whole system.

I have chosen in my proposed system to extend functionalities to both incorporate a specialized paper and ioTags. Even though it takes more resources to develop specialized paper, because of the paper design and pattern cost, I still believe this is the best way to give the students in PPE the flexibility they need to enhance the note taking and sharing experiences.

If the course can take on the paper expenses by printing the necessary amount of paper and provide them to the students, the system will from the students' point of view become more affordable. This way they can choose if they will buy their own paper or not, giving them the flexibility of utilizing customized paper when needed to and 'normal' augmented paper when preferred.

9.6 Deployment proposals

This system requires a computer to enable the digital properties which are the system's advantages over using normal pen and paper. But there are still students in PPE that do not own their computer.

To provide support for students without computer, a docking station at the practice school can be an idea. The students can download their notes into the computer and then send it to themselves.

Also the specialized paper proposed here can be printed with normal laser printers (see chapter 8.1.6); this makes it possible for the practice school to print the augmented paper on site, enhancing the availability of paper resource for the students.

Chapter 10

System evaluation

This chapter presents the expert and user evaluations of the proposed customized digital note taking system. The evaluation method is inspired by the Heuristic evaluation method [39], making it possible to perform a less time-consuming evaluation and which can be performed by both experts and users.

The chapter will first inform on the evaluation method, and then it will present the evaluators and the outcome of both the expert and users evaluations.

10.1 Method

The proposed system in this thesis is not a completed implementation but rather a overall design with a few implementations to better illustrate the possibilities of this system. Therefore is a heuristic like evaluation method more suitable for this system. It is less time-consuming and it can be performed by both experts and users. The evaluation process has therefore been divided into two separate sessions, one with experts and the other with target users of the system, the PPE students.

Following is a description of the evaluation process.

10.1.1 The process

Introduction of my work

The evaluators got a short introduction of my work. They were shown the Logitech io2 digital pen and different augmented paper formats (notepads and -books) including the specialized paper developed for the PPE students.

The evaluators were told that my main objective with this system was to:

Support and promote note taking and sharing in the practice based study, PPE.

by

Easing the archiving of different types of notes

Easing the collaboration by sharing of notes, such as comments, questions and thoughts

The evaluators were briefly informed about the results from the students experiment in my autumn project [2], and then about the updated Logitech io2 system, and how this has made the system better suitable for supporting note taking in the practice based PPE.

Scenarios walkthrough

I used the scenarios from chapter 5 to give them a walkthrough of the system. Explaining how the students can utilize both the specialized paper (see figure 9.3.1) and the ioTags (see chapter 9.3.2) to achieve the functionalities described in the scenarios.

Evaluation criteria

Then the evaluators were asked to evaluate based on these criteria:

- Scenario realism
- System usability
- Usefulness for PPE students

They were also encouraged to discuss the strengths and weaknesses of the system.

10.1.2 Experts

I invited two experts to evaluate my proposed system with illustrative scenarios and demonstration of system elements. In heuristic evaluation method it is suggested that the expert evaluate the usability of a system individually to get a more independent evaluations. But I feel that a discussion with several partners after the walkthrough will be more informative for my work.

Expert X

Expert X is a prominent person from the teaching education staff at NTNU, which has carried out several experiments for promoting reflection and learning at PPE. He has worked a lot with students in PPE and understands the pedagogical objectives of PPE.

Expert Y

Expert Y is part of the MOTUS 2 project. Through a master thesis work on collaborative technologies for PPE, this expert has gained a thoroughly knowledge of the PPE students, their learning environment and how they can react to new technologies.

10.1.3 Users

The intended users of this note taking system are the students of PPE. All the participating students from my previous work were invited to a user evaluation session.

Three of these students participated in this user evaluation session.

Student 1

This student was part of the pen deployment group. He was the ambitious one, and was fond of taking a lot of notes. He was very organized and did frequently sort and organize his paper notes into folder. From the pen deployment experiment, he was the only one to finish of his provided Anoto enabled notebook. He did report use of the system for other activities than taking notes (preparation notes for his classes) and then store them into dedicated folders at download. He had expressed that it was a bit strenuous to bind the folders together and move them to dedicated folders at download, because he did not download very often, maybe once every two weeks, often when the pen memory was full.

This student has a science background

Student 2

This student was also part of the pen deployment group. He was the unorganized one that came to realization of the importance of note taking during the start up interview. He kept on taking a lot of notes, all types: meeting, preparation notes, and log. The notes seemed to be kept quite short and

could be done in all types of paper formats. But his notes quickly became chaotic and losing notes was a problem for him.

Student 3

This student was part of the group without pen deployment. She likes to take notes with pen and paper. She was semi organized, but not a 'binder-type' as she expressed herself. She uses one common note pad for all her notes. She prefers to tear out preparation notes to bring to class, and when it is used, the note is put back into the note pad. The notepad becomes quite chaotic after a while, and it is not easy to find the right note after a long semester.

She was one of the few students who actually reported sharing with other students, but she preferred to write it into the computer before sending it to the recipients, wither by email or by print out.

Discussion of users

Gender issue: male users might be more open for deploying new technology, while female focus more on the usability and the new utility value of using a new technology. When the female student is able to do the same with already familiar technology, she wonders why she should change. She can see the usage, but she rather focus on the utility value. She would only change if it actually adds more utility value.

The users that participated in this evaluation were the students that were positive to the digital writing system from last time. This might influence the evaluation of the new system, because every new feature is an improvement to a system they already like. On the other hand, these types of students are the main target group. The system is not meant for converting students to do more handwriting notes, but to promote more note taking amongst students that already takes notes by hand, or that does not take much notes at all. The PPE study has a big variety of student types, what subject they are learning to teach, what their background is, and their technology competency and so on. Therefore will an evaluation performed by students that are positive to this system, only emphasize the type of students this system is meant to target.

10.2 Evaluations of system deployment scenarios

This section presents the evaluation made by the experts and users on the scenarios in chapter 5. They were to evaluate the realism of each scenario and the usefulness of enabling these scenarios for the PPE students.

10.2.1 S1: Question to tutor at startup with portfolio work

The S1 was demonstrated with figure 10.1 to show the nature of ioTags. The evaluators were also informed that S1 could also have been carried out by using action boxes on paper, but the ioTag Email was chosen here because it fit better with the scenario of having a question while doing other notes. With the ioTag Email the student could choose to only send the relevant note and question to his tutor, and not the whole page with other notes.

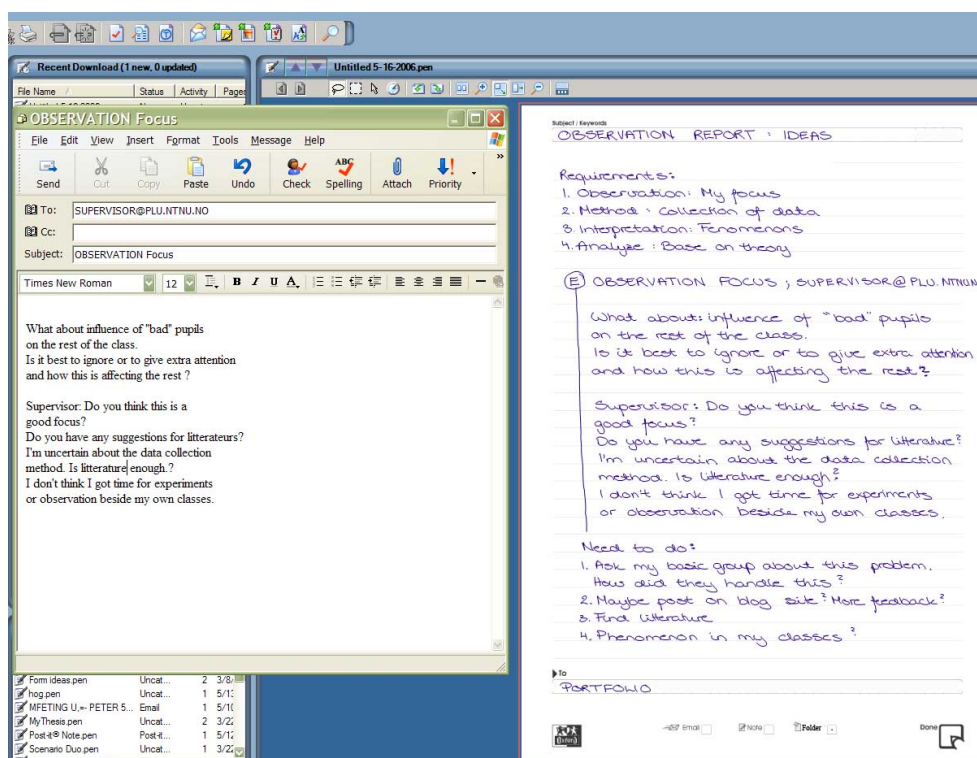


Figure 10.1: S1 deployed with ioTag Email

Experts

The experts thought that this scenario is realistic. Expert X has been PPE tutor, and has received many requests on email about approving problem formulations and literature tips. The expert believes that this will be a useful functionality to be able to compose an email on paper and have it automatically send at download.

Expert Y commented that the final send action that has to be done in the email application before it is sent, can cause some trouble or require a lot of time if a students make a lot of email notes before downloading. But understand the need for reviewing because the handwriting recognition is not 100% reliable.

Users

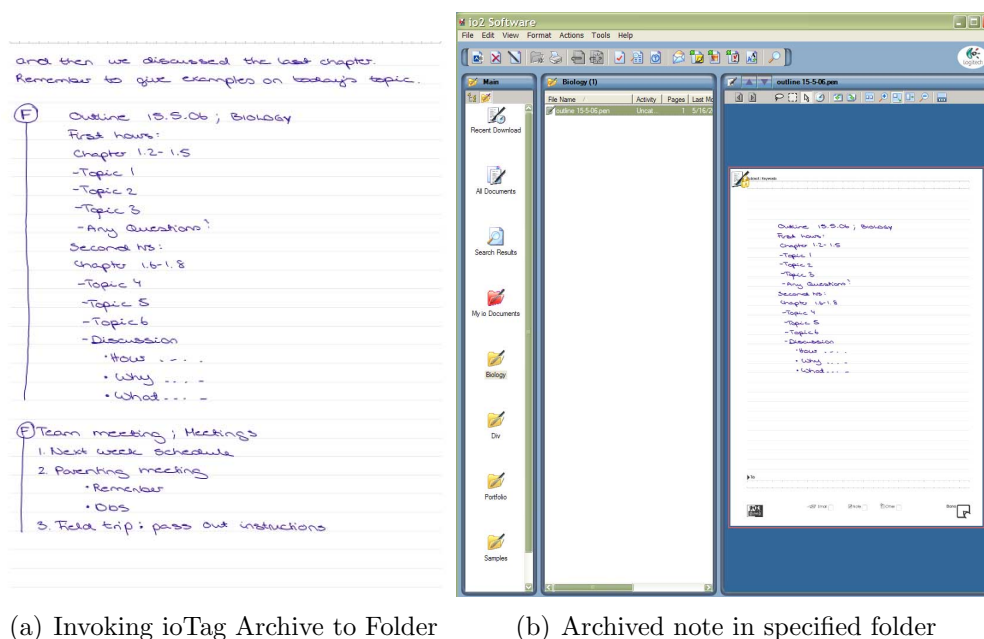
Student 1 thinks this is a very realistic situation, and could imagine himself take advantage of this functionality. He likes that the questions can be converted to machine fonts when sending to email, especially in this situation where it can be easy for the tutor to reply with comments in-between the students questions, that way the student can have both the question and the answer in one file. He also mentioned that as a ‘visual person’, he likes to see everything written down on paper, so even with pc he still prefer to take note by hand.

Student 3 was less impress with the email possibility with ioTag because small emails can be just as equally done on the computer. This of course requires the student to have a personal computer at home. She believes that this system can be extra useful for those students without own computers.

Student 2 placed himself neutral to this functionality; he felt that this functionality will be useful for some students, but he is not sure if he would have taken advantage of this.

10.2.2 S2: Archiving of class preparation notes

The S2 was demonstrated with figure 10.2. This scenario is illustrating the use of the extension implementation: ioTag Archive to Folder. The student marks her note with the circled F and specifies the filename and folder destination as seen in figure 10.2(a). When the file is downloaded, the file is stored into the specified folder, as seen in figure 10.2(b), without any more effort from the student.



(a) Invoking ioTag Archive to Folder (b) Archived note in specified folder

Figure 10.2: S2 deployed with ioTag Archive to Folder

Experts

This scenario is realistic, and the experts thought it was very useful. Expert Y thought that automatic saving to folder without fuss seems to be the biggest advantage in this proposed system.

A concern is that if the system is going to enable pen file download at practice school, as suggested in chapter 9.6, the archive-to-folder functionality might not work, because it requires the folder to exist prior to download. This might be solved by providing the students their local home directory by connecting the NTNU network to the practice school.

Expert Y commented that saving each note page or portion as an own file must generate a lot of files, and wondered if there was a way to bind coherent notes together. The expert was informed that this is possible in the system application, but I have not found a good way to solve this issue from paper level.

Users

This functionality in this scenario was the most appreciated by all the students.

Student 2 perceives this as a very useful functionality. In PPE she has do to a lot of trials of concept, and it would be great to have comments and

reflections archived together with other relevant notes in the same folder. It would make it easier to find relevant comments and reflections to the concept notes.

Student 2 says she is not great with organizing notes into binders, as student 1, so this functionality would be great for her. Especially because she likes to tear out the preparation notes and bring it with her to class and not bother organize them into binders after, but still likes to hang on to them. This functionality fits perfect for her. She can just throw the physical paper note away when the notepad becomes to chaotic. Everything is still organized in the computer anyway.

All three students perceived this functionality to be great for their organization of notes. And to be able to do this without much fuss is a big improvement from last semester.

10.2.3 S3: Sharing of thoughts to a common blog site

The evaluators were told that S3 can be solved by using both ioTags and specialized paper. No demonstration was done for this scenario, because if the student employed ioTags for this scenario, then it will be quite similar to S1, and the specialized paper has not been fully implemented and it was therefore not possible to show a demonstration. However, the evaluators were told that the main focus of this scenario is to illustrate the possibility of this system being used as an interface to other external systems, and it should be evaluated based on this.

Expert

The experts were positive to the idea that the system can include and work with external systems, and acting as an interface to other systems.

Expert Y commented that the scenario in itself seems realistic, because of the nature of blog postings which are impulsive actions. And to be able to write a blog entry whenever and where ever supports the impulsive nature of blogs.

Users

The users think the scenario seems realistic. Only student 2 has experiences with writing log, so the others could not comment from their own experiences. But they all think that it can be a very useful functionality if the blog system is introduced to the students at the beginning of the study and with some

training/small course to show how it works and to recruit students to use the system.

Student 2 was skeptic to sending email from paper, but was rather positive to the sending-to-blog functionality. She argues that because blog entries are usually about something that has just happened, and the author wants to share it when it is still fresh in mind. With the digital pen system students can write a blog entry right after class or meeting or other situations where there might not be access to a pc right away.

She has her own private blog on MSN and has experienced that while working with the finalizing of the portfolio deliveries, she has stopped updating her blog because she has not felt like she had the time to access the internet just to write a blog entry. She could imagine that she would keep on blogging if she had the opportunity to write an entry in her notepad and had it sent to her blog at next download. Maybe she could even blog from the bus with such a system. She appreciates the possibility of doing this anywhere.

But if the students were to use a blog site, then it is necessary that all or most PPE students are involved in the blogging. Student 2 told that she knew another PPE student with Norwegian as a teaching subject, and they are apparently using blog for their subject, and she had the impression that it was very useful for the Norwegian students to have somewhere to go to for information and tips.

10.2.4 S4: Basis group collaboration

As with scenario S3, this scenario had no demonstration either. The focus here is the possibility to collaborate through sharing of comments to multiple recipients.

Expert

The experts thought this scenario was realistic. Expert X said that he has experienced that the students send email frequently to their response group. To be able to send comments to every one in the group with only a tick of the pen seems very useful for the PPE students.

Users

The students thought this was a good scenario. It seems realistic and absolutely useful. Student 1 says he usually write all his comments to a response

text with pen and paper and then type it into the computer afterwards for sending. With this functionality he would have saved a lot of time.

Student 2 said she has daily face-to-face contact with her response group/person so the comments are just written on the physical text document and handed to the recipient. But she can imagine the usage of this functionality for those that do not have that much face-to-face contact.

The sharing of task; giving and getting response, can be effectively done with this enhanced digital note taking system.

10.3 Evaluation of the new extensions

Improved 'Subject' and 'To' text fields

The students liked the new improvement and think that it will be easier to use these fields now that they are bigger and with no restriction on the single letters.

The experts have not experienced writing in the old text fields and can only say that it sounds like a good improvement.

New functionality: Archive to Folder

This was the most appreciated functionality of all in this system. Both experts and users thought that this will be very valuable to enable students to archive their notes with minimal effort.

Proposed customized action boxes

These action boxes (Email, Group, Tutor, Blog and Folder) were well received. Both experts and users thought they seemed rational, realistic and useful. They make the sharing of long notes easier, and the fact that this was an alternative to use ioTags, provides the students with more flexibility which improves the system usability.

Expert X mentioned that these functionalities can suit well for students in science subjects in the next semester (autumn 2006), because there will be imposed more collaborative activities on these students.

10.4 System strength and weaknesses

Strength of this digital note taking system is that it enables students to take digital notes and other pc-related activities without needing to own a

computer. It provides digital properties that can be invoked at note taking time.

All agreed in the end that it is individually how useful the functionalities will be. But that the folder option will be useful for everyone. So the most important strength of this system is that it enables digital organization of handwritten notes in an effortless way.

A weakness of this system is that the email functionality requires the user to approve and click to send the email. If the students have made a lot of emails, the opening of all this email might cause computer troubles and it will take a lot of time from the students.

Another weakness is the perceived usefulness by students who have own computers and prefer to write on it, these students might not appreciate the new functionalities beside Archive to Folder, then this system will not add more value as a digital note taking system.

10.5 Miscellaneous

The evaluation form opened for discussion of other aspects than just the system functionalities. Following are the various issues that were discussed during the evaluation sessions.

Accuracy of conversion program

Expert Y was concerned about the accuracy of the conversion program, so she tried the ioTag Email function. The subject and email address were converted correctly, but the message content was written in Norwegian and came out as nonsense. This shows how important it is to have the conversion program in the local language. The handwriting and conversion program used in this system is still not very accurate, but as discussed in chapter 7.5, the development of this technology is going strong and there are already optimized versions of this program on the market. But this program was not used here because it is no longer free, and the focus of this thesis was the system extensions.

Context information capture

Expert Y suggests capturing of context information as a system extension. By making check box on the side of the notebook the students can give their notes more context information that is relevant for the note. But expert X argued that context in for example classrooms, are so many that there will be close to impossible to just choose a few for paper form. This is more

an issue for the pedagogical course to imply for their students, so they can include context information on their own.

Adapting the system for students without pc

At the present the students do not have access to personal profile on the computer. So the automatic storage to folder functionality can not work. The possibility to solve this issue is to make the NTNU network available to the practice school, for example through VPN connection. Or just make it possible for the functionality to create new folders at download and then the student can send it to themselves by email. But the best would be to connect the practice school to the NTNU network, just as the student housings apartments are, this way the students can access their home directory with their own folders from university campus, practice school and for some, also at home.

Paper formats

The preference of notebook format was diverse. From last semester a couple of student made a big deal out of the inflexibility of the notebook handed out. But Student 1 and 2 said they like the hard cover because it is more durable, tougher. Student 2 said he prefer smaller notebook format, right now he is using a small 'moleskin' A6 notebook. It is good because he has it in a dedicated pocket in his bag and then it does not get lost or become hard to find in the main bag pocket.

Student 3 said she absolutely prefer the spiral notepad because it feels more flexible, which corresponds with last semester feedback.

It's Learning

My impression from last semester was that they did not care much for this system, but I got quite contradictory signals this time with these three students. One said that her seminar group (2 basic group for the student management seminar) used the It's learning facilities to set up a system for debating, finding literature and other relevant information links etc. She found these facilities very useful, but she had to admit that her group was the only one that went for It's learning to set up such a site. She thought it was very good because they did not have to meet face-to-face as often as other groups.

It's learning is also good for storing all communication with tutor. Said that even mail and storage to her computer can sometimes be difficult to find (find the right file with the right comments). When this communication

goes through the It's learning system she can easily track down the wanted comments in the communication archive.

Economical issue

Expert Y was concerned about the economical aspect. She wondered if the digital paper (or notebooks) is expensive and if it was possible to print on site, or even design a paper form on the spot and print it.

The paper is more expensive than normal paper, but compared to the digital affordances of the system, then it is a better alternative to PDAs and Tablet PCs. The design of paper requires a licensed pattern purchased from Anoto, so designing on the spot might be a bit too complex to be worth it. Printing on the spot however is possible, but the printing of the paper file takes longer than printing of normal documents, so it might pose as an issue to print in huge amounts. But if the special paper is printed at the practice school it will make the system cheaper to deploy be the students and maybe it will be the system more popular.

10.6 Summary

The evaluators were asked to evaluate the scenarios and system functionalities after these criteria: Scenario realism, system usability and usefulness for the PPE students.

The scenarios were all perceived as realistic situations for the students to deploy the system and the usability of the system were perceived good.

There were some worries about the handling large numbers of invoked email actions simultaneously. This might pose some trouble and the students would need to spend a lot of time on it. They also worried about the issue of providing downloading stations at practice school. If the students were to be able to download their pen files at a docking station at the practice school, then how will the archiving to specified folder be resolved? A possibility is to connect the NTNU network and the practice school to provide the students their own home directories.

As for the usefulness of the system, the functionalities that enabled archiving of notes and blogging from the paper were thought very useful; this was agreed by all evaluators.

One student questioned the usefulness of email invoking functionalities. Students that are comfortable with writing on computers will think that it is as easy to do it directly on the computer and not bother to utilize the paper alternative.

But as there are many different types of students in PPE and the students agreed that there are still many students that will appreciate the various functionalities provided in the digital note taking system.

Chapter 11

Overall evaluation

This chapter aims to present an overall evaluation of my thesis work, from the research method to my contributions and finally the method used in the system evaluation.

11.1 The thesis goal

The main goal of this thesis was to design a customized digital pen and paper based note taking system for the practice based teacher education, PPE. This goal has been achieved by providing a system design that is in accordance with the research questions in chapter 2.4.

RQ-1: What are PPE's pedagogical objectives for their students?

This question has been answered in chapter 3, the pedagogical objectives of PPE is to make their students connect theory and practice in their education, and to promote this the students should do more critical reflection and collaboration.

RQ-2: How well does the students note taking and sharing pattern in their practice period correspond with the pedagogical objectives?

This has been answered in chapter 4. Note taking has been assumed to train critical reflection and the students note taking habit various among the students. Some do frequent note taking and organization of their notes, while there are still many who do not take much notes because of attitude related reasons, handwriting quality and organizational reasons. Sharing of notes among students is scarce and is an area that should be promoted more.

RQ-3: How can a digital note taking system promote the pedagogical objectives

Chapter 5 presents scenarios where a pen and paper based digital note taking system. These scenarios are examples of how such a system can promote the pedagogical objectives by providing easy sharing to different recipients and archiving of notes to cater for both less organized students and students who takes a lot of notes.

RQ-4: What extensions are needed for a customized system for the PPE students?

This question has been answered in chapter 6 Requirements. The requirements have been established by looking at the PPE students' common needs and the results from the autumn 2005 project, and focus on the most needed functionalities to enhance digital note taking and sharing.

RQ-5: How should these extensions be implemented to give the PPE students good usability?

Chapter 9 has tried to answer this question. The technology provides two possibilities to implement the proposed extensions, they are specialized paper with action boxes and ioTags, a written command, both of these alternatives provides functionalities that can be invoked by the students at note taking time. The difference between these two is that action boxes perform an action on the entire page while ioTags performs the action on a marked section of notes on the page. The solution proposed in this thesis is to combine both to provide the students with more flexibility on how to handle their digital notes.

11.2 Research methods

The methods deployed in this thesis are:

- Further literature review on the PPE study to motivate the focus on note taking and sharing in PPE, and to answer the research questions RQ-1 and RQ-2.
- Literature review on the state-of-the-art in the field of pen and paper based digital systems to get inspirations for my own work. This literature review can also function as inspiration for further exploration

of the possibilities to implement the system proposed in more specific situations, for example specific classes or activities in PPE.

- Developing deployment scenarios to support requirements and system evaluation.
- Experts and users system evaluation. These evaluation sessions have given valuable feedback on the systems value for the PPE students.

I believe that the research methods have provided a good base to answer the research questions well. And the outcome of the thesis work based on these research methods have given a well informed system design that can be implemented in the future.

11.3 System evaluation method

The evaluation method employed in the expert and user evaluation sessions were inspired by the Heuristic evaluation method which provided valuable feedback using minimal of time.

The evaluators were to evaluate deployment scenarios and the proposed system, and since the system has not been implemented in full, the evaluation method used here worked well to inform the realism of the scenarios, the value and usefulness of the proposed system, and it also opened for further discussions on other issues connected to the system deployment. The issues mentioned in the evaluation sessions can inform possible focus for further work with this proposed system.

The method employed here has provided satisfactory feedback and I believe this method has worked well for the system as it is. For a fully implemented system, the evaluation method should be more structured and be performed by the users to fully evaluate the usability of this system.

11.4 My contributions

My contributions in this thesis have been the deployment scenarios, the set of requirements for the system and its extensions, and the system design with some implementations.

11.4.1 Scenarios

The scenarios were made to illustrate possible deployment of the digital note taking system. I have based the scenarios on results from my previous project

and the literature review of the PPE study. I have tried to make these as realistic as possible, and I am pleased that they have been evaluated by both the users and experts as very realistic scenarios. This suggests that the scenarios have been a reliable source for the requirements and the extended system design.

11.4.2 Requirements

There were established three types of requirements for the digital note taking system; functional requirements, general non-functional requirements and specific non-functional requirements (see table 6.4).

Most of these requirements were fulfilled, see table 7.2 and chapter 9.2.

One requirement that was not fulfilled was *FR-3: Binding of notes at note taking time*.

The reason was because I perceived my proposal for this requirement to be not good enough, and I recommended further investigation in this area before a method is implemented for this requirements. This functionality was also asked for during the expert evaluation, suggesting that this should be a focus for the further work with this system.

The requirements for handwriting recognition and Bluetooth enabled digital pen are not fulfilled, but the technologies to support these requirements are assumed to be available in the near future.

Bluetooth enabled digital pen is already available, but the Logitech Bluetooth digital pen is not compatible with the io2 software and was therefore not chosen for this system.

11.4.3 System design and implementation

The proposed system design provides the PPE students with the most important functionalities to cater for the main areas identified in this thesis: *Note taking and the handling and sharing of these notes*.

During this thesis work, I have designed a system which extends the Logitech io2 system, which has received positive feedback in evaluation session.

To further inform on the development process the proposed ioTag: Archive to Folder, was implemented, and the specialized paper was implemented into the Logitech io2 system and it is recognized by the system. Due to limited knowledge of the development technologies, mainly C# and MS Visual Studio .Net 2003, the paper action boxes are proposed to be implemented in future work, when the future developers can focus more on learning the development technologies to implement these functionalities.

One of the expert evaluator suggested that this system, when fully implemented, could be interesting to employ in an experiment with some PPE students with science subjects in next years course (2006/2007). This shows that the system is perceived as useful.

The implementation of the ioTag: Archive to Folder, provides the PPE students with a very useful functionality. Both the experts and users evaluated this as the most useful functionality of the proposed system. This suggests that the system with the ioTag extension and simple augmented paper can be complete enough to be useful for the students.

11.4.4 My contributions with respect to state of the art

In chapter 2.1 State of the art, I have presented some present works that involve pen and paper based digital systems. Many of these systems also utilize Anoto technology to enable digital note taking with pen and paper or to enable pen and paper based interface for computer infrastructures.

The note taking systems have been focused on providing the user the ability to invoke the merging of handwritten notes with other digital media while taking the notes. With for example the ButterflyNet and iDeas (see chapter 2.1.1 and chapter 2.1.1) systems the user can decide on the order of notes and other digital media, such as pictures, on the note book and have it automatically inserted in the right place in the system application, and from there the users are also provided with more functionality, such as adding more pictures to the note and then share the digital notebook. My proposed system however, has focused on providing the users with more flexible note handling and sharing options at note taking time.

My system proposal has been inspired by the possibility of using Anoto technology as a pen and paper based interface to external systems, such as utilized in the UbiComp Scrapbook system and Kolberg et. al works in chapter 2.1.2. The sharing to Blog is therefore proposed to illustrate the possibility of utilizing this system as an interface system to other PPE relevant systems, such as It's learning.

Chapter 12

Conclusion and further work

This chapter is the final and aims to conclude this thesis work.

12.1 Conclusion

The goal of this thesis has been to design a customized digital pen and paper based note taking system for the practice based teacher education, with the focus on the pedagogical objectives of PPE.

Further literature review on PPE has provided the pedagogical objectives of PPE. These pedagogical objectives have been compared to the empirical data about students note taking and sharing pattern found in my previous work to find what areas need improvements to fulfill the pedagogical objectives. Literature review of state-of-the-art has given an overview of other systems that also utilizes Anoto technology, which is used in this thesis work. Together, the researches have informed four scenarios to illustrate the deployment possibilities with the note taking and sharing system.

Based on all this, a set of requirements was derived for the system. The system design was based on the Logitech io2 system deployed in my previous work. The Logitech io2 system enables user extension in the form of plug-ins and specialized paper.

The extensions were focused on the handling and sharing of notes. A specialized paper was designed which illustrate the possibility of customizing action boxes for sharing to multiple recipients. Then a plug-in was implemented to enable archiving of notes to a specified folder at note taking time, by taking advantage of a new feature of Logitech, ioTags.

The extended system design was evaluated by experts and users, who gave positive feedback on the realism of the scenarios and the usefulness of the system for the PPE students. The functionality that was most appreciated

was the enabling archiving of notes to specified folder at note taking time.

The system design has gotten positive feedback, and the note handling and sharing functionalities were perceived as useful, this suggests that this system is valuable as support for the pedagogical needs of practice-based teacher education.

12.2 Further work

Full implementation and testing

This thesis has provided requirements and a system design that can be useful for students' note taking and sharing purposes in PPE, and further work should be to finish the implementation and test the system with the target users. An idea is to employ the system with the implemented ioTag extension and augmented paper without the specialized functions. And then employ the fully implemented system in the spring semester to compare the usefulness of a system with only ioTags support, and a system that combines both.

Non-fulfilled requirements

The system proposed in this thesis does not fulfill all the requirements set for this work. The non-fulfilled requirements were mainly hardware or software requirements that are assumed to be covered by commercial products in the near future.

Binding of notes was a requirement that was not implemented because of lack of a good method for doing this. This functionality was mentioned by an expert evaluator, and should focus on a possible further extension of this system.

Specific deployment

The literature review of state of the art has shown the possibility of deploying this kind of systems in more specific subjects. This thesis has focused on the common needs of the PPE students and has therefore only designed a system to handle and share notes. A suggestion for further work would be to extend the system to be deployed in specific subjects.

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Appendix

Appendix A

Appendix A is a summary of the results achieved in my autumn 2005 project.

Appendix B

Appendix B is the list of Portfolio required texts in the Pedagogic subject. The requirements are translated by me from a Norwegian list to English.

Appendix C

Appendix C is an introduction to non-Anoto note taking systems that are also pen and paper based: Pegasus MobileNoteTaker and ACECAD DigiMemo.

Appendix A

Previous work: Students in practice

In autumn 2005, I did a case study on the teacher students at PPE, NTNU [2]. As seen in 3.5, one of the pedagogical objectives in PPE is to promote critical reflection among the students. Note taking (in various forms) is thought to be an important component of self reflection. In order to gain more information on this topic, I followed a group of 8 students through their practice period. I also introduced a digital writing system by Logitech to 4 students. The objective of this experiment was to see the potential of a digital writing system enhancing their note taking habits/attitude(???) and therefore make them better prepared for their portfolio assessment.

Another pedagogical objective of PPE is to promote collaboration among the students in both professional and social aspects, so it was also one of my objectives to get an insight in how this collaboration among students was working in the course and if it can or should be improved.

Following, I will give a summary of the different parts of my case study and the main results.

Note taking in practice

Types of notes

The notes that were taken can mainly be categorized into two groups:

1. notes that support people's retrospective memories and
2. notes that present information for future use

The types of notes that were reported taken by the students can be seen in the following table A.1. The types of notes are listed in a decreasing order that was reported from the student surveys.

Application area	Categorization
Class preparation	2
Meeting notes: evaluation	1
Meeting notes: organizational	2
Test marking and evaluation	2
Supervisor document	1,2
Evaluation of others: pupils and students	2
Seminar	1
Log	1
Supervising/tutoring	1
Reflection on practice	1
Forms for practice period	2
Literature	1,2

Table A.1: Note types

As we can see in table A.1, the types of notes that were reported from the students were distributed equally into the two categories, but the top most applied areas consisted more of category 2 notes than 1. Informal notes were taken in more extent than retrospective support. This might indicate that most of the students did not see how important reflection induced notes are for the course.

The situatedness of notetaking

Note taking in practice environment is different from the theory part of the course. The students are placed in actual school where they are assigned a limited work space and they have to be more mobile during the day because of meetings, classes and preparation for classes. Meetings can be both formal or informal, this means that the meeting places can vary between assigned rooms to just a sitting area situated in various places at the school. This makes the note taking environment quite mobile.

Note taking is not limited to fixed places, but vary for different situations. This makes heavy and big note taking artefacts, such as laptops, inconvenient. Traditional pen and paper artefacts becomes the most convenient tools for note taking in this environment. But even paper has its limitations. Too many loose paper sheets are easy to lose track of, and multiple note pads

or even just one big note pad can become hard to easily find a specific note. The students are at the practice school for a limited time, and then they will continue their study at campus as normal. Together with the limited work space, this put some restriction on storage space for these students.

Note taking habits/attitudes

Pen and paper were the most popular choice of note taking artefacts. 2 students preferred pc or laptop, but that was mainly because they did not like their own handwriting. This was given as the main reason for using pc/laptop. Those using laptop also commented that it was easier to edit and format their notes into complete texts. It was also reported that they rarely deleted anything/notes written on the computer, but almost all notes taken by hand have been thrown short after its usage.

The rest of the students used pen and paper for own notes, but when they needed to share their notes, they preferred to write it into the computer and then either sendt by email or printed out and given by hand. Exception seems to be for small informal notes to for example their responsible teachers at the school. This could includ note such as small feedback on how the class has been, absence list and pupils test- marks og comments.

The attitude towards note taking as a good support for reflection and learning in the course was varying among the students. A couple students expressed that they did not need much notes to be able to deliver a good portfolio, or as one said: *he didn't think it would matter*. While several expressed that they know how useful notes, logs and reflections, are but still forget or feel it unnatural to start taking notes during a discussion or very informal meetings. During the work shop after the practice period was over, one student admitted that she *realized now how much she has forgotten, even though right there and then it seemed so important and interesting that she thought it would be easy to remember*.

Only 2 students reported to make regular logs during the practice period, while 3 said they did it unregularly. The rest were not convinced that it would matter that much for their portfolio deliveries 3.3.1. But then again some of these students did not know what exactly was required for the portfolio deliveris.

One student especially changed his attitude towards notes already from the first interview for this study. During the interview we talked about the importance of note taking for reflection and it resulted in a student that was really comitted to taking regular notes, both from meetings and log notes. But he was very unorganized and feared that most of his notes would get lost eventually.

Experiment with a digital writing system

The experiment with a digital writing system included 4 students. The digital writing system was suppose to be a lightweight note taking supporting tools for the students, and it was to be used whenever it felt natural during the practice period. The system consisted of a digital pen and a special notebook that virtually functioned as a normal pen and paper. They gave feedback during the period through the diary surveys and we discussed it at the work shop after the practice period.

Digital writing system: the components

The chosen note taking support tool was a Logitech io2 Digital writing system. It consisted of:



Figure A.1: Digital pen and cradle

io2 digital pen This pen had normal ink and gives the same results as a normal pen on paper, but in addition it is also able to track with a optical sensor, and store pictures of what has been written with the pen when used on paper that enabled anoto functionality.

io2 cradle This cradle is a USB link, and is the method for transferring the stored note files in the pen over to the computer. This can be configured to do automaticly or by prompting when the cradle, pen and computer are connected.



Figure A.2: Anoto functionality enabled notebook



Figure A.3: Open notebook

Anoto functionality enabled paper This is normal paper printed with almost invisible dots that makes a code pattern that the digital pen can track. It also have action boxes that gives the user the ability to decide on action already at paper level.

io2 software This software is compatible with the digital pen and the special paper. When the files from the digital pen is transferred to the computer the software handles the actions already chosen at paper

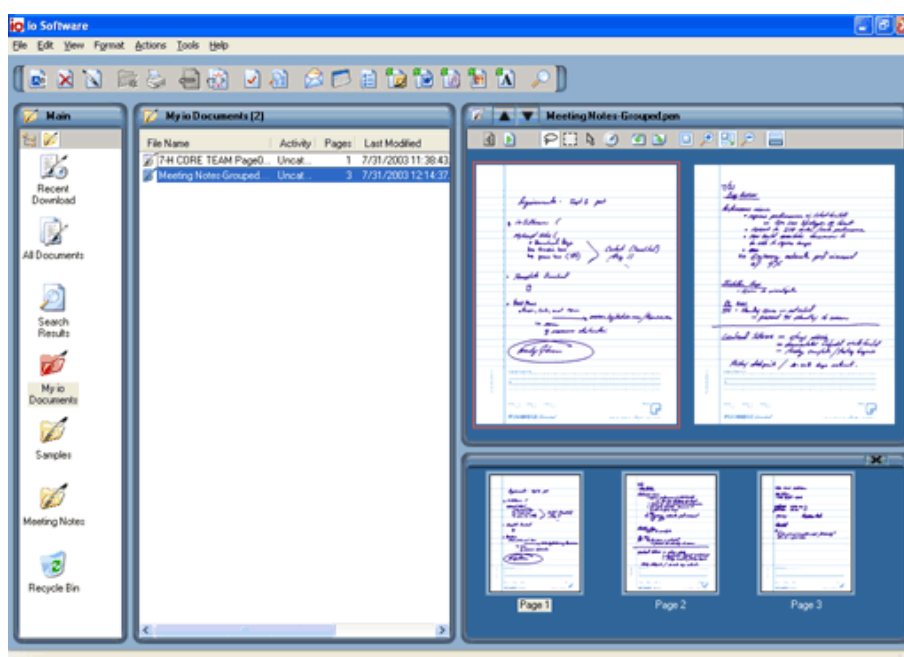


Figure A.4: io2 software

level and opens for more editing of the files that is uploaded. Possible actions were converting handwritten texts to computer texts, using MyScriptRNotes, sending the file as a picture file, jpg, to an email program etc.

The experiment

The students were handed the digital writing system at the start of their practice period. They were also handed a short practical manual in addition to the one that followed the package to give them some more tips about the system that was not clear in the original manual and to help them kick start the usage of the system. Each student were told that this is a study on digital pen for supporting note taking in practice teacher education and that they can use it when they felt it natural.

Since the digital pen and notebook work virtually the same as a normal pen and paper, I expected that they would use it for most of their normal note taking activities. The interesting aspect here is to see if they will find new ways to utilise the system and if they will find it more useful or better to use than normal pen and paper.

The usage and feelings about the digital writing system were to be re-

ported in the twice a week diary survey during the practice period. The students were to report how many times the pen was used, for what purpose and if any functionalities in the software was used or only tried. The students were also to report any technical problems with the system. At the work shop that ended the whole study, the students had the chance to discuss more about the system, what did work, what did not work and how can it be improved.

Feedback

The general feedback from the study was that the system was a bit bothersome to use.

One student did not find any use at all. He was one of those that did not normally take notes with pen and paper because he did not like his handwriting. He had big expectations for this system, but felt as if he was taken a step backwards by using the system. Writing and composing texts were more rapid on the computer and since the handwriting recognition did not function for norwegian language, the main advantage of the system fell away.

Another student did also find little use of the system. Both the pen and notebook felt big and un-mobile when it was in use. One of his teaching subject was music, and to use the digital writing system when the paper did not support notesheets was pointless. It was better to either just fill inn a notesheets with regular pen or fill it directly on the computer. The digital writing system as it is did not support this type of note taking.

The two last one used the pen quite a lot. They liked the ability to store their notes in one place and have it organized. Especially the one that are un-organized and feared that his notes would get lost, were trilled about the system. Still they did not make all their log notes in the distributed notebook, one because he liked to have everything organized into its own folders so he used another notepad, and the other one because he tended to take notes on what ever available at that moment.

None of the students found other use for it than taking notes as normal and archiving it all into one place. No special functionality was mentioned as usefull, they all agreed that it was easier to just start writing on the computer if they need to send it to someone or need to edit it.

All in all, the ones that were positive to note taking did find it useful. But except from the digital storage ability, they did not find it better than ordinary pen and paper. The system need to be able to convert norwegian handwriting to computer texts and they wished to see more editing functionalities on paper level. One student also wished that there were more

paper formats that could be used with this system, for examples filofax and notepad with tear-off sheats.

Collaboration

The PPE course wish to promote more collaboration among the students, and the organization of the practice period try to make it easier and more natural for students to cooperate or collaborate. As we can see in 3, the partnership model, the seminar and the school take-over 3.2 open for and encourage collaboration. The students even have some group assignments where the basic group has to work together on an assignment text.

During the case study, I observed the students at their practice schools several times and from the surveys, interviews and work shop, there were little indication on collaboration among the students. The basic group and the partnership group had good social contact, but their professional collaboration was limited to in-formal discussion in the work space or while car-pooling to and from practice school.

There were some collaboration among students that had responsibility for the same class or same subject. They had often closer contact with each other, but there were little written exchange here too.

The most active collaboration in this study seemed to be between a student and his or hers tutorer/supervisor. Texts were more often sendt between these in email format. It was also more often that the students had meetings with their tutorer than other fellow students. Maybe that is because the students don't need to allocate meeting times for discussions when they do it regularly with whom ever available between classes and other meetings.

The general tendencies

The general impression from the case study is that the students feel they have enough collaboration with other students. They don't have more tasks that require collaboration and all feel they get to discuss plenty with other students about their experiences during practice period.

There seemed to be little tasks that require more deep collaboration among students. Collaboration among students as a mean to encourage deeper level of reflection was not observed during the case study. However meetings and "collaboration" with tutorers or other teachers have seemed to given the students more foundation to reflect on. Class report and both group and individual meetings with tutorers or teachers present have been observed to bring up more reflective topics and thoughts among the students.

These opinions are based on few observations and will only be used for suggestions for how a customized system for note taking and collaboration can be.

Appendix B

Teacher Students' Portfolio

”In a Professional Development Portfolio, the candidate reflects on growth of knowledge, skills, and dispositions over time.”

Students portfolios are for creating a flexible working arena for part time students and students who completes their study outside campus. For these students there should be put more work into developing a digital arena for modifying and storing of studentns portfolios.

The above is hints for the need of virtual rooms for portfolio. To incorporate it into a blog site can be an idea. Have it private for each individual user until they are finish and can have it displayed for their future employers maybe. This rise a problem with the right to access a course specific site, even if it is a blog site. Can old users keep using the site after they have finished their study?.

On the other hand, it can develope into an alumni site where new students can get information from alumni students and in this way even enhance their learning even more.

Portfolio deliveries

The students are examined on their portfolio deliveries. In 2 semesters they have to deliver all in all 9 texts based on both their pedagogical study and their practice experiences:

1. Observation report
 - (a) Observation - focus/problem definition(problem stilling)
 - (b) Method - how did you collect the data?

- (c) Presentation/Interpretation - what does the observations show (the phenomena)?
 - (d) Analyse and discussion - what does the observations mean?
 - i. Use theory to explain/understand phenomena
 - ii. Use theory to support your opinions (syn)
2. Practice summary
- (a) Put your practice in a context (class/year, schooltype, nr of students, professional level, sex distribution..)
 - (b) What did your practice consist of (subject, project, take-over (week))
 - (c) What did you succeed with?
 - (d) What kind of problems/challenges did you encounter?
 - (e) Why did you succeed/fail? (back up with theory)
 - (f) What do you wish to work with in the next practice period?
 - i. As concrete progress goals as possible
3. Teaching plan (undervisnings opplegg)
- (a) Background information (subject, class/year, description of group/class..)
 - (b) The goal of the plan
 - (c) Theoretical arguments for the plan
 - (d) The teaching plan (content)
 - (e) The execution of the plan
 - (f) Results (the pupils reactions/experiences/apprehension (oppfattelser))
 - (g) Analyse/evaluation: In what degree did the plan succeed?
 - i. Did you reach your goals? Apply theory to analyse/argument (begrunne)
4. School political theme
- (a) Outline the theme
 - (b) Put the theme into a context
 - (c) Your view on the theme
 - (d) Discuss your view against others (politician, teachers, experts)

- i. Use theory to argument
 - ii. Theory can include legal framework, education plan, specialist literature
 - iii. Theory can also include own observations and experiences
- 5. Seminar contribution
 - (a) Orally genre
 - (b) Presentation part:
 - i. Presentation of theory?
 - ii. Presentation of observation?
 - iii. Presentation of teaching plan?
 - (c) Argument-/discussing part
 - i. Theory to support/back up own views
- 6. Progress document (additon to text 2 (bygger på))
 - (a) Has to contain goals after 2nd practice period: thoughts about further progress (utvikling)
 - (b) Shall show how progress goals from first semester are followed up
 - (c) Practical experiences shall be discussed based on theory (drøftes i lys av)(see text 2)
- 7. Integrated task
 - (a) Integrated task in subject1 and pedagogic
 - (b) Includes subject didactics ("fagdidaktisk ") and pedagogic theory that are employed in understanding and reflection over real situations from the classroom/school in a broader context
 - (c) You can base on a case/teaching plan/experiences from practice, describe this, analyse with the help of subject didactics and pedagogical theory, discuss which consequences this have for future practice (pedagogical consequences)
 - (d) The work can be based on a work from the first semester which you would like to elaborate
- 8. Text about: Class environment development, adaptated education, bullying, equality questions, ethnical and minority questions in school

- (a) The text can be a pure theoretical or
- (b) The text illustrates the topic through experiences from practice and theory
- (c) The topic has to be reasoned for (why is this topic central for you?)
- (d) The text must contain a problem to be addressed through discussion

9. Personal text

- (a) Free choice of topics and genre, but have to in one way or the other deal with the teacher profession
- (b) The texts must not contain theory
- (c) You can readily explicitly in the preface or epilogue say why the content is significant for you as a teacher/teacher student
- (d) Ideas: an incident from your pupil that has made an impression. A teacher that has meant something special. A student from practice that has made an impression.

Appendix C

Non-Anoto pen and paper based note taking systems

Pegasus technology

Pegasus [40] has developed a digital note taking system that lets the user take notes on regular paper, using a simple digital pen and a memory device which receives signals from the pen. The technology is based on ultrasonic positioning technology. This technology utilizes ultrasonic transmission, from the tip of the pen, and time measurement of the duration since the pulse had left the pen until it reached the receiver. The memory device captures all handwritten notes and provides a digital copy of the note.

Pegasus has two product lines in this category: PC NoteTaker and Mobile NoteTaker. As the name implies, the latter is a mobile version of the PC NoteTaker. Since these two products are basically the same, I will only look into the mobile version, since this adds more functionality.

Mobile NoteTaker

Both the PC NoteTaker and the Mobile NoteTaker, see figure C.1, utilize a clip on memory device as the sensor for the handwritten notes taken on the attached paper. While PC NoteTaker requires a constant connection to the computer, the Mobile NoteTaker, as the name implies, has a mobile memory device. This device does not require connection to the pc application to make sense of the writing.

The pen transmits its tip location in real-time to the receiver located in the base unit. The tip location is then drawn on the base unit LCD, and saved into memory, which can save up to 50 pages of A4 size paper. After

loading the saved notes to the PC, the PC Notes application translates the tip XY location to digital format that enables the user to view their handwriting on the screen. The screen also enables the user to go back and review their previous notes and delete if wanted too without going through a computer. For more functionalities the device must be connected to the computer with USB cable, and download its note files.

In connected mode, the Mobile NoteTaker can also function as a digital tablet, with its compatibility with MS Office; the user can do direct annotations and drawings on Power Point files, Word documents, Outlook, Excel etc. The digital note can be send to anyone, but this requires that the receiver has the PC Notes application installed and running.

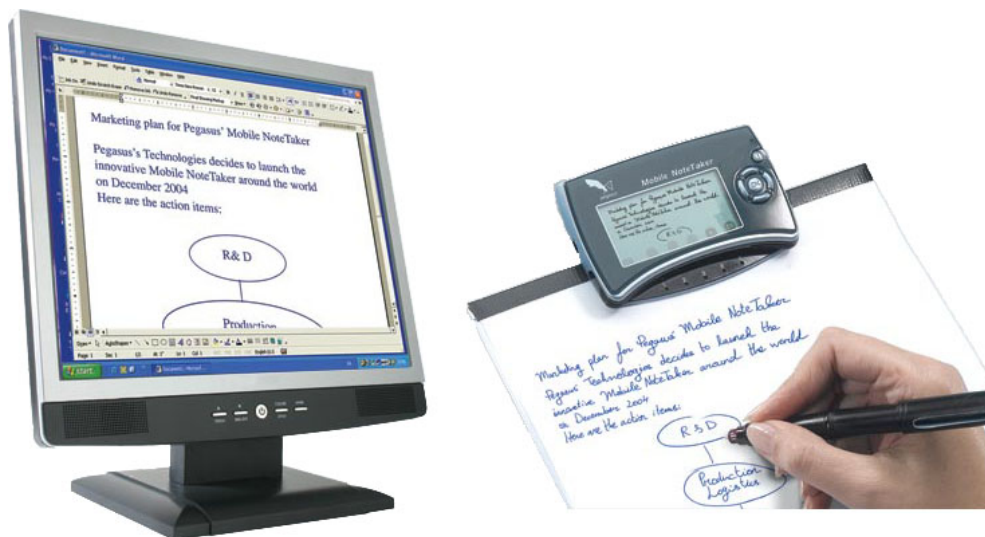


Figure C.1: Mobile NoteTaker

This system utilizes normal AAA battery for the memory device and button cell (SR41) batteries for the digital pen. And the dimensions and weights is shown in the table C.1

Mobile NoteTaker	Dimensions(mm)	Weight(gr)
Memory Unit	107 x 65	90
LCD	128/64 pixels 66x32	
Digital pen	136 x 13.7	16
Total		106

Table C.1: Mobile NoteTaker Dimensions

ACECAD Technology

ACECAD's DigiMemo [41] is also a pen and paper based digital writing system that has its main sensor mechanism outside of the pen. The technology is based on a electromagnetic notepad and a simple¹ digital pen. When the digital pen is writing on paper attached to the digital notepad, the pad capture the pens motions and stores it to the internal memory or to the extra memory card in the notepad. The digital copy of the notes is downloaded to computer by connecting the pad with a USB cable.

DigiMemo

The newest version of DigiMemo, A502, has a digital notepad that can handle paper up to A5 format and can work with up to 12 mm of paper or approximately 120 sheets.



Figure C.2: DigiMemo

As seen in figure C.2, the digital pad has a small display to show the page number, each time the user wants to start on a new page, he or she must press on a button to tell the system that it has started on a new page.

¹Simple in the meaning of no memory, processor etc

DigiMemo offers a 32 MB built in memory and has a memory slot for optional CompactFlash memory card. The digital pen utilizes a button cell (IEC-SR66) battery that is claimed to work for up to 14 months. This enables the users to work away from their computer for a long time without worrying about the battery capacity. Its dimensions and weight is showed in the table C.2.

DigiMemo	Dimensions(mm)	Weight(gr)
A502 digital pad	309 x 209	560
Digital pen	34 x 11.3	13.8

Table C.2: DigiMemo Dimensions