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Touch, learn, play -
what children do with an iPad in the classroom

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Acknowledgments

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Abstract

This thesis presents a case study of technology acceptance of iPad as a classroom tool. The study spans an eleven months period within the context of a rural Norwegian elementary school. Six iPads were introduced into classroom information ecology of a fourth grade class. Through ethnography-based observations, workshops, questionnaires and interviews, changes in the classroom information ecology are documented.

In cooperation with the teacher, some parts of the curriculum have been adapted to this new platform. Observations were made around the use of iPad both in the classroom setting as well as at home for the purposes of learning, entertainment and socialization.

Contents

1 Introduction

In this thesis we describe a case study of introduction of iPad in the context of education, as an instance of classroom technology. Through Cuban's research (Cuban 1986) we see that historically, many waves of new technology have passed through schools and classrooms, none leaving a lasting effect. Computers have been found to be unused or underused (Cuban 1999; Cuban 2001) in most schools. Factors contributing to this situation are many and well researched (example (Norris, Sullivan et al. 2003; Zhao and Frank 2003)). About the tablet, Cuban says: *"There is very little evidence that kids learn more, faster or better by using these machines. iPads are marvelous tools to engage kids, but then the novelty wears off and you get into hard-core issues of teaching and learning".*

The tablet, while it may be viewed as an educational technology, really is a piece of general-purpose mobile technology. Education, as it often happens, is using this new technology not originally intended for educational purposes, and attempting to adjust it to an educational context (Cuban 2001). However, unlike "desktop technologies" mobile technologies have potential to change the time and space for learning, with considerable advantages, both pedagogically and technologically (see for example (Kukulska-Hulme and Traxler 2005). Many of the technical limitations with classroom technologies are often easily overcome. Terms frequently associated with this form of learning are "any time" and "any place", "personal", "opportunistic", "persuasive", "situated", "private" etc. With the appearance of tablets on the market, in particular iPad, this potential for redefining what constitutes a learning space, how and when learners engage with learning activities, has been seen by many as the real shift in the mobile learning paradigm. Many educators are aware of this potential for change towards a more constructivist approach to learning. Studies are being conducted worldwide evaluating the use of iPad or similar tablets in the classroom (see (Chen 2010) (Hu 2011), or (White 2010)). The principal of a Danish school conducting one such experiment (Vollen 2011) said: *"It does not sound nice, but we'll see if we can claim a larger portion of students' free time. The path to learning is now shorter. Students may, whenever the opportunity arises, read school related texts or watch videotaped lectures in the comfort of their sofa in the evening."* (Culén and Gasparini 2011).

Several different approaches have been used to gain understanding around factors influencing acceptance and use of new technology in the classroom. Three of them have been directly or indirectly used in this study.

The first one is based on exploring technology acceptance models (TAM) in an educational setting. (Teo 2011), for example, a book that gives in part 1, general introduction to technology acceptance in educational settings, while in part 2, it moves into exemplifying acceptance cases of specific technologies. Teo (Teo 2011) define the technology acceptance model in a proper way:

"Technology acceptance can be defined as a user's willingness to employ technology for the tasks it is designed to support ... These circumstances have provided the impetus for researchers to examine technology acceptance in educational settings. Although these studies have typically involved students and teachers as participants, their findings have far-reaching implications for school leaders, policy makers, and other stakeholders. In recent years, technology acceptance research has been reported with increasing frequency in education-related journals and this is an indication of its growing importance in the realm of educational research."

The models suggest that a number of factors influence users' decision about how and when they will use the technology: perceived usefulness, perceived ease-of-use (both defined in (Davis 1989)), cognitive absorption, personal innovativeness, the role of teacher, information satisfaction, self efficacy, relevance to the context of use, playfulness, perceptions of external control, support etc. In a study considering acceptance of the iPad within a higher education institution, it has been found that various forms of ownership play an important role in acceptance of the tablet for the use in an academic setting (Culén, Engen et al. 2011). This study was a predecessor to the one presented in this paper. The main result of that study was that iPad was not accepted as a tool, and some of these results will be presented in chapter 8 this thesis. However, while we could establish some of the factors that led to non acceptance, we did not establish what would make an iPad into useful piece of IT in our study context, very much in accordance with (Barki and Benbasat 2007): "*in the final analysis this approach* (TAM) *has basically provided explanations or antecedents for one set of belief perceptions via another set of belief perceptions, without also increasing our knowledge of what makes an IT useful."*

The second approach ((Knapper 1980) Effective Research Designs for Improving Learning; Chapter 3) is based on locally valid and useful research designs and focusing on understanding how schools, school districts, and state and national educational authorities move through the process of investing in and implementing educational technologies. The question ((Knapper 1980) Effective Research Designs for Improving Learning; page 87) that is central to this work *"How can researchers act as mediators, synthesizing the findings of locally generated evaluations to inform policy?" This question requires a response that links together two sets of goals: (1) finding scalable and substantive ways to support local school communities in thinking differently about evaluative questions and about evidence; and (2) finding equally substantive and effective ways to synthesize and disseminate local findings to a much broader policy community."* is of high relevance for the kind of research presented in this paper. The research is very local, and some interesting evidence has been found. From the researcher's perspective, it is usual to report the findings through conference or journal papers in the research community and it often ends there. The aforementioned goals call for taking the next step, and disseminating local findings to both schools and policy makers.

The third approach and the one adopted for this study is based on the information ecology. The concept of information ecology was introduced by Nardi and O'Day (Nardi and O'Day 1999) as "*a system of people, practices, values, and technologies in a particular local environment*" and it focuses on five defining characteristics 1) it is a *system* 2) the system contains *diversity* of people and tools 3) there is a change or *co-evolution* happening over time and through use of technology 4) *keystone species* are part of the ecology (their presence is critical for the system's survival) and 5) *local habitation* (the habitation of technology is its location within a network of relationships).

Nardi argues: "*Human expertise, judgment and creativity can be supported, but not replaced by computer-based tools."* One should contemplate the technology with both the head and the heart and not fall prey to either technophilia or technophobia. In 1984 Turkle (Turkle 1984) states the following regarding computer technology: "*Most considerations of the computer concentrate on the "instrumental computer", on what work the computer will do. But my focus here is on something different, on the "subjective computer*". This is the machine as it enters into social life and psychological development, the computer as it affects the way we think, especially the way we think about ourselves. In some ways, much has changed since 1984 when the book was first published. Yet, much has also remained the same. These days it

is the mobile technology that is becoming ubiquitous in the classroom, and tablets are of special interest. We see both the view of “instrumental tablet” and “subjective tablet”. The instrumental side is answering questions around how the iPad may be best used in the classroom and outside of the classroom for the purposes of learning. The subjective side addresses the plethora of factors such as personal relationship with iPad, social changes it induces, taking a larger freedom in designing the curriculum, avoiding stigmatism in cases of children with special needs, self image, changes in a way of thinking etc.

In choosing the classroom information ecology approach, we may observe both the instrumental side and the subjective side of the tablet use at once. Some changes to the defining concepts of classroom information technology need to be made in order to include new participants such as friends and family, enlarged network of relationships, broader range of locations, yet more personal relationship to the device.

The personal relationship to the device opens up for the new uses of the iPad in the classroom setting, such as assistive technology (AT) for children with special needs (see, for example, (Shah 2011)). In the setting in which this thesis work was conducted, we have found a small number of students with reading difficulties and conducted an experiment with a simple goal to show the possibilities the iPad may offer to these students.

In the next chapter, we first state our research questions and motivation behind them. This is followed by some reflections on technologies that were tested as candidates for classroom use prior to the introduction of the iPad, most notably e-book readers and personal PC´s. We also discuss briefly iPad´s technical specifications. In chapter 4, we provide literature search on iPad in education. Since this part of the thesis was done first in the process of writing, it may be that a body of work that was published between then and now is not represented in our findings. But the chapter represents accurately what could be found about iPad at the start of the work. In chapter 4 we describe our case study of the acceptance and use of iPad in the elementary school setting.

A special note: part of this research has been published (see (Gasparini and Culén 2011; Gasparini and Culén 2012)). The author of the thesis is the first author of the two papers that are the backbone of this thesis.

2 What is Interesting about iPad

2.1 Motivation

As mentioned in the introduction, iPad is a mobile device that was not originally designed for education, but has a potential to be successfully adopted for that purpose. Many pilots and trials, some of which will be mentioned in Chapter 4 confirm that iPads have considerable pedagogic potential, and that many of the technical limitations of classroom desktop technologies may be easily overcome. Mobile learning is now gradually moving from small-scale, short-term trials to larger, more sustained deployment in classrooms worldwide. Variety of devices have been employed in different settings and studies such as handheld computers, personal digital assistants (PDAs), e-book readers such as Kindle, mobile phones, smart phones, wireless laptop PCs and personal media players such as the iPod. These platforms are often enhanced by location-sensing functionality such as the Global Positioning System (GPS), digital cameras and others. iPad, like for mentioned devices possibility of design for learning that is essentially situated, spontaneous, personalized etc. as well as giving opportunity to aim specifically at certain aspects of learning that may be supported by device such as sharing the content, cooperation and communication as well as production of applications that may be student or teacher generated, thus catering to very specific needs of users. Due to this last feature, the very first study (Culén and Gasparini 2011) the author did was with graduate students at the University of Oslo, in hope to see some user generated content or at least a selection of content from the Apps store or fine tuned lectures from the iTunes University. None of these possibilities were used. The strongest three factors for non acceptance of iPads were identified as various forms of ownership, time and perceived ease of use (Culén, Engen et al. 2011). Thus, the starting point for this thesis was to situate it in an environment where these factors are eliminated. Elementary school students were chosen since they still do not have attachments that would define their relationship to proprietary software for example, or the fact that they do not actually own the platform itself. They also have more time and less stress and worries about their future, so they from the start could have more playful relationship to the iPad. However, the chosen groups of users, the fourth graders, are still to young to be candidates for generating the content. Their teacher, who was very positive to trying this technology in the classroom, was not interested in production, but rather consumption of material on the iPad. Thus this work is seen as part of the larger work

that is to come; it is seen as the first step towards learning about classroom use, how classroom ecology changes with introduction of the iPad, what happens when the boundary between home and school is a blurred.

2.2 Research questions and methods to work with them

Question one: **What is known regarding iPad and education?**

This question was tackled using extensive *literature search*. Using different resources a large body of results was collected. The results of the search were then analyzed. This part of the research is presented in Chapter 4.

Question two: **How suitable is the iPad as a tool for elementary school education?**

This question has been addressed by using a *case study*. A case study is in depth study of particularity and complexity of a single case, which may lead to understanding its activity within some context. In our case, even though the case is about the use of iPad in a specific school and a specific classroom, the hope is that it will illustrate and inform about introduction of this technology in elementary school classrooms with children in grades one through five, as at that age, the children are mostly consumers of new technology.

We, of course, do not have the final answer in this thesis regarding the question of use and acceptance of iPads in classrooms. Our case study is still going on, as we desire to observe long-term effects, we need to know what happens when the novelty wears out and new technology floods the market (such as android, for example). The results we gathered for the first 11 months and described in Chapter 5 are giving some answers to the above question.

3 Background

3.1 Predecessors of iPad: PC's designed for educational purposes and e-book readers

Two important artifacts had already made its way into classrooms before the iPad entered the market. The e-book reader and a PC's for education.

The e-book readers were developed foremost for the broader market of leisure reading. An example is the e-book reader Kindle, developed especially for the online bookstore Amazon. In an effort to introduce it in the educational market and sell digital curriculum a larger e-book reader was developed, but failed at large to satisfy the students (Princeton 2009).

The author of the thesis has had an opportunity to test the first e-book readers such as Iliad and Sony in several different contexts (see Figure 1). Some of this research is reported in (Culén and Gasparini 2011).

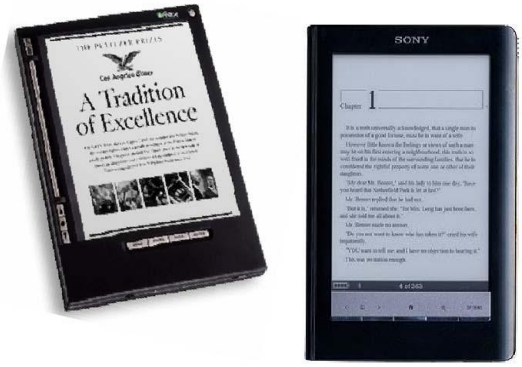

Figure 1 - E-book reader Iliad and Sony

Sony has already produced six models of e-book readers. The first one came out in the USA in 2006. The new series of e-book readers, available from 2009, come in 3 different sizes to fit some specific uses. A pocket edition with a 5" screen and navigational buttons, a touch edition (see Figure 1) with a 6" touch screen and a memory card slot and last the daily edition with a

7" touch screen, weighting from 0.5 lb to 0.75 lb. All of the readers have wireless connection through 3G mobile networks.

The interesting question at that time was difference in experience between reading in paper and reading digital content (Culén and Gasparini 2011).

As noted in (HCI-book 2011) , "*Reading itself was for many centuries mainly conceived of as a ruminatio (pondering at length). In the eighteenth century, a new relationship to reading appeared, making it legitimate to browse through vast amounts of reading material. This form of "extensive reading" became pervasive with the advent of newspapers and magazines."* In order to better understand the dynamics of interaction between the reader and artifact (whether book or e-book reader), we have conducted ethnographic studies to observe how people read books and other printed material as both active and passive readers. Active reading implies other type of activities such as annotation, text comparison etc. while reading. This kind of reading is often related to education and learning.

The following summarizes what was important about paper books to readers we observed and interviewed:

- The smell of the book, in particular in the library and at used bookstores.
- The sense of touch, the feel of the book as one picks it up.
- The quality of the paper. As one subject described, "*Touching a glossy page of a book from a photographer, makes me more respectful than reading a novel in a pocket format*."
- The size of font and spacing between the lines.
- The weight of the book.
- When the user keeps the book in his/her hand while reading, the grip of the book provides a sense of how far along one has come in finishing the book.
- Cover art (its content, style, quality, texture etc.).
- Quickly finding a specific location in the book (through the index, for example).
- Page indexing using post-it notes or other markers give extra functionality to the paper book.
- The ease and speed with which one can move back and forth between pages (see also (Tajika, Yonezawa et al. 2008)).
- Notes and underlining done by others in used books is important (and can be experienced as either frustrating or interesting/helpful).

- The amount of wear of the book can affect the choosing of it (see also (Druin, Bederson et al. 2001)).
- Sharing a book is important to many readers (not only the actual physical copy but also in discussing the content with others).
- The social aspect of holding and reading a book may be used to communicate certain message about the reader. *"Reading a medicine text book on the bus gives another signal than if I am reading comics,"* remarked one reader.
- Variety of ways of using books (such as pressing something with them, using them as physical objects)

It was interesting to ask: what happens to all these sensorial and emotional factors related to paper books when they are digitalized?

A sample of 41 users was selected from library attendees to tell us about the difference in reading on the e-book reader vs. paper. All of the 41 users were interested in trying reading on an electronic device. Approximately half of respondents (21 users) preferred text in PDF format, finding it easier to read.

All respondents (41 users) desired a better framework for downloading e-books from the library into the reader. Six users found the Sony software for communicating between the e-book reader and their computer was difficult to use.

Eight users pointed out that turning the pages on the device was annoying because it took too long.

Six respondents noted wanting to be able to annotate and mark the text on the e-book reader. One person said s/he would want a dictionary included as part of e-book reader software.

- From direct observations of people using e-book readers and short interviews with users, we found out, consistent with the findings of earlier studies (Schilit, Price et al. 1999; Tajika, Yonezawa et al. 2008; Moore 2009) that users would like the electronic texts to have:
- Color images and text
- Information about original pagination
- Tables of content for each document
- Fixed/standardized layout and page orientation
- Providing a structure to keep similar texts together
- Portability and comfort in use from different positions (sitting, lying down)

- Focus on reading comfort (with clear and large text

and the ability to adjust to different lighting i.e.

outdoor vs. indoor, daylight vs. nighttime)

- Search capacity (through both the text in use and

those available on the device)

- Annotation tools
- Highlighting capacity
- Simplified navigation between documents
- Capacity to interact between different information

platform media

- Tools to facilitate collaboration

The aforementioned e-book readers, Iliad and Sony, were tested by the author in the context of active academic reading and it became very clear that e-book readers couldn't be easily adopted for active reading. One may read academic texts on them, but annotation or any other kinds of interactions (such as searching) were difficult.

However the iPad supported many of the above-mentioned functions with ease and stability and was thus embraced by many schools as a viable classroom technology.
The question that partially motivated the research in this thesis is: "Will iPad fare better then Iliad and Sony, or for that matter Kindle, in the academic setting?"

The latter initiative started with "100$ laptops" that evolved into a PC tablets named Classmate PC (Sharma, Abraham et al. 2010), basically a laptops with key characteristic very close the ones iPad has. The characteristics includes touch screen, writing on screen, rotational camera, accelerometer and small size. The focus of the initiative was to see if the children and the teachers were motivated to use this new format for reading and writing. The introduction of this artifact in the classroom was of interest also in regard to how children create knowledge at school or wherever they use this Classmate PC (a child as a producer, not only a consumer of knowledge).

As mentioned before the Classmate PC (CMPC) has many unique characteristics, but all present in the iPad, making this artifact obsolete now. Observing Figure 2, it is possible to se

in the first image the rotation of the screen making the artifact like a tablet. The motivation for making the CMPC was to support activity of reading, handwriting, and drawing in the classroom. Research point out that children today spend more time on computer then reading, emphasizing the need to offer on the CMPC services performed before on paper (Sharma, Abraham et al. 2010).

Figure 2 - PC tablet developed for educational purposes and in cooperation with children

A test done with the CMPC (Sharma, Abraham et al. 2010) reviled the following:

"Children loved that one device was enabled to do all these reading tasks, could store multiple e-books which saved physical space and considered this environmentally friendly. Further, students had access to the same e-book unlike in libraries where the copies are circulated or stocks limited."

The CMPCs had, according to the authors, the perceived usefulness and perceived ease-of-use mentioned before in the context of TAM framework. Concluding observations made in that project, relate also to the need to take into account teachers and designers when working with children and classroom artifacts. However, the between children and the platform, as well as the access to digital content, are key factors to success. As this thesis will show, those factors are supported with the iPad.

3.2 Technical specifications of iPad

The project described in this thesis is based on the use of the technological artifact iPad (see Figure 3) produced by the American company Apple and launched in April 2010. It belongs to the class of devices called tablets. The size of the first version was 242.8 mm cm x 189.7 mm and only 13.4 mm thick. The weight was 0.68 Kg. The first iPad had a touch sensitive screen, but did not cover the whole screen area, specifically the border around LCD screen. The display had a fingerprint-resistant oleo phobic coating.

Figure 3 - The iPad

On the screen the iPad has only one button, which activates the communication to the screen. On the right hand side you have a volume up/down bar and a switch to mute the sound directly. On the top, a jacket for the earplug is present. On the bottom, you have a 2 cm long 30-pins dock connector port used to connect to a personal computer or to charge the battery. The iPad has a three cm large built-in speaker. One of the important advantages in relation to a laptop is the battery time. The iPad has a ten hour uptime when using it continuously.

The tactile interface is enabled when using one or more fingers across or taping on the screen. The iPad has also a gyro sensor enabling another communicating interface between the user and the artifact. This sensor registers movements of the iPad. This is very easy to see with an application named BUMB, which allows communication of pictures, contacts and so on, between iPads or iPhone through a wireless connection. It registers the connection only when the two objects are "bumped" together at the same time.

The iPad communicate using two types of access, Wi-Fi and cellular. The cellular gives access by using the 3G mobile networks. The iPad has also one short-range communication support, the Bluetooth. The Wi-Fi and the cellular enable access to the Internet.

A wide range of accessories to be used with the iPad is also available, but the two we consider to be invaluable for classroom use: the adapter for VGA and the original iPad cover that enables multi positional viewing. The VGA adapter, that allows the iPad to connect to the smart board and show the content of the iPad on a big screen, was used in this project. The iPad Case was not used. Simple protective bags were used (see Figure 4), but the functionality of multi positioning viewing was not there. The iPad Case have reinforced panels to provide structure and it folds in a way that acts as a stand that holds iPad at an angle perfect for typing on the onscreen keyboard.

3.3 App Store and iTunes

For an efficient use of iPad, a user needs an iTunes account in order to access the "App Store", Apple's official online application distribution system for iPad, iPhone, and iPod Touch. iTunes does more than selling of apps, it also automatically takes a backup of all the content on the iPad and stores it locally on a Personal Computer. The applications one can purchase through the App Store vary in price, with average price per app being only $2.20 (Metrics 2011). Many applications are also offered free of charge. Total number of active applications is 510,412 per November 20, 2011. Searching for a subject of interest gives usually a vast range of choices, covering subjects like creativity, productivity, education, entertainment and many more (see Figure 11). To install an App, the user needs to have access to a Wi-Fi network and the only action left is to click the install button. For the 4th grader, installing an App on the iPad is quite a bit easier than on the Personal Computer,

where antivirus, user permissions and locations for the installation are issues that even some parents do not find so easy to accomplish. Since Apple does control both the content and the functionality of the software on the iPad platform (all apps are subject to approval by Apple, and Apps with dubious content are not approved), a young user is given a constrained arena, often perceived by parents to be "safer" than the PC. This has its positive and negative sides, which will not be discussed here. We touch only lightly on the issues of proprietary software in Chapter 8. In order to uninstall an App, the user needs to hold the finger on the App, until it starts vibrating and showing a little x that needs to be pressed. The App is then uninstalled on the device. The children we worked with never had any technical problems or issues with reaching the App store, installing or uninstalling applications they used.

Figure 4 - Categories in App Store

4 Literature Review

With the introduction of the Apple iPad in April 2010, a new wave of tablet PCs has entered several marketplaces and new uses of the compact devices are being explored. Publishers, libraries, schools, newspapers, and other knowledge-based companies have tested the iPad for possible use in applications, workflows, and enhancing education. To get a better overview of possible arenas where the iPad can be applied, we created a map of possible practical applications (se Figure 5). Based on this picture, we developed a search strategy.

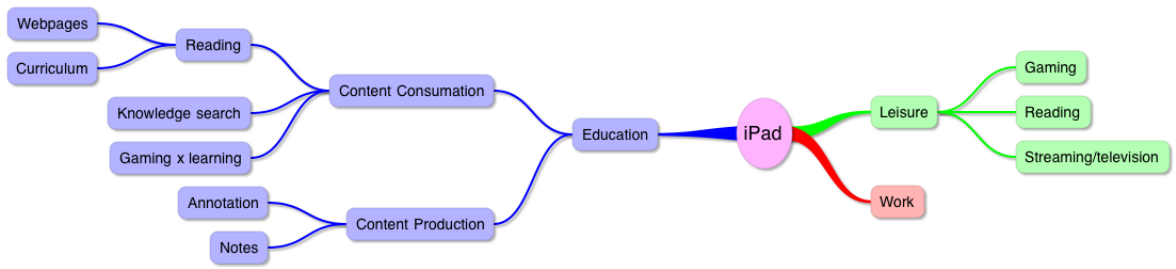

Figure 5 – Effect of the iPad on different fields

The search terms were restricted to the fields closer to the aim of this thesis: the use of iPads in connection with teaching and learning. While searching, subjects and fields taken into account included how the introduction of information technology communication (ITC) in a classroom would affect the teacher and the students and the importance the collaborative learning spaces.

4.1 Search strategy

The main strategies for the literature search were based on the resources of the University of Oslo Library (BIBSYS, DUO, PRIMO, and X-port). BIBSYS contains information about books and magazines at 100 libraries in Norway. DUO includes electronic versions of theses, dissertations, and special assignments and a growing number of doctoral dissertations and

articles at the university. X-port offers, among other things, access to databases with references to articles. In addition, via X-port, it is possible to perform meta-searches on specific journals. Via the portal X-port, users can also access the portal at NTNU, the University of Bergen, and the University of Tromsø. We used these services because some meta-searches use different databases and journals. The author also looked for academic papers in Google scholar. Finally, we used a new service, Primo, launched in the summer of 2011 by the University of Oslo Library. This service is similar to Google scholar, but it has a better meta-search with a large common index made of information from many databases.

4.2 Methodical search

Searches were made via X-port in the databases recommended for computer science (ACM Library, Collection of Computer Science Bibliographies, IEEE Xplore, Inspec, and ISI Web of Science) and education (ERIC, Sociological Abstracts, and JSTOR). BIBSYS was searched with Norwegian and English keywords. We also searched directly to some journal providers, such as Emerald. Then references to other articles or research reports were checked, since they can provide valuable information about projects or studies that have not yet published. The time period the search for literature was done range from January 2011 to June 2011.

4.3 Criteria for search

The search focused on five main terms regarding teaching and the iPad: iPad, iPad project, iPad children, iPad education, and Tablet PC. The terms “teacher,” “math,” and “report” were also added to the search as needed. These were necessary when the results were influenced by the fact that the word “iPad” is used as an expression in both medicine and physics.

4.4 Results

The summary showed the results of the “hits” from the various databases where the main term "iPad" was used in searches. The number in brackets indicates the number of hits when "education" was added to the searches.

PRIMO	4474 (469)
ERIC	14 (0)
IEEE	43 (3)
ACM	317 (93)
Emerald	77 (32)
JSTOR	2 articles
Sociological Abstracts	0
ProQuest (18 databases)	>1000
INSPEC	89
Web of Science	187 (2)

Due to the high number of hits from the Primo database, additional criteria were added for this database. This gave 31 hits on the keywords "iPad education children".

4.5 Summary of search results

The literature review revealed only a few empirical or case studies. Furthermore, part of the available literature was based on personal experience and perception of how and why an iPad would be useful in teaching. Among the relevant findings were some reports that analyzed results in a scientific manner. A majority of these though, were based on simple questionnaires or analyses of the iPad and other tablet PCs in a limited context.

A major problem with the lack of information is that most of the published research was done in higher education. When the literature search was restricted to studies on children at the elementary and junior high school level, the number of articles was even more limited, even though there were many initiatives (Hu 2011). In spite of the lack of literature, what are there points towards the potential the iPad has in helping children and young people with learning, especially in mathematics. Focusing on the effect that the iPad can have on the learning experience, an overview can be represented by Figure 6.

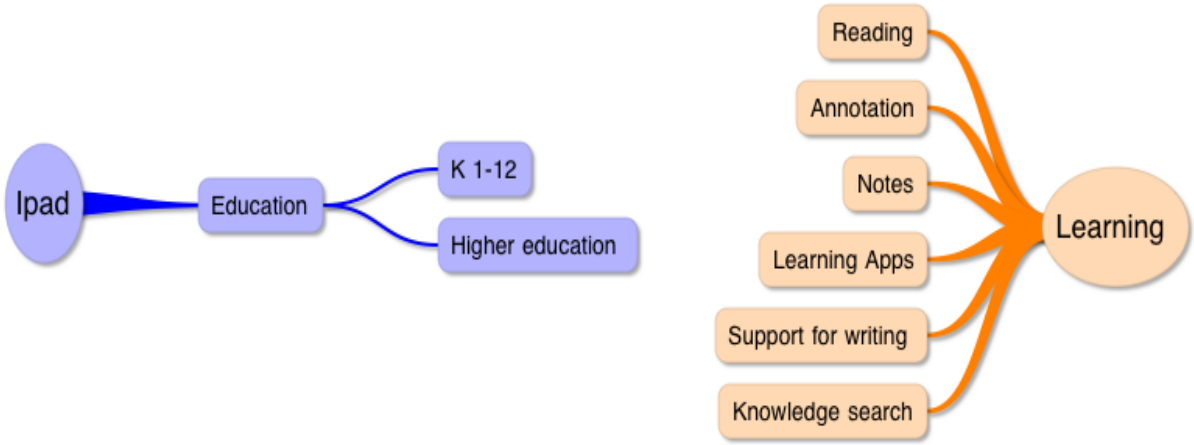

Figure 6 - Possible use of iPad in learning

In a U.S. research report (Larson 2010), the impact of Kindle on children's understanding and learning were analyzed. Although this study covered third graders of an elementary school (students age was 7–8 year) in the American Midwest, the described findings were positive. Manipulation of texts by children, as well as greater interest in the subject, had interesting results, such as increased understanding, the study claims. The features of the Kindle that assisted with increased understanding were enlargement of the font, search in the Kindle's dictionary, and text to speech. All these features are also available on the iPad. Other related research has shown that enriching the presentation of content provides a basis for e-books to be more easily accepted as a platform, than paper versions of books (Jung-Yu and Chih-Yen 2011).

Another U.S. study, also conducted on third graders in Ohio, addressed the "quiet reading" from the iPad as an issue to be researched on (Grace 2011). In this project, data were collected and compared from two questionnaires given to two groups of students after they had read

two chapters from a book. One group read from a paper book, while the other group read an e-book on the iPad. The digital publication of the book was a digitized copy of the paper book and access to it was through the application iLibrary. The entire test was then done again with the groups switching which format they read. The results of this study showed that the difference in understanding the reading material based on the format were not statistically significant. This questionnaire emphasizes problems concerning the kind of impact context has on the result of this type of test.

In a study from Columbia University, 107 children between six and seven years of age were observed in an iPad project that analyzed how the interface affected mathematical understanding (Segal 2011). Findings showed that children who used the touch interface solved the math problems more quickly, than when solved on paper. The study also found that the touch interface was more effective than using a laptop and mouse, and the strategy chosen to solve the task was more advanced in iPad users.

In applied research, an American publisher developed an iPad application based on their own algebra book (Poole 2011). This was further developed through pilot testing in six U.S. high schools in the state of California with 400 students. This application contains support videos, interactive tests, annotation support, and math analysis. The students had the possibility to review the support videos multiple times if they had trouble with the material. Naturally, the teacher was an active support person and gave training in all the functions of the iPad. The results of the study, based only on interviews (Barseghian 2011), showed that the use of the application resulted in increased student interest in the field of mathematics.

Another large body of research was done by the Scottish school Cedar School of Excellence where each student had his or her own iPad (Speirs 2011). The approximately 115 students could take their iPads home but there were strict rules imposed, such as the students could not install applications on their iPads without having permission from a teacher. However, many applications were available, especially for creative subjects like Arts and Crafts. When it came to the curriculum, the school did not manage to provide curriculum online for all subjects. The novelty of the iPad has an impact on the amount of research published, and probably we will see more articles in the near future.

The amount of literature about research on introducing technology in the classroom is quite different from the one about the iPad, especially personal computers or tablet PCs. The body

of literature is quite large and cover a large area of fields (Granger, Morbey et al. 2002) (Cuban 1986; Cuban 2001). For instance, some good points are about the teachers understanding the consequence of introducing technology, but foremost the beliefs in the pedagogical effect (Ertmer 2005).

4.6 Summary and analysis of findings

Reviewing the literature uncovered only a few research projects about the use of iPads in the classroom. This was expected, as the device has been on the market for too short a time to unveil results from longer research projects. In the lower age groups, the prevalence of projects dealing with iPads is quite large, but it is difficult to obtain information since many of the projects were done ad hoc, like the one at Cedar School of Excellence where they did not had a specific plan of what they wanted to achieve (Speirs 2011). While few studies attempt to break out of the old teaching methods, a desire to offer new and better studies arenas for students is present in the literature. In fact, some of the projects have tried to obtain electronic curriculum with varied results.

When it comes to using the iPad for entertainment, the findings are interesting. In most cases, for the K–12 level, the limitation of use was caused by the strong security regimen that most schools have adopted about downloading applications on the iPad. On the other hand, Web access may be allowed for certain forms of gaming, streaming video, and social media. This use at home or at school is not covered in any of the articles that have been found.

When it comes to reading in class, one of the studies found that if the iPad were used as a book with only text on the screen, the difference in the learning effect in children school was negligible (Grace 2011). On the other hand, if the multimedia capabilities of the iPad were used, an improved learning effect was the result (Larson 2010; Barseghian 2011; Segal 2011). Yet it seems that the findings indicate a "consumption" of content rather than "production". This is likely because young students are not encouraged to produce content. In a context where the iPad is locked or only on loans for a limited period, creativity does not have the right arena to grow. One of the most innovative characteristics of the iPad is the ability to adapt and create content using applications.

We have seen that the tactile access to additional information increases understanding, and the use of videos or audio embedded in e-books offers immediate positive learning effects. Unfortunately, the remaining studies in the literature are based solely on project about migrating text from paper to electronic format. If we take also in account problems with editing or formatting it makes the e-book problematic to read, with the result that the students do not get an advanced learning experience. In the worst-case scenarios, the users become disappointed.

None of the studies explains how students function socially among themselves after the introduction of the iPad in the school environment or at home. Also a serious lack of support systems, where students can exchange experiences and discuss the varied uses of the iPad is present in the literature.

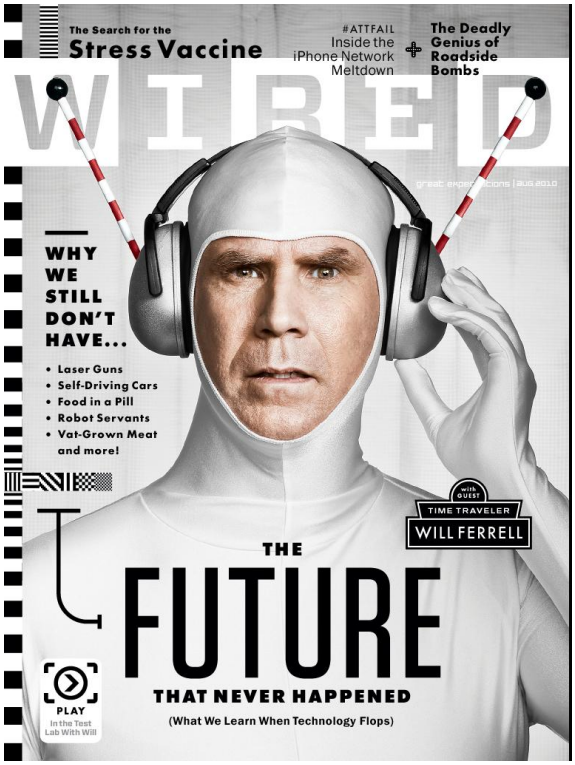

Figure 7 - Apps version of Wired Magazine

Lack of commitment to innovative thinking in the development of software for the iPad is not just in the educational arena, but also in other fields. Newspapers and magazines (see Figure

7) have spent considerable funds to develop and adjust publications for the iPad format, but they have not been able to exploit its opportunities completely. For some of this newspaper and magazine application, the sale have been lower than expected (Bjerkestrand 2011).

5 Case Study - iPads in the fourth grade

How do complex inter-relationships among different aspects of young children's activity and learning change by introducing a small tablet like iPad into the equation? Some of the important factors in these relationships are predefined, such as the guidelines from the department of education that the teacher needs to follow in organizing classroom activities. Others get established in the context of the class. A system consisting of students, teacher, practices, values and technology may be considered as classroom information ecology (Nardi and O'Day 1999). The iPad was not an item in the collection of guidelines from the department of education this year; however, an elementary school teacher thought that iPad would be a worthwhile addition to her classroom's ecology. The school did not have enough books to distribute to every student, and having the iPads with school curriculum on them, was a sufficient incentive for the teacher to want to participate in this study.

Six iPads were dedicated to the study. The teacher received one of them. The remaining five iPads were to be used by 25 students. The study duration is one school year; from January 2011 until December 2011. The thesis needed to be delivered before the end of the study, but it covers the first semester, as well as the beginning of the second. This provided the opportunity to observe the "California effect" – whether the novelty of iPad will wear out and the initial excitement be replaced by extinction from the classroom ecology.

5.1 The context of the study

The school is located in a rural part of the country. The classroom is spacious, equipped with a Smart board, laptop (usually connected to the Smart board and used exclusively by the teacher) and three stationary PC's for student use. This is standard equipment for classrooms at this school and a common setting for other elementary schools countrywide. There was no wireless connection in the classroom; so wireless mobile broadband was installed for the purposes of this study. As the iPads were to be taken home as well, it is relevant to remark that everyone had a wireless network at home and access to either a PC or a laptop. The children are in the fourth grade (aged 8-9). The composition is such that there are eleven boys

and fourteen girls, all but two Norwegian. The two not Norwegians lived in Norway over the long period of time and there were no differences in language mastery, or other communication barriers. The academic life for the students of this school was based on subject classes with some different teachers, including one main female teacher. A school day lasts approximately 5 hours.

The children in this particular class have been involved in the course project that the author has been part of (for the course in interaction design) a year prior to this study. The children have been very cooperative in that instance. The project was about redesigning the interface for an e-book reader, with a purpose to make it more appealing and easily accessible to youngsters. In Figure 8, students, than third graders, are testing Iliad e-book reader, choosing books in PDF format, with short text on the side describing the content, using the stylus.

Figure 8 - Third grade students trying Iliad e-book reader.

The class in that context was visited two additional several occasions. The first one of those was dedicated to the workshop where the children were engaged as informants to design. They were being asked to envision how the interface could look like or what would consider as an interesting way of interacting with the children's part of the library on en e-book reader. Figure 9 shows one of the suggestions that have with some changes lead to Figure 10.

Figure 9 - Dino helps choosing books

Figure 10 - Redesign of the interface from Figure 9

Both the teacher and the students have been thus exposed to some concepts and ideas of how the technology may be designed with children as active participants, along the line of work of Druin and others (see (Druin, Bederson et al. 2001; Buckingham 2007; Druin 2009)).
Thus, we were rather confident that we could ignite students interests in this class and these students enough to explore the possibilities iPad would give to their learning and play.

Digitalized curriculum is not yet common in elementary schools. In spite of this, access to digitalized curriculum was obtained from the academic publisher (and free of charge) Gyldendal for Religion Studies, Mathematics and Science. These three subjects are taught on

Tuesdays and so Tuesdays were chosen as observation days. English is relevant both as the subject at school and as the language of applications. The students have some knowledge of the language, but many are far from fluent. The traditional way of teaching English was supplemented from the start of the study with stories and Apps that could help students to improve their English through play (Alice in Wonderland or Balloons among others).

Much has been written about learning through play. How much sharing, how much playing, inside (see (Barab, Gresalfi et al. 2009)) or outside of the classroom, on their own or collectively would these students engage in with their iPads? We were very interested in the boundary between learning and play and for this reason no restrictions whatsoever on what they could download and how they could use the tablets in their free time were imposed. Each iPad had an iTunes account with 25 USD. The children were to decide on the economy: if they wanted more expensive Apps, they could join forces and pay for them as a group, or find some other fair way of managing the available funds. Each iPad came with a Dropbox containing the curriculum books and iAnnotate application that allows for highlighting of the text, making notes etc. No stylus, or cover for multi-positional viewing was given to the students. However, a set of two carrying bags (see Figure 11) was given with each iPad for the storage of device and chargers.

Figure 11 – Simple protection bag

5.2 Methods

We chose *ethnographic approach* (see (Sharp, Rogers et al. 2007), p.330) to study the classroom ecology. During the spring semester (January-May), one day per week, the use of iPad was observed in the classroom. In addition, two *workshops, interviews* with two families (including students), as well as one with the teacher, were conducted. Teacher's role and influence in the context is crucial. In the classroom ecology, they are the key species. In technology acceptance (Barki and Benbasat 2007), teachers competence and interest are one of the main factors leading towards acceptance or non-acceptance of the technology. Support among the teachers of the school and the Director, and even broader, policy makers, have influence, but for this thesis, only the role of the main classroom teacher was studied in depth.

Parents, family and friends have also a very important place in the children life, and must therefore be taken in account for in the analysis. Some of them may be not in favor of technology and may have a strong impact on the willingness of the children to use new artifacts.

Data was collected using audio, video, notes, photographs and periodic collection of iPads in order to view and document the content.

A standard consent form was delivered to all the parents in the class. Especially we asked if it was possible to take picture or video of the children (see Appendix 1 in Norwegian). The consent explained also: "*Children will be asked to do some tasks (such as reading books and doing exercises) with this tool during this period.*" Finally the consent also stated the possibility for the children to withdraw: "*Children's participation is completely voluntary and they can withdraw from the study at any time, without explanation.*"

Many informal conversations during the observations were very valuable. Mostly, fly on the wall method was employed during the class periods, but breaks have allowed for spontaneous conversations with children in different constellations (one or more at the time) and contexts (sometimes it was about helping them with something, other times the questions were answered). These conversations were not documented during the time they were taking place. Rather, if something interesting came up, it was noted from the memory. They play the role of supporting material in this research.

Some quantitative data was collected through four short *questionnaires* (1-5 questions at the time). As we have discovered during the first semester, some of the children have reading difficulties. The number of children with difficulties was to small to run a real scientific experiment. In spite of that, we have designed and run an *experiment* with the two children with problems vs. a control group of three random children from the class without reading difficulties. The results of the experiment give an indication that the iPad may be used as assistive technology.

5.2.1 The first five weeks of the study

The usual way of seating in the classroom, 2 students per desk, 3 desks in a row, was the first big change in the classroom ecology. The classroom (see Figure 13) got reorganized into 5 work areas, 5 students per area.

This was the setting for our first hour and a half long lesson on the basic use of iPad, marking the official start of the study (see Figure 12). A group of really well behaved, but clearly excited children greeted us on this occasion.

The iPad was used during class without causing distraction. Since the children had the iPad at home, at the start of the each school day all discussed about new games or apps discovered and downloaded at home. When the bell loudly marked the start of the working day, all the iPads were placed in the center of the group tables. Also during lecture, the iPads were only in use when the teacher asked them to search for supplementary information, or to do other school related work. As so aptly stated by the teacher in the interview: *"This is simplifying matters for me, because I can tell them to check for information's on the iPad, and they do it by them self. They know how to deal with this kind of things!"*

Two major activities were done on the iPad, reading and searching. The searching was done by using a web browser or by using specialized application like Wikipedia, Planets and many others. The apps Planets have a presentation of the objects in the solar system and give the user very restricted and contextual findings. On the other hand, a search on the Internet gives a lot of noise, as a remark from a girl from the class points to: *"It is easy to find the planet Venus with this App, but why are the answers so different when searching "Venus" on Google?"*

Figure 12 - The first meeting with iPads

Figure 13 - The photo shows three (out of five) work areas, with the children focused on their iPads

The children learned how to log into their iTunes accounts and download Apps. They learned how to search the App Store, in particular education and entertainment. "Planets", "IDCL", "Alice Light" and "The Little Red Riding Hood" were downloaded and tried. The teacher showed how to open documents from the Dropbox. The children were given instructions on how to take care of iPads. The iPads were to be returned to school fully charged. After the lesson ended, the children left their iPads and concentrated fully on traditional instruction. However, they were clearly excited, asking one million questions during the break and telling about everyone they knew who had an iPad.

The six App Store accounts were made by the author with different emails account thus, the author had access to all information regarding the downloads of applications (see Figure 14).

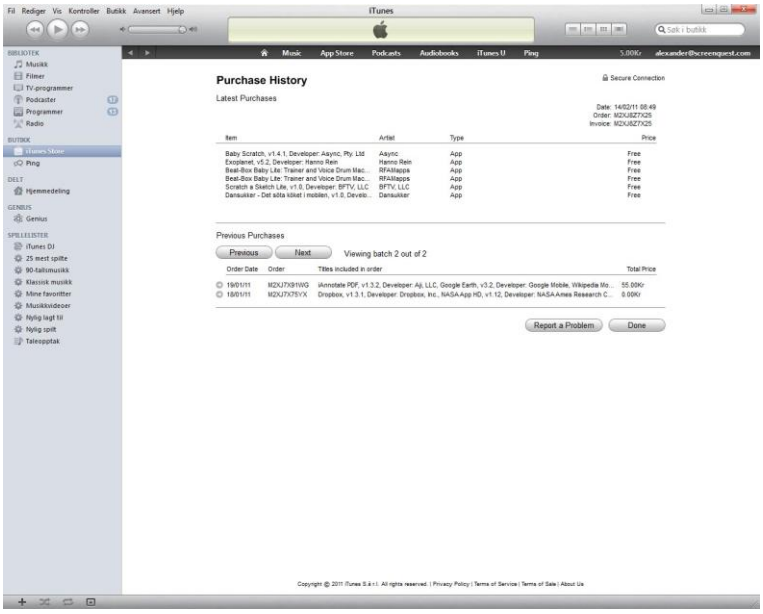

Figure 14 – A typical info from iTunes about purchase history on one of the school iPads

Some applications were installed in the consultation with the teacher and for the learning needs of students, and others were installed as the need arose in relation to this research.

The apps that we installed in the start are listed below; some of those were especially chosen since the first period of use was when the class was studying astronomy.

Exoplanet: This is app access a daily updated database of all discovered extra solar planets.

iAnnotate: The software gives also the possibility to annotate in PDF files with colored marker, to underline or strike through text. It also gives opportunity to write comments like "post-it" in small windows (pictures needed here). All this annotations are saved automatically in the PDF document. iAnnotate PDF support different possibility to download or upload PDF files to or from the iPad.

Evernotes: This is a more advanced program than iAnnotate. Gives the possibility to make notes and do recording.

Recorder: Give the possibility to do recording. The file is stored locally and can be played again.

Dropbox: Cloud based hard-drive, perfect to give access to curriculum for the students. Two Gigabytes of free space is included with this app. Dropbox have also the possibility to be accessed true a web interface, an application you can install on your desktop machine or true an iPhone app. Also several other applications, like iAnnotate or apps to make notes, use Dropbox as API to save data.

ICDL: This is an International Children's Digital Library and provides free access to children's books from around the world. Some of the books are in public domain, while others are used by author's permission.

Wikipedia: Direct search into Wikipedia site, with languages interface.

Google earth: Using this application the student can navigate all over the planet.

NASA: This app includes different information about ongoing project the NASA has.

3D sun: Up to date observation of the sun by satellite. The presentation is in different wave length.

Touch Paint free: Application to paint with finger.

During this first five weeks of use everyone learned how to capture images from iPad (clearly visible in Figure 15), and tested various painting and drawing applications. Some iPads had hundreds of beautiful pictures stored in saved pictures; some were screen capture, but many just simply beautiful pictures of horses, berries, tigers etc. All of the iPads had many Apps, entertainment Apps dominating in numbers. Some of the favorites in this group were Zombie makers, different talking Apps such as The Talking Obama, Talking Cat etc. and probably, the favorite ones for the girls were different love meters.

Figure 15 - After five weeks of use iPads looked like this

The students learned how to group the Apps and make categories. The most interesting thing though, was a new behavior pattern emerging spontaneously: coming to school about 20 minutes early to share the iPad related experiences.

At the five weeks mark, some free Apps with inappropriate advertisements showed up on iPads. In cooperation with children, the decision was made to remove such applications. It was agreed that they could keep two games of their choice, with no advertisements. With discipline worth every respect, the children removed all other pure entertainment Apps as agreed. Finally, the password to iTunes was changed, and only the teacher had access to it. Installation of new applications on the iPad had to be done either by the teacher or by the researchers.

A decrease in interest was expected. However, no change in children's behavior or interest was observed. The early morning meetings continued as usual. The discussion about games was simply replaced by discussing and using educational apps. With time it became obvious that the children developed stronger relations with each other and that the joy was as much in the meetings as in the use of iPads.

5.2.2 Observations regarding the use of the iPad

The five weeks have also marked the first "cycle" where all the children, in turn, had one weekend with iPads at home. There were no, surprisingly enough, problems with the way they organized the sharing and until the time of the writing of this thesis, all the communication around the iPads and the sharing them has been very good.

The activities at home were not so easy to observe and document, but some indications could be obtained from the children. One child told a story, during one of the weekly visit of the author at the school, about how the family discussed the iPad at home. In fact he explained how afraid he was of not having time enough with the iPad at home, since parents and sibling were also interested in trying the iPad. And the child´s problem was they liked it and so if they all got to do what they wanted to, how will he get the time for himself?

Some technical problems did occur with some of the Apps they used for entertainment at home. For instance, children used four fingers to activate the Talking Dog App, causing the iPad to stop. This problem can be described as a false positive response (Saffer 2007), where the iPad did not understand the command from the user.

Doing homework was pointed out as a pleasant time when they had the iPad at home, not only because of the apps on it, but also because of the digitized curriculum. The children told me on several occasions that they: "*remember better with iPad because it is fun!*" Why is it fun? The answers were always around enlarging the text possibility and colors.

The iPads were collected twice during the first semester, once after five-week mark and at the end of the semester in order to see what content was the most interesting for children. The

content on the iPads at the second collection showed that the children really liked creative applications; in particular, many have made a number of stories using the Puppet Pals, indicating that this type of application was really appropriate for their age and interests.

Another interesting finding was that the log of the Safari web browser (see typical example on Figure 16, right image), does not show much use per day. But the use does show that it is school and learning related, in addition to some messaging. The image in Figure 16 on the right shows some game sites and search sites. Some of the pages accessed were about animals and used to make screen capture images. The images were then used in a variety of applications.

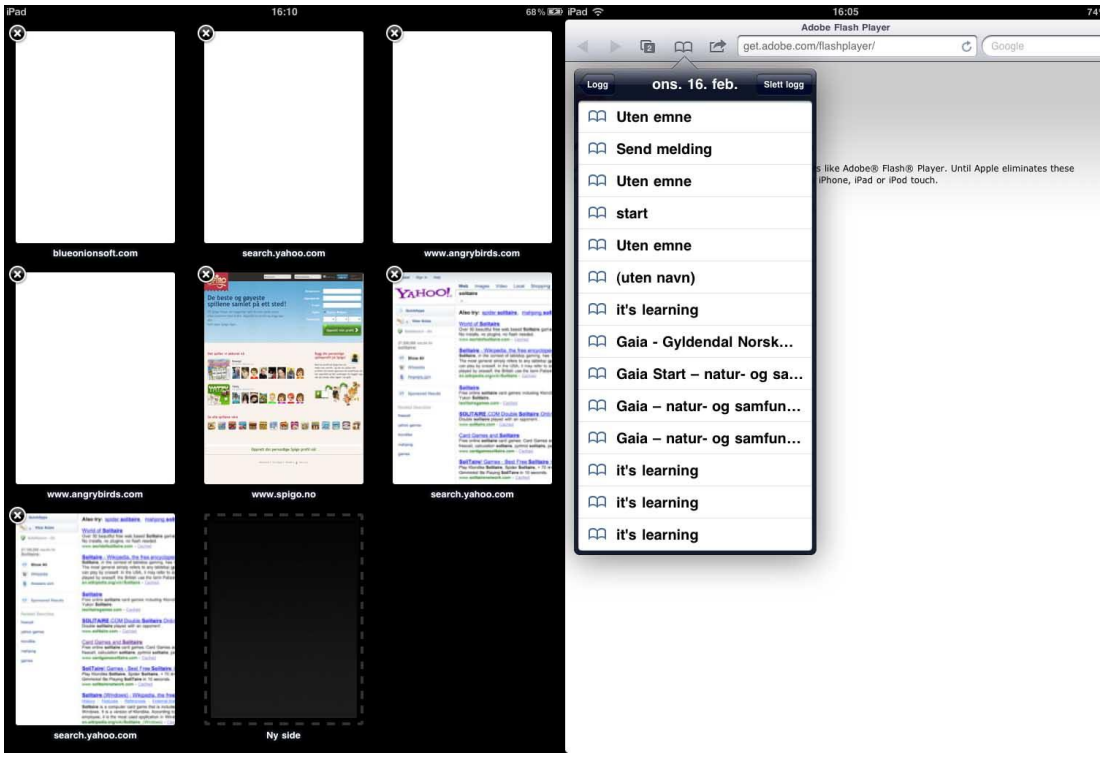

Figure 16 - Log from Safari

One it come to observation of the use in the classroom, one note diminished use of the classroom PCs. Usually, when used, they were very slow to start up, and also the "log in" procedure was really time consuming. The classroom had also a smart board, and the iPad was perfect and easy to connect to using the VGA adapter. In this way the teacher had the

possibility to share apps that were not installed on all of iPads, and since many of the activities were supported by apps for which there was no equivalent on the PCs, the class had the possibility to share new knowledge in this simple manner.

As the study went on the author made several observations regarding the use of the iPad and the paper book in class. Due to scarce funding, the school did not have enough curriculum books for all the students, and the teacher often made paper copies to send home with children so that they could do their homework. The children were extremely positive to having the iPad at home and being able to have a color copy of the book to work from. One child said in a short interview: *"If they are made on the iPad we use them"*. Many have commented on the difference in experience between having homework in black and white copy paper and on the iPad in color. They really liked the color part in particular.

The iPad could not be used for studying all kind of subjects in the class. For instance religion is more based on discussions than searching for information's or using applications. The teacher tested also some Norwegian web resources for Mathematics, but they failed on the iPad since they was running on the Flash platform.

Observations in class showed that the book and the iPad could complement each other very well. As an example we can mention the period where the class was studying astronomy and having group work around it. Where the book gave them a 2 dimensional view, with the iPad it was possible to rotate and enlarge a 3 dimensional representation of the solar system using Planets. As one child said: *"The planets look more real!"* But the information in the Planets App was very nicely complemented with the information they had in their books.

5.2.3 Questionnaires

To collect opinions from the entire class, several short questionnaires were used. One of them, administered twice was about the difference in experience in reading from the iPad vs. paper. The first questionnaire was held after a month of iPad use in the class. Before the author started the questionnaire, the students had a reading lesson in the class. Each child had to read from the iPad to the rest of his or her own group. Before the reading session, a part of a story in Norwegian was downloaded to the iPad via Dropbox. This story was taken from the

curriculum. It was digitized in advanced and prepared using the optical character recognition (OCR) software from Adobe. It was also optimized to use with iAnnotate. This expertise was acquired from an earlier project (Culén, Engen et al. 2011) where severe problems with scanned curriculum in PDF format were resolved.

The questionnaire was based on a Likert scale, consisting of two five-level Likert items, one rating the reading experience with the iPad and the other with paper. The five stars model was used, five stars for the best score and one for the worst. Of the 20 children asked, 17 rated the iPad as a preferred or equal platform for reading. Only 3 were negative regarding the reading experience on the device, at the time still a new experience.

After additional four weeks of iPad use, we repeated the short questionnaire. Surprisingly, 5 children changed their rating, but it was in such a way that 17 were still positive and 3 were still negative (some who previously preferred iPad, preferred books now, but some that preferred books opted for iPad this time).

The questionnaire was very simple, and is meant to be used as an indicative measure of what students like and if there would be drastic changes due to prolonged use. The questionnaire was not needed beyond this point as we could see from the observations that the usage patterns were stabilized and we did not expect any new and different results from this type of questionnaires.

5.2.4 Workshop 1

The first workshop was held March 8, 2011, together with my supervisor. The aim was to determine how the children performed search, and to discover if the iPad had the possibility to help students resolve the task in a new or more efficient way than they did previously.

Motivation for this workshop was Druin's work with children (Druin, Foss et al. 2010), a paper which discusses the roles children play as online searchers, another research by Druin (Revelle, Druin et al. 2002) a paper which describes a quantitative study evaluating a children's digital library developed at the Human–Computer Interaction Lab (HCIL) on searching and part on Hole in the wall project (Mitra, Dangwal et al. 2005).

From the class three boys and three girls were selected at random and taken into a smaller room adjacent to the classroom for the workshop. Everyone had an iPad, and the children were timed as they used their iPads. The first task was to find an explanation for the term "biotechnology" and the term was written on the blackboard both in the children's native language (Norwegian) and in English. The time used was between 5 to 9 minutes and the children used different search strategies.

For the boys, one used the iTunes App Store and found an expensive application of about 40 USD, another used Google, and the last one tried to search on YouTube. Even if the task was intended to be done individually, the boys cooperated with each other. One of the boys found information in Malaysian and tried to read this unknown language. Another one found an application about a biotech restaurant in New York, since he had spelled the word in his native language in the search field. In conclusion, Google was the best strategy here and the only one that gave the answer the boys were seeking.

For the girls, one searched with Google Video Search (see Figure 17) to find information, another used the iTunes App Store, and the last one used the images search service from Google. The images found were of various quality and scope, and after starting to cooperate, two of the girls found a phrase that described biotechnology from a biotechnology school and one of them wrote it in the Notes application.

Figure 17 - Navigating within Google Video

The second task was to find information on how to tell a story (storytelling), both as a pretest for the forthcoming second workshop and to check if the search strategy changed since the scope was quite different. This time the children were allowed to cooperate and they agreed to search about old-fashioned rural stories like "Askeladden". One of the boys found a poem and suddenly started reading it aloud. They used almost the same amount of time as the previous task, but the search strategy was a little different since they discussed and cooperated more open on search terms and strategies. Nobody completed the actual task, within the time allocated for the workshop. This task proved to be too difficult, and the focus on the content of the stories they found was distracting the students from continuing with the task. Also, it was the end of the school day and the children were eager to go home.

5.2.5 Workshop 2

This was a larger workshop, in relation to the first time, since the whole class was participating. Thus some help with the workshop was solicited from my supervisor and two other master students. In addition, two observers from the publishing house were present. The workshop was organized around five different modalities to tell the story: create a short story using StoryKit for iPhone, make a story with origami, make a story with animation, make a story with Puppet Pals and write a story on paper. Five tables were prepared with needed props and applications. StoryKit, Animation HD and Puppet Pals were pre-installed on iPhone and iPads.

Table 1 – Make a short story with StoryKit

Using the iPhone, the children tried to make a short story with the StoryKit application (see Figure 18), which was developed by Druin et al at the University of Maryland. In (Franckel, Bonsignore et al. 2010) the paper discusses the co-design experience for the creation of mobile stories by children.

The idea behind this test was to see how the children used this application to make a story, using also a camera, and at the time of the work-shop the iPad 2 was not on the market. The instructions were to decide on who would be the actor, who would be the director, and what

the story would be. Then they were to take photos, write on the iPhone, and record the story. The result was somewhat poor, since they managed to make a few short stories with almost no text.

The stories were about friendship, problems in class, water, eating cakes, and even one about the Norwegian Troll. The writing was minimal, even though the application allowed for it. The pictures taken with the iPhone were of people, cake, and a bottle. Another picture was taken from the pictures already on the iPhone. Afterwards, the stories were uploaded to the University of Maryland's website.

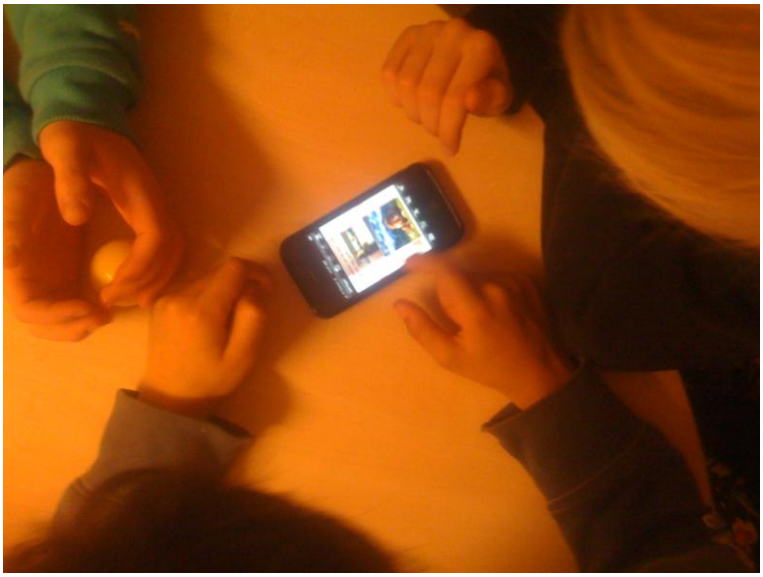

Figure 18 - StoryKit application on the iPhone

Table 2 – Make a story with Origami

The aim of this task was to select any of the origami objects on the table and use them to as props for the storytelling. The task was repeated with different amounts of figures to see if it affected how they made their stories (see Figure 19). The first objective was to see what worked better: preselected 3D objects or other objects available on the table. The second objective was to see what kind of interest the children had in their story once it was finished (e.g., would they want to change something, if they would like to record it in some way or preserve it). The results here were that children used the origami creatively, making really long and rich stories. Some children expressed the desire to have the story videotaped and to be able to view it later again.

Figure 19 - Story telling with Origami

Table 3 - Make a story with Animation

The goal of this table was to create a story using Animation HD application. Since every child at this table had an iPad, they could work alone. The task was to use the fingers to draw figures on the iPad surface. A different image was drawn for each frame, so that when the frames began to roll, they became an animation, much like in a traditional flip book. After a short introduction, the children were able to start making animations (see Figure 20). Some worked fast and well, while others had "artistic" issues – they were unsure in their own capability to draw well. So this presented a real barrier for some students.

Table 4 - Make a story with Puppet Pals

For this table, the students were asked to create a story using the Puppet Pals application (see Figure 21). To go with their story, the children were able to select in the application pictures from Svalbard and troll. This application allowed users to create a story easily and with minimum cost (the application was free, but we had to buy additional images for a cost of 11 NKR). Puppet Pals was easy to use, as making a story needed only the use of fingers. While text could be used, it allowed speech or sound to be recorded as a complementary part of the

visual story rather than relying just on text. The children enjoyed creating stories with this program, and everyone managed to develop at least one story. However, it was interesting to note that the children preferred choosing their own pictures from the application rather than use the preselected images (trolls and Hansel and Gretel).

Figure 20 - Drawing with finger

Figure 21 - Making a story with Puppet Pals

Table 5 - Make a story on paper

The children at this table were given two minutes to think up a story and then two minutes to write down the beginning of this story on paper. The children were also asked to make a drawing on paper that described the story (see Figure 22). Finally, they read their stories to each other. The results were different from the other tables. Some students made a well written story with nice drawings; others could not do as well.

Figure 22 - Writing stories on paper

In general, the work here was individual, as it was with the animation program, while other areas required collaboration. So, just like with Animation, the creative side of each participant either "kicked in" or not. The same was true with the focus and concentration on the task. In a way, the advantages and disadvantages of working individually vs. cooperatively were clearly shown.

5.2.6 Summary of the workshops findings

The most interesting observation of this workshop captured the difference between the Animation HD and Puppet Pals applications. At the table where the children used the Animation HD application, some of the participants had problems creating a story, while others made entertaining and original animations. What made the difference here was their perception of their own ability to capture the object that was to be animated. The iPad's touch interface did not remove this barrier. The children who had problems with drawing were drawn to Puppet Pals, as they felt that their creativity could be expressed through the story itself rather than through the drawing of the story's characters. This was highlighted by one child's statement: "*You know they have in some way draw it for you, so if you are not so good, you manage to make a story anyway!*"

5.2.7 Interviews

Interviews helped the author to go deeper in certain issues about how the iPad was used and how or if, it changed the ecologies at school and at home. The content of the interviews was based on the data collected from observations, workshops and questionnaires in the classroom.

We decided to have interviews with open questions at first to get as much information as possible without guidance regarding the topic. The second part of the interviews was more structured with concrete questions. We had selected two families randomly and the main teacher to be interviewed. From the family it was easy to get an appointment at theirs home, giving to us the opportunity to observe the use of the iPad in a more familiar context. The interview with the teacher was done at school.

Interview with the first family

The members of the family participating at the interview consisted of two girls about ten years old from the class participating at the research, a little boy 2 ½ years old, an older boy of 13 year and a mother and a father.

The family had another iPad (with a 3G support) that was a gift from the husband to the wife. This iPad is used to read email and newspaper, music, Facebook, and games. The mother uses the iPad most. The girls are also borrowing the iPad from the mother. But the father is not using it so much. And it happens that the mother borrows the iPad from the girls like last time they had it and the mother used it to look for a special kind of dog that she wants to get.

The girls are teaching theirs 2½ year old brother how to use the iPad. They remark on how fast the small kid is learning. He can play with the "Ballongame" and the "Tom Cat". The girls explain also that the little child likes looking at cars as well as videos on the You Tube.

The parents are not against playing games on the iPad, but they are against the overuse of PlayStation 3 by the older child. The child responds in the well known way: "*But, I learn English really fast and easy that way*". The parents point out that one of the girls is playing less on the iPad, and she always stops by herself, as she gets bored with games.

The iPad sharing seems to work well at school, said the one of the girls. Another student at one point wanted to be in charge of the iPad, deciding on what will be on it, but they sorted it out in the group by themselves. The girls say that the class is talking a lot about the iPad. They are talking a lot about subjects they are using to find with the iPad, like "horses". For instance one of the girls told us about a situation where a girl was sleeping over and they get up at five o'clock in the morning to find the iPad, take it in bed and play with it before anyone else wakes up.

The girls regularly visit the App Store in order to check if there are some new apps that are related to the subjects they are interested in. After the main teacher denied them to download apps from the App Store, the girls explain to us that it was a little bit sad, since they find a lot of interesting apps on the App Store and they really wanted to have them.

The girls are taking pictures of the horses from YouTube and Google pictures, but Msn/chatting and Facebook are not in use.

The family is using the "Wiber" App to communicate between them using both iPads and iPhone, when they are in different floor, especially the older boys is communicating a lot with

the mother. Skype is used by them too. They also share information about apps that work well for them.

The girls also explained how they talked on the way home with other classmates about what they search for with the iPad. They also told about several test to use the iPad on the way home, but it was to freezing cold on the fingers. The family told us about a situation in Spain when they used the mother's iPad to navigate (GPS), but the problem was the prohibitive cost. The father said they could use the taxi for the connection price.

Once asked about learning with the help of the iPad, the girls said that it is fun to learn with the iPad. But one of them elaborates "*the other e-ink eBook reader you took with you last time in class was really boring*".

While doing the homework, they explain, if we have the iPad at home, we can log easily in to "It's learning" to get the exercises to be done, reading the Gaia book (it is in color while the rest of the class gets a black and white paper copy). They explain also how they read, they show to us how they enlarge the text, and quickly scroll the page.

They have also tried to use the "Alice in wonderland" app that contains the book and animations, but sometimes experiences the problem with turning pages.

When asked about searching, they told about the use of Google Earth to find the house they are living in. "T*hat's fun*", said one the girls.

They are reading all the lessons on the iPad when they have it at home. One of the girls explains better: "*If the books are made available I use them, and therefore I don't care to bring with me the paper book at home!"*. When it comes to reading in bed with the iPad, the girls explains that it is most playing; even if the mother had said that they need to read.

The parents also point out that the girls are "much more" interested in homework since they got the iPad. But it is interesting that the parents are not really checking to see what kind of things they are using either for the school or for entertainment when the iPad is at home.

One of the girls describes the iPad experience like this: "*We are lucky that we had the iPad and the chickens (in the second grade, they watched the chickens clack out of their eggshells)!*"

Interview with the second family

The second family we interviewed was quite different from the first, consisting in a girl attending the 4th grade class, a three year older brother and the mother. The mother was a lot more conservative regarding the use of the iPad in relation to the other parents. Access control to the internet and the time used with technology these were the issues she was concerned about. The girl told us about how she used to do homework and how much she used the iPad for leisure. She used the iPad to read the digitalized schoolbook and to play the "Fruitninja" game. Our primary impression was that the mother was more concerned with controlling what is being done with the iPad and less interested in using it herself, which led to reduced interest for the girl, too.

Interview with the teacher

The teacher was interviewed at the end of the spring semester. The interview was semi structured. The questions we were interested in were the ones about the ecology: how were iPads used in relation to other classroom technology, what was the view on iPads in relation to other 4th graders who did not have them, and we wanted the teacher to tell us about any other interesting stories involving the use of iPad. Here are some snippets of what the teacher said: *"It has been very nice, I think, to the extent that we have used it, So I think that it has been a very fine bonus in sessions. When we were learning about astronomy and the space, or cartography, students could just go on the internet and check about these things. We only have three stationary PCs, so they have used the iPad to find the information. So it is easy to work with. Not all the tasks have to be planned; some may be taken on the fly."*

When asked if there was much distraction with iPads in the classroom, the teacher said: *"No, not so much. They learned very quickly how to work with iPads. They are easy to use. Students have become autonomous. The first time, when we were supposed to download something from the Dropbox, I showed them how to do it, it all went very well then and continued to do so since."*

Asked if she could say if something would have been different with students of the same age, but a different class the teacher said: *"In this class there is no problem. The class I had prior to this one would have probably been a lot harder to organize. There, I had the feeling that there was nothing I could do to get the students to focus. In this class, it was natural."*

"But it is clear that iPad helps. You will meet several different learning styles, those who need to touch and see, to understand things and not just hear what I say, they get real value for money when they can do things on the iPad, such as the solar system that we could visualize and move it, spin it. In that sense, I had the opportunity to offer multiple learning styles and keep more people focused on learning by catering to the ways they best receive information." Asked if she had any input on how one could measure the impact of the iPad on learning after this first semester experience with the device, she offers: *"It could be done by taking a test before a theme, in this class and one of the parallel 4th grade classes, and then test after the theme was covered with and without iPad. But there are many margins of error here. My class and another class have differences to start with anyway. But perhaps one could get some indications and trends."*

Discussing the children with special needs, the teacher thinks that the school should purchase some iPads. The largest barrier there was the language, she thought. The apps would need to be in Norwegian.

Discussing the applications from the App Store, as well as digitalized school books, the teacher says: "*it has been wonderful to have the apps that can read the stories. For mathematics, we found some exercises, but the book was not very useful as the iPads do not have Flash. We did not find much in App Store. We often used a lot of time to find exercises that students would not consider as boring. We need them for things that they must practice, over and over again. It was also hard to find good maps. We did use Google Earth.*

It would be important that all resources are available in Norwegian. Generally, there were two things that have been challenging. The language, as discussed and the level of difficulties of the apps. Seems like a lot of things are developed for very young children or for adults. Content for this age is lacking.

Another point is that I have used it all the way in teaching as it was easy to show things directly from the iPad on the smart board. The other teachers could not do the same stuff without the iPad as there were no Apps for the PCs"

On the kind of apps the children are interested in, she says: "*I believe that they are more into puppets than the angry birds! Just the fact that you can record it and show for everyone is*

great".

Discussing the sharing, the teacher thought that 5 iPads were perfect. It was possible to control the content, distribute and update easily. It would have been much more work with 26 iPads.

5.3 Summary

We have observed, as well as heard from the families, students and the teacher that iPad has enhanced both teaching and learning. Students were more immersed in their reading and creative activities. iPads have also worked great for independent tasks that students could help define (using a variety of Apps for creativity, 3D viewing, searching or simply working with curriculum).

Students have shown exceptional discipline in adhering to the routines and schedules developed around the common use of iPads. They have also expressed quite clearly their gratitude to their teacher for allowing them to have this experience.

iPads have not been used extensively in the Religion Studies or Mathematics. In the Religion Studies, the use was limited to reading only. In Mathematics, there were problems with digitalized content requiring Flash, which iPad does not support.

iPads have brought students closer. They have given them more influence in designing the curriculum and in working with it. Their learning practice has changed. It remains to see what will happen over the extended period of use.

6 The use of the iPad as an assistive technology

School and university libraries have traditionally offered help for their users with dyslexia or visual impairments. Libraries would often have expensive equipment such as special enlargement screen and computers using "text to speech" software. The reasons the libraries have all this special equipment is the prohibitive cost of the equipment paired with "access for all" philosophy. An additional benefit for users was help with mastering of this rather complex equipment generously provided by library personnel.

With the arrival of the e-book readers, and later tablet PCs, this scene is changing for dyslexic students. What they had to go to the library for before, they could now have with them, anywhere, anytime. A new world of possibilities has opened up for the dyslectic community, although tablets may be used as assistive technology (AT) for other kinds of impairments as well (Sampath, Sivaswamy et al. 2010).

In the general, 5-15% of Norwegian population has reading difficulties. There is no reason to assume that at school these numbers would be much different. From 25 students in the class, we found out that two students have some reading difficulties. We will call them Iris and Josh, both 9 years of age. These children do not have any kind of diagnosis. Neither the teacher nor parents are trying to have the children diagnosed. This approach may have some advantages (such as not being stigmatized), but it also has problems (such as having some disadvantages in the world that is largely based on the ability to read). The main issue identified in the literature for such situations is children's low self-esteem (Humphrey 2003; Lackaye and Margalit 2006).

In the beginning, the children with reading difficulties were indistinguishable from their peers. From the start of iPad usage in the class, we observed that many pupils liked enlarging text, sometimes quite a bit, while reading. When we collected the iPads for the first time in order to see what kind of content the children have placed on their iPads, one iPad differed from others significantly. Josh has organized all the content into thematic groups, being displayed quite neatly on the iPad. That was strange, but even stranger was the fact that one of those groups had to do with languages and translating from one language to another using speech.

The organization of content soon became a class standard, but no other students ever installed apps for learning languages or translating from one language to another. These actions made Josh visible.

How we got interested in Iris is quite different, but it is omitted here due to confidentiality reasons.

In a later interview with the teacher, it was confirmed that both children have difficulties reading. However, this was confidential.

The teacher had some very specific wishes regarding the use of the iPad in class to help children with special needs. She stated: *"Groups who need special education can be helped by the school acquiring some iPads that could be sort of a "carrot on the stick" for students who cannot be helped so easily and who are struggling a lot".* The statement, positive as it is, also had a note of resignation in the face of the complexity of the problems comprising the child's self-esteem, self-perception, perception by others (often involving stigmatization), parent's involvement etc. not even mentioning the capacity to actually help take these tablets into use, adopting them to the need of each child.

From children, we found that they do prefer to read from the iPad rather than from the paper, mainly because of the ability to enlarge the text.

In order to be able to grasp what kind of difference in comprehension could iPads (through text-to-speech App SpeakText) enable for these two children we designed a simple experiment. The experiment engaged 5 children: the 2 with reading difficulties, and 3 without difficulties.

6.1 Experiment design

Our null hypothesis was that there is no difference in understanding the text for children with and without reading difficulties when they read from paper and when they select the text on iPad and heard it read to them.

The hypothesis involves two independent variables each having two conditions (children with and without reading difficulties and reading from paper or iPad's app SpeakText).

The dependent variable (understanding of the text) was measured by how the children answered 8 quite simple questions, 4 of them retention based and the other four based on understanding causes and effects in the story.

Due to a low number of children with reading difficulties that we could recruit, within the group design was an obvious choice. Thus each student repeated the reading session, followed by the answering session, twice - once from paper and once from the iPad, where which was to be done first was determined at random. There were two sets of eight questions (4 memory based and four understanding based) on two distinct, but equally long (374 words vs. 380 words) and difficult paragraphs from a children's book. The iPad app (with 380 words paragraph) needed 3 min. and 18 seconds to complete the reading. The children's reading from the paper was timed, in order to be used as an indication of difficulties in reading. The answer session was not timed, but the children knew what to expect the second time around and they were somewhat faster on the second set of questions than on the first, indicating that some learning effect has taken place.

6.2 Results of the experiment

Table 1 summarizes the results obtained from children without reading difficulties and Table 2 the results of those with reading difficulties. Each child could answer 4 memory based questions and 4 comprehension based questions.

TABLE I. SUMMARY FOR CHILDREN WITHOUT READING DIFFICULTIS

Under-standing	**Child 1**	**Child 2**	**Child 3**
iPad	4 memory 4 comprehension	4 memory 2 comprehension	4 memory 3 comprehension
paper	Reading time 1:54 3 memory 4 comprehension	Reading time 2:27 3 memory 2 comprehension	Ca 2:30 4 memory 3 comprehension

TABLE II. SUMMARY FOR CHILDREN WITH READING DIFFICULTIES

Understanding	**Child 1**	**Child 2**
iPad	3 memory 2 comprehension	4 memory 4 comprehension
paper	Reading time 15:29 2 memory 0 comprehension	Reading time 6:27 1 memory 0 comprehension

Each cell in Tables 1 and 2 contains the number of questions in each category that were answered by the child. Note that neither of the children with reading difficulties has answered any comprehension questions when reading from the paper. Retention questions did not fare much better. Although not perfect for both children, the results after the iPad use were improved. It is also interesting to note that for the children without reading difficulties, the iPad use shows slightly better results.

These results are, of course only indicative due to a very small sample size.

Post experiment, we collected impressions from the children around the experience of reading from the iPad. The children remarked that they liked zooming on the text as well. Iris in particular mentioned twice that zooming helps her. It would have been perhaps interesting to repeat the experiment with both readings from the iPad, one of them with possibility of enlarging the text and one with SpeakText App.

6.3 Conclusion related to the iPad as AT

In spite of the small sample size, the study with elementary school children, at the very least, indicates the need for more research related to AT for young children.

The introduction of the iPad in the elementary class has in general, been a success. In particular, it offers clear advantages to the children with reading difficulties. While it is still true that each child/student with dyslexia needs individual assessment as to what works and what does not work, there is a number of possibilities that were very simple to try with iPads (things like different programs for text to speech, changing synthetic voices in order to find the one that works the best, enlargements, color annotations etc).

A very important point in favor of mobile assistive technologies is that it minimizes stigmatization of the ones using it. At the same time the user may be able to attain more self-confidence in the academic arena

7 Comparison of the work in the elementary school and the pilot study at the University

As mentioned in the Introduction, a pilot study with iPads in academic setting was conducted in the Fall semester of 2010 at the University of Oslo. It is interesting to compare some findings from this study to what we found out about iPads in the elementary school.

Context of the university pilot study

Forty students, 1 lecturer and 3 teaching assistants participated in the study in the fall of 2010. Each iPad had the class curriculum downloaded in advance. The curriculum for the course consisted of book chapters, lecture slides, maps and academic papers. Each iPad came with a Dropbox containing the curriculum. The students have also received a gift card of approximately $25, and were required to get iAnnotate and Elements applications from the Apple Apps store which would enable them to add their own annotations, highlight the text etc. No stylus or cover for multi-positional viewing of iPad was given to the students. The physical setting for this course was typical for higher educational institutions countrywide. Students have lectures in a large auditorium and discussion/work groups in small groups and rooms. Wi-Fi is available everywhere at the University premises, but student housing, where many international students from this class lived, did not have Wi-Fi, thus disabling iPad Internet use while studying at home. Their program is very competitive and fast paced, thus leaving students with little time for anything else but studies. The students have signed an agreement to participate in our study, and committed to participation in one workshop and two surveys.

Figure 23 - University students discussing iPads

In the university pilot study, graduate students of informatics worked with students of geology during the semester. The students of informatics observed the use of iPads in the classroom, carrying out a contextual inquiry, and also doubling as technical support. Additional data was collected from two surveys, one workshop and three group interviews (2 interviewers per group and 4-6 participants). After the end of the course, 3 students and the instructor were interviewed individually. All interviews, group and individual, were recorded and transcribed. The interview data was consolidated using the sticky notes method (one observation per note) to map the observations into an affinity diagram (see Figure 24). The analysis pointed towards ownership and cooperation as new and interesting variables to consider in relation to mobile technology adoption in education.

Figure 24 - Affinity diagram

The set of challenges was identified in the work with students mainly. This fall into four main categories: organizational, technological, academic and physical. Thinking about how these things impact the introduction of the iPad is important.

Organizational challenges

This set of challenges addresses issues around the premises on which the iPads are distributed (short term loan, long term loan, owning) to students, how the content is acquired and later accessed, who is to provide the support, and when.

In both studies, participants are "borrowing" iPads for a given length of time (one semester for students and a whole year for schoolchildren). In both cases, technical support was made available to all participants. Both students and schoolchildren needed support of various kinds, most notably with equipment breakdowns (one iPad stopped working completely, but many participants experienced temporary problems when iPads were not shut down for a long time). The students needed a tutorial on iAnnotate (YouTube 2010); the elementary schoolchildren were given one hour of introduction to iPad at the beginning of the semester, and once a week they could get help with whatever problems they had, most often with the wireless network connection and with download of Apps as well as some guidance on how to use them.

The most important variables that were directly, but only partially, related to organizational challenges were:

- Perceived intuitiveness and the ease of use of iPad
- Perceived ownership

General perception that touch user interfaces (TUIs) are natural, intuitive etc., was falsely extended into thinking that applications would be equally easy to master by graduate students. However, they needed guidance on the use of the basics they got with the iPads, such as Dropbox and iAnnotate. The students felt that learning all these apps "properly" would take too much time. Therefore, in order to make them more willing to set the time they need to get used to working with iPads, a tutorial for iAnnotate was made (YouTube 2010). All of this was perceived as rather complicated to use, in spite of the fact that the TUI itself was found to be very easy by majority of students.

The children, on the other hand, were not under time or academic pressure. They were interested in exploring and found it not to be difficult at all. Thus, for the level of tasks they were performing, they found the iPad to be easy to use, intuitive and playful. It is perhaps interesting to remark that arrangements around sharing of the 5 iPads among the children have gone without any problems and was fully self regulated. They have never complained about

someone doing something on the iPad they did not like (such as removing content they placed on it).

When it comes to ownership, a more detailed report may be found in (Culén, Engen et al. 2011). It suffice to say that the schoolchildren live "in the now", and the timeframe for which they could use the iPads did not weigh on them. Neither were they concerned with the destiny of their work stored on iPads. They are happily unaware of many aspects of the ownership issues, and this variable was of no importance for them. Quite a different picture is seen when it comes to students. Again, part of the problem could be resolved by organizing the terms of the loan of iPads to students in a different manner (as was done at Stanford University (White 2010)), but other ownership issues, such as proprietary (Apple) software or ownership of annotations made on PDF files and stored in the cloud, would still persist.

Challenges due to physical environment

In this category, findings were also quite different. Students have quickly found out that taking notes on iPads is hard, not only because iAnnotate is difficult to master, but also, because their physical space is limited to a chair with a small work surface, which is insufficient for holding an iPad, a book and some paper and pencils. They were much happier with use of iPads in smaller discussion rooms with tables, where they could share images and texts from their iPads. Apart from this, as aforementioned, the availability of Wi-Fi on iPads was limited to the University, thus forcing the students to use devices that could be connected to the local area network by wire.

When it comes to elementary schoolchildren, the adjustments and changes in the physical environment they had to make due to the number of iPads they got (the classroom was now organized into 5 large work areas, one for each group of children with an iPad they could jointly use) fostered collaboration and sharing, and increased the interactions among the children. They had also the only Wi-Fi equipped classroom in the school (enabling increased use of the internet in class). The Wi-Fi did not work perfectly, but everyone was very patient with it, indicating that the benefits outweighed the problems.

Academic challenges

When a new device is put into a classroom use, it naturally changes the way students work. In the university pilot study, we found that time pressure and the need to obtain a good grade in the class were factors that prevented students from making much time to explore the possibilities that iPad offers. Their field has a strong tradition of how the things are done. Students often resorted to these traditional means (please see the (Survey2_Geology 2010)) thus missing the benefits of some features iPads offer. For example, none of the university students searched the curriculum on their iPads for specific themes or concepts, or shared their own notes taken during the lectures via email or Dropbox.

In the study with children, the challenges concerned the selection of appropriate educational applications that could adequately supplement the teaching, a common theme for many of the studies concerning the iPad in education.

It is well known that the role of the teacher in acceptance of new classroom technology (see for example (Baylor and Ritchie 2002)) is very important. The teachers in the two studies were providing different role models for their respective students:

- The University professor has a well-established course, with a long tradition, and learning to use an iPad efficiently would take a lot of time: "*When I have very long working days and I want to be as effective as possible, the effort of sitting down for 2 - 3 hours to learn the iPad is too great for me".* (Trans. Culén). He did not use the iPad when teaching.
- The elementary school teacher used the iPad actively every day during classes for variety of tasks.

Technological challenges

These challenges were of much greater importance to students and they have given a long list of frustrations, some of which are:

- Two applications cannot be open at the same time (for example, it is not possible to follow the lecture slides and browse at the same time). Students are used to multitasking in this field.

- Reloading pages or slides in PDF format takes a very long time (for example, if the text references some figure that is on a different page, it can take a considerable time to find the figure; similarly when zooming on a figure, which Geology students often do, it may be slow to reload).
- Downloading files was difficult for many students.
- No support for Flash.
- Problems with 3D viewing.

Some of the challenges that emerged during the course of the two pilot projects were not too "serious". They could be eliminated or bypassed. Others could be resolved when iPad is redesigned, or when some other tablet offers better support for active reading.

Samples from interviews and surveys

Surveys were focused on both environmental questions (as mentioned in the introduction, mainly related to the reduction in printing) and on use for course work. Regarding the use of paper, we see a positive trend in both studies. The students have achieved a significant reduction in the amount of pages they printed for the Geology class. 57% of respondents have answered that they have printed much less than usual. Before the iPads, the school children used to make copies of the book pages in order to do exercises, but with iPads, they had no need to make extra copies. Thus, they too, have reduced printing significantly.

As mentioned earlier, of 20 respondents in both questionnaires conducted at the school, 17 students preferred reading on the iPad, vs. 3 that preferred the paper. In percentages, 85% of children answered that they prefer to read from the iPad than from the book. They liked the ability to zoom in and out, and while reading, many of them were changing scopes often.

The data on the reading habits of the university students can be found in surveys. The two surveys are provided in their entirety at (Survey_Geology 2010) for the first one and (Survey2_Geology 2010) for the second one. Some highlights: 51.9% of students use iPad for reading less than an hour per day, 81% say that the benefit they got is that it is portable (easy to carry around).

While differences between the two groups of participants were numerous, there were some noteworthy similarities, too. Most notably, both groups enjoyed sharing the content from

iPads and collaboration. All interviews with students were semi-structured and one of the questions we asked them all was in what situation have you found the iPad most useful. The answer was invariably related to work in smaller groups, when it was possible to share the information. The second most useful situation was while travelling, both in relation to the longer field work trips and locally. The schoolchildren already had the groups around iPad, the question for them was if there were any problems in sharing. Without exception, they said that sharing was not the problem but fun.

Summary

The pilot study conducted at the University level has pointed towards non-acceptance of iPads as a learning platform for Geology students. Various challenges contributed to this situation: from problems with physical space to academic challenge. The two variables that played an important role in the study were perceived ownership and perceived ease of use. A more thorough study is called for in order to better understand the ownership issues, especially in relation to the emerging cloud computing. In contrast, in the elementary school, we observed, but also heard from the families, the children and the teacher, that iPad enhanced teaching, learning and play. The variables that were most prominent for the acceptance of the technology were creativity, attitude toward learning and the emergence of new social patterns. The study with schoolchildren is now continuing, observing if there would be any changes in established patterns with prolonged use, as well as closer observation of how the device actually contributes (or not) to the learning itself now that the novelty of it is in the past.

8 Conclusion and future work

In conclusion of this study, we can say that the iPad has become part of the classroom information ecology. It is perhaps no longer viewed as the brightest colored fish in the aquarium, but it is a healthy small fish swimming in it. Its position in the ecology can change and evolve in several ways: by children growing into producers of knowledge and taking a more active part in creating content for the iPad (apps) as well as using it for more serious production of content with the existing applications, improving its usage as consumers by better selection and placement of the content that is adjusted to the user group's age and level of difficulty, by using it even more extensively as sharing and cooperation tool, or simply connecting to the internet more frequently. This list is not extensive or complete but indicates the possible venues for co-evolution with iPads in the classroom.

As future work, we see the need for mediation of the research results to the school leadership, wider community and policy makers. In this respect, the iPad as assistive technology is a great example for the future work. The sample used in this work was small, but working with several classes would give a large enough sample that could lead to significant results. If ways to use this technology to assist the children are found and documented, methods for working with that material would be needed in order to make it known to the people who can change the practices at schools.

Last, but not least, working with children has been very interesting, inspiring and giving. We hope to have the opportunity to continue this research, even if the master thesis does have to come to en end.

9 Appendix 1

Samtykke for deltakelse i studien:

"Evaluering av iPad-bruk i grunnskolen"

Dette forskningsprosjektet er utført av førsteamanuensis Alma Culèn og Andrea Gasparini ved Institutt for informatikk (UiO). Målet er å studere brukbarheten av grensesnittet til iPad, samt hvilke gevinster elever kan få av å bruke den. Barna vil bli spurt om sine inntrykk og meninger om bruken av iPad, og indikere hvilke deler de har problemer med. De vil få deler av pensum på iPad, samt noen ferdig installerte applikasjoner som er knyttet til blant annet astronomi undervisningen. Barna vil ha tilgang til 5 iPad i noen uker.

Prosjektet er en videreføring av et samarbeid om iPad og elektronisk pensum, mellom Akademika, Universitetsbiblioteket i Oslo og Institutt for informatikk:
http://www.aftenposten.no/kul_und/article3810657.ece

Barna vil bli bedt om å gjøre noen oppgaver (for eksempel lese bøker og gjøre oppgaver) med dette verktøyet i denne perioden. Mens de utfører oppgavene, vil vi, i samråd med [redacted] observere bruken av iPad i noen av skoletimene og stille dem flere spørsmål om sine handlinger.

Resultatene vil bli rapportert i en masteroppgave ved UiO, samt noen faglige artikler.

Barnas deltakelse er helt frivillig og de kan trekke seg fra studien når som helst, uten nærmere forklaring. Svar på spørsmålene til barna og observasjoner vil bli nedtegnet. I tillegg ønsker vi å ta noen bilder av barna mens de utfører oppgavene. Nedenfor kan dere krysse av

☐ Ikke bilde ☐ Bilde uten ansikt ☐ Bilde med ansikt dekket ☐ Bilde med ansikt

Eventuelle data som er samlet i studien vil forbli fullstendig konfidensielle. Barnas navn vil ikke være tilknyttet noen publiserte resultater.

Undersøkelsen vil foregå fra 20. januar og ikke lenger enn 18. februar.

Underskrift foreldre/forsørger: Barnets navn:

Prosjektansvarlige:

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