iPads in Context: Interaction Design for Schools

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Abstract: In this paper, we present our findings from an on-going classroom study at an elementary school in Oslo, Norway, where teachers and pupils use iPads for learning purposes. To obtain the present results, we studied pupils' use of iPads over a period of one year. The key question we explore in this paper is whether the iPad's interaction designs affects pupils' approach, use and learning outcomes. We analyse our findings by drawing on concepts from human-computer interaction theory, namely Norman's design concepts of visibility, feedback, affordance, constraints and mapping. In particular, the analysis focuses on how interaction design may influence the learning process in developing key competences such as the ability to read and write. We conclude that interaction design is a crucial element that may influence intended learning activities and outcomes.

Introduction

In the past few decades, there has been increased focus on using information and communication technologies (ICTs) as tools for learning and instruction, with heightened pressure for teachers to use ICT in the classroom (Cuban, 2001; Mifsud, Mørch, & Lieberg, 2012; Säljö, 1999). This focus is evident in the emphasis on ICT in terms of digital literacy in the Norwegian National Curriculum, where it is one of five basic skills or key competences which need to be developed. The competences of reading, writing, numeracy, oral and digital skills (Framework for Basic Skills, 2012) are to be integrated in every subject area.

In this paper, we report the results from an on-going classroom study at an elementary school in Norway which invested in iPads in order to fulfil the directives laid out by the National Curriculum (LK06). The key question that we address in this paper is whether the iPad's and the applications' (apps) interaction design affects pupils' approach and use, and if so, how. We have adopted a Human Computer Interaction (HCI) perspective to inform our analysis. We look at how the pupils use the iPad and apps, focussing particularly on the properties of the user interface that promote or inhibit the iPad's use as a pedagogical tool and how this affects the intended learning outcomes.

This paper is organised as follows. First, we present some recent studies on the use of tablets in education. We then discuss the concepts that we use for the analysis and present the data. Finally, we discuss our findings and raise some of their implications for education.

Tablets in Education

The term mobile learning, or m-learning, is often used to refer to learning supported by mobile technologies (Sharples, 2005; Tatar, Roschelle, Vahey, & Penuel, 2003). As such, mobile devices are not new in educational settings, and research studying their use in the classroom has spanned the last two decades (Engen, 2002; Frohberg, Göth, & Scwabe, 2009; Inkpen, 1999; Lundby & Engen, 2002; Inkpen, 1999; Mifsud, 2005, 2012; Sharples 2007). Recent research on the use of mobile technologies for learning purposes has been concerned with whether they elicit new forms of learning, what the attitudes of teachers are to the new technology and how the role of the teacher can be characterised (Ng & Nicholas, 2009; Rogers & Price 2008; Mifsud 2012; Tondeur, Harmans, van Braak, & Valcke, 2008). These issues have also been raised in terms of the use of tablets such as the iPad and Samsung Galaxy (Jahnke & Kumar, 2013; Lorentzen 2012). Lorentzen (2012) concludes that the teacher must facilitate the educational use of tablets, and that specific subject didactical needs have to be the point of departure for using the technology. Jahnke and Kumar (2013) raise the question of whether iPads are a substitute for textbooks or whether teachers create new didactical approaches. They conclude that new technologies do not lead to a change in teaching practices or learning experiences by themselves. This is supported by earlier research, which argued that traditional

teaching patterns might even be reinforced using new technology (Lorentzen 2012; Mifsud, 2012). The teachers in Jahnke and Kumar's (2013) study were positive concerning the use of iPads. However, the authors point out that the teachers were 'early adopters'. Similarly, Kjartansdóttir's (2013) study of the use of iPads involved a team of teachers who can also be described as early adopters, as in their study, the teachers initiated the use of ICT and were familiar it for teaching and learning purposes. Jahnke and Kumar (2013) point out that a further challenge for teachers is when *not* to use the iPad, that is, determining when the tool is not appropriate. They advocate a more learner-centred approach to teaching. However, teachers need to have time to collaborate, explore and develop their teaching (Lorentzen 2012).

Understanding Technologies – An HCI Perspective

Our paper is informed by Human Computer Interaction (HCI, specifically Norman's (1999) design principles. In applying the interaction design to our analysis of pupils' use of iPads in the classroom, we have relied on principles of user-centred design from the HCI research field, which deals with questions about how to study, plan and design the interaction between people (the users) and computers. Furthermore, we have applied these design principles to an educational context. Norman's design principles can be summarised as visibility, feedback, consistency affordance, constraints and mapping.

Visibility refers to how visible the functions in the user interface are, which increases the likelihood of users understanding what possible actions they can carry out next. For example, developing applications for children would imply that the user interface should be simplified. *Feedback* focusses on the information about the action that is sent back to the user. It can consist of audio, tactile or verbal information, as well as a combination of these. For instance, the hourglass which signifies that the computer is processing shows users that their last action is being processed. *Consistency* refers to the principle wherein an interface should have similar design elements for achieving similar tasks (Preece, Sharp & Rogers 2002). A consistent interface follows rules such as clicking the left mouse button to activate a function, or on the iPad, tapping one finger.

Affordance, a term that was originally coined by Gibson (1986) to describe perceived and built-in characteristics of things in the environment, refers to the attributes that an object has which allow users to know how to use it; these are also termed 'clues' (Preece, Sharp & Rogers 2002). For example, a button signals that it possible to push it. Norman (1999) integrates affordance with other concepts, most notably *constraints*. Moreover, Norman's (1993, 1999, 2002) notion of affordances can be extended to the characteristics that allow a user to 'do', whereas constraints 'limit' doing. Constraints are what control and limit possible action and operations. For example, when some functions are shown as faded, it is not possible to use them. Norman further emphasises the notion of *mapping*, which refers to the relationship between the controls and their effects. An example of good mapping is where actions are represented by buttons the user can activate or deactivate in the user interface, or when the arrows on the computer keyboard are used to represent the up and down movements of the cursor.

The adoption of an HCI perspective highlights what the technology – in this case, applications or 'apps' – can and cannot do. Consequently, we raise the issue of whether the iPad's interaction design influences the pupils' use of the tool, and if so, how.

Method

Data were collected by means of observation, documented by field notes and short videos of the pupils' activities on the iPad. Two or three researchers were present in the classroom at the same time and field notes were compared at the end of each observational session. We also conducted in situ interviews with the pupils, where we asked them to verbalise their thoughts as they moved through the interface; this clarified a number of points concerning the pupils' use of the technology. The in situ interviews can be described as 'thinking aloud' evaluations, a method applied in usability testing (Nielsen, 1993). Furthermore, we conducted individual interviews with the teachers, ICT support teacher and the headmaster at the end of the observational period, as well as focus group interviews with the pupils. Interviews were audio-recorded, and eventually transcribed and partially translated by the authors. We observed iPads used in the $1^{st}/2^{nd}$ grade, $5^{th}/7^{th}$ grade and special needs education. In this paper, we report observations in the $1^{st}/2^{nd}$ grade (6 to 7 year olds) spanning one calendar year.

Preliminary Findings

In this section, we present our preliminary findings. During our observations, we saw that some aspects of the user interface were associated with the design of the iPad, while some were associated with the app itself. *Design* is an ambiguous term; in general, it may be understood as the form and function of a given a solution. In focussing on

design in a pedagogical context, we highlight how it may shape teaching and learning activities. Pedagogy is about facilitating learning such that students acquire knowledge, skills, norms and values. Thus, *pedagogical design* can be defined as form and function aimed towards facilitating learning (Skaar 2005). In our analysis, we narrow down the term 'pedagogical design' to refer to how the user interface corresponds to a specific target group in a learning context, investigating whether the design supports the intended learning activity and how it accomplishes this.

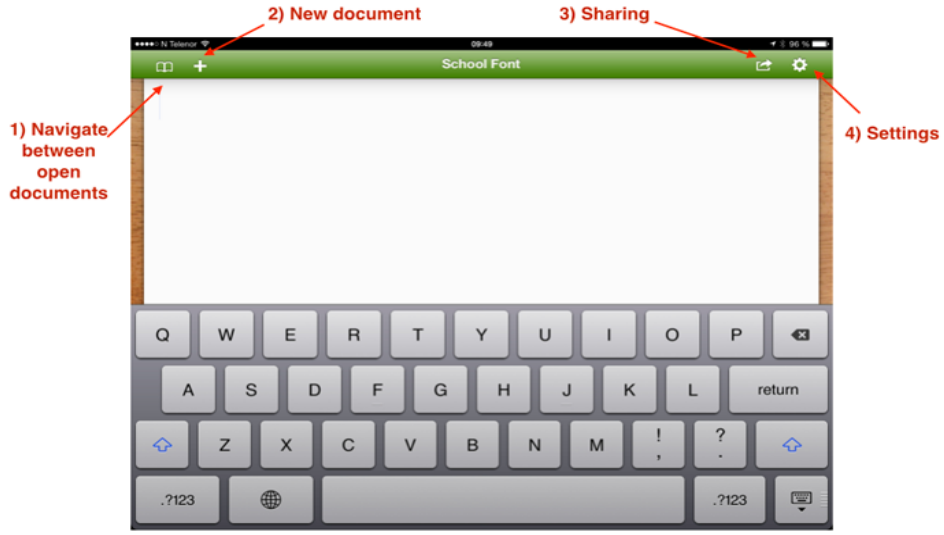
In this paper, we focus on two apps that were frequently used in the classroom. One was designed as a teaching aid related to writing, while the other was designed to support reading activities. In different ways, these apps represent support for two key competences – the ability to read and the ability to write (LK06). The following apps were assessed:

- **School Font**: A writing programme where the letters that are typed by the users on screen are read aloud when the space bar is pressed and where the complete sentence is read at the final punctuation; and
- **Red Riding Hood and the Wolf**: A read-aloud illustrated application about Red Riding Hood and the Wolf. The tale can be listened to or read aloud.

In the 1st/2nd grade, the iPads were mainly used in station-based teaching. Groups of pupils were based at different stations and rotated every 12 minutes. While one station was teacher-led, the others were autonomous; one of these was an iPad station.

Key Competence: The Ability to Write

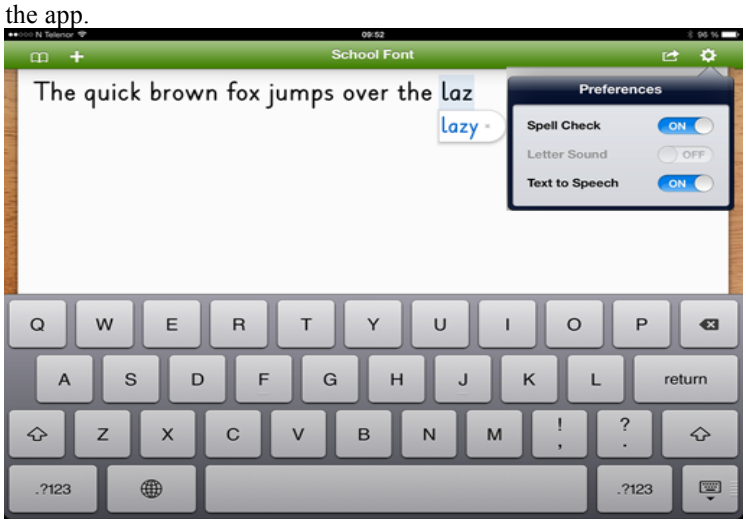
In terms of basic reading and writing training for the 2nd grade pupils, the app School Font was observed frequently in use. From our perspective, School Font has a well-organised interface with a clear pedagogical design.



As can be seen in the above image, the interface is relatively simple. When the pupils start the app, they are presented with a white sheet and a QWERTY keyboard. Other than these elements, there are only four icons to choose from, as follows: 1) navigation between documents the pupils might have open, 2) creation of a new document, 3) sharing the document via e-mail, Google Drive and so on and 4) settings. The interface clearly exhibits the design principles of 'visibility' and 'mapping'. In terms of visibility, it was obvious for the pupils what to do next after they had started the app. In terms of mapping, the icons are an intuitive graphical representation of what the user should expect when tapping the four different icons. Furthermore, the app uses consistency principles and Apple's human interface guidelines.

The application has a clear pedagogical objective. Besides being a word processor, it has built-in auditive 'text-to-speech' support, giving auditive feedback to the pupils as they typed words. For example, writing the sentence 'The quick brown fox jumps over the lazy dog' gave 'just-in-time' auditive feedback on each word that was typed. In case of misspelling, the text-to-speech feature reads the word phonetically, making the pupil clear over the misspelling. Setting a full stop gave the pupils auditive feedback on the whole sentence. This feature also serves as a reminder that sentences must always terminate with a full stop.

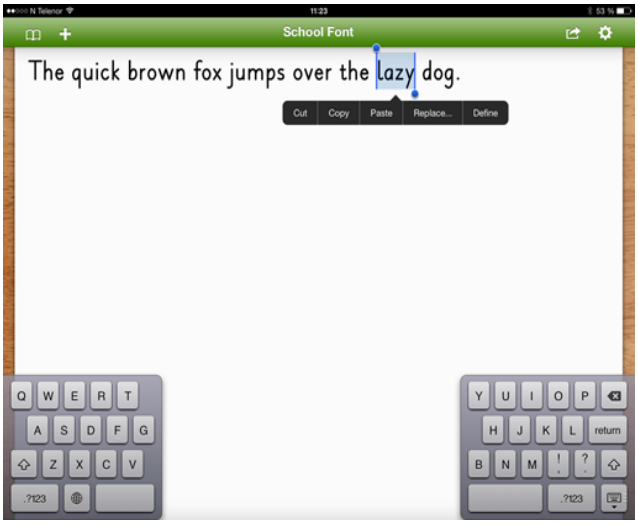
School Font is an example of a digital teaching aid which represents a good technical as well as a pedagogical solution. However, in analysing how the app functions together with the iPad's general interface, some problems arise. At the system level, iOS has built-in support for both spell checking and word suggestions. In the case of School Font, the spell checking option can be turned on or off, either in the iOS system settings or locally within the application settings. However, the word suggestions function can only be turned off using the iOS system settings, and not within the app.



As illustrated in the above image, the pupils and teacher could turn the system spell checker off or on within the app, but this did not apply to word suggestions, which consequently led to a problem. Disabling the automatic word suggestion option was far too complicated for the 7-year olds. While this might initially appear to be a trivial problem, our observations indicate that these settings undermined some of the pedagogical intentions. Pupils' spelling and their construction of sentences were overruled by system-wide and application-specific settings. For example, the iOS built-in features meant that two spaces = full stop. We observed pupils who wanted more space between words and tapped in two spaces. These pupils ended up having a full stop half way through the sentence, and half of the sentence read aloud. In our opinion, neither word suggestions nor spell checking should be turned on by default in an application which is meant to teach 7-year olds how to write and construct sentences. Our observations indicated that having these settings 'on' detracted from the pedagogical value and purpose of having auditive feedback.

In interviewing the pupils, we asked them their opinions of School Font. Their views were mixed, but several of the pupils commented that they found the app confusing at times. This gives an interesting perspective to the understanding of how the application is used. While the 'mechanical' text-to-speech feedback is developed as a pedagogical affordance, built-in features function as pedagogical constraints in that pupils think that they have misspelt words. As one student stated, 'I think it's difficult to use School Font. She [the text-to-speech voice] says so many weird things that I make mistakes. Sometimes when she says the wrong thing I think I've misspelt, but I haven't'.

Other system-wide settings and features of the iPad interfered with pupils' learning activity. For example, we observed a boy who accidentally split the keyboard, as the image below illustrates.



This challenged researchers, teachers and pupils, and it was only through trial and error that we – together with the pupils – managed to put the keyboard together again. Incidents like this made us aware that there are different actions embedded in the iPad that may lead to situations which hinder the pupils' learning progress. Another example of iOS built-in features can be seen in the functions that appear when double tapping a word. As illustrated in the screenshot above, the functions 'cut', 'copy', 'paste' and 'read' appeared when text was marked, which confused the pupils.

The pupils were in 2nd grade and the simplicity of the app was appropriate for the age group. However, most pupils were not used to the keyboard and their writing was hampered by problems such as 'How do I create a space?', 'How do I start a new line?' and 'How do I make capital letters?' This is an example where mapping was not intuitive due to pupils' limited exposure to the icons on the keyboard and what they represent.

Key Competence: Ability to Read

Interactive reading activity apps include books with or without auditive support and other media such as inbuilt interactivity or movies. One app we observed in this category was an interactive illustrated book about Red Riding Hood and the Wolf. We observed the 1st/2nd graders using this app. According to the teacher, some were good readers, while others were not. From a pedagogical perspective, the app supports individualised learning, as pupils have the option of whether to read on their own, listen or a combination of the two. Getting started, the cover provides the instruction to '"Swipe" from left to right to turn the page' [our translation]. 'Swipe' is not a Norwegian word, and the text is quite small. For pupils who could not yet read, the text was meaningless, and did not assist the pupils in progressing with the text, as we describe below.

From our observations, the pupils started the app without any apparent problems. However, when the pupils tried to turn from the first page to the second, they encountered several difficulties.

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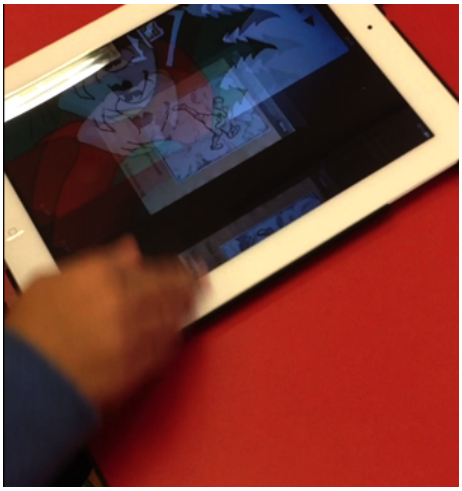

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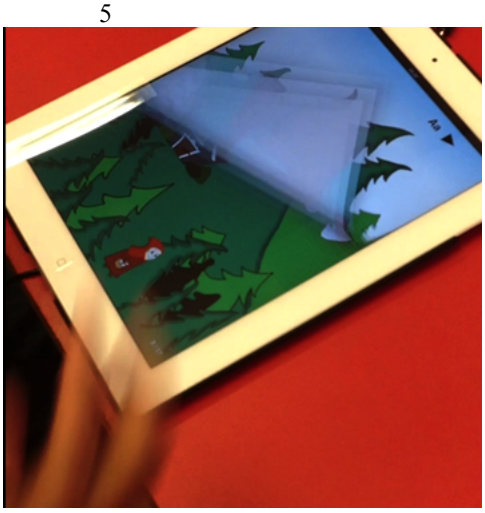

As we can see from image 1 above, the pupil had finished either reading or listening to the page and was ready to go to the next page. In attempting to turn the page, however, s/he used two or three fingers instead of using just one, as shown in image 2. It is perhaps common for pupils at that age to use several fingers to turn a page, whether the book is digital or not. However, on the iPad, this movement activated the command to switch between open applications and brought up another app instead. On discovering that s/he was in the wrong application, the pupil reversed the action to get back to the app/story about Red Riding Hood and the Wolf (image 3). When several fingers did not give the desired result, the pupil attempted to turn the page using one finger (image 4).

After several attempts to swipe using one finger from right to left in a horizontal movement, s/he suddenly – more or less accidentally – succeeded in turning over to the text page (image 5). However, in analysing image 5 closely, we see that the visual feedback is moving in another direction. While the movement to initiate the page turning was from left to right, the movement of the page being turned was diagonal. In turning over to the next page, the pupil attempted to mimic the diagonal movement, with the result that the page did not turn next time. From an HCI design perspective, this is an example of lack of consistency between the action required to activate the mapping and visual feedback.

This example is an illustration of a good pedagogical idea, but a poor pedagogical and technical design. From a pedagogical perspective, the pupils were given instructions in a mixture of English and Norwegian. Furthermore, the instructions were given in writing to a target group which was just learning how to read. From a technical perspective, there were no built-in mechanisms to overrule system-wide multi-touch gestures on the iPad. In terms of HCI, there was no correlation between gestures and visual feedback. Furthermore, the pupils had to tap on the letter 'Aa' (see image 4) in order for the text to appear; the text was not the default. As we see from the above images, the pupil did not have the text visible, and listened to the story without any form of textual input or support. In addition, there was no correlation between the text and narration. When the pupil turned the page, the narrator continued reading from the previous page. While the teacher's intentions in choosing this app were pedagogical, as she pointed out, she wanted pupils who were not read to at home to enjoy being read to, as well as being exposed to written words and their sounds simultaneously; thus, her intentions were not entirely fulfilled by the app. The app did not support the key competence 'ability to read', as the main action was listening. The problem, from an HCI perspective, had to do with the poor pedagogical and technical design of the app, as well as system-wide settings on the iPad, as can be observed in images 1–5.

Conclusions and Directions for Further Work

We introduced this paper by raising the following question: Does the interaction design affect the use, and consequently the pupils' learning outcome? We chose two examples to illustrate how interaction design may influence the learning process and serve as a key element in designing and constructing teaching resources for the iPad. While some apps are designed to support key competences such as the ability to read and write, the built-in affordances and constraints in the design undermine the teacher's pedagogical objectives. First, the iPad is not always as intuitive as one might think, especially within the school context. Furthermore, teachers have to consider several elements before introducing an application into the classroom. In this paper, we gave examples of good technical and pedagogical design combined with a clear pedagogical objective that were unfortunately ruined or overruled by iOS's built-in features. We also described and discussed an example of an application with poor technical and pedagogical design; although the pedagogical objective was clear – supporting the ability to read – the app was more geared towards supporting listening. The design of the app is crucial to the way in which it is used and the learning outcomes.

While the potential of tablets to support teaching and learning has been focussed on in recent studies, the emphasis has been on teachers' use and their didactic approaches. In contrast to this, we argued that an HCI perspective on learning and teaching is crucial to understanding the effect of design on the learning outcomes. Furthermore, in terms of applications for tablets, there are several actors on the market – both educational and commercial or amateur developers – publishing applications which can be used to support learning. However, their effect in the teaching and learning context is not yet well documented. Studies need to take this aspect into consideration when studying the use of tablets in education.

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