Bringing Tablets to Schools
Lessons Learned from High School Deployments in Germany

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Abstract: Tablet deployments at schools are becoming more and more popular. Research on how to effectively use tablets for teaching is unfortunately mostly missing. With this paper we share our experiences from various high school deployments in Germany. During these deployments we have developed a novel learning style designed for tablet-based teaching. We have evaluated our deployments through interviews with teachers and students. A quantitative survey compares the use of tablet devices with laptop computers.

1 INTRODUCTION

Tablet computing is quickly spreading in schools around the world. Even though the device category of tablets has just been introduced a mere two years ago, we see an astonishing rate of adoption in a market, which used to be more conservative. We see a wave of enthusiasm by both teachers and students unequal to anything we have seen before as far as computing at school goes. Particularly, this excitement seems to have completely been missing from previous laptop based school projects, such as the One-Laptop-Per-Child movement (Negroponte, 2006) and other deployments.

Based on our experiences gathered from high school deployments in Germany, we want to discuss the elements of tablet computing that make a difference. We are trying to answer the following research questions: What are the strengths/weaknesses of tablets compared to e.g. laptop computers? How can tablets be successfully deployed at schools?

Above all, there is a need for teaching concepts and learning content to support teachers. Teachers have to know how best to use tablets It is certainly not enough to just handout iPads. This is why some deployments have failed or were discontinued.

In this paper, we present the results from interviews and surveys conducted in various tablet deployments at high schools in Germany. Based on these experiences, we propose a novel interactive learning style with a focus on tablet-based teaching. For our deployments, we developed learning content, which leverages both the multimedia capabilities and simplicity of use of tablet computers. The corresponding lessons were implemented using the open data format proposed in (Weible and Seemann, 2013).

Figure 1: Main screen of the developed tablet software for high school students.

2 RELATED PROJECTS

Research in the field of tablet based teaching lags obviously behind real world deployments. Schools have started to adopt tablet devices before large scale scientific evaluations could be performed. The first iPad appeared in April 2010, since then the research community has not had much time to develop, deploy and evaluate these devices. First results from

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pilot projects have often not yet been published or are sometimes not even scientifically evaluated. One of the first published results by Isabwe et al. (Isabwe et al., 2012b; Isabwe et al., 2012a) concentrates on math teaching and peer assessment techniques. Still unpublished efforts include an initiative for K12 math by Shocken et al. (Schocken, 2012) (creator of Nand2Tetris (Schocken et al., 2009)). A more comprehensive discussion on the use of tablets in different subjects is, to our knowledge, still missing. The research community is certainly trying to close this gap, but we are only starting to catch up.

2.1 Tablet Deployments

Tablet devices have already been widely deployed at many schools in the US and Western Europe. Often, these deployments result from the initiative of local teachers and parents. Larger deployments initiated by government organizations are much less frequent.

In the following we would like to briefly mention two examples of those deployments in Italy and Germany.

One of the larger deployments is a project in sourthern Tyrol, Italy (Farias, 2011). Several hundreds of students participate in a pilot project on tablet-based teaching. The project uses Android tablets and all school books are provided in electronic form by the respective publishers.

The first goal of the project to replace conventional textbooks has already been accomplished and both students and teachers are very satisfied with the solution. The crucial point of adapting the text book's content to tablet based teaching has not yet been tackled by the publishers so far. In most cases they just provide a PDF file of their traditional paper-based text book.

Another deployment is organized by the city of Mannheim, Germany (Klinga, 2011). This deployment of some hundred tablets is based on the popular Apple iPad. The iPads are not supposed to replace conventional text books, but e.g. to create multimedia presentations or documentations. The exact use of the tablets in the curriculum, however, depends on the individual teachers (Klinga, 2011).

Since publishers are not involved in the project, it is often not obvious for teachers to find appropriate content. While there is a certain amount of material available in English (e.g. in the iBook Store), content in other languages e.g. German is mostly missing. Many critics therefore even believe that tablet-based teaching is a temporary, short-term fashion, which will eventually fade. This again stresses the urgent need for optimized, interactive content.

2.2 Learning Content

Because of the lack of scientific and practical experience, publishers and teachers seem to be unsure how to create content for the new devices. There is no widely accepted learning concept or content available for tablet devices.

Apple has proposed a proprietary standard namely iBooks to create such content and wants to provide the technical platform. Relying on this iBook standard, however, gives Apple full control over the distribution. More over, publishers are restricted to features provided by the iBooks software. These are two of several reasons why many publishers have so far been skeptical about this platform.

Some publishers prefer the competing Android platform developed by Google. At this moment, there is, however, no established standard and little content beyond traditional books (provided as E-Book).

3 COMPUTER USAGE

Historically there have been many debates on whether to use computing devices for teaching. The more important question, however, is when and how to use those devices. Here the new form factors of computing: laptops and tablets have paved the way to a more ubiquitous use of computers in schools.

All of these form factors have certain strengths and weaknesses as far as effective learning is concerned. We will discuss these in the following two subsections. In particular, we would like to point out the reasons, why tablet devices have become so popular in such a short time.

3.1 Laptops

Even though there have been many ambitious projects, e.g. the One-Laptop-Per-Child project by Nicholas Negroponte (Negroponte, 2006), laptops have not revolutionized our way of teaching. While they are very capable devices, in fact, they are much more capable than today's tablet devices, teachers are still hesitant in the adoption.

One issue has certainly been the relatively high price for schools and students. However, the more important issues seem to be that laptops are complicated. Schools need trained system administrators to setup and maintain the devices. And also students, particularly younger students, need training to get accustomed to keyboard, mouse and a complex operating system.

3.2 Tablets

Tablet adoption is very much on the rise, even though they are often not cheaper than conventional laptops. What are the reasons for this?

According to our experiences tablets provide multiple advantages over laptops. First, tablet devices need less administration. This is, on the one hand, due to the fact, that they currently offer a more limited set of functionalities. On the other hand, the respective tablet ecosystems are tailored towards ease of use. Students do not have to be skilled with the mouse or keyboard and applications are typically stripped down to the essentials, but also offering less functionality than their desktop counterparts. Audio/video playback and recording works out of the box without turning knobs in the settings. Tablet devices are always "on" and time consuming boot up procedures are eliminated.

The interaction through touch feels, in many cases, more natural and is even fun to use. Ironically, tablets feel mostly snappier than much more powerful laptop computers. For schools this ability to let students interact more naturally via touch is essential. Our evaluation has shown (see section 5) that most students prefer this way of interaction.

4 CASE STUDY: DESIGN AND IMPLEMENTATION

Tablet-based teaching at schools and universities is in an early phase. The community still needs to figure out the best ways to use tablet devices. For this it is necessary to conduct case studies, where tablets can be tested in practice.

For our case study, we have deployed tablets at schools in Baden-Württemberg and Berlin (Germany). We have conducted many in-depth interviews with teachers and students, which provided valuable feedback. It was also interesting to observe the students while learning and interacting with the devices.

In the following, we will explain the design choices, which have been made based on these experiences. We will also explain the software and interactive content, which has been developed during these deployments.

4.1 Basic Software and Hardware

The interfaces of the major tablet operating systems Android and iOS (iPad) are both simple to use. They are, however, NOT designed with a focus on teaching. That is, there is a focus on the concept of apps, whereas we wanted to stress the learning content. That is, the main interface should highlight lessons, lectures and functionality (e.g. taking of pictures). From our initial discussions with teachers and students it became also clear, that the learning content should be organized by subject. In order to meet these requirements for a main interface, we developed a novel user interface for tablet-based teaching (see Figure 1).

Distraction of students by the possibilities of the internet or pre-installed apps (e.g. games or Facebook) turned out to be one of the major hurdles for successful computing deployments. We therefore implemented a Kiosk mode, where teachers could control which apps and functionalities are available to the students.

4.2 Concepts: Learning Content

Learning content is essential, when we want to fully exploit the potential of tablet devices. The lack of content or even of a concept how to use existing content with tablets are the main reasons why some tablet projects have been less successful or even abandoned. This is e.g. the case for the Orestad Gymnasium in Denmark where an iPad deployment has been canceled after 6 months of testing (Andersen, 2012).

The same is certainly true for other computing equipment as e.g. interactive whiteboards. Those are very widely deployed but seldom used as more than a simple projector.

The goals of our deployments have therefore been in two main areas. First, to provide learning content, which is designed for tablet-based teaching. For this, we developed a novel learning style. With this learning style we combine hearing (ear phones), seeing (pictures and video) and doing (touch interaction) in a way, that makes the learning experience interactive and fun.

We want to provide two examples of our proposed learning style. One example for teaching foreign languages and another for teaching math.

Foreign languages can be taught very effectively with the help of a tablet device. A student can e.g. read through an illustrated story at his own speed. With the help of ear phones he hears the pronunciation associated with the words. He sees and hears at the same time. New words can be learned from the context of the story and the pronunciation can be repeated over and over if necessary. Touch interaction is enabled throughout a lesson and by clicking on a word, additional information or the translation can be displayed.

To further encourage active participation, lessons

Figure 2: Touch-based interaction is possible throughout the lessons. Here an English verb is translated by clicking on it. The translation is highlighted as a speech bubble.

are interrupted after relatively short periods of time with questions and educational exercises or games on the newly learned content. For foreign languages such a game could be a word puzzle where a student has to find the correct spelling of a newly learned word from a provided anagram (see Figure 3).

Figure 3: Practice the spelling of newly learned words by shuffling the letters.

For math teaching similar techniques can be applied. Content and exercises should always be presented through a problem statement or story. In our sample lesson e.g. we introduce the concept of negative numbers, through analogies in real life or compute the time to travel to the international space station ISS Newly learned facts or rules, should be immediately applied through interactive questions.

Math is often not very popular with students. In our opinion, the main reason for this is, that students get stuck at a problem and fail to follow the rest of the class. This is also very much true for conventional education, where all students have to follow the pace defined by the teacher.

In order to use tablet devices effectively for math teaching, we therefore have to make sure that students can learn at their own pace without getting stuck. That is, the tablet has to react to possibly wrong solutions and intelligently help the student. For this we developed our content in a way, that a teacher can provide hints and pointers depending on the solution provided by the student. As students are interactively tested after short periods of time, common mistakes can be avoided early in the process. For our math sample lesson e.g., we carefully analyzed the answers of 30 students and now provide updated hints and pointers (see section 5).

The second area of improvement is in the area of student motivation. Research in the area of serious games (Klopfer, 2008) (a term often misunderstood by people outside of the education community) shows how motivational elements can help to improve student results. Unfortunately this research has not yet found its way to most schools. We believe that the introduction of tablets should be accompanied by the introduction of elements of serious games. That is learning content should be developed with student motivation in mind.

5 CASE STUDY: EVALUATION

Our deployments at schools in Germany started in May 2012, since then we have gathered usage data and evaluated the teachers' and students' experiences with the devices and software.

The focus of the deployments were students in grade 7 at German high schools. That means students at the age of 12 to 14. We have developed a software, which replaces the main screens of the tablet operating system with a teaching centered user interface. For this user interface, we have created novel interactive content.

The schools have been provided with a complete bundle of hardware, software and a portable server, which allows network and internet access to all tablet devices.

Additionally, we have conducted trainings for the teachers at the schools. Firstly, this has been done to familiarize as many teachers as possible with the usage and user interface. Often teachers see tablets as additional technical burden and realize only later on, that those devices coupled with the right content can make teaching easier. The students learn by themselves and the teachers can concentrate on weaker students needing special attention. Maybe this skepticism comes from the teachers' own experiences with laptops, which are often frustratingly difficult to setup and maintain.

During the trainings, we wanted to introduce the teachers to tablet-based teaching techniques and in particular to the ideas behind the provided interactive lectures. Finally, we wanted to demonstrate what

tablet devices are capable of doing (e.g. as a media production device) and in which circumstances they are to be avoided (e.g. writing a long text). We have received valuable feedback from these trainings. In particular, we have received ideas for use cases we did not have in mind initially.

For a more quantitative evaluation of the project, we conducted a formal survey among the students in October 2012. The obtained results will be presented and discussed in the following paragraphs.

The first questions, we asked in our survey, were how tablets compare to conventional laptop computers. We wanted to know whether students prefer the tablets for their learning efforts. Informally, students enjoyed working with tablets. Being able to quickly and intuitively interact with the devices really seemed to play an important role. Our survey underlines this impression with approximately 80% strongly preferring tablets over laptops. Only 4% think, that laptops would be better suited for learning (see Figure 4).

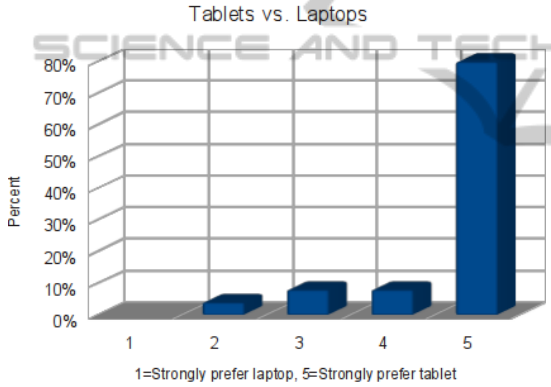

Figure 4: Comparison between tablets and laptop computers. Students mostly prefer tablet devices. Possible ratings were: 1 = strongly prefer laptops, 2 = prefer laoptops, 3 = equally suited, 4 = prefer tablets, 5 = strongly prefer tablets.

A similar result was obtained for the ease of use. Here 76% responded that tablet software was intuitive and simple to use. Approximately 10% think that the learning curve is similar to other computing devices.

Most students also seem to be content with the virtual keyboard with more than 70% of the responses arguing that a physical keyboard is not necessary. Probably, this number very much depends on how the tablets are used in class. In our deployments the focus was on interactive content, where keyboard input is less of an issue.

As far as the self-reported motivation of the students was concerned, an overwhelming 84% of the students were more motivated when working with a tablet than during normal classes. It remains to be seen, whether this is a temporary effect, but at the moment there seem to be a very positive impact in this area.

The interactive questions and games during the lessons were equally well received with nearly 90% of the students considering them essential for their learning progress. Approximately 70% responded that the combination of illustrations and audio greatly improved their understanding and helped them to better remember the content.

Overall 64% of the students are convinced that they have learned more by using the tablets than they would have in ordinary classes. And nearly 90% would like to continue self-learning with the devices at home, e.g. for exam preparation.

The feedback we received from teachers was very positive and even older teachers handled the tablets proficiently after a short training. Teachers also pointed out that short video tutorials as often used in online learning, e.g. (Khan, 2006) provided considerably less learning incentives and students very much preferred interactive lessons.

6 CONCLUSIONS

Based on our observations, we truly believe that, if done right, tablets can vastly improve the process of learning and in particular enable students to better learn for themselves. In this area traditional paper-based books are certainly not optimal.

Our survey has shown that tablets are accepted by students. They feel more motivated and are convinced to learn more effectively. The key, in our opinion, is the appropriate presentation of the learning content. The learning style proposed in this paper is designed for tablet-based learning and focuses on touch-based interaction and student motivation. Further analysis of student responses will help us to iteratively deliver better content.

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