



# Tablet PCs in Elementary Education

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*A Pilot Project at the Practice Primary School of the KPH at Campus Vienna/Krems*

**Abstract.** One class of the practice primary school at the church-affiliated former pedagogical college (KPH) at Campus Vienna/Krems located in the 21<sup>st</sup> district of the capital of Austria was equipped with Tablet PCs at the beginning of the school year 2011/2012. These devices for all students of a third class were financed by the institution and partly the parents. The Austrian Federal Ministry of Education and Women's Affairs funded the evaluation and documentation of this two-year project. As recent international studies on the use of tablets (mostly iPads) in primary and secondary education confirm, also these nine years old kids quickly got familiar with the used Pearl Touchlet tablets. The pupils were highly motivated and tried out different applications. The tablets were used also outside the classroom which is a key benefit of any mobile computing. Tablet PCs support individual learning and enable cooperative social forms and interactions during lessons and also in leisure time. As personal mobile devices they are catalysts for self-directed "just-intime" learning. Each 21<sup>st</sup> century student should have one at his/her disposal.

**Keywords:** Tablet PC, Pearl Touchlet X4, primary school, mobile computing, KPH Vienna/Krems

## 1 Introduction

A tablet PC is a mobile computer with a touchscreen display that uses finger or stylus gestures substituting for the use of computer mouse and keyboard. [1, 33, 34] They are larger than smartphones or

personal digital assistants at 7 inches. Tablet PCs appeared on the market either as so-called slates or convertibles. Convertibles include an integral keyboard that can be either twisted in order to convert the tablet into slate mode or even totally removed. The functionality of a tablet is more extensive than that one of a smartphone, but tablets mostly lack the keyboard of a notebook. You can dial with the latest devices available on the market thanks to built-in Wi-Fi feature in wireless networks, and so surfing the web, typing emails, edit photos and watch videos, listen to music and upload all types of files and download data. You can take pictures with the camera located on the back side of the tablet. On basis of an inserted SIM card the front camera allows video calling in an existing cellular connection via UMTS. In addition, installed office applications can be used for writing short texts also without for newer models attachable supplementary keyboards. Moreover, one can send wirelessly multimedia data to external devices such as a TV. Most new tablets offer a GPS function.

Since 2010 these devices have become popular and conquered the IT market as a new class of mobile tool. But at this time the price of high-end tablets was relatively high. Instead of paying hundreds of euros for an Apple iPad or the Galaxy Tab from Samsung, other companies offered alternatively cheaper tablets such as the Touchlet series from Pearl.

Considering the fact that mobile computing had found its way into school education meanwhile the Austrian Federal Ministry of Education and Women's Affairs (BMBF) was asked to support a further evaluation project at the practice primary school in Vienna-Strebersdorf starting in the school year 2011/2012. This Tablet PC project has been already the sixth ICT project in the focus of supporting a technology

enriched learning within 12 years undertaken at this location with financial help of the BMBF (new organized in 2012, instead of culture and arts now with women's agenda) and the support of different IT companies such as Hewlett Packard, Promethean and Asus. **Table 1** illustrates this.

Coming back to the tabkids project: For teaching and learning purposes suitable additional programs for tablet PCs are available in the app stores of the three largest manufacturers: Apple

with the iOS operating system, Google with Android, and finally Microsoft with its Windows 8 [35]. While primarily Apple in regard to its company and business policy terms practices strictly a self-contained operating system concept on all devices, the starch of Google lies in the openness of its apps ready to be downloaded, many of them are free or at low cost. The Microsoft Store also continuously increases its app portfolio. The Touchlet X4 used the Android operating system, so the project team<sup>1</sup> was searching suitable apps at the Google Inc. platform.

The following chapters of my contribution describe the main issues of the project, highlight the positive (didactical) findings and show also some technical restrictions of the device itself. Finally I refer to current international case studies on the use of tablets in primary schools and present the results of scientific research and pedagogical estimations in the field of mobile computing.

## 2 Project Goals

Through the evaluation it should be found out to which extent the positive results reported by international studies [2, 6, 7, 8, 16, 19, 20, 25, 29, 32, 33] are confirmed during this specific Austrian Tablet PC project. The following procedures and issues had to be considered:

- Checking the IT market for affordable but technically seen sophisticated equipment
- Purchasing (funded by the school authority) of a larger quantity of devices to have substitutes in case of defects
- Identifying organizational and technical conditions required for the tablet use, i. e. reliable options for storing and charging the devices, maintenance and updating the software, and Internet access;
- Raising further ICT competence which included training the students in the use of hardware and software, building awareness of responsible handling and of possible risks, in particular concerning the Internet;
- Exploring the educational potential of the tablets by testing programs and applications with regard to the benefits for different educational subjects in primary school as well as for the use at home.

### 2.1 Selection of the Hardware

From the very beginning on the Tablet project at the practice primary school was focused on a 1-to-1 ratio, e.g. one device per child in order to foster mobility, portability, independence and responsibility

**Table 1. ICT evaluation projects at the Practice Primary School at the KPH in Vienna-Strebersdorf**

School year	Project
2015	Coding (in consideration)
2011-2013	TabKids [24]
2008-2010	eeePC@school [4]
2007/2008	activboard@school [12]
2004-2006	ppc@school [3]
2001/2002	Computer integration in class [11]
1999/2000	Electronic learning center



[32, p.40; 19, p.38, 16, p.79]. The project started in autumn 2011<sup>2</sup>, at this time the choice of hardware, which corresponded to the financial possibilities of the school, was limited. The IT distributor Pearl Inc. offered a tablet PC that fitted both technically and financially, so 27 devices were purchased with the following features:

- Type: Pearl Touchlet X4, 193 x 115 x 16 mm, 346g incl. battery, 7 inches capacitive multi-touch display (up to five fingers at the same time) with a resolution of 800x480 pixels.
- Android 2.3
- Front camera with 1.3 megapixels
- CPU frequency 1 GHz
- 512 MB DDR2 RAM
- 4GB Nand-flash in the project case with a 2 GB Micro SD-card added (max. 32 GB available)
- Wi-Fi 802.11 b/g, Bluetooth
- Connectors: Mini-HDMI, Mini USB 2.0 with host function,
- 3.5 mm audio jack, Micro SD slot
- Protective case with built-in USB keyboard

In comparison with currently (2015) available devices, the technical data remind on the 100-Dollar-Laptop XO-1, an initiative ("one laptop per child") founded by Nicholas Negroponte in 2005<sup>3</sup>. But when our Tablet PC project started, there was no alternative in this price range (around 120 Euros).

Then next step was to find useful software for the Touchlet X4 working with the Android system [35, p.17; 9, 10]. Olive Office, suitable for devices with less powerful processors and available free of charge, was installed, but its graphical interface was rather limited. Text documents could be saved in the docx-format and were readable by other word processing programs. To read PDF-files, a free of charge reader for Android was used. In addition to the office software package the following apps were installed and used [24, p.17]: ES File Explorer (file manager)

- Multi Touch Paint (drawing)
- Musical Lite (musical instruments)
- Scan (QR-Reader)
- FTPSyncX, SyncMe (file synchronization)

## 2.2 Acquisition of Handling Skills

The kids should learn to use the tablet as another working tool in the learning process. They should get to know its functions in order to work independently without the help of teachers. [24, p.20; 27] At the beginning common rules were manifested that should guarantee a safe and gentle handling of the Tablet PC itself. In order to learn operating well with the apps and essential functions of the Android operating system, the parents agreed with the project management that all children of the project class should attend

the optional lesson "Computer assisted learning" offered by Martin Newald.

Each child received his/her personal tablet and identified with it in some way, wallpaper and home screens were set individually. From the beginning, it was important for the project team to give children an awareness of the value of their tablet PCs and the order to handle them carefully. Over the entire project only one greater damage to one of the devices happened. The remaining incidents, such as problems with loading the battery, defective USB adapters or software conflicts, were not in the sphere of influence of the children.

In the first two months of the project students worked only with the touch screen and without the additional physical keyboard. The main task was to get acquainted with important functions of the Android 2.3 (to set date and time, to create folders, to implement applications such as FTPSyncX for synchronizing files and set up the synchronization folder). The keyboard was handed to the children, when they showed a certain degree of security when handling the device.

About six months after the start of the project, the program "Olive Office" was used, that generated text-files in the docx-format. With this program the students learned also labeling and formatting of parts of the text. Important issues of handling the tablet in this context were the control of the cursor on the screen, the use of dropdown menus with a longer finger pressure as well as the individual setting of the zoom in Olive Office. Sooner or later all children mastered the functions and soon any learning dictionary-file received its personal outlook from differently colored headings in an individual font size. Parallel with Olive Office the students learned the handling of the ES File-explorer, which allowed them to manage files on their devices easily. Soon, copying and renaming of files was no longer a problem.

From time to time it happened that the Office program did not start or a file was not properly opened. In such cases the process was cancelled or the Tablet PC was rebooted which was no challenge anymore for the kids after a while.

In the second year of the project, a new version of Olive Office was announced that should offer a better graphical interface and a more user-friendly operability. The enthusiasm among the students was great when installing the new version, but already the first steps exceeded the computing capacity of the slow processor of the Touchlet X4, so the software did not work properly. After a short time the project team decided to return to the old familiar version.

## 2.3 Technical problems

During a two-year project various issues in regard to hardware and software cannot be considered before, or anticipated. For

example, when using QRcodes (Quick Response codes are images that contain the encoded information that can be extracted with appropriate software again) the camera shot only turned-upside photos, which was not really noticed until that time. To use this codes anyway, it was necessary to print out a mirror image to get a useful result (e.g. for a class project).

The synchronization application could not correctly evaluate the time information of the data to be synchronized, so a complete synchronization of all working folders and a high data traffic were the result. The file server was overloaded by many concurrent requests, so synchronization lasted extremely long and was faulty. A workaround for this problem was the group-wise synchronization. Later, the synchronization program was replaced by another, but this one depended on a different protocol, which required a significant effort in the configuration of the individual tablets by the project team.

Other difficulties were caused by the low resolution of the tablet Touchlet X4 and the browser version. Flash-based Websites (including the used wiki) could not be fully displayed.

A small construction flaw was found in the power supply. Due to the frequent plugging a solder-joint broke on some devices, but the teachers were able to repair it by themselves – the tablet was very easy to take to pieces and put together later on again.

Unfortunately, it also turned out that the keyboards of some children refused to function. A defect adapter cable was detected that connected the keyboard with the tablet. The search for a suitable replacement was relatively difficult because this adapter had a proprietary connector size and was no longer available. Thanks to the persistence of the class teachers, an alternative was found.

Due to the relatively "weak" technical equipment unfortunately not all useful apps could be installed or used. During the project it had often been necessary that at least one functional and fully charged tablet was additionally available in class. Notpredictable failures of individual devices (empty battery, faulty screen, softwareproblems etc.) could be bridged for a short period.

## 2.4 The Use of the Touchlet X4 in Various Subjects

As mentioned at the beginning the project "tabkids" aimed to make children in primary school age familiar with the use of a specific tablet and demonstrate meaningful didactical units for teaching and learning at elementary school level [24, p.19; 9, 26].

One goal was to find out in which subjects the Tablet PC could be used effectively. The focus was set on German (Reading,



**Fig. 1. The students write with keyboards and scan a QR-code**

Writing, Spelling), General Education with natural science and geographic elements, Music and to some extent also in Calculating (basic mathematics).

In one lesson in the subject German the pupils should distinguish between the words "seid" ("you are" as personal form of "to be") and "seit" ("since" as temporary preposition). The teacher read a text, in which the two words appeared frequently. The students listed with a pencil on paper how often the two learning words were mentioned. Then they worked online on a text with their tablets using the keyboards. Each child received a feedback immediately how many words were chosen correctly. Afterwards the two terms were practiced further as school exercise in the German text books.

Because of a lacking flash-enabled browser several websites could not be displayed on the Tablet X4. This concerned also the subject mathematics. So the project team found apps like "King of Mathematics" (Basic Calculations), "Math Genius Trainer" (additions in the number space 1 to 30), Bubble Breaker and Loosen Wire (both for spatial orientation) that could be used for learning aims.

The kids enjoyed playing "A Little Night Music" by Mozart on their tablets and worked with much engagement in cooperation on their wikis.

### 3 Evaluation of the Project

At various stages of the tabkids project the team collected the experiences with the devices, the applications as well as the practical knowledge of the students and the estimations of the parents [24, p.32f].

#### 3.1 Evaluation issues

In order to evaluate the use of tablet PCs in the classroom the following issues were taken into account at the beginning:

- How does the Tablet PCs contribute (in general) to the realization of modern and student-centered teaching methods?
- What basic skills in ICT on elementary level are required for a meaningful use of the tablet in the classroom?
- What additional skills do the children need to acquire to use the device independently and appropriately?
- In what subjects can the tablet be used



predominantly?

- Do children of this age manage handling with such a sensitive device without damaging it?
- Does the work with the tablets contribute to increase the learn motivation of the kids?

Further issues surrounding the tablet PCs were considered such as the infrastructure at school and at home, skills, motivation, carefulness, technical problems, funding and others. These were theme in an anonymous questionnaire survey partly before and especially towards the end of the project.

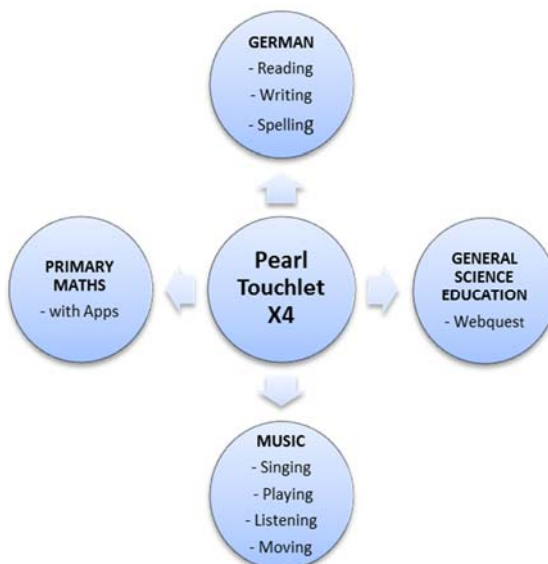
#### 3.2 Feed-back from the questionnaires

- Most children had access to a PC or notebook a home, but only a few children to a further tablet PC.
- Mostly (learning) games, painting programs and Internet browsers are used at home as well as text-editors (office packages) and e-mail programs.
- Both in the survey of the children and their parents' answers it became clear that the children were already familiar with the technique (multi-touch-function) of such devices as confirmed through surveys about the media use of the youth [see also 5, 22, 23].
- The kids had no fear, to use the tablets as additional learning and working tool. The girls and boys were highly motivat-

ed and not irritated if any difficulties with the applications occurred. The joy of learning of the children lasted over the length and the different phases of the project. Especially the use of the highly versatile Open Source DokuWiki in the second year of the project opened the children the opportunity to link various learning content across the disciplines of elementary school in a project with high demanding character: Research of content, checking in the group, writing texts, incorporating images and Web links, and finally as a highlight the presentation of the results to the class. The kids had most fun with the offered games, chosen by the teachers in terms of game-based learning. It was also visible in practice and the survey that the children assisted each other with their know-how. Their knowledge was acquired mostly during the common visited additional (only optional) ICT skills lessons with a didactical background in informatics where the students learned many technical tricks they could use in the classroom phases.

- The children treated their devices in a very high extent with care and attention, problems were caused essentially by hardware defects, for which the children were not responsible at all.
- The majority of the parents showed in the survey retrospectively the willingness to financially participate in the purchase and maintenance of the Tablet PCs. It should be mentioned that the parents only financed the keyboard and memory cards. An amount between 50 and 100 Euros was mentioned, but some parents would have been willing to spend more for a device on a higher technical standard such as the tablets from Apple and Samsung available in 2011/2012.

**Fig. 2. The Pearl tablet PC was successfully used in different subjects**





### 3.3 Workflow and Comments of the Project Team

The kids learned how to write with the Ten-Finger-System when using the Touchlet X4 keyboard which was suitable for children's fingers. Both the compact size and the relatively low weight of the Tablet were assessed positive. It fitted easily into a school bag. The maximum using time in classroom was about two hours, before the batteries had to be recharged. The defect susceptibility of a component in the power supply was a handicap, but it could be repaired by re-brazing.

The access to the Internet was provided via a Wi-Fi hotspot installed in class that was connected with the secured network of the KPH. The selection of the applications for instruction depended on the teaching aims and the technical criteria of the operating system Android 2.3 and the performance of the processor in the tablets.

Different apps were working conflict-free side-by-side, when it came to software conflicts occasionally some apps had to be un- and re-installed.

The experiences of the teachers involved in the project and the feedback from both students and parents showed that the tablets provided an added value for teaching and learning. The two factors were mobility and the possible combination with other (new) learning media such as a beamer. The parents supported the use of tablet PCs in the class, they think that mobile devices are an indispensable part of work and learning at school nowadays. The children were largely happy with the devices and proud to be in the "tabkids" class.

Tablet PCs seem to replace established computers, especially laptops and netbooks [see also 6, 13, 14, 19]. The technical standard of current tablets is already so far away from the Touchlet X4, that a comparison is almost no longer possible. In the same price range, the processor

performance, the display resolution and the data storage space has improved very much. Today the battery power is sufficient for a full day at school without any problems, and also the mechanical stability has increased. Every day more and more useful apps appear that can be used for didactical purposes [27]. NFC (Near Field Communication) and WiFi Direct facilitate the configuration and direct exchange of data between devices. In combination with a properly equipped beamer, DLNA (Digital Living Network Alliance) enables the presentation of picture and sound from each tablet.

Nowadays GPS is even integrated in low-priced hardware (the Touchlet X4 did not have GPS onboard). With the Android operating system detailed geographic views through Google Maps and Street View allow easier orientation.

### 4 International key-findings

When searching the Web you can find an increasing number of interesting case studies [6, 7, 8, 16, 19, 25, 29, 33] concerning the use of Tablet PCs in primary and secondary school education that are documented in project reports and scientific evaluations. But they are often focused only on a single class as the tabkids project and have a limited sample size and data collection length. And the one-to-ratio, e.g. one device per child, according to Burden and Hopkins "the most important factor for successful use of this technology" [7, p.9], is rather seldom because of the costs for purchasing the devices. Often only one tablet PC per class was available which was used with a data projector. Or sets of 15 Tablet PCs on a trolley also equipped for charging the batteries were moved between the classes. Alternatively the students were using them in small groups for a certain time. Some schools extent the number of Tablet PCs according to the policy "Bring-Your-Own-Device" to enable one-to-one computing.

The approach when and how to use the devices depend on the infrastructure of the school, that should include a reliable and fast wireless network, adequate technical support and a budget for the maintenance of the tablets [6, 19].

It has to be stated that there is still a lack of longitudinal studies lasting several years. Through mostly qualitative research methods including observations the perceptions of the students as evaluation criteria are taken into account. Literature reviews show clearly the positive impacts on pupils' learning with Tablet PCs – in most cases Apples certified iPads are used. Pupils and teachers alike emphasize the benefits of these new mobile devices—as proclaimed in an UNESCO report of 2013: "Students and teachers are already using mobile technologies in diverse contexts for a wide variety of teaching and learning purposes, and key educational players – from national education ministries to local school districts – are experimenting with supportive policies to promote innovative mobile learning in both formal and informal education settings. Many of the experts [...] feel that mobile learning is now on the threshold of a more systematic integration with education both in and outside of schools." [31, p.11].

In Europe Great Britain has been leading in the use of ICT for teaching and learning aims over the last three decades. Early initiatives to launch Tablets PCs in schools go back to the year 2005. In the beginning of December 2004 and early February 2005 Becta with the academic support by the Open University carried out a study that involved a specific focus on the use of Tablet PCs in schools in England. This study included two strands, namely an extensive literature and projects review (including phone surveys, web-based questionnaires etc.) and one case study in each of 12 from over 90 selected schools. For the Austrian project the case studies on primary schools (7 of 12) were partly relevant even though the key-findings emerging from the case studies did not differ strictly between primary and secondary school: "Tablet PCs for maximum benefit,

- needed to be used in conjunction with a wireless network
- needed to be introduced in a planned way that took full account of the school's vision, as well as of the technical infrastructure, support and staff development, and day-to-day management issues
- increased the amount of ICT use and the degree of integration of ICT across the curriculum
- at some schools were used effectively to replace an ICT suite and thus free up space
- increased motivation, and hence were likely to have a positive impact on learn-

Table 2. Positive aspects and technical restrictions of the Touchlet X4

Positive aspects	Technical restrictions
Touchscreen handling	Low-end-device
Functioning Apps	Low screen resolution
Additional keyboard	Slow processor
Audio recording	Adaptor cable defects
photo and Video	No flash-enabled browser
Memory Expansion	No handwriting recognition
Network connectivity	No GPS and UMTS
Reliability	No digitizer pen
Added value for teaching and learning	Short battery life
Cheap price	High radiation values



ing outcomes

- supported moves to more independent and collaborative study
- used with a wireless data projector, provided a better solution than a desktop or laptop and hardwired interactive whiteboard
- were seen as being more versatile than laptops, although the higher price of Tablet PCs relative to similarly specified laptops was prohibitive.” [33, p.5]

Many schools in England considered the ability of the Tablet PC to recognize handwriting and its portability as one crucial aspect. Children who had age-related difficulties with handwriting or impaired motor-skills were motivated to practice [29, p.2]. The handwritten notes could be turned into typed text. When handwriting was not recognized the additional keyboard was the option as in the tabkids project.

Benefits in creative writing, maths and for presentations either with a whole-school wireless network to other students’ tablets or via a projector (instead of an interactive whiteboard) were reported. Thanks to the audio and video facility of the devices comments could be added that led to more interaction between students and teachers. As other mobile devices such as netbooks and phones also Tablet PCs could be used outside school for instance on excursions which was seen as further advantage.

According to a survey of December 2014 almost 70% of primary and secondary schools in the UK have introduced Tablets meanwhile that are used for teaching and learning. But the study says there is no clear evidence of academic improvement for pupils using tablet devices. The study, commissioned by education technology charity Tablets for Schools, looked at a representative sample of 671 state and independent schools. Many pupils reported that they took an internet-connected device to bed to continue social media conversations as reported by the BBC<sup>4</sup>.

The British experiences and key findings corresponded with those in other coun-

tries. In general Tablet PCs as tools for mobile learning promote the curriculum and improve communication, collaboration and motivation. They are portable, nowadays affordable and like phones always on.

Kearny, Schuck and Burden. [20, p.7] describe three central features of any mobile learning, namely authenticity, collaboration and personalization. Personalization as corner stone of e-learning includes learner choice and self-regulation. Authenticity means that learners can generate their own reach contexts with their mobile devices. A high degree of collaboration takes place by making rich connections to other people through networking and in interactive environments.

### 5 Conclusion

Nowadays mobile learning with high-end tablets has become a new paradigm and is practiced in developed countries in nearly all school types and ages of the students. According to the research these devices bring innovation into schools both for teachers and students, higher engagement, independent learning, improvement of communication and collaboration. Teachers can adapt their teaching styles to individual students and customize or create content related new material. But these benefits for learning depend on a functioning infrastructure.

Compared to smartphones tablets have a greater functionality, larger screens, an increasing variety of interactive apps, more processing and battery power and the availability of audio and video recording software. The prices of tablets continue to come down. But despite of all the facilities tablets and other mobile devices offer, we should not overestimate them as new media tools in the classroom. A balanced variety of methods of using modern media for teaching and learning is recommended.

I close with Bjerede and Bondi who did a research project providing Samsung Galaxy Tablets to pupils in a primary school class in Oregon, USA for a

“With respect to the question of mobile devices vs. laptops or desktops, our experiences reinforce our preferences for the mobile devices:

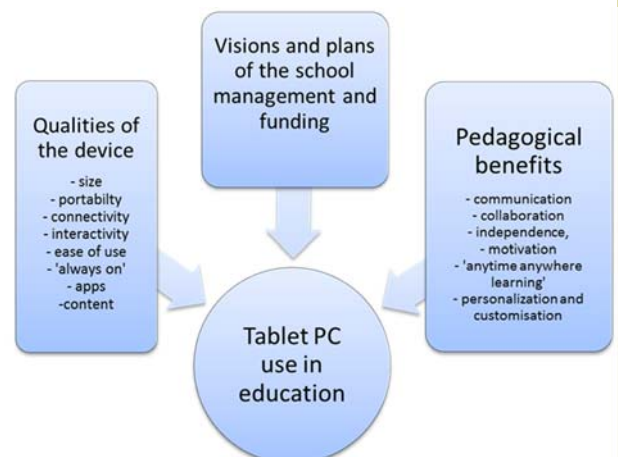
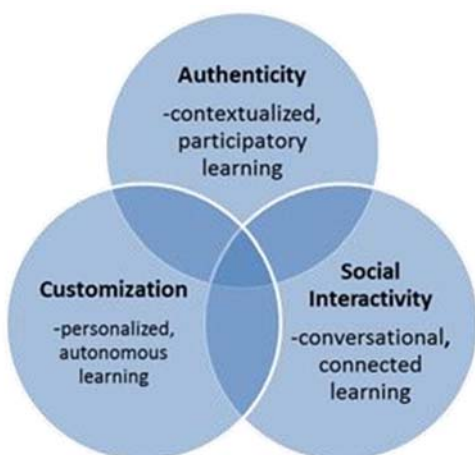
- We feel that tablets are a significant improvement over pencil and paper for creating content, though clearly not as large an improvement as laptops.
- While we feel that personal mobile devices are catalysts for self-directed “just-intime” learning, laptops are a better choice for making the mechanics of writing and editing simple and efficient.
- We believe that 21st century students need personal devices AND ready access to high quality, responsive desktops or laptops, but that if we have to choose between them, always-on, always-connected personal mobile devices provide the greater advantage.” [6, p.5]

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Fig. 4. Clarke and Svanaes [8, p. 43] by referring to Johansson [18, p.37] offer a summarizing overview about the future adaptation of Tablet PCs for educational and didactic use

Fig. 3. Three key aspects of m-learning



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#### Endnotes

- <sup>1</sup> Class teacher Richard Pirolt was assisted by Martin Newald in regard to technical questions and problems and Dir. Prof. Ilse Bailicz who supervised the project.
- <sup>2</sup> At the same time a secondary modern school with special focus on computer science located in Neusiedl/Burgenland, started with financial support of BMUKK a project using iPads in class which was never evaluated but mentioned in literature often [17, p.22]. B. Zuliani, a female teacher of a primary school in Vienna, used iPads to promote the creativity of the pupils [32, p.122]. The project was documented in her master thesis [36].
- <sup>3</sup> The One Laptop Per Child (OLPC) initiative supported by Nicholas Negroponte was a new educational approach to changing education in developing countries, the XO-1 should empower the children of developing countries to learn. See <http://one.laptop.org>.
- <sup>4</sup> <http://www.bbc.com/news/education-30216408> and <http://tabletforschools.org.uk>; see also [15]

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