

Interactive Lessons for Tablet-based Teaching

A Proposal for an Open Data Format

Heiko Weible¹ and Edgar Seemann²

¹Visual Generation, Berlin, Germany

²Furtwangen University, Furtwangen im Schwarzwald, Germany

Keywords: Tablets, Schools, Teaching, Interactive, Android, iPad, Multimedia, Math, Foreign Languages.

Abstract: Tablet devices like the Apple iPad are ideal for interactive learning content. Unfortunately, at the moment it is still quite difficult for authors to create interactive content. There are very few standards in the area of tablet computing, in particular, if authors do not want to restrict themselves to a single platform e.g. iOS or Android. In this paper we propose an open data format, which makes it easy for authors to create interactive content. We achieve this by separating content description from the visual appearance and behaviour. Thus, allowing to create interactive content without the need for complex tools or even programming skills. The data format may be implemented for any of the leading platforms. Thus, giving content creators the control over the usage and the distribution of their content.

1 INTRODUCTION

Computing devices are becoming more and more popular in education. While previous efforts like the One Laptop per Child project by Negroponte et al. (Negroponte, 2006) have seen some success, there are now two trends which are about to change our education systems and our way of doing education.

These trends are, on the one hand, the field of online learning and on the other hand tablet-based teaching with devices like the Apple iPad or comparable Android tablet devices. Both fields are very new, but exciting progress has been made in the past year.

In the field of online learning, we have seen the first courses with tens of thousands of participants, something which was unimaginable a decade ago. The Stanford university with their professors Thrun and Norvig have been pioneering in this domain with their artificial intelligence class (Thrun and Norvig, 2011). Since then we have seen the appearance of online universities like Udacity (Thrun et al., 2012) and Coursera (Ng and Koller, 2012).

Tablet devices have only been available for less than two years. Yet we see a large number of deployments at schools in North America and Europe, for example (Farias, 2011; Klinga, 2011). Touch-based interaction is very well suited for educational content and both teachers and students have been quite enthusiastic about the new possibilities.



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

While these developments and adoption of new technology is certainly welcome, standards have yet to be established. In the field of online learning e.g. each individual player (e.g. Coursera, Udacity) has its own teaching style and platform. For tablet-based teaching, there are standards for electronic Books (e.g. ePub, iBooks), but as far as truly interactive content is concerned there are no established methods, learning styles or data formats available.

Based on our experience from tablet deployments at various schools in Germany, we propose both a new learning style for tablet-based teaching and an extensible open data format, which may be freely imple-

mented by educators.

Our proposition of a new learning style is discussed in detail in a separate paper (Weible and Seemann, 2013). The contribution of this paper is therefore the proposal of a novel data format tailored towards the requirements and properties of tablet-based and online teaching. Our goal is to facilitate the distribution of interactive learning content to all platforms (e.g. iPad, Android, Windows).

In the following we will first discuss related projects, then continue to describe requirements for tablet-based learning content. We continue with the specification of our open data format and conclude with an outlook on future developments.

2 RELATED PROJECTS

The fields of online and tablet-based learning are both rather new. Historically online learning started with the distribution of conventional books and lecture notes over the internet. Demonstrations e.g. via Java-Applets followed, but remained limited in scope. In particular, there existed very few truly multimedia or interactive content which covered a larger topic.

With the appearance of online video services like e.g. Youtube online learning shifted to providing video lectures. In the beginning, these lectures often were simple recordings of traditional university lectures. With the success of Salman Khan's video tutorials on Youtube (Khan, 2006), the community realized, that a different learning style is necessary and that videos should be much shorter.

Only recently, we see interactive courses, which combine short video clips with online questions and exercises. In particular, the online universities Coursera and Udacity (Ng and Koller, 2012; Thrun et al., 2012) use this new online learning style. Even though these platforms build on web technologies, there is no common data format underlying these courses. It is also not possible to work with the interactive material when no internet connection is available. However, we start to see cooperations on data format and platform usage. Most importantly edX has recently been founded as a joint project by MIT, Harvard, UC Berkeley and the University of Texas.

Google has also recognized the need for a common platform and recently released a course builder to create online courses (Google, 2012).

For tablet-based teaching there are even less common standards available. Firstly, there is no established learning style and publishers seem to feel a distinct uncertainty how tablet-optimized content should look like. Moreover, the competing platforms (iOS,

Android) require both educators and publishers to make a choice which to support. The past two years have been too short for researchers to tackle the problem and there is unfortunately very little research available (see e.g. (Isabwe et al., 2012)). We see, however, two developments. On the one hand there are data formats for electronic books (e.g. ePub, iBooks). On the other hand, interactive educational apps appear, which cover a certain educational topic.

While iBooks is a specified standard which may be used by publishers and educators, it has various restrictions. Firstly, it is a proprietary standard, which cannot be adapted or extended to support additional features. Secondly, distribution is exclusive to Apple's Appstore for iOS devices. Publishers in some countries have therefore been reluctant to Apple's iBooks standard. Interactive educational apps, on the other hand, share no common learning style or data. They are also difficult to develop and differ very much in terms of user experience. A common standard data format along with a reference implementation would be certainly welcome by many educators.

3 REQUIREMENTS FOR TABLET-BASED TEACHING

Tablet devices provide a set of benefits compared to both desktop computers and laptops. First, they are typically smaller and easier to handle. This is not only true for the actual hardware, but also the included software.

For the learning experience touch screens are crucial since they allow more natural and quicker interaction with the device. A survey conducted after the first months of our tablet deployments clearly showed this. In fact, we were surprised by how few students missed a physical keyboard or mouse (Weible and Seemann, 2013).

Based on the experiences from online learning and the positive effect of touch interaction, we believe that learning content for tablets should exhibit the following characteristics.

Content should be divided into small manageable parts. It should be presented in a way, which allows the student to see, hear and interact with the content. The interaction is accomplished via touch-based exercises or questions. An example, could be a cloze procedure, where possible responses can be dragged into position with finger touches.

Content Creation. In some sense, developing such interactive content is quite similar to game development. In order to allow educators to create content

without special knowledge like programming skills, we need a data format, which abstracts this complexity. That is, the educators define the content only. The behaviour may be created in a reference implementation by a programmer. Thus, educators can reuse these reference implementations for different styles of exercises and questions (for more detailed information see section 4).

A common open data format would allow educators to share their content and remix other existing contents. Additionally, programmers could provide implementations for various operating systems or adapt the visual appearance and behaviour of the content to improve the learning experience.

Offline Content. Another hurdle for the deployment of learning content in schools is the lack of internet connection. Even in developed countries internet access in every classroom is not available. Thus, learning content needs to be available offline, which eliminates the use of many great online resources. Again, if the content, which is available online would be in a standardized format, it could be easily transferred to tablet devices (this applies to free content e.g. released and creative commons licenses or paid content).

Self-learning. Tablet-based teaching should focus on self-learning. That is, students should be able to work through the content on their own. As it is the case for online learning (e.g. Udacity, Coursera) this will drastically change who can participate in education and what students are able to learn. In our opinion, this is one of the greatest strength of tablet-based teaching to empower the students to better learn for themselves.

4 PROPOSED DATA FORMAT

As pointed out in the previous section the data format should describe the actual content. The visual appearance of this content is part of a reference implementation, which is independent of the underlying data format. That is, similar to a graphics format, which may be displayed with various image viewers.

The design of our data format follows the subsequent design goals.

Interactive Content should be Easy to Produce. For educators it is hard to produce multimedia content. They have to record audio, video and subsequently process this raw material. This often re-

quires complex software (e.g. video editing software), which combines video, audio, images and text. The involved software is not only difficult to learn, but the content generation is a time-consuming process.

It is getting even more difficult, when the content should be interactive. In online scenarios, this is mostly accomplished through programming via e.g. HTML5/JavaScript, Java Applets or Adobe Flash.

In order to allow the generation of multimedia and interactive content with minimal effort, our data format divides content in small chunks or frames, which can be described through simple text. These frames may contain videos, images, audio and even interactive exercises.

All content within such a frame is played at once. That is, on opening the frame e.g., the text is displayed and read to the student and an additional visualization in the form of an image or video is displayed.

An example would be:

```
(01) Not far from River Rhine, not far
from the Swiss town Schaffhausen is a
small cave called "Kesslerloch".
<Kesslerloch.jpg top>
```

Here the number (01) specifies the frame number. It is followed by a text, which will be displayed on the screen. An audio track which possibly reads this information to the student does not have to be specified explicitly. Since the audio belongs to a specific frame, we can associate its file name with the frame number. In the above case 01.mp3. In many cases, e.g. foreign language education, the content author and the speaker are not the same person. The above naming convention allows both content authors and possible speakers not to worry about file names. Associated media files are specified in brackets. Here a JPG file is used as an illustration at the top of the frame.

Note, that the splitting in more manageable frames also removes the need of alignment of media files and text, which typically requires a lot of effort in video editing.

Obviously, such a simple format restricts the possibilities a teacher has, when creating content. This is intentional. On the one hand, we want the content to be clean, i.e. there should not be an overflow of information or clutter. On the other hand, there is a trade-off between simplicity and speed of creation and flexibility. As we will see in the subsequent paragraphs, however, the data format contains a set of predefined templates, which can be used. Thus, allowing a wider variety of ways to present content and to include interactive elements.

Note, in particular that the content may even be

created without the need for a development environment with a standard text editor.

Data Format should be Human Readable. All content should be described in human readable form. This has various advantages. Firstly, it allows a speaker to read through the data files and record the respective audio tracks without special tools. A foreign language teacher can e.g. create a lesson, save it in the above data format and have a native speaker dub the content. Note, that content, which needs to be skipped by the speaker is always in parantheses (e.g. the frame numbers or the media files). XML files, which are often used for data storage are mostly human readable as well, but they are visually much harder to process by the human eye. This is especially true for speakers, which are typically not familiar with XML, at all.

The XML and other file formats are optimized to make it easy for a computer to process the data. In our file format, we want to make it easy for humans (either authors or speakers) to create and process the content. In some cases, this means, that a parser for the format is slightly more complicated to implement, but that is a one time effort, whereas content generation is a continuous process.

For our deployments at high schools in Germany (Weible and Seemann, 2013) we have already created a parser and reference implementations of a learning environment based on this data format for all major platforms (iOS, Android, Windows).

4.1 Interactive Elements

Our data format describes a set of interactive elements, which may be used by content creators. Again, the actual visual implementation is part of a reference implementation, not of the data format itself.

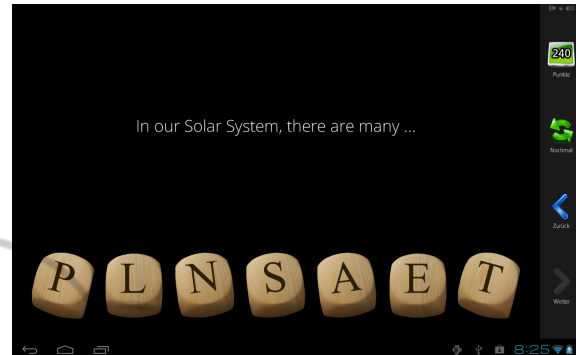
Shuffled Letters. The first type of interactive exercise is called shuffled letters. It is intended to better recall newly learned words and to remember their spelling. The main application is in the area of foreign languages, but it is also applicable to learn terms in the fields business or engineering. An example for the description of such an exercise is depicted below:

```
(02) In our Solar System, there are many
      ...
-> Correct! In our Solar System there
      are many *planets* .
```

From the above data, the computer automatically generates an anagram of the solution, which is in this case the word "planets". The student has to then to

use touch interaction to reorder the different characters.

The corresponding frame as implemented in our own reference implementation looks as follows:



Remember, the design goal has been to make it easy to create content. In this case, an author just has to provide a sentence, which needs to be completed (denoted by the ellipsis). The success message starts with a text arrow. This part is, obviously, only displayed once the student has found the correct solution. The corresponding audio tracks need to be stored in files named 02.mp3 for the first part and 02b.mp3 for the success message. If an audio track for the success message exists, the message will not be displayed, but only read to the student. The correct solution is specified in the success message by surrounding it with stars. The same technique is commonly used in e-mails to highlight a word. As can be seen, it is extremely easy and fast to create such an interactive exercise with the above scheme.

Shuffled Words. In a similar way, we can create other exercises like shuffled words. The main application here is to learn the grammar of a foreign language by bringing the words of a sentence into the correct order. For this, we specify the words or parts of the sentence in square brackets and separate them by commas. Alternatives from which a student has to choose (e.g. does versus do) are defined by a slash.

An example is:

```
(03) [how, long, does/do, the journey,
      take/takes]
-> Correct! The answer is *how long
      does the journey take*
```

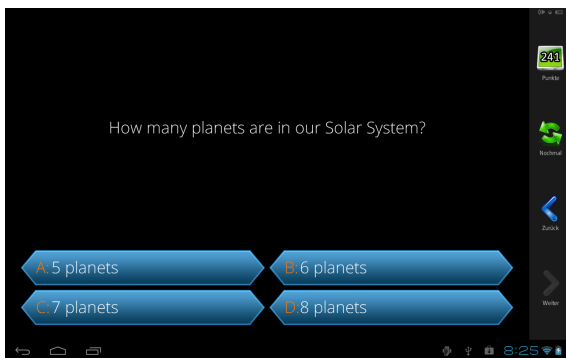
Note again that the author does not have to shuffle the words manually, as the computer can shuffle them automatically at run-time. This procedure is also less error-prone, since it makes the exercise more readable for the author. When shuffling words manually, authors sometimes tend to forget to specify one of the words in the sentence.

Multiple Choice Multiple choice exercises are the most commonly used type of question. In our data format the questions may be specified in the following manner:

(04) How many planets are in our solar system?
 - 5 planets
 - 6 planets
 - 7 planets
 - 8 planets
 -> Our solar system contains *8 planets*. You're right!
 -> There are actually *8 planets* in our solar system. Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus and Neptune.

Note, in particular, that there are two lines starting with text arrows. Next to the success message, a result message is added when the student has picked the incorrect answer. Following our naming scheme for the audio tracks, a speaker would store the question text in a file 04.mp3, and the two result messages in the files 04b.mp3 and 04c.mp3.

In our reference implementation, the above question is displayed as follows:



Numeric Computations. In math education as well as in other technical disciplines, most exercises require the user to enter the result of a numeric computation. This application is also specified in our data format.

An example would be:

(05) Marc is giving two pieces of chocolate to his brother and keeps three pieces for himself.
 3 pieces of 5 pieces = ?%
 -> Correct! He is keeping *60*%.
 -> Try again, 50% are half of the pieces and four pieces constitute 80%.

Again, it is extremely easy for an author to create such an exercise. A question mark with a leading

white space character is used to indicate, that the student should fill the answer at the corresponding position. For tablet devices a custom virtual keyboard is displayed to allow the student to conveniently enter the result.

Further Elements. In a similar fashion further interactive elements can be specified e.g. fill in the blanks style exercises. We have currently integrated twelve styles of exercises and plan to expand this in future versions.

The full specification and feature set of the first version of our data format will be finalized and released to the public on <http://scoolbook.org>.

5 CONCLUSIONS

Tablet-based teaching will become pervasive in the next few years. There is demand for content, which is tailored towards this new style of teaching and self-learning. Currently, there is no standard for this new type of content. In this paper, we have proposed a simple, open data format, which may be adopted by authors to create interactive content.

The format is extremely easy to use and implement. In various tablet deployments at schools in Germany, we are already working with a reference implementation for this data format. Our feedback from teachers working to create new content has been very positive. In fact, interviews with authors has shown, that especially non-technical authors very much prefer this format over XML-based formats.

We encourage the community to contribute further ideas for this data format, create content based on it and adopt it in other deployments.

REFERENCES

Farias, M. (2011). *Pilot-Projekt Tablet PCs im Unterricht der Landesabteilung Informatik*. <http://urly.it/1i5w>.
 Google (2012). *Google Course Builder for Online Education*. <https://code.google.com/p/course-builder/>.
 Isabwe, G., Reichert, F., and Nyberg, S. (2012). Towards integrating technology supported peer-to-peer assessments into mathematics education - experiences with ipad mobile tablet technology. In *4th International conference on computer supported education (CSEDU)*.
 Khan, S. (2006). *Khan Academy*. <http://www.khanacademy.org>.
 Klinga, S. (2011). *Tablet deployment in schools in the city of Mannheim*. <http://www.mediaculture-online.de/blog/?p=8821>.

- Negroponte, N. (2006). *One laptop per child*. <http://one.laptop.org>.
- Ng, A. and Koller, D. (2012). *Coursera — Take the World's Best Courses, Online, For Free*. <https://www.coursera.org>.
- Thrun, S. and Norvig, P. (2011). *Artificial Intelligence Class*. <https://www.ai-class.com>.
- Thrun, S., Sokolsky, M., and Stavens, D. (2012). *Udacity — Learn. Think. Do*. <https://www.udacity.com>.
- Weible, H. and Seemann, E. (2013). Bringing tablets to schools — lessons learned from high school deployments in germany. In *5th International Conference on Computer Supported Education (CSEDU)*.

