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# MORE

## *Mobile Referencing System for Printed Media*

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**Abstract:** Smart phones have become the indispensable communication and entertainment device for students and pupils. In this paper we are going to present an approach based upon smart phones in order to offer a possibility to use these phones as learning devices in combination with learning material in a different media as in our case a book. The paper presents the realization of an extensible mobile learning management system with a small footprint, which can be used to easily add exercises to the belonging learning material. Once the learning material has been created, it can be published as a smart phone app. Learners install the app and it will display the related exercises once the user scans their associated QR tags in the book. The system has been exploited from a German publisher and is currently being used for the standard course book about Old and Middle High German at German universities. We will describe the results of our initial user study and the first feedback from the learners using the system.

## 1 INTRODUCTION

Nowadays the usage of smart phones among students and even pupils is widespread. This observation is not astonishing, having a look at the numbers of mobile phone subscriptions in the developed countries, which is 117.8 % (ITU, 2011), i.e. many users possess even more than one mobile phone. Especially the usage of smart phones has arisen tremendously. A study from Ball State University shows that "smart phones now account for 49 percent of mobile communication devices on college campuses" (Ransford, 2010). This fact is further emphasized by the finding that manufacturers shipped 74.4% more smart phones in 2010 than in 2009 (IDC, 2011). While commuting to school or university, pupils and students use their phones listen to music, play games and write messages. In their spare time they take pictures and communicate with their friends using various services like SMS, facebook, etc.. Finally they use it also for communicating the "traditional" way, i.e. calling somebody. A result of these observations is that smart phones belong to the life style of the

younger generation and they are an indispensable part of their life. A trend, which contributed to this movement are the technical advances. Smart phones usually possess good computing power, a descend battery life, a music player and a camera.

Our idea, which we will present in this paper, is to make use of this development in a way that we offer the possibility to use the commuting and spare time for learning using the mobile device. Our concept focuses on a combined approach of traditional media and online material, which provides learning lessons for a course book on a mobile phone. Afterwards we recognized that we can't take a smart phone as a given. Therefore we implemented a second version for personal computers as well. More precisely, we have focused on building an adaptable platform, which can easily be used to augment other media with mobile learning capabilities. Such a system also has to provide an easy to use and extensible authoring tool, ideally offering an interface to existing e-Learning platforms for integrating already created material. Finally the system shall run on different smart phone

operating systems without major development efforts.

For getting real user input we work together with the publisher UTB<sup>1</sup> and Vandenhoeck & Ruprecht<sup>2</sup>, who wanted to incorporate our solution in the new version of a book about Old and Middle High German (Bergmann, Moulin and Ruge, 2011), which is the standard course book about these topics at German universities. Furthermore the publisher wants to offer the service as a general service for the authors.

In the following sections we will start with the motivation of the MORE<sup>3</sup> system. Afterwards we will present systems that target a similar goal than ours in the related work section. Then we will develop the concept of our system and describe the realization of the application. In the following section we will present the results of our evaluation and the first findings of the system usage. We conclude the paper with a short summary and an outlook on our future work.

## 2 MOTIVATION

As recent studies show, e-Learning systems are beneficial for learners, compared to traditional only face-to-face situations, especially when using a combined approach between face-to-face and online instructions (Means et. al., 2010). However, these systems usually require at least a laptop or a tablet computer, which is not permanently carried around by learners. In contrast to this, students and pupils are almost constantly carrying their smart phones with them. Based on these observations we have wanted to combine the benefits of both trends, providing adaptable solutions for learners on their smart phones, so that they have a further alternative to listen to music, chat with their friends and play games. Using the smart phone in this way, can be an advance for learning material.

One drawback of smart phones is that they are limited to their display size. Therefore an exclusive smart phone based learning solution is not suited in most of the cases, even though it shows positive effects in certain learning settings (Wendeson, Ahmad and Haron, 2011). For this reason we have decided to use a combined approach, where the smart phone is a further way in order to have access to learning content everywhere.

Studies from (Mcconatha, Praul and Lynch, 2008) and (Motwilla, 2007) show positive effects of mobile learning. (Milrad and Spikol, 2007) point out that students who have been introduced to mobile learning even start asking for further resources on the mobile phone.

A supporting development, which is perfectly suited for the form factor of smart phones is the advent of the concept of microlearning (cf. Robes, 2010). Basically, it is the principle of learning in small steps. Here only small samples of the content have to be presented to the learner.

Our goal was to offer a solution, which can nicely be combined with learning material in different systems and especially on different media without tying the learner or the author to one single software system for the complete solution. In our case the challenge was to integrate such a solution in a traditional book to augment the book with a mobile learning part.

In order to build such a system several further questions arise:

1. How can we directly reference the digital material to the printed material in a user friendly and generic way, so that it can be easily integrated in learning material, delivered on other media?
2. How can such a system provide platform independence for mobile phones to a large extent without being forced to implement large parts of the mobile learning application anew for each operating system?
3. What authoring system will be used in order to support the editor to establish the learning material and is it possible to integrate already existing learning material, e.g. from a web based Learning Content Management Systems (LCMS)?
4. How is it possible to minimize the follow-up costs, for example the administration and hosting of a permanent web service?

As it concerns the first question we have decided to use logical links, which can easily be integrated as well in a printed book as in other media in form of QR codes. QR codes are quadratic two dimensional codes, which encode binary information. QR codes are widely used today and almost every smart phone provides a QR code reader, either installed or as a free download from an app store. This solution will be further described in section 4.1, the idea is based

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<sup>1</sup> <http://www.utb.de/>

<sup>2</sup> <http://www.v-r.de>

<sup>3</sup> <http://more.uni-trier.de>

on the mobile tagging<sup>4</sup> process and we call it Smart Referencing.

We have accessed the second issue in a way that we did not build a completely proprietary application, which has to be realized for each operating system (e.g. iOS, Android, Windows Phone/Mobile, etc.) from scratch. We pursued the idea of a small system dependent wrapper integrating the learning material in a web based format, which can be interpreted by a web browser. This approach will be further emphasized in section 4.2.

As it concerns the third point, we analyzed the e-Learning platform ILIAS<sup>5</sup>, which is widely used at our universities. However, the analysis has shown that the authors of the mobile learning platform have formulated requirements, which could not be satisfied by the authoring tools provided by ILIAS. This has forced us to come up with an independent solution. We will illustrate this point in section 4.3.

The last point of our question list was realized by dividing the system architecture in a client part, i.e. an app, which contains the data for the exercises and the user data. Therefore the user is in sole responsibility for the administration of the app and possibly has to update the system from time to time. On the other hand we will provide updated versions in the appropriate app stores once the training material changes.

### 3 RELATED WORK

As we have elaborated in the previous section, three different points are important for generic mobile learning systems: an extensible authoring tool, a seamless integration between different media and a content delivery solution, which is adaptable to different smart phone platforms.

The system uLearn (Mitchell, Race and Clarke, 2005) is a prototype application delivering content for independent learners on a smart phone. The goal of the system is the delivery of situated content to children in museums and parks. The context of the user i.e. the location is gathered by scanning a visual tag (cp. (Rohs, Gfeller, 2004)) with the camera. The system consists of a web server running ASP.NET a database and a smart phone. The evaluation of the system showed a positive feedback of the children in

regard to the access of the information via scanning a visual tag.

The platform KnowledgePulse (KnowledgePulse, 2011) is a commercial system, offering a platform for creating and delivering learning material to mobile phones. The system provides clients for Symbian, iPhone and Android OS. The content creation is accomplished using a web interface or an excel sheet. Furthermore a learning algorithm is integrated, offering questions after a certain time, that have been previously answered wrong. A statistics tool for the learning progress is integrated as well. Other than in the first system, the user has to select the lessons manually since there is no other possibility to identify the lesson. However, it was not clear how far the system can be extended in regard of introducing additional question types and integrating the system in e-Learning platforms from developers outside the company.

UbiLearn (Breitner et al., 2010) is an LCMS with a strong emphasis on microlearning offering a mobile client since version 0.3. The system has been created by the business informatics department of the University Hannover. Later it became a commercial product. It bases on Microsoft C# and .Net and supports Windows mobile and Android as mobile clients. Another access to the system is accomplished through a web browser or a micro browser in the backend using PHP to communicate with a MySQL database. The UbiLearn system is a comprehensive but closed system. The focus is rather to provide a complete and integrated solution than offering a mobile enhancement for other media.

(Schulz and Becker, 2011) present the idea of creating an adaptive system in order to digitally enhance school books. The referencing between books and digital material is realized through a so called MediaID, which identifies a part of a book. The user has to type in this MediaID manually in order to access the belonging material. As learning content management system, the LCMS moodle<sup>6</sup> is integrated. The system is still in a demonstrator stadium. The focus rather lies on the aspects of adaptivity.

The above systems show the rising interest and maturity of mobile learning systems. The idea of augmenting items with a visual tag in order to access the belonging material is a promising approach to provide a user friendly interaction. Ideas concerning adaptivity and integration of a learning algorithm are very inspiring for future developments. However, since our goal is to keep the system as open as

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<sup>4</sup> Process in three steps: Scanning the code, decoding the data and displaying the information

<sup>5</sup> <http://www.ilias.de/>

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<sup>6</sup> <http://moodle.de/>

possible for creating and importing learning material, none of the above systems fits our requirements.

## 4 CONCEPTS OF THE MORE SYSTEM

One of the main goals of our system was to make it as convenient as possible for users to access the content, especially the right content for the current lesson (cf. figure 1). Furthermore, providing a comfortable solution for the authors and being able to support a broad range of devices. In the following we will illustrate the concepts in more detail.

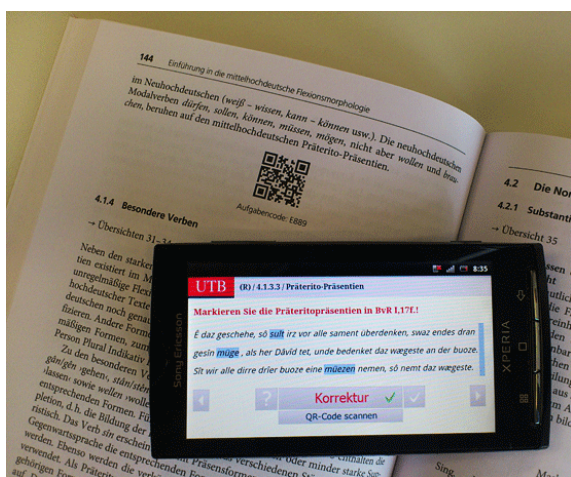


Figure 1: Workbook, chapter code and exercise

### 4.1 Smart Referencing

Learners shall be provided with an easy to use and handy solution for accessing exercises, related to the lessons to learn. For this reason we have integrated visual tags in our learning material, similar to the uLearn system. In contrast to this, we have integrated the nowadays frequently used QR (Quick Response) codes. QR codes have been developed by the Japanese company Denso Wave<sup>7</sup>. They are two dimensional codes, containing up to 2,953 bytes information and they can be used cost free and without paying license fees. Today QR codes are frequently used for encoding URIs. On almost every smart phone platform, free QR code readers are available in the app stores. In our case these codes are used to encode the actual lesson of the book. However as a fall back and for the users

<sup>7</sup> <http://www.denso-wave.com/>

that are familiar with the system, references of different chapters can also be entered manually. For our system, we binary encode the information about chapter, section, subsection, etc. followed by the number of the exercise. The code for a chapter offering all exercises for this chapter would encode the following information:

General Syntax: <ISBN><Chapter>  
ISBN: 978-3-8252-3534-5  
Chapter: 1  
Encoded Information: 978-3-8252-3534-5 1.X

When this code is scanned all the exercises of chapter 1 are displayed. The same way individual exercises can be encoded in the QR tags.

### 4.2 Content Delivery

The content has to be delivered to the devices in an appropriate format. The way the content is delivered also has an impact on the overall system design. In general we want to support a broad range of devices. For this reason we have chosen to use technologies that are widely supported as well in the smart phone sector as for web pads and PCs, i.e. HTML, XML, Java, CSS and JavaScript. As it concerns the smart phones, this content can already be rendered using the built-in browsers and we can easily extend a solution based on these technologies to other client platforms, as mentioned above. Since we wanted to provide a user experience like users know from other apps, we wrapped the browser with a small system depended wrapper.

Furthermore, using this approach we have the advantage of being able to render the same content on tablets and PCs as well.

For the first version of the system we have concentrated on the Android platform. In the near future we plan to add support for the other operating systems as well.

### 4.3 The authoring system

The authoring system has initially been the LCMS ILIAS. The idea was that already existing content could be integrated into the mobile platform. Users that are already familiar with this system can easily write new content. A small prototype showed the general feasibility of this approach, but the authors quickly asked for further functionality, e.g. the combination of question types in one exercise. This is a functionality that ILIAS does not provide.

For this reason we have added an independent authoring tool, which can be easily extended. This

decision has also been beneficial for users new to the system, since they did not have the effort to get familiar with a complex LCMS.

Our authoring tool has been realized with the use of Ruby on Rails, which has turned out to be a flexible solution for extending the system in regard to different question types.

Currently we support the following question types:

- Multiple Choice
- Single Choice
- Error Text
- Cloze
- Dropdown
- Combination of the types above

Furthermore, the authoring tool is able to generate the appropriate QR-codes, depending on the authors concepts, i.e. only codes for the chapters or codes for the individual exercises.

In this case a "Text Marking" exercise has been selected. The words that the learner has to select are marked with "(:" and ":)" (cf. the text input field on the bottom of figure 2).

The rendering of the appropriate information on

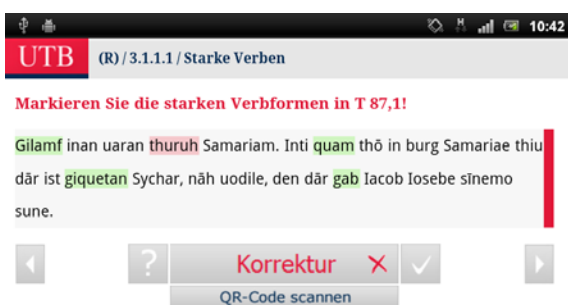


Figure 2: Depiction of the exercise on the mobile device

the mobile device is displayed in figure 2.

The learner has to mark certain parts of the text. In the screenshot, the answer has already been evaluated and the green parts show the correct solution, whereas the parts marked in red were wrong choices.

The user interface consists of up to 6 buttons. The learner can always chose to scan a QR code for continuing to another question through the use of the button at the bottom of the window. Using the arrows on the left hand and right hand side the learner can navigate to the next or the previous question. If a learner selects the question mark, background information about the topic of this

exercise will be displayed, that shall empower the user to solve the problem. Selecting the check mark displays the sample solution. Pushing the large box in the middle submits the solution. After the evaluation the label and color indicate if a learner has correctly solved the exercise. If the solution is correct, a green check will be added as well. In our case the answer was wrong and the user sees a red cross.

## 4.4 Didactics

Our initial tests (cf. section 6) showed, that the strict separation of displaying the sample solution and correcting the user input is beneficial for the user, as shown in figure 2.

At the beginning, the correction and the sample solution were displayed in the same screen. For example in a text, where a learner had to mark certain words (cf. exercise type as in figure 2) the correct answers were displayed in green, the wrong answers were displayed in red and the words, that belonged to the right answer but have not been selected by the learner, were marked in blue. Consequently the users immediately knew the complete answer after submitting their solution. Due to the user's remarks we have changed this in a way that both modes are separated.

In the current system the user can still select to view the sample solution. However, the correction shows only if the answers of the user are right or wrong and which answers are correct and inaccurate, without showing the complete sample solution. Like that the user can reflect her answer and consider if her answer was only wrong or if he also missed some parts.

With this approach we implement a microlearning functionality in our system. For example, now the user can ask for help using the question mark button and an appropriate information to the topic is displayed. In our case we provide references to related literature or translations, which help the learner to solve the exercise. Additionally references to further publications can be added. Like that the learner gets information about further, more detailed reading.

Additionally, the learners can view their learning progress on a page, which displays the exercises correctly solved and those that have not yet been answered or not correctly. Departing from this view they can directly navigate to specific exercises.

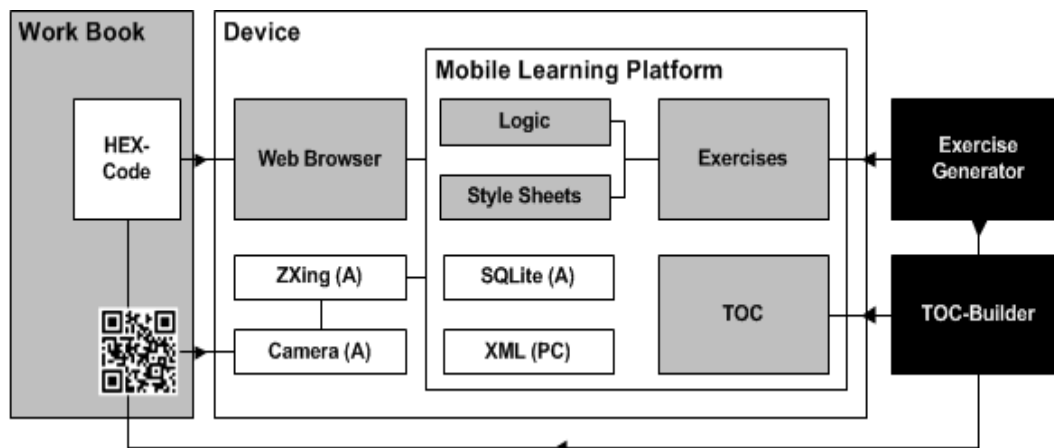


Figure 3: System architecture

## 5 SYSTEM DESIGN

The general architecture of the system is illustrated in figure 3. On the left hand side the book with the integrated QR code is depicted.

On the client side we currently support Android phones as a first platform and also Android tablets since these devices are frequently used from our students.

The QR code will be scanned using the built-in camera of the mobile device. Then it is passed to the ZXing module. ZXing is a multi-format 1D/2D barcode image processing library, which runs on Android. This library is able to extract the information, which is encoded in the QR code.

The mobile part of the learning platform consists further of a SQLite database, which is a public domain in-process library, implementing a self-contained, serverless, transactional SQL database engine<sup>8</sup>. This database contains the exercises belonging to the book. If the learning system shall run on a PC, an XML file will be used instead.

The Style Sheets are used to customize the application for the publisher. Fonts, colors, logos etc. are integrated in order to generate a visual appearance which fits to the corporate design of the publisher. Like that the app can directly be associated with the book and also with the publishing company of course.

The Logic contains the information needed to correct the exercises.

The TOC (table of contents) displays the structure of the book. It provides an overview over different exercises and offers an alternative access to them.

Finally, the authoring system provides an interface to an exercise generator and creates a table of contents.

## 6 EVALUATION

We have carried through an evaluation of the system before publishing it in the app store. Currently we are gathering user feedback from learners, which work with the system, through the Android app store functionality.

### 6.1 Initial User Study

The initial user study has been carried through in two phases. The first phase consisted of 9 persons, i.e. authors, employees of the publisher and technicians. This evaluation showed weaknesses in the navigation of the initial system. Formerly, the following exercises could only be selected by going back to the chapter level after completing an exercise, which has been criticized by the testers. As consequence the two buttons in the mobile user interface have been added to go backwards and forwards to the next or the preceding exercise. For the a similar reason the button to scan the QR code has been added to directly scan a new code and to jump to the exercise.

<sup>8</sup> <http://www.sqlite.org/>

In the second phase, 10 students were involved. Basically their questionnaire asked questions about two topics: technical problems and problems with the content. The analysis of their answers revealed another weakness, already mentioned in section 4.4. Our idea was to make the system as comfortable as possible. For this reason we have combined the correction of a solution together with the display of the sample solution. Hence, the learner only had to push one button. However, this approach has not been intuitively comprehensible for students. Therefore we have split up the two functionalities. Now the students can display the sample solution using the button with the check mark. The evaluation of the solution will be performed by pushing on the large button in the middle saying "Korrektur".

## 6.2 Results from User Feedback

The system is available to download in the Android app store since beginning of October 2011. Within approximately two months, 10 installations of the full version and 90 installations of the demo version have been executed. Due to a failure in the system setup we could not count the downloads and installations of the app at the beginning. This problem has been solved meanwhile.

The PC version has been downloaded 360 times from the server.

So far we have only one user feedback from the app store with the highest rank (5 stars).

Because the publication of the book was very close to the semester start, there are only three universities so far, that use the course book. We expect much higher numbers in terms of downloads and feedback at the beginning of the next semester, when other universities will introduce the book as well.

## 7 CONCLUSION AND FUTURE WORK

We have realized a mobile learning platform, which can be used for augmenting media coming from various sources. More precisely the systems consists of an authoring tool for creating exercises. These exercises are integrated in an automatically generated smart phone app, which is published in the belonging app store. We have additionally realized a PC based client, which laid not in our focus formerly, but which has been easy to realize due to the modular architecture of our system. It equally

offers users without smart phones the possibility to access the same learning material.

In our case the goal was that the learning material augments a course book. QR codes are used in order establish the logical link between book and exercise on a smart phone. Scanning these codes allows to access the belonging exercises on the smart phone or tablet.

The QR codes are a means to comfortably access the exercises and inherently provide the information of the context of the exercises since chapter and section information are encoded therein.

To sum up we affirm that the learning process saves time compared to use traditionally paper based workbooks. The system realized this in form of two ways. First it is helpful for the organization of the learning process and second it assists the learner as a reference tool between content and lesson.

In the future we will first have a closer look at the synchronization between the mobile client and the PC client. Right now there is no connection between the two systems. The integration of other learning platforms in order to import already existing exercises is another issue we want to address. Offering a way to adapt the system to the user and to intelligently select the exercises presented to the user are further challenges we will look into. For a first step we want to store the current state of the exercises, especially the wrong exercises, so that a user can continue working on her former input.

Finally we will look at the feedback we get from the app store for prioritizing the next development steps.

Currently we can emphasize that MORE is executable with the operating systems Android, Mac OS, Linux and Windows. The First one is compatible with almost 800 smart phones and tablet devices.

The project MORE has been designed and realized by department for Historical Linguistics of German and the department for E-Learning Coordination, both are institutes at the University of Trier and the department of Computer Science at the University of Applied Science, Trier.

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