# Mathematics App as Mobile Assessment beside LMS Assessment

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#### ABSTRACT

This proposal presents a self-developed mobile Assessment in short, an App for School Mathematics. The path from idea to implementation and why there was the decision for the development of such an application is described. The app is a further development of the studies beginning phase. After testing the first prototype with 30 students during mathematics preliminary course at our university several changes where done. For instance the handwritten formulas where changed to LaTeX formulas and an English language package is added. Beside the learning management system (LMS) Moodle at BTU Cottbus - Senftenberg the app has similar functionality for assessments and complements in this way. This LMS is intended to serve as a reference for the app in this paper.

Keywords: Mobile Assessment, LMS Assessment, Training, Distant Learning, Educational Technology, Engineering Education, App Development

### **1. INTRODUCTION**

The number of mobile devices is rising in all age groups from year to year. So now almost 99% of the youngsters between 12 and 19 years, according to current JIM study 2015 (Youth, Information, Multimedia, Germany) [1] have their own smartphone. Mobile devices are from point of media technology vision always versatile. So they are multiple used as video camera, camera, scanner, TV, computer, book, for playing games and by the way still as telephone and so on. In [2] a collaborative mobile learning research project between education and industry is presented. As a conclusion it is seen that learning with smartphone is regarded as more flexible, and a benefit is considered, that learning is independently of a specific place and a specific time. In [3] a study of using of LMS by students before and after the implementation of mobile app is performed. The study in this paper shows above all, that the app in addition to the learning platform at specific times will be used more intensively (in the early morning, late afternoon and early evening) as the learning platform. Finally in [4] an app for game based learning mathematics for middle school is developed and analyzed how math ability index of students, aged from five to seven according to the field of 9-whole-year mathematics learning results were achieved without support math learning app with digital learning materials (pre-test) and with the support of math learning app (post-test). As a result it is found by the experiments that such Math Learning Apps help a lot to enhance student's interest in learning mathematics and enhance the effectiveness in learning mathematics.

Within the scope of our project promoted by the Federal Ministry of Education and Research (BMBF) "Anfangshürden erkennen und überwinden: Blended Learning zur Unterstützung der fachspezifischen Studienvorbereitung und des Lernerfolges im ersten Studienjahr" various digital scenarios for helping students are developed and evaluated in the initial study phase since 2012. The materials are aimed at beginners of engineering science at the BTU in Senftenberg. The gap between actual and required knowledge of mathematics is high and the available time is often too short to close the knowledge gaps among prospective students. There is the approach point for the concept. The materials used are partly LMS dependent, but others from outside the LMS can also be used. The field of mobile learning describes opportunities for learning using mobile devices. Learning can take place anytime, and anywhere, as with learning management systems.

So the concept was growing up [5][6][7] to develop an own app for learning school mathematics for the study beginning phase at our University. We use the learning content of the LMS (of Mathematics preliminary courses [8]) in order to build a sensible additional content for the app. The students from the preliminary course have the opportunity to strengthen again and deepen their acquired knowledge. And the prospective students can test their school knowledge before the start of the study by using the app.

## 2. DIDACTICAL CONCEPT

The app was developed to enable students for time and location independent learning. Further the application consists of 25 self-control tasks and explanations for a possible solution. It is based on a statistical calculation algorithm, which detects the right and wrong solved tasks. The application consists of several tests and pools with different tasks in differentiated levels of difficulty. Depending on how the prospective student solves the tasks he gets other tasks of the same type but different difficulty level or move to the next test. This serves to the individual weaknesses of the students respond and compensates for this. Figure 1 represents the flow chart of the application.

The 5 tasks per test belong to different subject areas of mathematics:

- Analysis
- Algebra
- Geometry



Figure 1. Program flowchart

The statistics are intended to give students an overview about the current state of knowledge. Here data from students with similar knowledge were collected and given as a comparison. A similar approach in the specified time has been taken out. The self-evaluation within the mobile application allows a respond to different learning situations and to adapt the overall evaluation.

The various digital media behind the links were taken to ensure a mix of textual, visual and audiovisual media. In this way, the different types of learning are better addressed.

The possibility to stop the application and resume at a later time at the same point is not only a proper technical advantage. Students receive a possibility for self-control.

### 3. TECHNICAL BACKGROUND

In the current version of the application, which is designed as native app for Windows Phone [9] and Android [10], there are five tests with five tasks of different subareas. The test texts are implemented with the optimized math expressions typesetting program LaTeX, see figure 2. All the different tests are to solve handwritten with pencil and paper. For each task a specific time for the solution is configured. The remaining time is displayed continuously to the user. Before starting a task the user can select help button to open tutorials with specific theoretical explanations for the task. The tutorials are statements on external websites as well as audiovisual media, such as videos.

•	. <b>dl 🖬</b> 12:36	•	. <b>d</b> 13:29
SchoolMath App		SchoolMath App	
TEST 1 Task 1		TEST 1 Task 5	
Solve the following qua	adratic equations:		
$3(x-2) \cdot (x+3) = 0$ and	ad $2x^2 - 24x + 40 = 0$	Solution:	
00:0	<b>2:52</b> For the intersection $y_1(x_0) = 2 \cdot (x_0) + 4 = y_2(x_0) = -3 \cdot x_0 + 2 \cdot x_0 + 4 = -3 \cdot x_0 + 9$		$P_0 = (x_0 y_0) \text{ applies:}$ (add +3 \cdot x_0)
		$2 \cdot x_0 + 3 \cdot x_0 + 4 = 9$ $5 \cdot x_0 = 9 - 4$	(add -4)
HTTPS://WWW.MATHSI QUADRATIC-EQ	ISFUN.COM/ALGEBRA/ QUATION.HTML	EBRA/ $5 \cdot x_0 = 5$ (divided by 5) $x_0 = 1$ For $y_0$ in $y_1(x)$ or $y_2(x)$ insert =>	
HTTP://WWW.PURPLEMATH.COM/MODULES/ QUADFORM.HTM		$y_1(x_0 = y_1(1) = 2 \cdot 1 + 4 = 6 = -3 \cdot 1 + 9 = 6$ So the intersection is $y_1$ and $y_2$ : $P_0 = (1 6)$ I have compared my solution with the given one, an marked everything either right or wrong $\checkmark$ OK	
HTTP://WWW.SOSMATH.COM/ALGEBRA/ QUADRATICEQ/QUADRAFORMULA/ QUADRAFORMULA.HTML			
HTTPS://WWW.YOUTUBE.COM/WATCH?V=1PVA- IV43NC			
BACK TO THE START	SOLUTION IS COMPLETED	BACK TO THE START	NEXT

Figure 2. Task with LaTeX text and solution

After the user has solved the task by hand, he stops the time. In the next screen he checks the correctness of his solution in percent and selects his feeling on a scale from very bad to very good while solving the task. All this information for all tasks will be saved continuously in the program.

For each test, the results are shown as a graphical evaluation chart, see figure 3. The test results of the application are only stored locally on the mobile device. A forwarding of data will actually not take place because of concerns that include data protection. The application has been tested extensively for possible errors. A first test run with about 30 freshmen of the preliminary course in 2014 was evaluated positively by the participants.

The entire app is been realized in its own performance at BTU with the help of student projects within the BMBF project.

The app automatically detects whether it is a smartphone with the German language setting or not. If this is the case, the contents of the application are also German; otherwise, they are in English.



Figure 3. Statistics for result and time with recommendation

# 4. COMPARISON APP AND LMS

One advantage of mobile devices is that learners can use their own (and therefore familiar) devices within the meaning of bring your own device. Due to limited input options from smartphones rather choice tasks for mobile Assessments are used more often, than free text objects. In LMS learning progress can also easily be clarified for teachers. In mobile applications it can lead to problems with the data protection. Furthermore, the learning materials can be easily adapted and released in accordance with the teaching progress in LMS. In learning management systems it is easier to create tasks, because here exist different authoring tools. Further, various dynamic tests can be created with appropriate feedback in moodle. [11] Additional advantages and disadvantages of mobile Assessments can be taken the following figure:

#### Advantages

- better use of travel time for students, for example. in trains or buses
- regardless of the internet connection (except help links)
- flexibility in the use
- multimedia usable

Disadvantages

- small screens
- multimedia requires constant internet connection
- battery life
- bluffs easily possible

Finally, it should be noted here that many LMS are now as good as apps adapted to mobile devices due to the responsive designs.

## 5. FURTHER BENEFITS

Besides the didactical and technical aspects more aspects exits. A key advantage is the publicity impact. The application is freely available in the respective stores. Prospective students can download the app. Within the application, there are references and logos that draw attention to the own university. (Figure 4) Mathematics, engineering and computer

science interested students get so already a glimpse of what is being developed at the University. So the contact with the students can be established at an early stage and the social live between students and teachers at University influenced positively. However, there is the risk that poorly designed or malfunctioning applications deter future students more. For this reason, a lot of effort in the development and testing needs to be operated.



Figure 4. Marketing tags within the app and program description

An example is the first test with 30 students in the preliminary course at our University; during the test, the students have completed a questionnaire with questions about how to evaluate the app, in addition to solving the tasks in the app. The questions were developed and evaluated by a student project and gave us valuable results for the further development of the app. Figure 5 shows an example of the evaluation that has been included in the current development.



Figure 5. Example evaluation app design and usability

In LMS the applications can be referenced. An example is this math prep course at BTU in Senftenberg in 2016. Figure 6 shows the links within the course in the LMS. So the application became part of a larger educational concept.

#### Online Tutorium

Hier haben Sie Zugriff auf den Livestream des Mathetutoriums. (klick)

In diesem Bereich werden Ihnen Aufzeichnungen der letzten Übungen aus dem Livestream bereitgestellt

1. Woche	2. Woche	
Finführung	Montag (klick)	
Di a di la		
Dienstag (KIICK)	Dienstag (KIICK)	
Mittwoch (klick)	Mittwoch (klick)	
Donnerstag (klick)	Donnerstag (klick)	
Freitag (klick)	Freitag (klick)	

#### Mathematik App

Unter den folgenden Links können Sie eine zusätzlich an der BTU erstellte App für Mathematik in der Studieneingangphase herunterladen:

Windows Phone: https://goo.gl/CBpMk0

Android: https://goo.gl/BxCW2L

(Die Inhalte sind nicht vollständig auf den Vorkurs angepasst)

#### eLearning-Bereich

Bei Fehler in den Tests unter c.waschnik@b-tu.de melden!

Hier können Sie im Rechnerpool oder von zuhause aus selbständig üben. Die Aufgaben werden jeweils dem Vorlesungsstoff angepasst.

Figure 6. Math prep course with app links

Students who co-developed partly free on the app get at the end a censorship with corresponding 5 credit points. Thus, the development also supports the teaching at the university.

### 6. CONCLUSION AND FURTHER DEVELOPMENT

LMS and mobile applications need not be viewed as competitors. Both are for the use of a learning scenario as well as for the other, there are advantages and disadvantages. It is possible to combining both. Explicitly designed for smartphone, apps have small advantages over the Responsive Designs by LMS. However, it is difficult to distribute content for a simple teacher, because there it often a lack of the knowledge about the development of apps. With both scenarios, different didactic scenarios can be realized.

The app has been used at the BTU in several pre-courses since the first publication in 2015 and has been positively evaluated by the students. The statistics for the current installations of the app in the respective stores have also steadily increased, especially the installations before the beginning of the semester. Mobile applications may represent a new marketing tool for universities. The precise impact should be further investigated. To appeal to international students further language (for example, Spanish) can be included.

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#### REFERENCES

- [1] Medienpädagogischer Forschungsverbund Südwest (mpfs), "JIM study 2015 (Youth, Information, Multimedia) of media education research group," JIM study 2015 Southwestern Germany, (2015).
- [2] Mohammed Samaka, Mohamed Ally, "Work in progress: Use of mobile technology to deliver training in blended learning and independent study formats," Teaching, Assessment, and Learning for Engineering, 2015 IEEE International Conference on Teaching, Assessment and Learning for Engineering (TALE), (2015).
- [3] Patrick Hung, Jeanne Lam, Chris Wong, Tyrone Chan, "A Study on Using Learning Management System with Mobile App," 2015 International Symposium on Educational Technology (ISET), (2015).
- [4] Rong-Chi Chang, Ching-Yu Yang, "Developing a mobile app for game-based learning in middle school mathematics course," 2016 International Conference on Applied System Innovation (ICASI), (2016).
- [5] T. Kutzner, O. Wälder, C. Trujillo, L. Eisenmann, "Mathematik App für Android und Windows Phone," 2. Tag der Ingenieurwissenschaften der BTU Cottbus-Senftenberg, (2015).
- [6] T. Kutzner, C. Steinert, "School Mathematics App for Study Beginners," Discovery Demo DEM12 Online EDUCA Berlin, (2015).
- [7] T. Kutzner, C. Steinert, "Unterstützung der Studienvorbereitung durch den Einsatz ausgewählter E-Learning Tools," E-Learning Symposium Potsdam, (2014).
- [8] Wälder O., Wälder K., "Grundlagen der Ingenieursmathematik im Bachelor Studium," Shaker-Verlag, (2012).
- [9] Tobias Kutzner eLearning, "App in Windows Phone Store:,"<https://www.microsoft.com/dede/store/p/schulmathe-app/9nblgggzlqnz> (28 October 2016)
- [10] Tobias Kutzner eLearning, "App in Google Play Store:," <https://play.google.com/store/apps/details?id=com.lern.schulmathe\_app> (28 October 2016)
- [11]C. Steinert, T. Kutzner, "Dynamische Self-Assessments mit Moodle-Gegenüberstellung des Nutzens und Aufwands bei der Erstellung," Erfolgsfaktor(en im) Selbststudium : Diskursive Fachtagung, 12 (2016).

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