

A Lightweight Mobile Quiz Application with Support for Multimedia Content

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Abstract

In this paper, we present a lightweight, media-supporting quiz application for mobile devices. The idea is to use the students' own smartphones as voting devices and to provide a quiz administration module which is integrated into the existing university's e-learning platform. For establishing the link between the devices and the platform we use dynamically generated Quick Response (QR) codes. The quiz is implemented as a web application, also providing the use of media content such as pictures and videos. We briefly evaluate our approach with respect to usability for students and lecturers, limits of the mobile browser technology and the QR code, and the impact on the university's network infrastructure.

1. Introduction

Electronic voting systems (often called TED systems) are an interesting concept of e-learning for schools and universities [20]. They allow the lecturer to get quick feedback about the state of knowledge, comprehension, and opinions of the listeners. Students can express their knowledge without stepping forward in front of the entire auditorium. However, some drawbacks of traditional voting systems, requiring special hardware, have to be considered: The voting devices and the corresponding receiver are expensive, and the wireless devices have to be distributed to the students before a quiz can be started. The acquisition costs, the administrative overhead and the risk of loss of devices increases with larger numbers of students. The content of the quiz has to be prepared before the lecture starts, and the answering options are severely

limited by the design of the devices (e.g., textual multiple-choice questions only).

At our university, we have developed a lightweight system that enables lecturers to ask ad-hoc questions electronically to all students in a very quick and spontaneous way. It is possible for the teacher to use multiple choice questions, questions requiring numeric answers and questions based on multimedia content such as pictures and videos. The system is easy to use by both lecturers and students.

Our idea is to exploit the proliferation of smartphones and laptops among students and to implement the *Mobile Quiz Application* as an extension of our existing e-learning management system ILIAS [7]. Most students own a smartphone or another mobile web-enabled device like a netbook, a laptop, or a tablet. These devices have built-in Wi-Fi access and a Web browser, and thus have the ability to be used as voting devices. Many courses at our university use e-learning groups in ILIAS. Therefore, we have implemented a plugin for ILIAS, allowing the lecturers to create, maintain, and perform prepared and ad-hoc quizzes during a lecture without the need of extra hardware. The quiz itself appears as a Web app on the students' devices and needs no software installation. With the start of a quiz round, a QR code [8] and a link in plain text are shown on the projection screen. The students can participate in the quiz by scanning the code with a barcode reader, or they can manually enter the link into their web browser. After the quiz is finished, the aggregated results are displayed on the projection screen, and the lecturer can discuss them with the students.

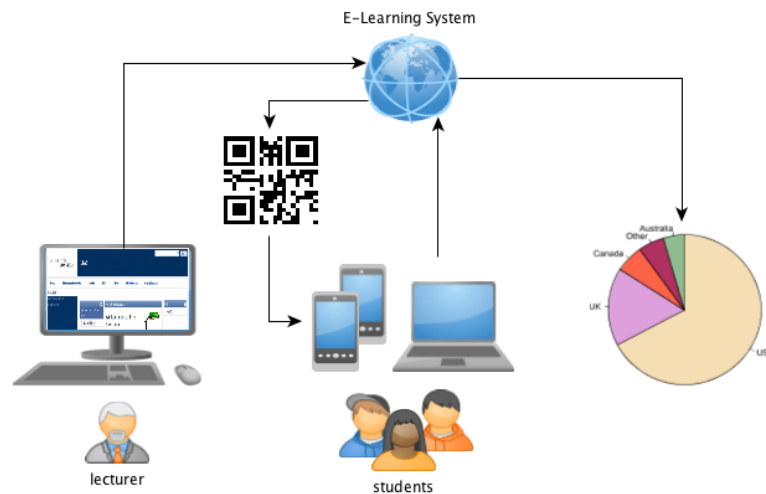


Figure 1: Mobile Quiz concept

In the following, we describe the related work, give an overview of our system architecture and the system itself, discuss the advantages and disadvantages, and point out further work.

2. Related Work

From the point of view of educational psychology, learning should be an active process [9, 24]. Interactivity is highly relevant for the individual learning success and gives the learner the opportunity to actively shape the learning process, rather than remaining a passive recipient. Thus, an active involvement of the learners has a big impact on the success of learning activities [17].

Much research was done in the last years on how to improve the activity of students in classical lectures. One major idea was to use small handheld devices to provide additional communication functionalities and thus to improve the activity and motivation of students. The aim of early systems like *Classtalk* [5] was to improve the involvement of every single student. The teacher transferred three to four *Classtalk* tasks per lesson to the students' devices, which were calculators, organizers, or PCs at that time. Another early approach was the *ConcertStudeo* project which used an electronic blackboard combined with handheld devices [3]. It offered exercises and interactions such as multiple-choice quizzes, brainstorming sessions, or queries. The Classroom Feedback System (CFS) was designed for online feedback [1] and allowed students to post annotations directly on lecture slides.

Scheele et al. have developed the Wireless Interactive Learning (WIL/MA) system to support interactive lectures [20, 11]. It consists of a server and a client software part; the latter runs on handheld mobile devices. The components communicate using a Wi-Fi network specifically set up for this purpose. The software consists of a quiz, a chat, a feedback and a call-in module and is designed to be easily extendable. The main problem is that students need to have a JAVA compatible handheld device, and they need to install the client software before they can use the system.

Novel mobile devices not only support the visualization or playback of multimedia content like audio, text, images, or videos but also allow an easy interaction with the device [4, 19]. HTML 5 especially supports the visualization of graphical and multimedia content¹ in Web browsers. Although most of the technical challenges have been solved today, some questions still remain, e.g., how to create more intuitive user interfaces or how to visualize pictures or videos on the small screens of mobile devices without removing important content [14, 10, 12, 13, 18]. Liu and Chen [15] focus on the quality of audio and video communication in a mobile learning scenario.

Ijtihadie et al. [6] propose to use an offline Moodle learning management system. The system is implemented with HTML5 that supports offline application capability. Mehta et al. [16] have developed a JAVA-based simulation tool that is

¹ <http://www.w3.org/TR/html5/>

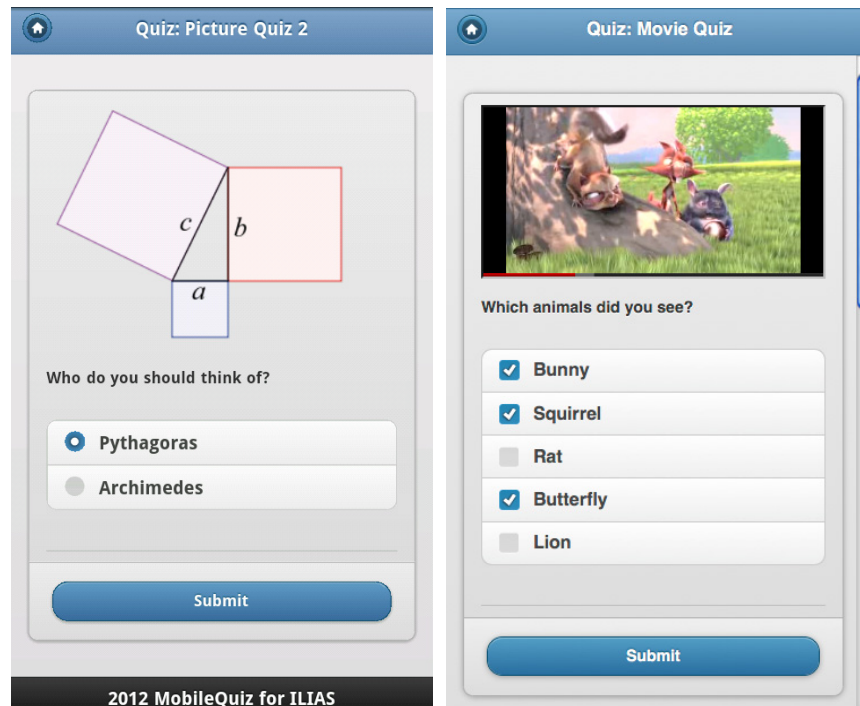


Figure 2: Examples of a picture quiz (left) and a video question (right).

connected to a learning management system that supports quizzes, online labs, animated demos and video lectures. Tabata et al. [22] present an online learning tool for the iPhone that allows students to answer quizzes at any time. Clunie et al. [2] present a platform that enables users to connect an Android phone to the content management system Moodle. The system supports features like alerts, chats, forums, or access to personal data like grades. Ullrich et al. focus on mobile learning in developing countries [23]. They argue that a major advantage of using mobile devices in comparison to laptop or desktop computers is the high penetration rate of mobile phones in those countries. Their proposed system allows a large group of students to use a mobile device for interacting with teachers during a lecture.

We define three requirements for our *Mobile Quiz Application*: (1) No additional software should have to be installed on the mobile devices. (2) Almost all modern mobile devices should be supported so that no extra hardware has to be purchased. (3) The system should be integrated into the learning management system of the university. None of the existing systems considers all these three requirements. In our opinion, it is much more suitable to require only a Web

browser, and of course, every smartphone, notebook, or tablet PC has one. In addition, in recent years, learning management systems (LMS) have become commonplace in universities, and thus an integration of the quiz tool into the LMS is reasonable.

3. System Overview

Fig. 1 gives a brief overview of the process of our Mobile Quiz Application. It consists of two parts: a backend provides the view for the lecturer and a frontend for the quiz participants. Both access data from the same database but are technically independent. This makes it easy to replace the modules at a future point in time. The backend is implemented as a plugin for the university's e-learning platform ILIAS. Although the frontend is independent of ILIAS, it is delivered in the same software package, which simplifies the installation and maintenance of the system. Additional information about the concept of the Mobile Quiz Application has been published before [21].



Figure 3: The QR code is displayed on the screen during a lecture.

3.1 The Lecturer's View

The *Integrated Learning, Information, and Work Cooperation System* (ILIAS) [7] is an open source e-learning software published under the terms of the GNU General Public License. It is written in PHP, and it is maintained and extended by an increasing number of participants.

One of its components is a comprehensive survey tool, which supports many different question types. Unfortunately, it does not meet our needs very well because it is not designed to create quizzes spontaneously, e.g., within a lecture. Furthermore, it does not allow anonymous quizzes, and it is not designed to support mobile devices. However, being a productive system, it already provides rights and roles management, and most of our lecturers are familiar with it. We thus decided to develop the quiz administration as a plugin for ILIAS. All the management activities, like creating questions, starting quiz rounds and visualizing the results can thus be done within ILIAS.

3.2 The Frontend System

One of our main goals is to make the Mobile Quiz Application compatible with as many devices as possible. It should be easy for students to connect to the mobile quiz and to answer the questions. Furthermore, the application has to be robust regarding connection drops. We decided to implement our quiz as a Web application by using existing Web technologies based on the jQuery mobile Web framework. A main advantage of our approach is the

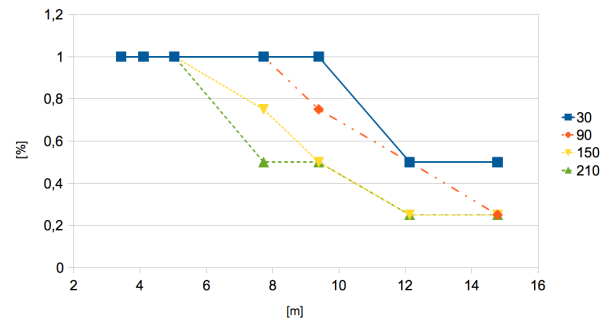


Figure 4: Evaluation of the QR code readability.

high accessibility for a wide range of small mobile devices, as well as laptops, netbooks, and tablet-PCs.

The use of Web technologies opens many new possibilities. Although the quiz looks like a smartphone application, the questions are presented on normal Web pages, opened by the devices' browser. Therefore, it is quite easy to include pictures, videos, and other media content. Fig. 2 (left) shows a question based on a picture. It is a referral to Wikipedia, and the video in Fig. 2 (right) is directly embedded from Youtube. Unfortunately, most mobile browsers do not yet support the latest web technologies, like desktop browsers already do. If we used HTML5 3D technology, only a few students would be able to watch the content. So, the question could not be answered by the majority of participants.

3.3 Quick Response Codes

To simplify the access to the quizzes we use *Quick Response Codes* (QR codes). They display the link to a specific quiz as a machine-readable image. Students can use their phone's camera and standard QR reading software to access a quiz, without the need of manually typing a link on the tiny keyboards of their mobile phones. QR codes are two-dimensional barcodes which store the data in a square pattern of black modules on a white background. Although this technology can be used to encode any kind of data, it is especially useful to represent a link to a web page. QR codes are often found in advertisements, linking to further information about an event or product. There are several standards, including ISO/IEC18004 [8] for the physical encoding, and a de facto standard for encoding URLs from NTT DoCoMo. The latter is optimized for fast readability, and it includes error correction to enhance its robustness. Figure 3 shows a QR code used during a lecture.

4. Discussion

Although our system is designed for good usability and easy accessibility, we were confronted with several difficulties. The technical implementation of the QR code, the bandwidth requirements for the Wi-Fi network in the lecture room and the students' acceptance, and were the biggest challenges.

4.1 Evaluating the QR Code

We did experiments to evaluate the limits of the QR code technology. We measured the readability of codes with 30, 60, 90 and 120 encoded characters and four different error correction levels, using four typical recent mobile devices. The tests were done in one of our lecture rooms (with 140 seats) in normal daylight conditions in six distances between four and fifteen meters. When increasing the number of encoded characters or the level of error correction, the amount of black and white squares within the QR code increases, the size of each square shrinks. This impairs the readability. Our experiments showed that using a minimal level of error correction resulted in the best readability. The reason for this is due to the used method of error correction. It is designed for burst errors, e.g., losing a corner of the code. However, this type of error is unlikely to occur when displaying the QR code on a projection screen. Figure 4 shows the impact of the number of encoded characters on the readability. The two devices with an 8 megapixel camera were able to read the 30 letter code from every position in the classroom whereas the two 5 megapixel cameras failed at a distance of about twelve meters. Only one device was able to read all codes from every distance. Consequently, we decided to use QR codes with minimal redundancy, and we have implemented an URL shortener to keep the amount of characters as small as possible.

4.2 Load on the University Infrastructure

Besides the readability of the QR codes, we identified difficulties that were not so easy to solve. Because we wanted to avoid setting up a dedicated network, all devices had to use the existing university Wi-Fi network or the data network of their mobile network provider. Unfortunately, the Wi-Fi network at our university is not designed to serve more than a hundred parallel data connections in one room. Therefore, we were interested in the network load and delay caused by using our quiz tool.

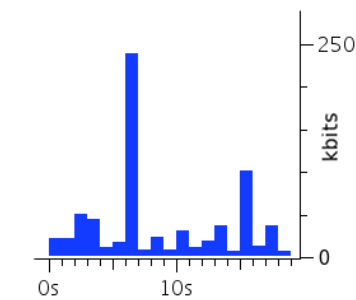


Figure 5: Network load.

Figure 5 shows a capture of the network load for one quiz participant. In this case, a quiz with five plain text questions and three possible answers was used. The download to the device caused about 240 Kbits, the upload for submitting the answers caused about 100 Kbits of traffic load. This causes a total network load for the entire process of 340 Kbits. The largest part of the downloaded data consisted of pictures which were used for the layout and the jQuery-libraries.

Beside the data capture for one participant, we also measured the load directly within the Wi-Fi access points of our university. We tested the quiz in two of our real lectures and looked at the load on all nearby access points for the entire lecture time. The students were asked to bring a web-enabled device and to participate in two quiz rounds. 30 of 50 students participated in at least one quiz round. Except of seven students who used the data connection of the phones' mobile network provider, the devices were connected to the quiz via the university's Wi-Fi network. The network traffic of the participating devices could not be recognized in the overall Wi-Fi traffic, it was absorbed by other general traffic. Our Wi-Fi access points can handle up to 100 Mbps, so even for more than 100 students the pure data load is no limitation.

Unfortunately, the Wi-Fi network delay increases with an increasing number of clients [25]. Additional packets are needed to regulate the network traffic and to avoid packet collisions. This causes a noticeable packet overhead and increases the overall delay. With the small number of students in our testing scenario we did not notice an impact on the network delay.

So far, we only examined quiz rounds with plain text questions. When using multimedia content, the amount of network load will rise according to the exact

size of the used media. We want to examine this impact in the future.

4.3 Usability

Even if most HTML5 technologies are already quite common on desktop browsers, they are typically not yet available for mobile browsers. When using HTML5, embedded complex media content like videos and 3D-objects cannot be displayed by most of today's smartphones. In the case of a quiz in a lecture, this type of content should thus be avoided. On the other hand, when creating a quiz for a remote video lecture where most of the students participate via a desktop computer or laptop, complex media content could be embedded directly via HTML5.

We also evaluated the students' acceptance in two lectures with 50 students and two quizzes in each lecture. Our experiments showed that all students who had a mobile web-enabled device at hand (at least 60%) participated in the quiz rounds. Most students participated with their mobile phone (73%) or laptop (27%). Some students with mobile phones without a barcode reader participated only in the first quiz round. The effort for typing the URL into the mobile Web browser was too high.

We have not yet evaluated the usability of the quiz from the lecturers' point of view but are planning to do this in the upcoming semester.

5. Conclusion and Outlook

In this paper, we introduced an innovative *Mobile Quiz Application*. We have designed and implemented an electronic quiz system which can be operated via the university's e-learning platform. It uses all forms of student-owned web-enabled devices for answering the quiz questions. From our early experience, at least 60% of the students own one of these devices and thus are able to participate in the quiz rounds. We implemented the initial connection to the quiz with a QR code and evaluated its readability in a typical lecture room. We further evaluated the impact on the university's Wi-Fi infrastructure and the user acceptance.

We extended our approach by adding multimedia content like pictures and videos to the questions and the answers. But most mobile browsers do not yet support the latest HTML5 technologies, so they could not be used in today's lectures.

Because the quiz only requires an Internet connection and visual sight to the QR code or link, it is even usable in remote video lectures or in a

combination of remote and local lecture without any additional effort for the lecturer. Lecturers and students of our university show keen interest in the system, and they are looking forward to a full rollout.

For future work, we will do additional experiments in larger lectures and investigate the impact on the wireless network in more detail. We want to extend the usability with more types of questions and improve the support of multimedia content. We also plan to evaluate the effect on the learning outcome. In addition, we want to extend the *Mobile Quiz Application* by implementing additional features like an offline mode, where the QR code is printed into the lecture notes so that the students can participate in the quiz from home and get their individual results.

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