Customized Teaching Scenarios for Smartphones in University Lecture Settings

Experiences with Several Teaching Scenarios using the MobileQuiz2

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Abstract: Many teachers use Audience Response Systems (ARS) in lectures to re-activate their listeners and to get an insight in students' knowledge of the current lecture contents. Plenty of such applications have been developed in recent years, they provide a high variety of different teaching scenarios with the use of the students' smartphones, including quizzes, lecture feedback and dynamic message boards. We developed a novel application based on an abstract model to enable this variety of customizable teaching scenarios within one application. After presenting the application to the first charge of lecturers, the responses were quite good, and several new teaching scenarios were created and used. This paper presents first experiences when using a variety of customizable teaching scenarios, the special opportunities and challenges as well as the opinions of lecturers and students, which we collected with a survey at the end of the semester.

1 INTRODUCTION

By now, Audience Response Systems (ARS) are commonly used to increase interactivity, activate the audience and get a realistic feedback of the students' knowledge. Besides specifically constructed hardware clickers, the first implementations were already written for PDAs and handheld computers. With today's availability of smart phones among students, the usage of ARSs within classroom settings has become very popular. Technologies are so evolved, too, that a simple ARS can be programmed by a student of informatics within a few months. Additionally, the demand for response systems grew significantly during the last years due to the perceived didactic benefits. Most of these systems offer comparable features, especially the opportunity to create test questions or self-assessment scenarios. Our own System, the *MobileQuiz* was developed in 2012 and directly integrated into the university's learning management system. It used the students' smart phones as clicker devices and was adapted by many lecturers, mostly for knowledge quizzes (Schön et al., 2012a).

With the increasing popularity, additional requirements were brought to our attention. Besides simple feedback and self-assessment scenarios, our lecturers asked for customized learning environments with more complexity, adaptivity and increased student interactivity. Requests ranged from guessing questions with multiple correct answers, possibilities for text input, message boards for in-class discussions up to game-theory and decision-making experiments for live demonstrations. So, every scenario differed slightly from already existing scenarios or other lecturers' ideas.

Therefore, we enhanced our system by designing a generic model to depict various in-class teaching scenarios on handheld devices. The model lead to the development of a prototype application that merges common features and scenarios of other tools within one system: the *MobileQuiz2* (Schön et al., 2015). Small sets of predefined elements were defined to describe diverse scenarios, including message boards, knowledge quizzes, guessing games and other customized scenarios. By now, several lecturers have used the system in their lectures and created multiple new teaching scenarios. This new freedom in designing individual teaching scenarios without the usual technical boundaries gave us interesting insights and lead to new, different challenges for the lecturer. A first evaluation with 6 lecturers and 27 students showed that students and lecturers appreciate the diversification in teaching scenarios. But while students see the most important aspect in having a stable sys-

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tem, lecturers are more concerned to execute a high-quality scenario.

This paper is structured as follows: Section 2 discusses related work and the didactic impact of ARS. In Section 3, we give a short introduction of the generic model and explain how the prototype works with it. We describe a selection of different teaching scenarios used by our lecturers in Section 4. Section 5 shows the results of our evaluation during the Fall semester 2015. Section 6 discusses the benefits, difficulties and limitations of our approach, and Section 7 concludes the paper.

2 RELATED WORK

As recommended by Beatty and Gerace (Beatty and Gerace, 2009) we distinguish between educational psychology aspects and technological aspects in the following discussion about ARS.

2.1 Educational Psychology

Teaching aims at supporting students to understand and learn the course contents. Unfortunately, common teaching styles focus on the presentation of knowledge, especially in large lectures. Research has shown that only the active usage of information leads to effective learning (Biggs, 2003). Therefore, activating elements and methods are essential for the success of a course. When trying to implement activating elements, lecturers are confronted with a range of hindering factors, especially time constraints and group size. Using eLearning tools is one solution to these challenges: technology can offer possibilities that save time and are well usable in large classes. ARS are one common way of bringing interactivity and variation to the classroom. Students can be asked anonymously for their opinion on course contents or course design. Lecturers can test the students' understanding and immediately use the results for further explanations or discussions in the classroom. Research has shown many positive effects of ARS within the last years of which only a few shall be mentioned here: ARS can increase students' motivation (Kopf et al., 2005; Uhari et al., 2003) and decrease the individually experienced boredom (Tremblay, 2010). Students value individual feedback about their standing in the class (Treesa and Jacksona, 2007). Students also believe in the improvement of their learning success by the usage of ARS (Uhari et al., 2003). Chen et al. (Chen et al., 2010) and Reay et al. (Reay et al., 2008) found out that the learning success is objectively higher in courses using ARS.

Ideally, lecturers can chose and apply methods according to their teaching goals ("form follows function approach") and should not adapt their teaching to the functionality of a system or, in the worst case, use the tool for the sake of the tool.

2.2 Audience Response Systems

Early systems like Classtalk (Dufresne et al., 1996) wanted to improve student activity by transferring three to four tasks per course to students' devices that were common at that time: calculators, organizers, or PCs. Some years later the system ConcertStudeo already consisted of an electronic blackboard and handheld devices (Dawabi et al., 2003). With ConcertStudeo a lecturer could create exercises and interactions like multiple-choice quizzes, queries, or brainstorming.

Scheele et al. developed the Wireless Interactive Learning Mannheim (WIL/MA) system to support interactive lectures (Scheele et al., 2005), using a server and a client software part, that runs on handheld mobile devices. By using a specifically set up Wi-Fi network, the components of the system communicated and offered the user a variety of functions like multiple-choice quizzes, a chat, a feedback function and a call-in module. WIL/MA offered the possibility to extend the functions with little programming effort. To use the system, students were required to have a JAVA compatible handheld device and to install specific client software, which made a university-wide extension of the tool rather complicated. Experts claim that the purchase of specific hardware devices leads to diverse challenges, like additional overhead for, e. g., buying the devices, securing them against theft, time for handing out and collecting the devices, updating and maintaining as well as replacement of broken devices, and finally the instruction of teachers and students about the usage (Murphy et al., 2010; Kay and LeSage, 2009). Hence, the integration of students' private mobile devices (tablets, smartphones etc.) and ARSs became more popular. Nowadays, mobile devices and especially smartphones are extremely widespread tools with a broad technical functionality, they can visualize multimedia content (Schön et al., 2012a) or use learning materials like lecture recordings or e-books (Vinaja, 2014). With the development of our first ARS: the *the MobileQuiz*, we were able to fulfill three basic requirements (Schön et al., 2012b): (1) No additional software needs to be installed on the mobile devices. (2) Almost all modern mobile devices are supported so that no extra hardware has to be purchased. (3) The system is integrated into the learning management system of our university. We were able to develop a tool that requires only a web browser that is nowadays integrated integrated in every handheld device or notebook. The access to the quiz tool was provided by a QR code or a tiny URL. This became a common approach at that time which was also use by other ARS like PINGO (Kundisch et al., 2012). Another common aspect of ARSs was the limited ability for customization and adaptation.

Web-based systems have been proposed like BrainGame (Teel et al., 2012), BeA (Llamas-Nistal et al., 2012), AuResS (Jagar et al., 2012) or TUL (Jackowska-Strumillo et al., 2013) to enhance the flexibility and expandability of the systems. User interfaces were improved to allow lecturers to add new questions on the fly, to create a collection of questions, or to check answers immediately. Data collection and the export of the data for later analysis is feasible, as well as the possibility for students to update their votes or to support user authentication for authenticated polls. Considering the technical innovations, some systems use cloud technology for better scalability in the case of large groups of students.

Several commercial ARS are available that include gamification aspects (Brophy, 2015). Kahoot[1] is an online ARS that also supports quizzes or surveys and aggregates all responses immediately. Students may also slip into the role of the teacher and create their own quizzes. ClassDojo[2] is another ARS focusing on gamification that supports a rewarding system and communication between students, teachers, and parents.

The main drawback of all these systems is the fact that only predefined scenarios can be used, every extension requires access to the source code, programming effort and programming skills. Therefore, we improved our system to function as a modular construction tool that allows lecturers to realize a huge variety of imaginable teaching scenario without changing any lines of code of the *MobileQuiz2* .

3 MODEL

We developed a model based on the assumptions that the process of creating a learning unit is divided into the five phases listed in Table 1 and that every teaching scenario can be constructed out of a few basic elements (Schön et al., 2015).

The beginning *blueprint phase* consists of stating the learning goals of the course unit and defining the concept of the teaching scenario. According to the learning goals, this could be a personal knowledge feedback, an in-class message board, a live experiment in game theory, or audience feedback on the current talking speed of the lecturer. The lecturer has to define the elements and their appearance on the students' phones, the interactions between the participants and the compilation of the charts he or she wants to present and/or discuss in the classroom. This phase needs a fair amount of structural and didactic input, because small details have a large influence on successful or unsuccessful scenarios.

Table 1: The five phases of a learning scenario.

Phase	Description
Blueprint	Definition of teaching scenario.
Quiz creation	Creation of an actual quiz with specific questions of a scenario.
Game round	Performance of a classroom activity.
Result	Presentation and discussion of the result.
Learning analytics	Analysis of students' behavior and scenario success.

After defining the scenario's blueprint, lecturers can take a predefined scenario and build a concrete entity of it, stated as *quiz*. If the scenario is, e. g., a classroom response scenario for knowledge assessment, the concrete questions and possible answers are entered here. These quizzes are then used to perform *game rounds* with the actual students.. In phase four, the students' input is displayed in form of *result* charts. Depending on the type of input data, the results are displayed as text, colored bar charts or summarized pie charts. The last phase is mostly for analyzing the learning behavior and performing didactic research with meta data which is logged in the background.

The elements of our model take the inspiration from a classical collection of family games. Such a game usually consists of different objects like tokens in different colors, cards with text, or resource coins in different values. *Objects* also exist in a learning scenario and could, e. g., consist of questions with answers. Comparable to a board game, these objects also have *attributes*, like the text and correctness of a multiple choice option. Beside the tokens and the board, a game has *rules*. They describe the logic behind the game and the way the players interact with the game elements and with each other. Such rules are also required for the execution of an ARS. They can be described as a set of *checks* and *actions*. Checks are conditions under which the rule gets activated, while actions describe the action that has to be per-

[1]https://getkahoot.com/

[2]http://www.classdojo.com

formed. This covers very simple rules, like a button-click triggering a player's counter to increase by one, to very complex ones where a sum of an attribute of all players exceeds a given value.

We have implemented a prototype to analyze the described model in real lecture environments. The *MobileQuiz2* is written in PHP and uses the ZEND2[3] framework and current web technologies like AJAX, HTML5, CSS3 and the common web frameworks jQuery[4], jQuery Mobile[5] and jqPlot[6]. Students open the quizzes with their mobile browsers by scanning a QR code or entering an URL directly.

4 EXAMPLES OF USE

Due to the high flexibility and adaptability of the model, the lecturers of the University of Mannheim used the *MobileQuiz2* for a variety of different scenarios.

Single and Multiple Choice Questions: The most popular scenarios use plain single and multiple choice questions, similar to many other ARS. They are mostly used to analyze the students' current understanding of the course contents. The benefits of this scenario are that the students are forced to reflect their knowledge, and the lecturer gets an overview of the students' knowledge gaps.

Question Phases: This scenario enables the lecturer to switch through different phases which contain different types of learning objects. The scenario was used several times in slightly different variations. In the most complex variation, the lecturer of computer science explained a mathematical problem and let the students train the solution. During the first phase, the students got a quite easy example, entered the result into the given field and submit their results as can be seen in Figure 1. The results were automatically compared against the right answer, and the students got direct feedback on their individual answers. When they were wrong, they got the possibility for another try. Thus, they were able to practice by themselves, while the lecturer got an overview of how many students already understood the topic. After a discussion about the correct result and right way of computation, a more complex problem was explained and the second phase was started, with a more difficult exercise. In that way, students were guided through four phases with a steadily growing difficulty.

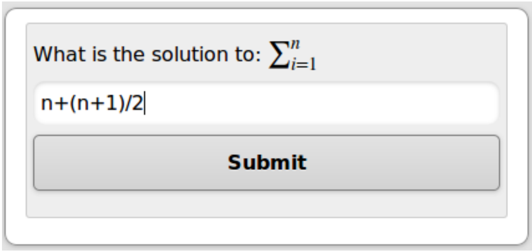

Figure 1: Screenshot of a question phases scenario.

Guess Two Thirds of the Average: Additionally to absolute repeatable scenarios, it is also possible to realize environmental-dependent live experiments. A professor in business economics uses a game theory example called *guess two thirds of the average*. With that, students have to guess a number between zero and one hundred. After everybody submitted his guess as can be seen in figure 2, the average of all answers is calculated and the student who is closest to two thirds of the calculated average wins the game. The average and winning number are calculated for the current setting as soon as the lecturer closes the quiz round, and the winning student gets an according message on the screen. The "correct" result, therefore changes for every iteration of this scenario.

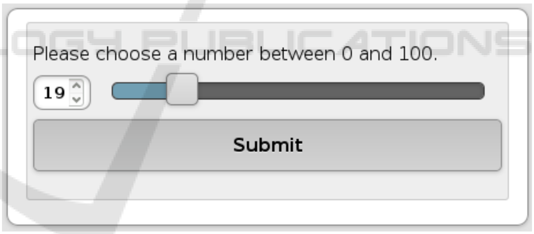

Figure 2: Screenshot of a guessing scenario.

Message Board: A special kind of scenario for comments is the Message Board. The students only see a short textual description, a text input field and a submit button. They are able to enter a comment into the text input field which is cleared again as soon as the comment is sent to the server by clicking the submit button. The comments are put on a Twitter-like[7] message board, where the latest post is displayed at the top. One of our lecturers used it during live programming in a big exercise with about eighty students who should write feedback and questions during his programming. After the first ten minutes, the students gave about 30 comments, which were discussed immediately. Unfortunately, after half the time of the

[3]http://framework.zend.com/
[4]http://jquery.com/
[5]http://jquerymobile.com/
[6]http://www.jqplot.com/
[7]a mikroblogging service. http://twitter.com

lecture, some students got bored and started monkey business by writing nonsense and inappropriate messages. Therefore, the *MobileQuiz2* was improved; the lecturer is now able to hide inappropriate comments, highlight noteworthy ones, and ban students from the current round when they misbehave.

Survey: The *MobileQuiz2* can also be used to collect information in a survey scenario. This scenario uses a Likert scale question to ask the opinion about a specific topic. The range of the scale can be changed by the lecturer. Therefore, the scale can be adjusted for the current question, e. g., from 1 to 4 or 0 to 10. It has a multiple-choice question to pick several topics out of a list and an open text question for free text answers as can be seen in Figure 3. Additionally, a *description* field can be used to describe the current question. This description appears as a read-only label on the students' devices. The answers can be displayed like in the other scenarios. This scenario was used to collect the data for the evaluations below.

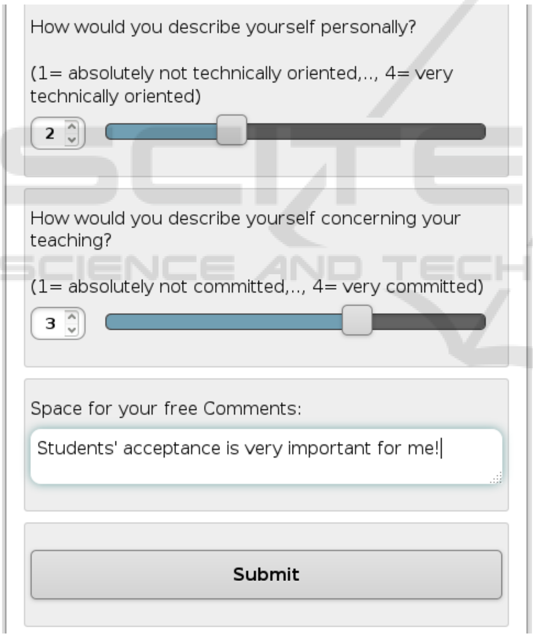

Figure 3: Screenshot of a survey scenario.

Likert Scale Evaluation: Slider elements can be used to create a Likert scale evaluation scenario. In this way, the agreement of the audience on specific statements can be collected (as known from social sciences). These statements can be a starting point for discussions and further explanations. Additionally, evaluations on the course design can be conducted. A lecturer of a weekend seminar on Economics education in Spring semester 2015 used such a scenario to let the students evaluate each other's presentations. The scenario consisted of several discussion points which were chosen by the lecturer. These discussion points contained a textual question and a slider from one to five. The students saw all discussion points at once and were able to express their opinions continuously during the seminar. The results were aggregated and presented directly.

Lecture Feedback: Similar to the Likert scale scenario, the feedback scenario uses sliders for catching the students' opinion about the current lecture. The scenario is designed to give the lecturer a live feedback about his talking speed and the comprehension of his course content and to enable free comments by the students. The scenario is used without an extra submit button, as the feedback is updated continuously.

5 EVALUATION

In addition to a continuous communication with our lecturers about challenges and needs for improvement of the new MobileQuiz2 , we did a evaluation at the end of the Fall semester 2015. We used the survey scenario of 3 and created one questionnaire for students and one for lecturers. Although we introduced more than a dozen lecturers to the *MobileQuiz2* , only a few actually used it regularly during the ongoing semester. Most lecturers wanted to wait for the next semester, using the vacation period to get into the system and prepare their scenarios. Therefore, we created three questionnaires in total and interviewed the hesitating lecturers, the performing lecturers and the students separately. We conducted the survey with all lecturers who already got an introduction to the new application (users and hesitaters).

5.1 Students

The short survey was conducted in an exercise of computer science where 27 of about 35 students participated. The students were confronted with seven statements and gave their rate of agreement on a four-point Likert scale from *absolutely disagree* to *absolutely agree*. The results showed that students mostly enjoyed the new quizzes. When asked about the improvement in understanding the course contents, the majority of the students stated that the quizzes support the understanding. More than 50% of the students agreed with the statement. But at least 30% of the students do not thought that their understanding was supported. We also asked if the system distracts them more than it helps the understanding. More than

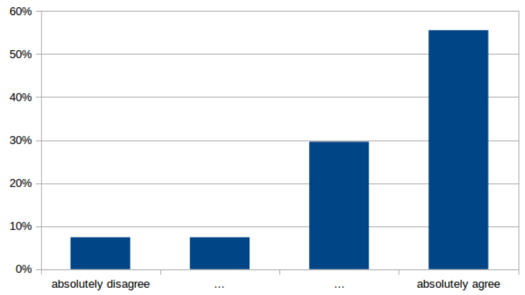

Figure 4: The new variation makes the course more interesting.

80% stated that they are not more distracted than it helps.

We asked if the variations in teaching scenarios which were possible with the new system increased the courses attractivity. The course lecturer performed at least five different scenarios during this semester. Figure 4 shows that more than 80% of the answers stated that these variations made the course more interesting.

When asked if the anonymous participation is important, 80% of the students agreed. Less than 20% slightly disagreed as shown in Figure 5. It is notable that the amount of *absolute agreement* is very high with about 60%.

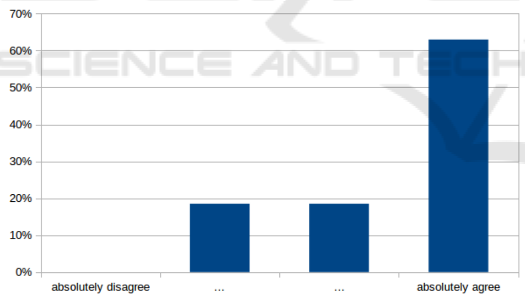

Figure 5: Importance of an anonymous quiz participation.

Figure 6 shows the results when the students were asked if they would accept to install software to participate in the quizzes. The answers were not as explicit as with the statements before, but about 60% of the students would not accept to install additional software. Only 10% stated that they *absolutely agree* to accept installing additional software on their phone.

We also asked if they wanted to be graded with the help of these quizzes. Figure 7 shows that almost 80% *disagree* with that and almost 50% even *absolutely disagree*. Finally, we gave space for a free textual comments. The student especially noted that the stability of the system has a high priority for them.

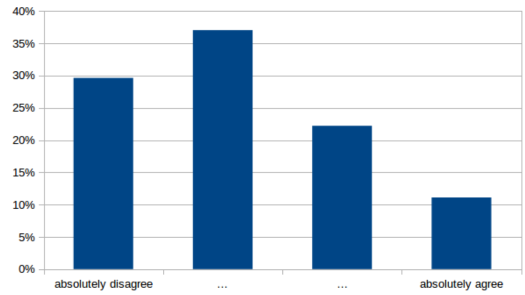

Figure 6: Acceptance of installing a separate software.

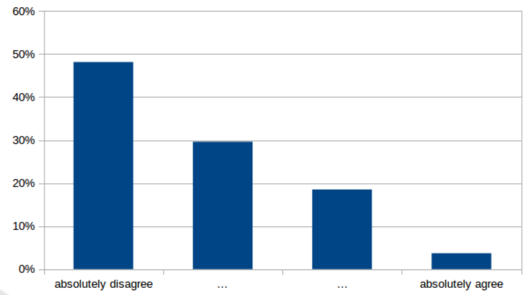

Figure 7: Acceptance of being graded by the system.

5.2 Lecturers

We asked six lecturers from different disciplines to give us a qualitative feedback. Two of them had an informatics background, the others came from didactics, mathematics and economics. They stated that they are very committed to their teaching (with one saying he or she is only slightly committed).

Not every lecturer had used the quiz in the past semester, even if every one of them showed high interest in the system and took part in a personal introduction. When asked for the reasons, the answers were mainly that they had time constraints during this phase of the semester, and that the current course concept does not include the quizzes yet. But they are looking forward to the next semester, where they have the semester break to prepare the next courses.

When asked how the students could benefit from the customized scenarios, the answers were similar to the benefits of regular ARSs. They mentioned the students' reflection of their own learning process and the lecturer's insight into the students' knowledge base.

All lecturers said that the application can be used without further support after an introduction, but the greater challenges are getting all the students to participate, the creation of suitable and wise quiz questions, and the design of good teaching scenarios.

Considering recommendations for improvements, the lecturers want a better usability and overall stability of the system to support larger user groups. They also would like to have more predefined blueprints of teaching scenarios.

6 DISCUSSION

The results in Section 5 give an impression about students' and lecturers' priorities. Despite appreciating the new variations in teaching scenarios, both groups have concerns. Students like the current quizzes and think that they do support their learning process, but they do not want to be graded with these quizzes, and they want to participate anonymously. These findings support the initial didactic focus of the tool: students should be able to apply knowledge in an active way within their learning process, and lecturers should thereby be able to identify gaps in understanding. A non-anonymous or even graded usage would lead to pressure to perform well already during the learning process. Consequently, only smart students would give answers and therefore make a realistic analysis of the students' understanding impossible. Weaker students would hold off and thus would not benefit from the potentials of the tool to identify strengths and weaknesses in the learning process. Nevertheless, there could be additional reasons why students refuse to be graded by the ARS system: maybe they fear the system's sensitivity for manipulation, or they prefer assessment formats where they can demonstrate their knowledge in more than, e. g., one multiple choice answer (and the input of a longer free text answer on a mobile device is very uncomfortable). Further research needs to be done to identify the concrete reasons. The questioned lecturers enjoy the new application and think it is easy to use after having an introduction. Nonetheless, only a few lecturers already use the system and found the time to create suitable content and to integrate it into their current courses. Many of the more complex scenarios were created and used by one lecturer. Others mostly hold with already known questioning scenarios.

One conclusion could be that the system is still too complex to easily be used by lecturers on their own, even after an introduction. The improvement to an even more intuitive usability and the offer of a permanent didactic support could help to overcome these challenges. Didactic support is also crucial to solve the problems of getting students to participate, of creating suitable and wise quiz questions and of designing other good teaching scenarios. Concerning the latter, one advantage of the system lies in the possibility to access teaching scenarios that were created by other lecturers. Thereby, teachers can get inspirations for their own courses. As expected, all lecturers that answered the survey described themselves as committed to teaching. A conclusion could be that these teachers are more open to innovations in teaching, and more experimental in using new tools. To widely spread the usage of innovations in teaching, another challenge would be to convince less committed lecturers. To achieve this, convincing arguments and a user-friendly interface are essential.

7 CONCLUSIONS

The evaluation showed that our five-phase model is able to depict customized teaching scenarios in a suitable way. Our application is able to perform a variety of different moderate to complex scenarios in lectures with up to seventy students. But when performing very complex scenarios with a large number of rules and more than one hundred students, we observed serious performance issues. One reason probably is the old desktop PC where the application server runs, but the described model also encourages a high number of database entries.

One could think that the students' acceptance of ARS tools is a short-term effect that vanishes as soon as ARSs become ordinary and therefore boring. In contrast, with the novel *MobileQuiz2* , lecturers have so many possibilities to vary and differently use the tool that a 'system fatigue' seems to be hardly possible. But the possibility to create customized teaching scenarios implies that lecturers have a fundamental knowledge in the field of instructional design. Furthermore, it requires a reasonable amount of creativity and audacity, as lecturers state they want to have more predefined scenario blueprints to choose from. So, although our system offers various opportunities to improve the student's learning, using it in a didactically reasonable way faces the lecturers with noticeable challenges. We conclude that offering didactic support and qualification is essential for a successful application.

We now trained about twenty lecturers in the usage of the *MobileQuiz2* , and many of them want to use the system in the next Spring semester. Therefore, we focus on further polishing our prototype for a smooth operation and will add some minor functionalities and connections to our older quiz applications. With the increasing number of active users, we want to evaluate the effects of different scenarios on the students more thoroughly and analyze the key success factors of ARS and their impact.

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