BROWSER-BASED MOBILE CLICKERS: IMPLEMENTATION AND CHALLENGES

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ABSTRACT

Didactic strategies in the classroom are influenced by factors like class size, prior class knowledge and level of class attention. In large classes, student activation has to follow different didactic approaches in order to obtain ad-hoc feedback from individual students than in small classes. One approach to increase class attention are classroom voting tools (known from quiz show formats for real-time audience feedback) that provide the teacher with feedback about the students' prior knowledge and learning progress. Additionally, feedback and attention increasing systems seem to be essential within spatially distributed classes (following the lecturer via web streaming), due to the fact that two-way communication is limited in these cases.
Supporting the demanded didactic functions, we developed a browser-based mobile clicker application within Learn@WU, the large-scale online learning environment of the WU (Vienna University of Economics and Business). We introduced and evaluated the application in lectures of the introductory study period. The integration into the established online environment shall support teacher acceptance and usability.

KEYWORDS

Mobile learning, classroom response system, activation, student feedback, mobile clicker.

1. INTRODUCTION

Since the first decade of the 21st century, universities in Austria have been facing the challenge of stagnant budgets, paired with an increasing number of freshmen students each academic year (OECD, 2011). University access is mostly free in Austria, meaning that in most cases no tuition has to be paid by students, and every student with a high school degree can start to study without having to pass any selection criteria in most faculties.

This situation has led to the demand to offer economically effective studies. E-learning facilities have been gaining increasing importance in order to support the learners in the learning process (Cross, 2004). Furthermore, especially in the first year of study, most lectures are held for large audiences. Universities have started to introduce live broadcasting to multiple lecture halls, and to provide live streaming on the Internet and lecture recording to be able to serve the students (Lorenz, 2011). However, one drawback is that feedback from a high number of (remote) students is hard to obtain without technical support.

Interactive elements in the classroom have the potential for critical reflections about newly learned topics (Draper et al., 2002). One approach to increase class attention are classroom voting tools (also known as clicker systems, classroom performance systems, audience/classroom response system, personal response system and other synonyms). Clicker systems are mostly known for their applications in quiz show formats to obtain real-time audience feedback. Applications in an educational environment were introduced by Harden et al. (1968) and Dunn (1969) in 1968 with machine readable paper based cards (see also Elliot, 2003). Draper et al. (2002) define the following didactic reasons for using clicker systems:

1. Formative feedback on learning within a class (i.e. within a contact period)
2. Formative feedback to the teacher on the teaching (i.e. "course feedback")
3. Peer assessment which can be done on the spot
4. Community mutual awareness building
5. Experiments using human responses
6. Initiation of discussions using the equipment

Furthermore, the usage of clicker systems in the classroom might enhance the motivation of the students (Deci et al., 1996; Perry et al., 2002). It is well known that motivation plays an important role in the learning process (Pintrich, 2003). However, as shall be discussed in the next section, conventional clicker systems bear some drawbacks, particularly when they are used in large classes.

At the same time, it is noted that in recent years, market penetration of mobile devices (i.e. smart-phones, tablets, netbooks or laptops) has strongly increased. Ebner et al. (2008) found that already in 2008, 80% of students at the University of Technology Graz (Austria) possessed a laptop. The Mobile Marketing Association Austria (2011) reports that in 2011, 56% of the Austrian population possess a smart-phone, a plus of 25% regarding 2010. Furthermore, 10% of the population report to use a tablet computer. These numbers point to a wide distribution of mobile devices and to an increasing dissemination of such devices.

2. PROBLEM STATEMENT AND PROPOSED SOLUTION

Conventional technical solutions for clicker systems comprise radio or infrared based transmitters and hand held receivers. However, these solutions require a specific hardware infrastructure and cannot be used for spatially distributed classes. Additionally, many radio transmitting products contradict the Austrian law due to the regulation of used radio frequencies. Furthermore, universities with large cohorts of students especially within spatially distributed classes might not be able to provide the demanded infrastructure.

Therefore, a new solution is proposed and presented in this paper. It is supposed to incorporate the advantages of a clicker system, a browser-based e-learning environment and a mobile device. Such a browser-based mobile clicker system, i.e. a system which can be operated platform-independently with mobile devices, is supposed to fulfill the didactic demand for interaction with remote students, and therefore adding a seventh didactic reason to Draper et al.'s list for using clicker systems:

7. Formative interaction with spatially distributed classes in live lectures

We are developing this browser-based, mobile clicker system to didactically support the teaching in large local as well as spatially distributed classes as follows:

- two-way and spatially distributed communication
- structured and unstructured, open questions
- ad-hoc and predefined questions from the teacher
- combination of students' answers with the grading scheme
- feedback to the lecturer about the crucial didactic parts of his lecture
- evaluation of the response data for further learning behavior studies, and
- easy deployment without the need of purchasing and distributing specific clicker devices.

Furthermore, the development of a browser-based, mobile clicker system is based on the following assumptions:

Firstly, a browser-based mobile clicker system enables a teacher to communicate with a large audience, in a location-independent way. This potential can be used both for large classes and for live streamed lectures within spatially distributed classrooms. By using their mobile devices, spatially distributed students can give instant feedback to polls triggered by the teacher.

Secondly, a browser-based mobile clicker system is well suited for integration into existing e-learning platforms. The setup of the clicker polls as well as the analysis of the poll results can be managed seamlessly through the e-learning platform. The results can be used for further purposes like grading and analysis of the learner activation. By integrating the system into an existing e-learning platform, the environment is familiar to the lecturer and the students, and therefore the acceptance and usability of the mobile clicker solution is believed to be high.

Finally, a central goal of the project is to develop a platform-independent tool which can be operated via any Internet-enabled device. No costs for handheld receivers need to be calculated due to the high penetration rate of student owned mobile devices.

3. IMPLEMENTATION

The technical implementation was realized in the e-learning environment Learn@WU. The e-learning environment is institutionally offered by the WU (Vienna University of Economics and Business) to enable teachers and students to collaborate online. The platform is accessed via a web browser, from within or outside the university premises. One of the characteristics of the platform is that practically all page views are generated dynamically. This fact allows us to personalize every page and to adjust its presentation according to the client devices. Therefore, it is straightforward to provide tailored interfaces for users navigating with, e.g., mobile devices. For the mobile façade of the clicker application, we decided to use the JavaScript library jQuery Mobile (Reid, 2011).

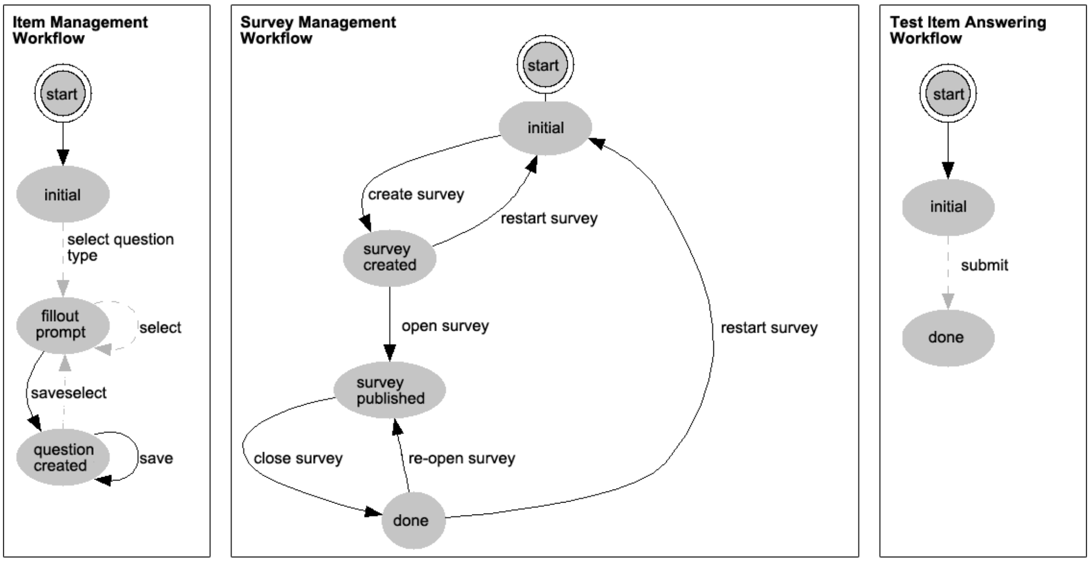

Figure 1. Item Management (left), Survey Management (middle) and Test Item Answering (right) Workflows

The clicker application was developed over the XoWiki Content Flow (Neumann, 2008) package, which is an extension of the XoWiki Framework (Neumann, 2007). The XoWiki Framework is a wiki based content management system providing revisioning over structured and unstructured content fields. This way XoWiki is capable to provide a text based interface for wiki-like applications as well as a form based interface of structured content (or a mixture of both). The Content Flow package extends XoWiki by managing state changes of content objects via a set of transitions. The basic mechanism follows the State Design Pattern (Gamma et al., 1994). Typically, in different states, different content is presented to the user. Furthermore, in every state, it is well possible to present different content to different kinds of users. Per state, the valid transitions are offered to the user via potentially multiple submit buttons. Using this mechanism, one can define various kinds of workflows, like, for instance, for filling in questionnaires with multiple forms, for providing various kinds of individual feedback and for defining online exercises or exams.

In our project, we defined three workflows based on XoWiki Content flow:

- Item management workflow: create, publish and unpublish test items (questions).
- Survey management workflow: create, publish and unpublish surveys (polls).
- Test item answering workflow: collect answers from the survey participants.

Figure 1 shows the workflows with their state transitions. The graph on the left shows the possible state transitions of the item management workflow, the graph in the middle shows the state transitions of the survey management workflow, and the graph on the right shows the state transitions of the test item answering workflow. The first two workflows define the interactions of the lecturer, the third one is for the participants. From a user's perspective, a lecturer has to perform two tasks to run a clicker poll.

A) Definition of test items

A1. The teacher can select a type of question from a predefined set of templates via a web interface.

A2. In a second step, the teacher can fill in a title, the question and prompt, and the text for the alternatives. It was a design goal that the definition and editing of test items should be achieved without technical knowledge and without any kind of external tools. The typical question types for mobile devices are quite simple and return only responses to a single variable. Therefore, this is well suited for summarizing the results later with a single tool.

B) Publishing of the poll

B1. The teacher selects a question from the defined test items and publishes it as a poll to the members of the class: in this state the students of the class are informed about the pending poll via a highlighted button in the banner of every page. By clicking on a single button, the students can open the poll (Figure 2). Every student can provide only a single response to a poll.

B2. To unpublish the poll, the teacher might close the poll at any time. Once the poll is unpublished, the students can no longer provide answers. In this state the poll is presented to the teacher with a pie chart diagram in the browser (Figure 3).

4. PILOT STUDY

A pilot study was undertaken to test the mobile clicker application. The pilot study was realized in the "Introduction to Finance" course at the WU. A total of 174 students was subscribed to this course which is held parallel to seven other "Introduction to Finance" courses at the WU. As with all courses at the WU, the course is supported by the online learning environment Learn@WU, where several applications like multiple choice questions, forums, automated and home exercises with random numbers, sample tests, a glossary and additional download material, are implemented.

The lecture of the pilot study was attended by 118 students. The pilot study was conducted in one lecture hall without broadcasting, and thus no remote students took part in this lecture. The students were informed in advance by email about the study and they were invited to bring their mobile devices to the lecture. The pilot study consisted of 2 clicker polls which were published consecutively during the lecture. The first clicker poll was a yes/no poll to check the technical functionality of the system ("Are you able to answer the question via the clicker poll?"), whereas the second clicker poll contained a five-category single-choice question which was subject related to the Introduction-to-Finance course. It gave the lecturer and the students feedback about their learning progress.

To investigate how the clicker application worked in the class context, a mixed methods design (Creswell & Plano Clark, 2006) was applied in the pilot study, consisting of qualitative and quantitative data collection. To gain qualitative insights, participant observation was carried out during the lecture. According to Jorgensen (1989), participant observation is particularly appropriate, among others, for explorative studies and for studies where participants can be observed in everyday life settings. A group of 5 researchers was in the lecture hall to observe the students' behavior and to conduct an observation protocol. To gain quantitative insights, a paper-based questionnaire was handed out to the students after the lecture. The questionnaire comprised questions about the mobile devices used as well as the usability and satisfaction with the clicker application.

Figure 2. Mobile e-learning interface showing a pending poll (left) and clicker poll interface (right).

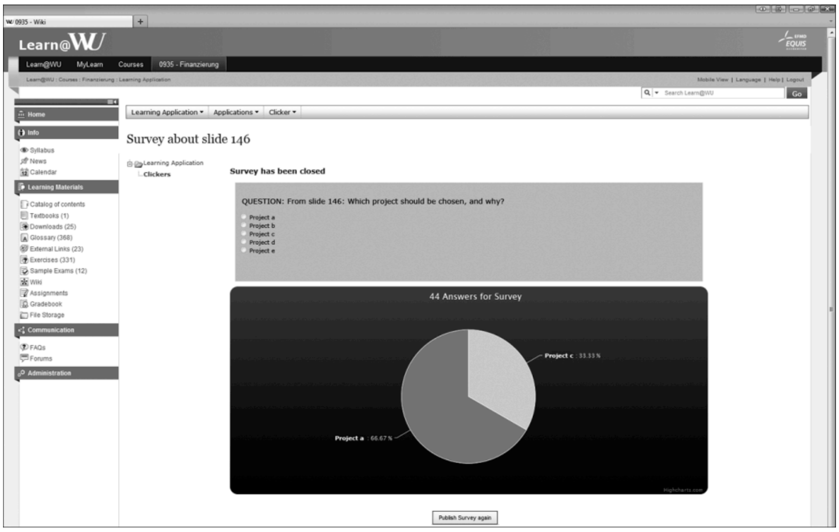

Figure 3. Clicker poll result pie chart in web based e-learning environment.

5. RESULTS

5.1 Results of participant observation

The first clicker poll consisted of a question to check whether the students were able to use the clicker application. The poll was open for submission for five minutes. In this period it was answered by 28 students (24% of participants), where 19 students responded within the first 2 minutes. The second clicker poll comprised a question related to the lecture content. It was open for submission for about 10 minutes, and 42 students (36%) answered.

It was observed that some students had problems connecting to the Internet or loading the website (this experiment was the first time the students had contact with the system). Furthermore, it was observed that some students (n=8) continued clicking on their smart-phones after the poll was over. Although no detailed information was available about what exactly the students were doing, the observers noted that on most smart-phones, Facebook was opened. However, about 30 minutes later, no student was using his smart-phone any more.

In the second half of the lecture, and thus after the clicker polls, a higher amount of student questions regarding the lecture content than usual was observed. This might be an indication that a clicker poll plays an activating role in a lecture. However, more data need to be collected to be able to confirm this observation.

5.2 Results of questionnaire

The paper questionnaire was completed by 76 students (64% of the students in the lecture hall). Participating in the questionnaire was voluntary; 36% of students did not fill in the questionnaire. One reason for this might be that this student cohort had another lecture subsequent to the test lecture and might therefore have had to leave quickly. Thus, future test settings will be planned in a way that the questionnaire is distributed earlier in the lecture.

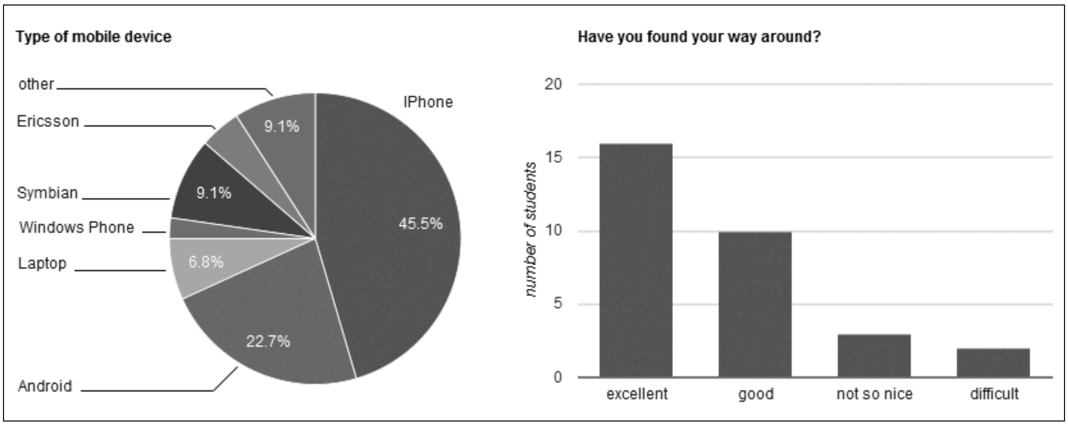

Figure 4. Questionnaire result about mobile device usage for the clicker polls (left side) and ease of use of clicker application (right side); n=31

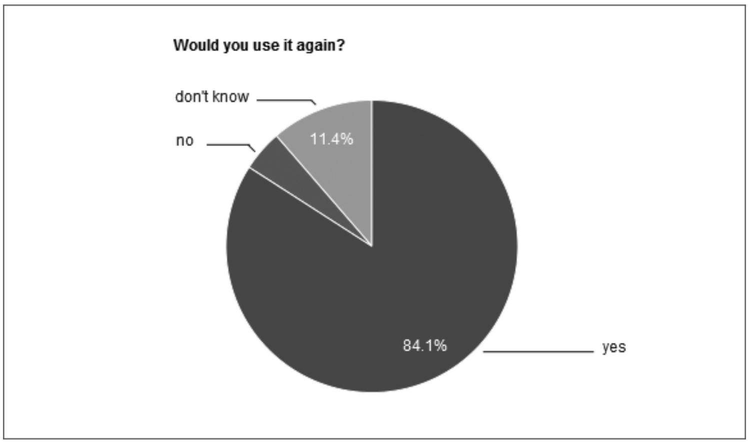

Figure 5. Questionnaire result about students' wish to use clicker application again (n=44)

The sample contained 36 male students, 35 female students and 3 students who did not specify their gender. Student's age was between 19 and 26 years. Among the respondents, 31 students reported to have participated in the clicker poll, 45 students did not. Major hindrances included the website loading too slowly (n=8), the Internet connection not being available or not working (n=12), and not being equipped with a mobile device (n=14). Only a small number of students (n=3) reported to have difficulties with the user interface.

A broad variety of mobile devices was used to participate in the clicker poll, as is shown in Figure 4, and over 90% of the devices were smart-phones. Those students who did participate in the questionnaire reported that they found the clicker application excellent (n=16) or good (n=10) to use. Only 5 students found the application to be not so nice or difficult to use. Figure 4 shows these results.

Although only 31 respondents of the questionnaire participated in the clicker poll, 37 students reported that they would like to use the clicker application again in a lecture, as is shown in Figure 5. Only 5 respondents were unsure about re-using it, and 2 students would not like to use the clicker application again. All the other students (non-participants to the clicker poll) did not answer this question.

6. DISCUSSION AND FIRST LESSONS LEARNED

According to the demand for live communication with large audiences, mobile devices show high potential to reach the students in live lectures.

The integration of a mobile clicker system into the existing e-learning platform regarding the initial assumptions worked generally well in the test setting. With the e-learning platform Learn@WU, an example was shown about a browser-based mobile clicker system being integrated into an existing e-learning platform. The lecturer was able to set up the clicker poll and present the poll results through the browser interface. However, it was noted in the pilot study that, although the lecturer was familiar with the e-learning platform, he had to carefully think about how to publish and unpublish the clicker poll, and how to show the poll results to the audience. Thus, it can be assumed that some adaptation time is needed in order to get familiar with the application.

The results of the pilot study support our assumption that the usage of an e-learning environment which is familiar to the students helps them to navigate quite easily through the clicker poll and to answer the stated question with the help of their mobile device. Indeed, most students reported to find their way easily through the application (see Figure 4)

The results of the pilot study indicate that the initial goal to provide a platform-independent clicker solution can be fulfilled. Figure 4 shows that the students accessed the clicker application with a variety of devices and operating systems. While platform-independence is a positive aspect, improvement is needed to reach more students through the clicker application in the future. Although it can be assumed that most students possess laptops, as Ebner et al. (2008) report, many seem not to bring their devices to the lectures. At the same time, although the penetration of smart-phones is strongly increasing in Austria, a significant percentage of students does not possess a smart-phone yet. One of the next steps in the mobile clicker project will therefore be to motivate more students to bring their alternative mobile devices, i.e. laptops, netbooks or tablets, to the lectures. Additionally, the smart-phone penetration rate should be monitored over the next semesters.

Building up on the implementation and the findings of the pilot study, some points for further research and next steps are suggested. Firstly, usability tests with teachers and students should be conducted to optimize the user interfaces. Although learning advances within classical clicker environments are highly investigated, usability issues regarding clickers are discussed less intensively in academia. However, usability is crucial within mobile and large lecture environments, because both the lecturer and the student attention on technical issues have to be minimized.

Secondly, the potential of gaining student feedback in a device independent way and from remote students should be investigated in the next step. A pretest of the mobile clicker application in a spatially distributed class should be conducted.

Thirdly, it should be investigated to what extent different question types can be handled easily in a mobile clicker application. While a conventional clicker system is able to handle only, for instance, up to four single-choice answers, a web based mobile clicker system could support various kinds of interaction types.

7. CONCLUSION

This paper described the implementation and pilot study of a mobile clicker system which is web based and accessible through the web with mobile devices. The advantages of such an approach were outlined. These include didactic advantages such as standardized communication with (or feedback from) spatially distributed classes as well as student activation and student performance testing like in traditional clicker systems. Furthermore, technical or usability advantages such as ubiquitous availability and platform independence of a web based system were discussed.

The implementation of the browser-based mobile clicker application was developed in the e-learning platform Learn@WU. Focus was laid on providing teachers with web-based interfaces for the management of questions and polls, and on providing students with interfaces suitable for mobile devices, specifically on the process that allows students to submit their answers to the published polls.

Additionally, we conducted a pilot study in a lecture with 118 students. The introduction of 2 clicker polls was accompanied by participant observation and a survey. The findings indicate that the mobile clicker poll is accessed with a variety of devices and therefore the promise of platform-independence can be held, and that through the application being based in the existing e-learning platform, the students quickly find their way through the poll. Although more systematic research would be needed, the participant observation in the pilot study indicated that students pose more content-related questions to the lecturer after a clicker poll.

However, it was also found that many students either do not posses or do not use their mobile devices in the lectures. The next steps therefore will address the motivation of more students to bring their mobile devices to the lecture. Nevertheless, the browser-based mobile clicker system is believed to be a valuable tool for activating students in large lecture halls.

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