DEVELOPMENT AND EVALUATION OF A CLASSROOM INTERACTION SYSTEM

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ABSTRACT

In order to reduce the passivity of students and enhance their learning experience in large lectures, we developed a browser-based tool called Classroom Interacter to promote classroom interaction. It allows students to use their own mobile devices to participate in the learning process. The main features of Classroom Interacter include live voting, status setting and question sending. The evaluation results showed that, students were satisfied with the usability and felt it was helpful for their study. Although distraction was reported by some students, the system received very positive evaluations. Most students showed their willingness to use Classroom Interacter in the future.

KEYWORDS

Classroom interaction, mobile device, voting, usability.

1. INTRODUCTION

Lectures are the most common form of teaching in universities. The typical features of lectures are large audience, lecturer-centered and little interaction. In such a lecture, only a few students actively participate in the lecture. Most students are passive absorbers of knowledge. Asking questions is the primary way to participate, while for different reasons, many students cannot ask their own questions in the classroom. Some students are too shy to ask questions. Some students view asking questions is a challenge to authority. Another situation is that the classroom is dominated by a few students who answer all the questions asked by the lecturer. In most lectures, only a few persons are involved. The majority of the students remain passive. According to the constructivist's perspective, however, learners construct their own knowledge and understanding, which requires active participation in the learning process (Rogoff, 1994).

How to promote the interaction between the lecturer and students and create an active classroom environment is an important research area in educational science. Numerous studies have suggested a variety of teaching strategies, such as collaborative learning, blended learning to foster students' engagement. While other scholars committed to developing new teaching tools to build dynamic classroom environment. CRS (classroom response system, also called audience response system, clickers, voting system or personal response system) is one of the most popular tools for engaging the students in large classrooms. Its first use can be traced back to the 1960's (Harden et al., 1968; Dunn, 1969). A number of studies (Mestre et al., 1997; Davis, 2003; Hall et al., 2002) have given positive evaluations towards CRS. Moreover, over the past decade, another tool for enhancing classroom communication called digital backchannel attracted the attention of scholars. It has been considered an effective assistance tool for classroom teaching (Du et al., 2012; Gehlen-Baum et al., 2011).

1.1 Classroom Response System

Studies about CRS using in educational settings appeared since the late 1960s (Harden et al., 1968; Dunn, 1969). A typical CRS includes a handheld transmitter that students use to send responses, a receiver that collects all the inputs and a computer runs a program to visualize the result. CRS is widely used in a variety of subjects (Caldwell, 2007). Studies (Mestre et al., 1997; Paschal, 2002; Stowell and Nelson, 2007) have proposed and verified pedagogical benefits that CRS can bring to classroom teaching. Most frequently reported benefits of CRS include improved classroom interaction, more active student participation and more enjoyable learning process. In addition, both instructors and students become more aware of the condition of the students' understanding.

However, traditional CRS requires specific hardware. Either institutes or students need to purchase these devices. Another significant problem is the overhead involved in distributing and collecting the handheld devices. Additionally, traditional CRS cannot meet the requirement of distributed classes.

With the popularity of mobile devices in universities, a new generation of CRS based on mobile devices and the Internet has been developed (Andergassen et al., 2012; Esponda, 2008). Related study (Bergstrom et al., 2011) showed that although the use of mobile CRS has its own challenges, there is no significant difference between mobile CRS and traditional CRS regarding the attitude of students' participation and learning outcomes.

1.2 Digital Backchannel

Digital backchannel is a non-primary communication channel between the speaker and the listeners, in which feedback is given to the speaker in unobtrusive ways (Du et al., 2012). It is software that allows students to contribute questions without interrupting the speaker. Audiences exchange their opinions during the lecture through a secondary, digital conversation. Studies found that many more questions were asked when equipped with digital backchannel (Gehlen-Baum et al., 2011; Bergstrom et al., 2011). Much higher levels of participation also observed in these studies.

However, Holzer et al. (2013) found that most questions contributed by digital backchannel were irrelevant to the lecture content. Bergstrom et al. (2011) and Holzer et al. (2013) reported the use of digital backchannel was limited by both software and hardware. Furthermore, Baron et al. (2016) reported that the presence of mobile phones in the class contributed to distraction.

1.3 Prototype of Classroom Interacter

According to a recent study (Van Eimeren and Frees, 2014) in 2014, 79.1% of German people who are older than 14 use the Internet. Among them, 100% of 14 to 19-year-old people and 99.4% of 20 to 29-year-old people are Internet users. 74% of people between 14 and 29 years old use laptops to access the Internet. While 81% of them use smart phones and 29% of them use tablets to surf the Internet.

In this study, we proposed and implemented a new classroom interaction system called Classroom Interacter. The aim of this system is to preserve the advantages of both CRS and digital backchannel and to avoid their drawbacks. Firstly, the system is based on browser and mobile devices. In order to provide users with an easy way to participate, we need to make full use of the advantages of widespread mobile devices and the campus wireless network. To use this browser based system, students only need to enter a domain name in their browsers. With this system, the lecturer can create polls any time during the lecture. Students send their answers anonymously through the Internet. Thus, a convenient classroom polling tool is provided and the shortcomings of traditional CRS are avoided. Moreover, according to the studies of digital backchannel, a function was implemented for students to send questions to the lecturer. As mentioned before, most questions contributed by digital backchannel are irrelevant to the lecture content. Distraction was also reported while using digital backchannel. Research (Lin et al., 2013) investigated the use of Twitter as backchannel in the classroom and argued that the predominant social use of Twitter by students limits its application in educational settings. We assume that the main benefit of backchannel is the increased questions during lectures. Thus, in our system, the interaction between students is cut off and the questions are sent directly to the teacher. Hopefully it can contribute more lecture-related questions and reduce the distraction. Lastly, we have implemented a student status feedback function. The lecturer can get a real time view of the understanding status of the whole class (the percentage of students who understand the lecture and the percentage of students who get problems). According to this view, the lecturer can adjust his or her lecture speed or content flexibly.

The contribution of Classroom Interacter to classroom learning is that both teacher and students can start an interaction conversation. The lecturer can start a live voting to interact with students while students can also send questions to the lecturer. The information flow in the classroom is not only from teacher to students, the reversed channel is also built up. The anonymous form of interaction can motivate students' participation (Ragan et al., 2014). And the view of student understanding status gives the teacher instant feedback of the whole class, provides him or her chances to adjust lecture speed and content.

2. IMPLEMENTATION

Classroom Interacter was implemented in an intelligent teaching system called "Intellichalk". Intellichalk is software we developed in order to enhance the classroom experience. The main idea of Intellichalk system is to re-produce the features of blackboard by using digital ink technology. The teacher and students may interact like using normal blackboard. Moreover, the digital blackboard is enhanced by multimedia technology and artificial intelligence, which makes it exceed the traditional blackboard in many ways. Figure 1 shows Intellichalk equipped in a multimedia classroom with four large screens. It gives the user infinite writing space.

Figure 1. Intellichalk equipped in an intelligent classroom

2.1 System Structure

The architecture of Classroom Interacter is shown in Figure 2. Students and teacher connect to the same server over the Internet. An information exchange mechanism was implemented on the server side to support classroom interactions. The system runs as a plug-in of Intellichalk. Only a browser is needed to use all the features of Classroom Interacter. Once connected to the server, students can send questions and update their status at any time during the lecture. The voting function can only be used when the lecturer starts a poll and the system is opened for submissions.

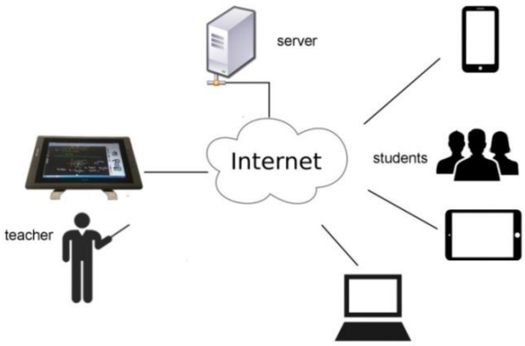

Figure 2. System structure of Classroom Interacter

2.2 Functions and User Interface

To start using Classroom Interacter, users only need to enter the server address on their browsers. When the page is loaded, users can use all the functions to interact with the teacher. The toolbar appears on the top of the webpage, as shown in Figure 3. Classroom Interacter has the following features:

Voting: When a vote is initiated by the teacher, voting button starts rotating. According to the type of question and the number of options set by the teacher, students can choose one of the options and send it to the server. Answers can be changed before the voting stops. After voting, the lecturer will get a statistical result of all responses (see Figure 4). It can be displayed on the screen in the form of bar chart, pie chart or table.

Student Status: Students may choose one of three different symbols to indicate their current understanding of the lecture. A green smiling face means "I can follow the lecture without difficulty". A yellow neutral face means "I can follow the lecture in general, although I have questions sometimes". And a red sad face means "I cannot follow the lecture". The teacher can see the statistical result of the whole class. Student status can be changed at any time to display users' real experience. According to this real-time classroom status, the lecturer may adjust his lecture speed or the form of teaching (see Figure 4). For example, if half of the students set their status as yellow or red, which means a number of students find it difficult to keep up with the lecture content, the teacher can choose to slow down lecture speed or start a poll to clarify students' problem. Or the teacher can start to answer the questions received from the students.

Question sending: Students can anonymously send questions to the teacher during lectures. In Intellichalk system, received questions are listed in an independent view. The teacher does not have to answer questions in real time, which may interrupt the lecture frequently. He or she can choose one of the three situations to answer questions: when an independent content is finished, when a certain percentage of students feel difficult to follow the lecture or when the same or similar questions are asked repeatedly.

With the use of these types of interaction, lecturers may form their own flexible teaching style. The passive classroom learning environment may be changed.

3. EVALUATION

3.1 Instrument

Classroom Interacter was developed to enhance the classroom interaction, change the passivity of students and create active classroom environment as well as support flexible teaching styles. Both observation and questionnaire method were adopted to investigate how the system worked in the class context. A 4-point Likert scale (4 = strongly agree and 1 = strongly disagree) was used in the questionnaire to collect quantitative data of users' attitude and satisfaction towards Classroom Interacter. The questionnaire was reviewed by two experienced professors before it was conducted. The Cronbach's alpha for this scale in the sample we studied was 0.80, indicating good reliability.

3.2 Participants

30 students from the course "functional programming" were invited to participate in the test. They are all undergraduate students majoring in computer science and have similar background knowledge. They were asked to bring their own mobile devices to participate in the test, which can be notebooks, tablets or smart phones.

3.3 Study Process

The test process was divided into three steps. First, a brief introduction about the Classroom Interacter was carried out (10 minutes). Then a professor gave a 60-minutes lecture about lambda calculus which would be taught in the functional programming course. During the lecture, participants were asked to vote twice. They could freely use the student status and question sending functions. After the lecture, they were requested to fill in a questionnaire about their experience of using the interaction system (20 minutes). It took about 90 minutes in total.

Two students were in the lecture hall to observe the students' behavior. The purpose of the observation is to find out whether the use of mobile devices distracts students' attention. At the same time, all interaction data were logged in the server for further analysis.

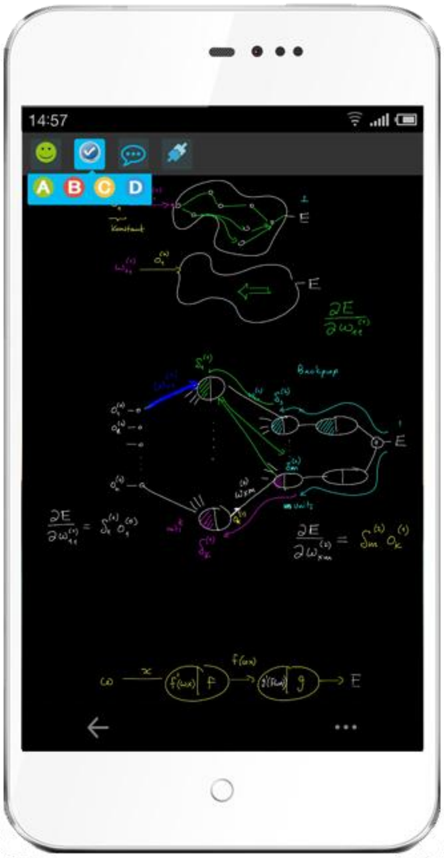

Figure 3. User interface of Classroom Interacter on student client

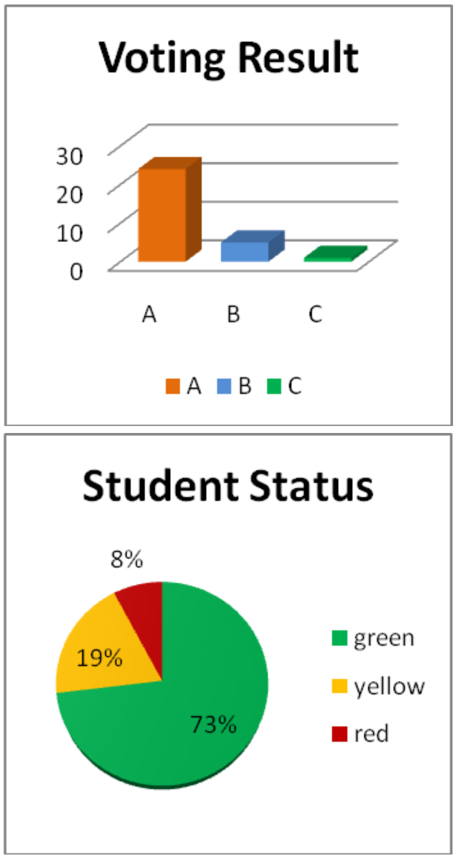

Figure 4. Voting result and student status on teacher client

4. RESULTS

The questionnaire was filled out by 28 students. But two of them were considered invalid due to incomplete answers. As we can see from table 1, students were satisfied with Classroom Interacter (overall mean = 3.32, SD = 0.79). Figure 5 shows that the Classroom Interacter system supports multi platform (windows mobile version was included in “Windows” category). Nearly all students strongly agreed (22, 85%) or agreed (3, 12%) that the system was easy to start (see Figure 6). Only one student expressed a different opinion. More than 88% of the participants felt it was easy to use the voting, student status and question sending functions (item 2, 3, 4). 85% of the students reported that after some practice, they could easily work on every function (item 5). We can see that the user interface of Classroom Interacter was highly appraised by the participants.

Regarding to the usefulness of Classroom Interacter (item 6, 7, 8), 92% of the students believed voting made them more aware of the condition of their understanding. Two polls during the lecture both got very height participation (24 and 25 students respectively). In the first voting, 67% of the students chose the right answer while 88% of them answered correctly in the second voting.

Student status function is a new idea we believe it may enhance the classroom experience. From the logged data, we calculated the overall status over time (see Figure 7). 142 status changes were detected during the one-hour lecture, 4.7 times per person on average. We can see that students were highly engaged.

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Table 1. Students' evaluation result of using Classroom Interacter

	4	3	2	1	Mean	SD
1. It is easy to start Classroom Interacter.	22 (85%)	3(12%)	1(4%)	0	3.81	0.49
2. The student status function is easy to use.	20 (77%)	4 (15%)	1 (4%)	1(4%)	3.65	0.75
3. The voting function is easy to use.	20 (77%)	5 (19%)	1 (4%)	0	3.73	0.53
4. The question sending function is easy to use.	16 (62%)	7 (27%)	3 (12%)	0	3.50	0.71
5. After some practices, I can easily work on every function.	16 (62%)	6 (23%)	4 (15%)	0	3.46	0.76
6. Live voting during lecture helps me know if I understand the course concepts.	11 (42%)	13 (50%)	2 (8%)	0	3.35	0.63
7. Using the student status function helps me get more feedback from the teacher.	7 (27%)	11 (42%)	7 (27%)	1 (4%)	2.92	0.85
8. Sending questions to the teacher helps me solve my problems.	10 (38%)	12 (46%)	3 (12%)	1(4%)	3.19	0.80
9. I would like to use the Classroom Interacter system in the future.	10 (38%)	14 (54%)	2 (8%)	0	3.31	0.62
10. Participation with the Classroom Interacter increases interaction with the instructor.	12 (46%)	13 (50%)	1 (4%)	0	3.42	0.58
11. Using digital devices during the lecture did not distract me.	8 (31%)	9 (35%)	7 (27%)	2 (8%)	2.88	0.95
12. Using the Classroom Interacter system made me more concentrated on lecture.	4 (15%)	12 (46%)	7 (27%)	3 (12%)	2.65	0.89
overall					3.32	0.79

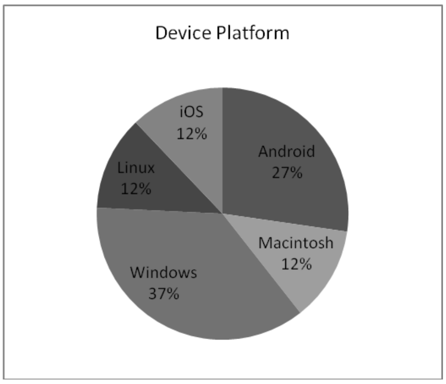

Figure 5. Platform distribution of connected devices

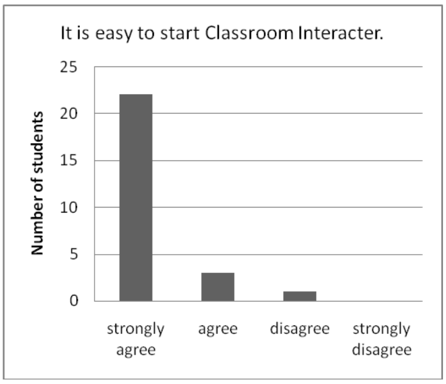

Figure 6. questionnaire result about ease of use

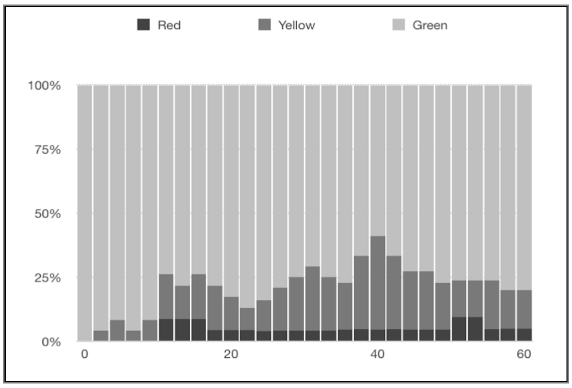

Figure 7. Student status change over time

According to the statistical result, most students (84%) also found sending questions to the lecturer could help their learning.

Students also showed their positive attitude towards further use of Classroom Interacter (Mean = 3.35, SD = 0.63). Only two students reported that they would not like to use it again.

Questions about concentration got lowest score in this investigation (item 11, 12). It was observed that some students (n > 5) open more than one Web page on their browsers and frequently switched between Classroom Interacter and other Web sites. It may explain why more than one third of the students (35%) reported they were distracted. Moreover, opinions diverged on the last question, 61% of the students felt the Classroom Interacter made them more concentrated on the lecture while others disagreed with them.

5. DISCUSSION

With the aim of changing the passive classroom learning environment and improving classroom interaction, we have designed and developed the Classroom Interacter. Our primary consideration is its ease of use. In order to facilitate user access, we adopted a browser-based structure. As can be seen from Figure 5, users could use Classroom Interacter through different devices and operating systems. The aim of cross-platform was achieved.

No need of installing and accessible with a variety of devices provides users with great convenience. Therefore, almost all (except one) users agreed Classroom Interacter was very easy to start (see Figure 6). Users also highly valued the usability of this system. The average scores about usability (item 1 - 5) are greater than 3.4. As for the teacher part, since the lecturer is familiar with Intellichalk, there was no problem encountered during the test.

Students believed that the Classroom Interacter system could help their learning, as we expected. They also thought it could increase their interaction with the lecturer. Voting function, among others, was considered the most helpful feature by students.

Figure 7 demonstrates that there were on average about 20% of the students set their status as yellow or red which means they were not fully understand the lecture. The highest point appeared at 40 minutes with 40% of the users marked non-green. But this ratio started to decline, we believed that was because the teacher began to answer questions sent by students. At the end of the lecture, around 20% of the students still had questions about the course content. There is no denying that there are always some students left with questions when the lecture is finished. But we have no idea how many of them have problems. Student status function gives the lecturer a general idea about this number. He or she can even ask students to set their status or start a poll to get a more accurate result at the end of the lecture.

Students contributed 15 questions during the lecture. 14 of them are related to lambda calculus. Interestingly, when the lecturer talked about the question Hilbert posed in 1900, "*Gibt es ein System von Axiomen, aus denen alle Gesetze der Mathematik mechanisch ableitbar sind?* ", she received several (n = 4) similar questions asking about the meaning of "*mechanisch*". It is an important question, but never been asked in the past functional programming courses. So we believe this function can really encourage students to ask questions.

Although users' perception of the usefulness is high, more feedback from the teacher is needed to motivate students to use the system. For example, using student status function cannot get feedback from the lecturer in a short time, so it got the lowest point compared to other functions.

We are pleased to see that almost all students have the willingness to use the Classroom Interacter system in the future.

Based on the work of (Ragan et al., 2014; Junco, 2012), classroom using of laptops has the potential to distract students' attention. Item 11 of table 1 has shown that one third of the class felt they were distracted by their mobile devices. But at the same time, more than half of the users reported that Classroom Interacter helped them focus on the lecture (item 12). It was also observed that during the last half of the lecture, some students stopped reading other Web sites. They left the Classroom Interacter open or half closed the cover of their laptops in order to eliminate further distraction and focus on the speech.

6. CONCLUSION

In order to provide an easy-to-use tool to promote classroom interaction, we developed a browser based classroom interaction system. It adopted strong points of both CRS and digital backchannel and made two-way interaction possible in the classroom. Both students and lecturers can start interactions through the system. Anonymous participation was employed to encourage students to use the system. The main features of the system were introduced, including live voting, understanding status setting and question sending.

A user test was conducted to investigate how the system worked in the class context. Both observation and questionnaire were applied. The test showed that Classroom Interacter was platform independent and the usability was highly valued by students. Students believed live voting was the most useful feature. From the experience of both teachers and students, the question sending function can effectively encourage students to ask lecture-related questions. Student status function gave the lecturer an overall view of the classroom understanding status. Although a number of students reported they were distracted by their mobile devices during the lecture, the system received very positive evaluations. Students also showed their willingness to use Classroom Interacter in the future.

Due to the small number of samples, no further statistical analysis of the data was carried out. The next step of this research is to systematically study the benefits which Classroom Interacter brings to classroom learning, including increased interactions and content-related questions. In addition, solutions to decrease distractions will be studied.

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