Mobile Phones in the Lecture Theatre - Using Wireless Technology as a Pedagogical Aid

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Abstract *— In most engineering colleges, giving lectures for 300 or 400 students is a practical necessity. Most lecture theatres are large and when filled up, they're intimidating to the average student and do not invite students to an active participation. They also restrict the teacher's opportunities to interact with the students. In this paper we describe a "proof-of-concept" system developed at Oslo University College that expoits the use of mobile phones in the lecture theatre to enhance teacher - student interaction and learning.*

Index Terms *— lecturing technique, mobile computing, wireless technology, pervasive teaching environment.*

MOBILE TECHNOLOGY AND LEARNING

The idea of incorporating mobile technology into the learning process is already an established thought [1, 2, 4, 5, 6, 7, 8, 9, 10, 12, 13, 14, 16, 17]. Universities and colleges worldwide have invested in wireless campus networks allowing students to work freely, anywhere, anytime.

Until recently, the main efforts in mobile learning have focussed on different ways of using laptop computers with wireless network connections [2, 3]. Students possess personal laptop computers that they carry around campus using them in the dormitory, the library etc for individual work, collaboration in groups or even to take notes electronically in the lecture theatre. However, laptop computers are large and cumbersome to carry and it takes some time to reactivate them once they are in sleep mode. Laptop computers therefore provide limited functionality.

Another technical innovation is the PDA [25], the personal digital assistant. PDA's are small and easy to transport and are to some extent a fashion accessory, but many students use PDA's for note taking during lectures. As it takes a very short time to start them up, PDAs are suitable for quick, urgent and impulsive actions. Still, not all students are in the possession of PDAs due to their relatively high cost. One level further down the device hierarchy is the mobile phone. The obvious advantages of mobile phones are their low price and wide availability. Nearly all students own a mobile phone, and they use them actively.

Mobile phones do have a potential as a pedagogical aid in learning. SMS (Short Messaging Service) has become a de-facto lightweight means of asynchronous communication among youths. Students can exchange meaningful and subject-related messages during and outside of lectures. For example, engineering degree programmes frequently rely on group work involving meetings. At Oslo University College students frequently negotiate meeting place and time for these meetings via SMS [24].

However, mobile phones are generally viewed as a nuisance in the context of lectures and classroom presentations. Incoming calls with loud annoying ring-tones and students rushing out of the room to answer the call frequently disturb and draw attention away from lectures. Even if a humorous ring-tone may lighten up a monotonous lecture, it generally distracts the focus away from the lecture. Worse are students playing games with their handsets during lectures. The overall common attitude among teaching staff is that mobile phones should be banned from classrooms and lectures. - So why then advocate the view that mobile phones may have a positive learning effect when used during lectures?

RATIONALE

Modern pedagogy clearly separates lecturing from learning; lecturing is a one-way communications situation - it's delivery of content. In spite of the fact that most teaching staff acknowledge that lectures don't necessarily assist learning, many engineering colleges are dependent on this form of teaching due to large student numbers and scarce resources; lecturing is not pedagogically optimal, it is a practical necessity. Most lecture theatres are large and may easily accommodate 300 - 400

students, and when filled up, they're intimidating to the average student and do not invite students to an active participation and communication with the teacher during the lecture.

At the Faculty of Engineering at Oslo University College 400 students are frequently served by one teacher. Our lecture facilities are organised into four adjacent lecture theatres each with a capacity of approximately 100 seats (see Figures 1 and 7). Each theatre is equipped with a projector connected to the teacher's computer. The four theatres are separated by removable walls, i.e. the rooms can be configured into four theatres with 100 students each, or 2 theatres with 200 students each, or with 100 students in one and 300 in the other or one theatre with the capacity of 400 students.

When the facilities are configured into four separate lecture theatres the lecturing environment is acceptable. A solid amount of teacher-student interaction can take place, and the teacher is free to use the blackboard instead of the projector providing a more relaxed means of presentation. But as soon as two or more theatres are joined together, the lecturing situation becomes drastically changed. The teacher no longer can rely on his or her own voice but is required to use either the stationary microphone positioned at the teacher's desk or a mobile wireless microphone. Secondly, the teacher is unable to use the blackboard efficiently since only the students in the same room are able to read it successfully. Thirdly, the teacher loses the vital visual contact with the students due to the distance and obstructing pillars (many students are situated behind the supporting-pillars in the lecture theatre). The lack of student contact reduces the quality of the lectures, as a good teacher relies on the body language and subtle cues from the students to adjust the delivery of the presentation. Consequently, teachers feel uncomfortable and the lectures become sub-optimal.

Obviously it is not only the teachers who find this environment problematic. Students in the adjacent lecture theatres have limited visual contact with the teacher and must rely on the projected screen and the amplified audio from the speakers. These students are unable to notice all the gestures of the teacher - gestures that intentionally or unintentionally might be essential for their comprehension of the material presented. Even more important, when sitting in a lecture theatre that is separated from the teacher's it is physically difficult for a student to ask questions and make comments underway simply because one is neither seen nor heard by fellow students and the teacher. The students who are in the teacher's field of view will often feel too intimidated to ask questions or comments simply because of the sheer number of students.

The problem we face at our faculty is simply: "How can the student-teacher interaction be improved in large lecture theatres?"

HOW TO TURN THE FORMAL LECTURE THEATRE INTO AN INTERACTIVE CLASSROOM

The current project attempts to address this problem, and our approach is to let the students use their mobile handsets to interact with the lecturer. The students log into the course web-site via their phones and access the appropriate software. The software allows the students to respond to polls, either planned or spontaneous, and make comments and ask questions anonymously in real-time. Comments and questions as well as poll results are displayed on the projected screen in the lecture theatres for everyone to see, and the teacher can therefore respond to the information appearing. For instance, the teacher may respond to a question asked by a student via the system. One apparent benefit is that even very humble and shy students can participate in the interaction anonymously. Another advantage is that both the students and the teacher have access to a log of the entire session, and the log can be studied after the lecture. The system can also be used to perform short in-class-examinations or tests with some degree of security.

In this paper we discuss a prototype system developed at the Faculty of Engineering, Oslo University College, that allows internet-enabled Java-phones to be used in lecture theatres as part of the teaching. The system is intended for very-large lecture theatres with more than 60 students, as such environments tend to be intimidating for students, resulting in less student-teacher interaction than what can be observed for smaller groups of students.

The current prototype has three main functions, a) performing real-time polls, i.e. the teacher can acquire the general opinion regarding various issues, or hold a quiz, b) the students can post requests or questions anonymously in real-time from the mobile handsets, and c) the students can send anonymous hints in real-time to the teacher, for example, that they do not understand a particular part of the lecture, that the teacher is advancing too quickly or speaks too loud. The information is assimilated by a server and accessed by a web-client and presented on a large projector screen in the lecture theatre that can be seen by both the students and the teacher.

WIRELESS TECHNOLOGY

As mobile phones and other portable devices are becoming more powerful with wireless internet connections and the ability to run custom wireless applications using Micro Java, they also become interesting from a pedagogical point of view. In only a few years most mobile phones will be equipped with these technologies and a majority of the students will be in the possession of such equipment.

Currently, most mobile phones on sale in Europe are internet enabled (GPRS) [19], and allow simple web-browsing of WML (Wireless Markup Language) and more recently XHTML-basic (Extended HyperText Markup Language) documents

[20]. Further, many handhelds come equipped with a Java virtual machine designed to run J2ME java programs [21]. The J2ME platform is a reduced version of standard Java. For example, only a subset of the standard libraries are available and there is no floating point number support. In addition J2ME comes with platform specific libraries designed for the limited user-interfaces and operating environments of the mobile handsets. In addition there are vendor specific libraries that allows the java programs to control model specific features such as vibration. Java programs for mobile phones - usually called MIDlets (Mobile Information Device) - can exploit basic internet connectivity, simple persistent storage known as records and simple mono and multicolour graphics. The advantage of MIDlets is that they can be designed to run on all Java-enabled mobile phones. All students with an Java-enabled phone should be able to run the programs irrespective of handset-model and manufacturer. Currently, the J2ME platform is predominantly used for games and entertainment.

THE GAMESHOW TEACHING SYSTEM - AN OVERVIEW

We have chosen to name our prototype teaching system the 'GameShow' with reference to the audience participation that can be observed in some television gameshows. The GameShow teaching system comprises three main parts – the students' phone-clients, the teacher's client and the server. Students possess internet and java-enabled mobile phones. Their handsets run instances of the GameShow mobile-client MIDlet software, communicating directly with the closest base-station operated by the mobile network operator. The mobile network provides a gateway to the Internet and thus the departmental Game Show application server. All the interactions are coordinated centrally by this server. At the front of the lecture theatre is the teacher's computer, either a stationary computer or a laptop computer connected to the projectors. This audio-visual setup is usually used for displaying PowerPoint presentations or perform other computer demonstrations. The lecturer accesses the teacher client using a standard web browser as the teaching portal has web-based interface.

The server

The server controls all the student-teacher interactions. Our prototype is implemented on the Java platform as a mixture of Servlets and JSP pages [22, 23]. A relational database (MySQL) is used for storing persistent data, for example prepared poll questions, poll results and entire lecturing sessions. The server is administered through a web interface using a standard HTML web browser, and the purpose built mobile client interacts with the server via the http-protocol.

The teacher client

A standard web browser is used for accessing the GameShow software. GameShow can be used by the students in a "live" mode during lectures, or in an "offline" mode during pre-lecture preparation or post-lecture analysis.

The teacher has the following options: 1. she can prepare general questions, requests and messages that she thinks the students would like to ask during the lecture. To pass the message or the question to the teacher, the student only has to activate the phone, look up the question or request she'd like to post and press the appropriate button. 2. she can prepare polls, quizzes or revision questions that the students will be asked to answer during the lecture. When the students have answered the quizzes, the statistics can be shown on the projected screen instantly (see Figure 5b).

To make modifications the teacher needs to be authenticated (see Figure 4). Teachers can register themselves. Once logged into the system the teacher is given a number of options (see Figure 5a).

If the teacher launches the "live" mode the web browser will allow incoming messages and gists to be displayed. The display is updated every 3 seconds, and the last 5 messages are always shown (see Figure 6a).

Using the questionnaire editor (see Figure 5c) the teacher also has the possibility of using a spontaneous generic test template to prepare poll questions and answer alternatives prior to the lecture. The questions are associated with a particular lecture and the teacher must specify for which lecture the questions are to be used. There are three templates - one for questions with two answer alternatives, another with three and one with four answer alternatives. The teacher client will in these instances only display the text "Select one of … ", and the question is spoken out orally by the teacher. The option "A", "B", "C" or "D" are displayed on the screen while the teacher speaks out what the letters "A", "B", "C" and "D" refer to.

The "perform poll" or "examination" function is activated from the main menu. This page displays a random security code (see Figure 6b) that is used by the students present in the lecture to post their answer. A continuously updated counter shows the number of replies received. The security code is only displayed when the teacher client is accessed from the designated computer in the lecture theatre or other authorised computers. The security code prevents external users from tampering with the voting results. External users, such as students at home, accessing the teacher client will not see the security code and hence are not able to cast a vote.

The poll runs for as long as the teacher desires and is stopped by the teacher. The results are shown on a summary page providing statistics, i.e. how many percent of the voters voted for the different options.

The students can also access the teacher's client in read-only mode, with no authentication required. Students unable to attend the lecture can then observe what is going on in the lecture remotely. Furthermore, after the lecture students have the possibility of revising questions that arose during the lecture.

The student client

The students' MIDlet application must be downloaded and set up prior to the lecture. This is only done once. The teacher will have to instruct the students to do so. The MIDlet is available from the departmental web pages, and the MIDlet is set up by registering the user the first time the MIDlet is run (see Figures 2a and 2c). The registration procedure consists of entering personal information (name etc) and select a password. Once the student is registered the student can log into the system using the chosen password for authentication (see Figure 3a).

The student is given four choices (see Figure 2b): 1) download the questions or quizzes for the lecture (see Figure 3b), 2) respond to a single question posted by the teacher (see Figure 3c), 3) send a question or a request to the teacher (see Figure 3d) or 4) log out. To download the questions the student must provide the security code. The single question function is chosen to access and respond to a single question posted by the teacher during the lecture. The send-question function is used by the student to post a request, a question or comment to the server. The request is subsequently displayed on the teacher client if it is in "live" mode. Currently, the students have to type their question or request, but future versions could also provide a list of preset comments, questions and iconic gists for commonly needed phrases to make the system more efficient to use.

FICTITIOUS GAMESHOW SCENARIOS

Emma is a second year computer science student doing a compulsory course in statistics. Consequently, the lecture hall is always full. Emma is a bright student but statistics is slightly outside her main field of study. One of her teachers, John, is a mathematician who loves the beauty of mathematics. One day John is covering the topic "analysis of variance" and is covering the theory behind this analysis technique. Towards the end of the lecture, John quickly summarises his main topic and moves on to the subject "two-factor anova". Emma notices that there is a change in topic but missed the conclusions, and felt that John did not cover the applications of the technique properly. She then retrieves her mobile phone, logs into the system via the MIDlet and selects the "send-question" option. She enters the question "Can u rep conclusion, plx" and presses submit. Two seconds later the text appears on the projected screen and on the console in front of the teacher. John does not notice it immediately, but 15 seconds later he sees the message. In the mean time additional messages of support have arrived from other students - "Agree, don't understand a thing". John gets the point and goes back to the conclusion to give it a more in-depth revision.

Birger is a computer science lecturer teaching computer security for a class of 170 students. Towards the end of the course he is teaching biometrics. He is curious about what the students think about the future of biometrics. He therefore asks the students the question "Will biometrics become commercially viable? select A for yes, and B for no!". Then he selects the 2-question-template question from the console and starts the poll. He tells the students to start. It takes about 10 seconds for the students to retrieve their mobile phones from their pockets, log into the system and locate the question. Then the replies arrive. After about 40 seconds he sees that 140 students have cast their vote and he also notices that not all the students have brought their mobile phones. He therefore concludes the poll and displays the results. 63% of the students thinks that biometrics will take off while 37% of the students are sceptical.

The results of the poll have potential for further follow-up by John, which he will of course consider at leisure in his office. But it's obvious that the use of the mobile phone has increased student participation and also given John ideas of how to follow up the activities during the lecture so as to increase the students' learning.

PRACTICAL DIFFICULTIES

A number of factors have prevented us from deploying the system with large groups of students. Firstly, the mobile coverage in the lecture theatre is poor due to the shielding of the thick walls and the distance to the closest mobile base station. Secondly, a single base station may not be able to reliably handle the traffic from 400 mobile users simultaneously. Thirdly, although the technology is available, only a minority of students have already invested in the new mobile-technology. Finally, it is currently not trivial to configure internet enabled phones so they can use the internet.

Computer students should be able to perform such a configuration quite easily, but less computer literate students from other departments may have problems doing so. However, it is just a matter of time before such technology is commonly available and in common use. Moreover, base stations are gradually becoming more powerful and more numerous in inner-city areas and should shortly be able to handle a large volume of low-intensity traffic, i.e. the packets transmitted by the student's GRPS handsets. Another possibility is the use of the schools own WLAN or Bluetooth. There are a number of competing, complementing, exciting and promising technologies on the advance.

CONCLUSIONS

An experimental “proof-of-concept” system - the GameShow - was introduced. The system was designed to strengthen the student-teacher interaction during large class lectures by the means of commodity mobile phones. The implementation of this or similar systems may change our view on mobile phones and their potential as pedagogical aids. Further development of the technology and its infrastructure along with further testing with regard to its pedagogical aspects may in the future give academia a new learning aid. The system can be freely downloaded from [4].

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TABLES AND FIGURES

FIGURE 1:
THE LAYOUT OF THE LECTURE THEATRE(S) AT OSLO UNIVERSITY COLLEGE.

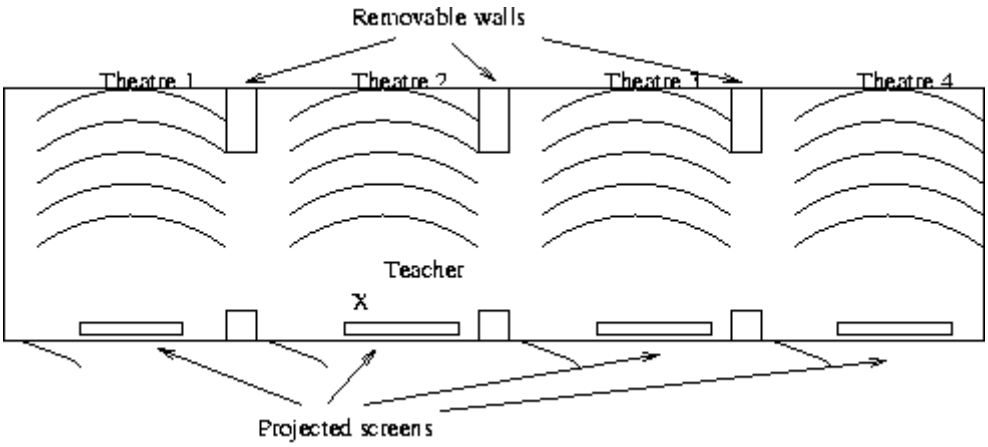


FIGURE 2:
THE STUDENTS' CLIENT

a) Splash screen b) Main menu c) User administration d) choisng a prepared comment.

FIGURE 3:
THE STUDENTS' CLIENT

a) Student logging into the system.

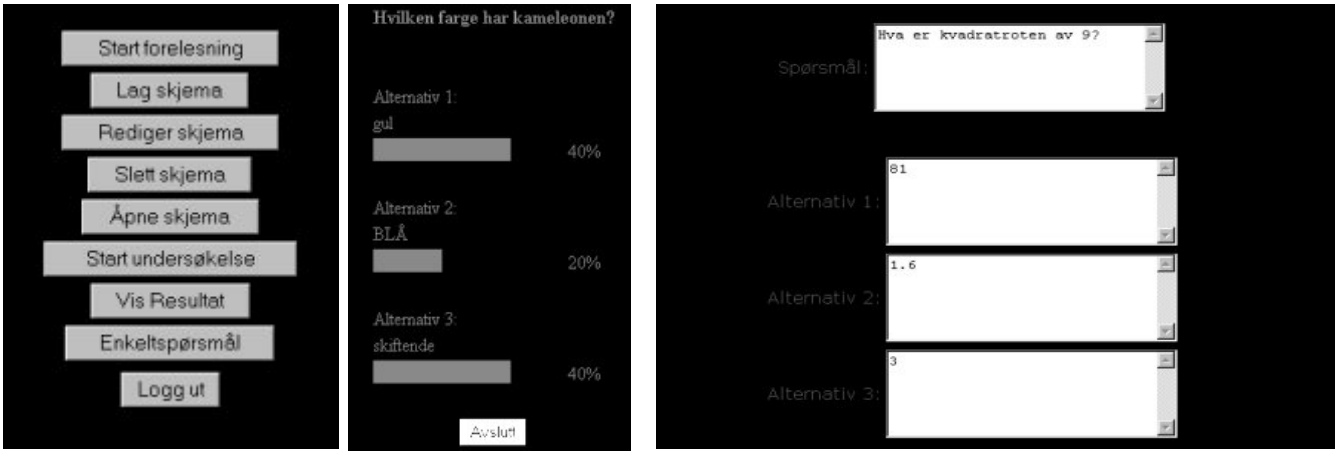
b) Student retrieving questionnaire

c) Student responding to a question.

d) Student entering a request to the teacher.

FIGURE 4:
THE LOGIN SCREEN FOR THE TEACHERS' CLIENT

FIGURE 5:
THE TEACHERS' CLIENT



a) Main menu

b) Statistical quiz results

c) Authoring questionnaires

FIGURE 6:
THE TEACHERS' CLIENT

a) Live mode – students' comments

b) Security access code displayed in the lecture theatre

FIGURE 7:
THE FOUR LECTURE THEATRES OF THE FACULTY OF ENGINEERING AT OSLO UNIVERSITY COLLEGE