THE INTERACTIVE LECTURE

A new Teaching Paradigm based on Ubiquitous Computing

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Abstract: In this paper we present a new teaching paradigm based on ubiquitous computing, which we call the Interactive Lecture. It specifically supports situations where the interactivity between students and lecturer is usually limited, such as lectures with a large number of students, or teleteaching scenarios. In an Interactive Lecture each student is equipped with a handheld computer. These computers connect to the computer of the lecturer via wireless communication. Interactivity between students and lecturer is then increased by a number of services. Examples for these services are online-feedback which enables students to give immediate feedback about the lecture (e.g., about its speed and difficulty) and online-quizzes were all students participate in solving problems described by the lecturer. We have developed a first prototype of the software and performed a thorough evaluation during a graduate course. The results of this evaluation indicate that interactivity was increased significantly and that the students were very enthusiastic about participating in Interactive Lectures.

1. THE INTERACTIVE LECTURE

The main goal of the Interactive Lecture is to create a new channel of communication between teacher and students. This channel is intended to allow new forms of interaction, which we call *interactive services*. For example, one service could be the ability of students to ask questions anytime without disturbing the general flow of the lecture. Another service allows them to continuously provide feedback about certain aspects of the lecture, such as speed and difficulty. The lecturer, on the other hand, is able to distribute additional information to the students or to provide them with short exercises by means of appropriate services.

In an Interactive Lecture all students are equipped with handheld computers like PocketPCs or Palm PDAs. These devices are easy to be carried along, and they do not obstruct regular classroom communication. The students' devices are connected to a central server by wireless communication such as Bluetooth or WaveLAN (IEEE 802.11).

1.1. WILD System Architecture

As can be seen in Figure 1, our software system to run the Interactive Lecture is designed as a classical client/server application. As the central part of the architecture, the server provides the fundamental functionality: connection management, user management and service management. *Connection management* establishes connections to the clients upon request, processes incoming and outgoing data and monitors the registered connections for broken links. *User management* identifies individual users via password and stores personal information for internal and external use. *Service management* dynamically loads a requested number of plug-in service modules, informs clients about the availability of certain services and controls the data flow between the services, within the server structure itself and between clients.

The services provide the actual functionality that is visible to the users. Services are built as independent modules that are loaded by the server at start-up time.

The client for the lecturer runs on a machine typically connected to the server via a wired network. This client is specifically designed to match the higher functionality that is needed to operate the Interactive Lecture, e.g., activating quiz rounds or answering questions asked by

students. All other clients use the wireless LAN to connect to the server. They are designed as a single homogeneous software tool that is able to operate all services that are available in a particular scenario.

By using an interface program it is also possible to connect a server to an external application. For example, we have conducted first experiments to attach a shared whiteboard system to the server in order to provide a unified user interface for both systems.

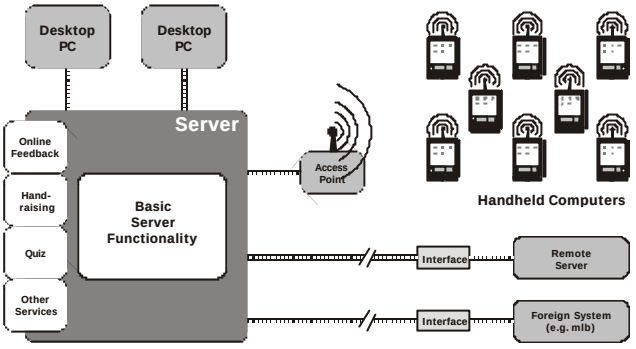

Figure 1. Architecture of the Interactive Lecture software.

1.2. WILD Services

This section gives a short overview over the most important synchronous services that are used in the Interactive Lecture.

Feedback. This service enables the students to provide feedback to the lecturer at any time. The lecturer is continuously informed about this feedback by means of bar graphs. To use this service, the lecturer sets up several categories; typical categories are speed and difficulty of the lecture. Students may then express their opinion about the category by adjusting a slider on the screen.

Call-In. The Call-In service improves upon hand raising tools, which are already implemented in many videoconferencing applications. In addition to virtually raising his/her hand, the student may enter a question or remark directly into the mobile device and send it to the lecturer. The lecturer sees the question ahead of time and can decide if, when and how to answer it. Also, this feature can be used to create an archive of interesting questions and possibly answers (a FAQ list). Of course this service also supports simple "virtual hand raising" as needed for very large lectures or in teleteaching environments.

Quiz. A quiz is a task that is prepared by the lecturer before the lecture. At the appropriate time during the lecture the lecturer transmits the quiz to the handheld devices of the students who will then enter their answers. The results are automatically statistically accumulated and displayed. The quiz service supports the teacher to prepare the quizzes, to activate them during a lecture and to analyze the results during and after the lecture.

2. EVALUATION

We conducted two classroom experiments in January and June 2002. The first experiment was a try-out designed to measure the acceptance of the students. In the second experiment we wanted to

find out how much the Interactive Lecture really improves interactivity, heightens attentiveness and increases motivation. Furthermore we investigated the effect of WILDs on the students' learning success.

The second experiment took place in the course "Computer Networks", lectured by professor Effelsberg. The content was split so that eight consecutive lectures in the middle of the course were offered as Interactive Lectures while the other lectures were not altered in any way. 100 students attended the course, 10 of them participated from a remote location (University of Freiburg) via videoconference.

During the interactive phase about 70 local students were divided into two groups. The first group was equipped with laptops or PocketPCs in the first four Interactive Lectures, the second group thereafter. The ten remote students has laptop computers all the time. Each lecture six to nine quizzes were transmitted to the students; additionally the students were able to send their questions to an assistant using the WILD call-in service.

The participants had to complete a knowledge test that was made up of about 80 multiple choice questions on the topics of the course. The first survey took place at the beginning of the course, the second at the beginning of the interactive phase, the third after the interactive phase and the last at the end of the course.

One of the accumulated results of the knowledge test is shown in Figure 2. The highest possible score was 24 points. The two bars on the left show the medium score of the students regarding the topics of the conventional part, before and after this phase. The bars on the right show the interactive phase. But although the initial score regarding the interactive phase was much lower than the score of the conventional phase (which was mainly due to the fact that the later topics were more complex), the final score shows that the students had gained more knowledge in the Interactive Lectures: in the conventional phase the average gain was three points while during the interactive phase they gained seven points.

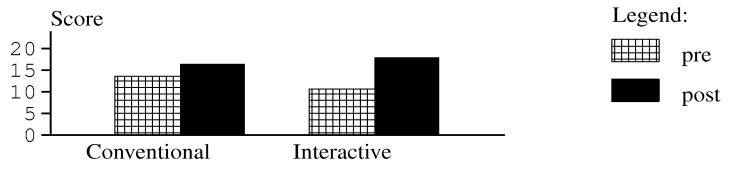

Figure 2. Learning increase.

We believe that the improved learning success is a result of the much higher motivation and level of attention of the students during Interactive Lectures. Observing the students during the lectures clearly showed that they were much more attentive than without the WILDs. Very interesting spontaneous questions were asked using the call-in service, and many students developed a strong ambition to get as many points as possible in the quiz rounds.

3. OUTLOOK

In the future we will develop and test additional WILD services and try to find out which combination of services is best for what type of lecture, and how to best integrate them into a curriculum. Also, additional evaluations in different courses are planned, most notably courses that do not relate to computer science. In Spring 2003, the WILD tools will be tested in a civil engineering course at Stanford University, and more tests are in preparation.