

MOBILE VIRTUAL BLACKBOARD

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ABSTRACT

Distance Education System (DES) is commonly used to increase effectiveness of educational process. Mobile devices imply additional changes in the way students interact as a society. Mobile learning (m-Learning) offers solutions that address the shortcomings of the traditional classroom.

The mobile virtual blackboard is elaborated in this paper. It is a mobile communication service integrated within our existing DES. It serves for consultations purposes and it is especially suitable for acquiring small and exact pieces of knowledge that can be immediately used. In that way, it creates an ideal environment for collaborative learning.

The feasibility of using mobile virtual blackboard within educational process was performed with the survey done with the students at the last year of undergraduate studies. We found that functions of the mobile virtual blackboard were effective in cooperative learning. The feedback from the students proved that the virtual blackboard system was viable for use within any project based curriculum.

KEYWORDS:

Distance Learning, Collaborative Learning, Mobile Learning Tools, Virtual Blackboard.

1. INTRODUCTION

Development of mobile communication devices and standards in wireless communication and networks has enabled people to use the devices in many different ways. Novel educational practices stimulated by the new information and telecommunication technologies enable almost instant access to latest educational materials. The requirement for low cost mobile networks to facilitate such a dynamic environment is obvious. That environment triggers the need for new approaches in providing both educational and administration services to the student. One of the most honorable utilizations of this new mobile technology is mobile learning.

Mobile learning is a new way of acquiring knowledge, which is highly adaptable to different kinds of student needs, from people that do not have time to attend normal courses to a practical enhancement of ordinary courses with additional access to the knowledge. Besides the static contents that are provided by books and different digital multimedia, very important aspect of learning is exchange of knowledge and consultation process among student participants and available expert authority (professor/instructor).

Students within the education process are usually familiar with using different technologies and devices for their studies and research. This fact opens the possibility for creating an education environment, that uses mobile and internet technologies to implement features and techniques which cannot be implemented in the traditional classroom. Distance Education System and Mobile Learning are commonly used to increase effectiveness of educational process by offering solutions that address the some of the shortcomings of the traditional classroom [1].

There are many desktop applications that support multimedia communication among participants. Communication among several participants which includes multimedia transfer is at the beginning of the development and utilization in the sphere of mobile handheld devices. Mobile handheld devices' primary use was personal assistance, making schedules and notes, and voice communication. New demands are imposed to these devices: greater processing power to support real time multimedia transfer (video stream, voice stream, and file exchange), greater memory space and data transfer. A great consideration should be given to the readability and utilization of small mobile user interfaces.

Collaborative learning is a term drawn from educational psychology to describe guided support that helps students mindfully engage in unfamiliar new work [2] [12]. Mindful engagement, in the context of Learning Environment, means actively participating in learning by finding out about the new concepts by asking within certain learning community. In this way students are encouraged to have engagement in the learning process by helping or asking other students (or instructor) to identify important learning concepts.

Colleges and universities are implementing various kinds of DES. DES's primary role is to enable and enhance educational process [3]. Educational process needs various educational materials organized in way that enables autonomous learning process [10]. It is very appropriate way of sharing educational resources. Classes can share an instructor using multimedia conferencing applications. It is clear that educational information can be accessed more easily from day to day. For example, the usage of wireless devices can increase accessibility of learning tools and materials [5] [7]. The next problem is how that information should be accessed and used.

Wireless LAN Solutions provide deployment of high-speed Internet and LAN connectivity not only in the classroom but throughout the campus as well. Accessibility of information, regardless of the location, is available for both, the students, and instructors.

It is very interesting to try to foreseen the further changes in the educational environment [11]. The students might feel free to ask the questions, and thus be more involved in the educational process, if they are anonymous [4]. The mobile learning device should be capable of addressing different challenges when presenting learning content [8]. Some work explaining the potential of the usage of mobile devices within learning environment has been presented in [9], where the mobile devices are used in simplified learning scenarios (quizzes, games). In our opinion, mobile devices should also provide wireless communication between professor(s) and student(s). At the same time, it has to be affordable, comfortable and practical

way of studying. Thus the mobile learning strategies and services have to consider different issues such as: limited interface, modest multimedia capacity, etc.

Several modules for communication were developed within our DES [6]: virtual blackboard module, chat module, project module, and virtual laboratory module. The mobile virtual blackboard is elaborated in this paper. It is a mobile communication service integrated within our existing DES. It serves for consultations purposes and it is especially suitable for acquiring small and exact pieces of knowledge that can be immediately used. The possibility of instant help from another student or professor creates an ideal environment for collaborative learning.

The second section elaborates the mobile virtual blackboard consultation system as a mobile learning service. The third section describes the design of the wireless mobile virtual blackboard. The fourth section presents some of the implementation details of the mobile virtual blackboard system and explains the features of the users' interface. The fifth section elaborates the evaluation of the efficiency of usage of the mobile virtual blackboard within the education process. The sixth section concludes the paper.

2. MOBILE VIRTUAL BLACKBOARD SYSTEM ARCHITECTURE

The mobile virtual blackboard is made for attending consultations on mobile devices, precisely on pocket PCs. The mobile virtual blackboard was inspired by the necessity to exchange information as soon as it is needed. When compared with other kinds of distance learning methods, mobile learning should give fast and exact answers to needed questions. Consultations in a group create implicit collaboration among students, which increase quality of obtained knowledge, because students can find answers to certain questions that arise from different real life scenarios.

Our Wireless mobile virtual blackboard, consultation system is implemented using a client - server architecture that requires less communication load on the client applications. That is done because mobile devices have limited memory and processor power. The server part is implemented as desktop PC application, since servicing clients might demand system with high performances and data throughput. The entire communication among the clients is carried out through the server application. The architecture is presented on Figure 1.

The client user's interface has controls that enable chat, drawing, feature for file upload/download, authority control (who should use the blackboard). The virtual blackboard consultation system also contains features for audio conversation with means of VoIP. The significance of this feature is obvious. Talking enables more precise discussion to be led in less time.

There are two types of clients, both implemented on a pocket PC platform. First client type is instructor application, which controls the resources in the group, and is the source of relevant knowledge. The second client type is a student application which uses the knowledge provided from the instructor. There is only one instructor and many students in one consultation session. All clients communicate together, leading conjoint conversation. The network communication is accomplished in a way that clients send UDP datagrams to the server, and the server resends the UDP datagrams, according to the contents of the received message. If the content of the received datagram is draw or chat, then the message is sent to all

logged clients. If a student asks the instructor for drawing on the blackboard, then the request is sent only to the instructor. The medium through which the communication is accomplished is wireless local area network, so the clients could be anywhere if they have the wireless connection to Internet. Desktop based clients (for both professor and students) can be also connected to the server.

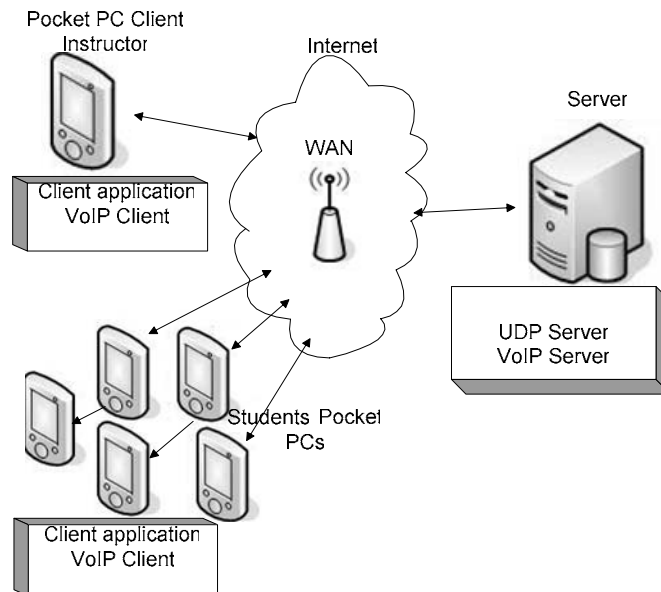


Figure 1. Architecture of the mobile blackboard system

The Figure 2, shows the Use Case of the Wireless virtual blackboard consulting process. The student can pose a question by using several ways of communication. These ways are: send textual messages, draw on blackboard, or show a specific part of the picture on the blackboard, and by speaking. The instructor can explain the needed topic by sending textual messages, by drawing or showing on the blackboard, or he/she can speak. Logically, the drawing on the blackboard would be followed by textual or voice explanation. In order all the participants in the consultation process to see the picture that the instructor uses in his explanations, the file transfer feature is needed. Only the instructor can upload a file, while download can be done by all clients. At any moment of explanation and drawing, users can save the changed picture. Because the blackboard and the speaking are the resources that cannot be used by many users at the same time, a control is included on the instructor's side. Initially, the instructor can use the blackboard and the voice. If the student needs these features, he can send a request for the blackboard, or request for speaking. The instructor can give the control over the blackboard (or speaking), and reclaim the control later. Instructor has the role of a moderator in the consultation process.

The most essential activity that happens in the consultation process is learning. Students can learn from the instructor's explanations by reading the chat messages, by listening and watching graphic explanations on the blackboard. For reminding of important graphic notes later, the student can save the picture at any moment. The instructor can save the picture at any moment as well, so he can reuse the important explanations on his next consultations.

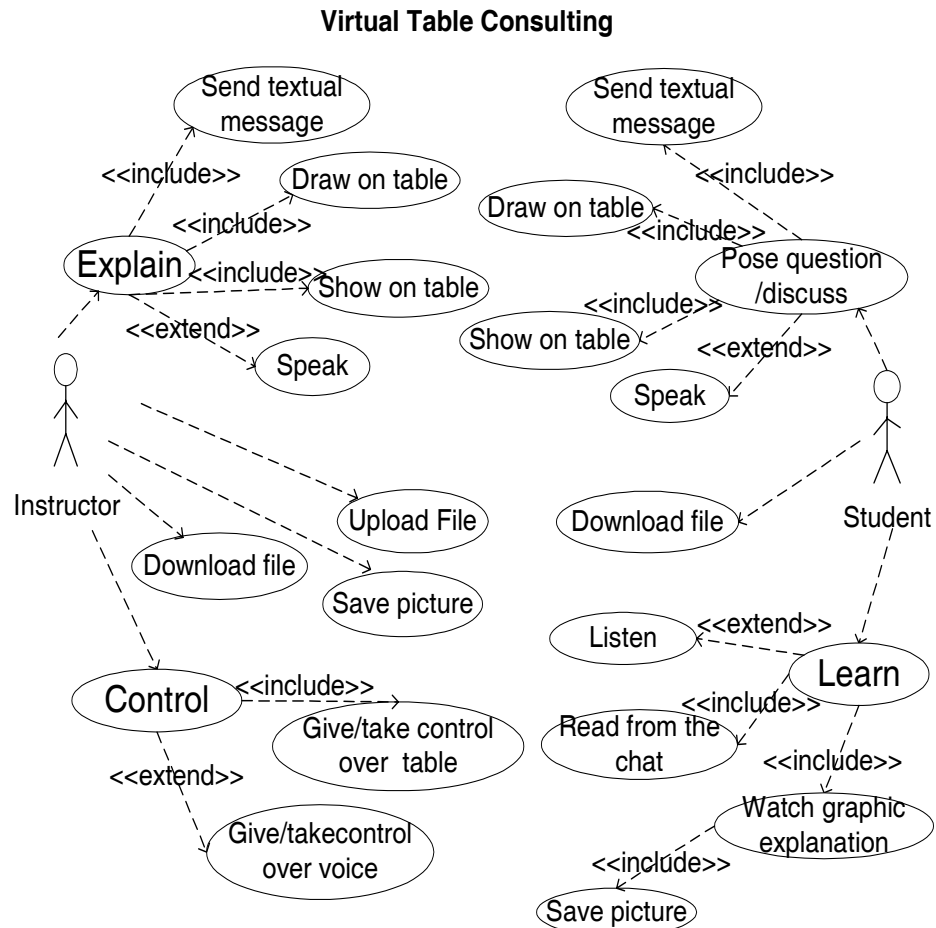
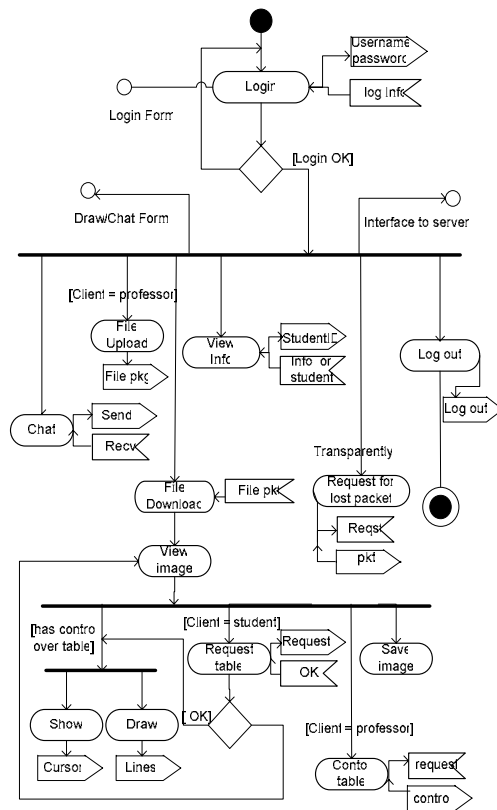


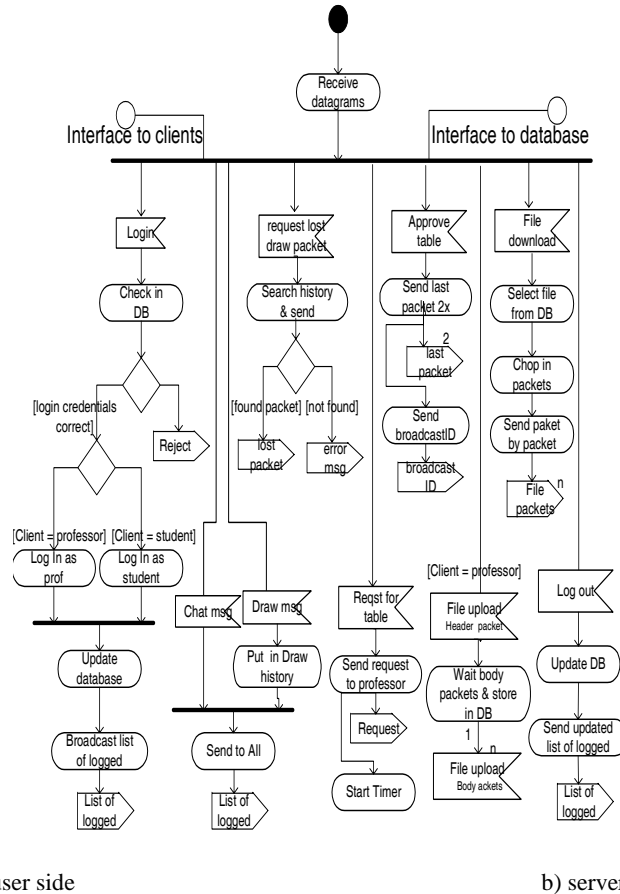
Figure 2. Use Case diagram of the virtual blackboard client

3. WIRELESS MOBILE VIRTUAL BLACKBOARD DESIGN

Interactivity is very important issue in mobile learning systems. The technology limitations should not interfere with the student-professor interaction and discourage the users of the system. On contrary, we have opinion that the technology has grown enough to accomplish this kind of a task, and even provide better conditions for consultation process. Many messengers available today, have practiced people to use this kind of tools in communication and collaboration. Implementing consultations on pocket PCs provides convenience by making people more available. Another notice is that the attention point where the topic is being explained is at the same place as the attention point where the student takes notes, or

draws own scenario to show to the rest of the group. When the instructor draws on a usual blackboard or paper, or projects fixed picture on the wall and students watch and take notices in their notebooks, they have to share their attention at two places. By merging these two attention points, the virtual blackboard consultation system provides greater attention and prompts discussions. Speaking, combined with drawing should be the most appreciated way of conducting conversation and explaining learning topics.





a) user side

b) server side

Figure 3. The mobile blackboard client's activity diagram

Figure 3 represents activity diagrams of the virtual blackboard client and the server applications. The server application has to be started first. The IP address of the server host and the port number on which the server listens are necessary for establishing communication. Valid login name and password must be provided for fulfillment of the login form in order to proceed to the virtual blackboard system. If the login succeeds, the list of all logged clients is received, and the virtual blackboard client interface is shown to the user. The client program has three interface points which serve for interaction with outside world, providing the necessary communication. The login form and the virtual blackboard form are two points of the human user interfaces, and the third one is for the communication with server. The user interface is represented with common controls like textboxes and buttons, a pen with different colors and a place on the form where drawing can be done. The interface to the server represents the means of communication with other machines and applications. This interface is represented with UDP socket procedures Send and Receive. The asynchronous UDP socket was used, so the clients can do many tasks simultaneously.

The part of the client application that implements the chat feature is designed in such way that conversation with all clients is visible in the same window. Everybody can post message and all the others can read it. Although, it's primary use is that the questions are intended for the instructor and the relevant answer is expected from this same authority. The server resends received messages to all logged clients, providing the senders' names.

When the File is uploading, the file is chopped in pieces with size of 500 bytes and sent packet by packet to the server. Every packet has a unique ID. The file is stored in the database on the server machine. When the client wants to see the picture that is stored on the server, the file is downloaded (packet by packet) to the client's pocket PC and the picture is shown on the virtual blackboard area. The client that has the control over the blackboard (initially the professor) can draw on it with several colors and several thicknesses. While drawing, the points that are drawn, containing absolute position on the blackboard and on the bitmap, with appropriate color are sent to the server. Sending the packets with drawing are triggered either by timer (in case a smaller number of points are drawn) or when 40 points are drawn.

The student can send request for using the blackboard. Datagram with appropriate structure is sent (containing information for the blackboard request and identification of who precedes the request). When triggering the request, a timer for this event is started. In a predefined amount of time, if the instructor returns the approval, the student gets the blackboard. If the timer counts down, the request is discarded. Request for the blackboard is shown in the instructor's application by showing and blinking of the student's name. Sending approval is triggered by the button click event. If a message is not sent, this means that the blackboard is not approved or the instructor is busy. The server application makes the transfer of the control from the student application to the instructor's.

Every client can draw, and make notes on the blackboard without broadcasting the drawing (if the client hasn't control). In this way, the student can make notes specific to him and if needed, he can save his own drawing. The client can log out at any time. In that case, a message for logout is sent. The list of logged users is updated in the database.

Process that goes on automatically, without concern of the clients, is the management of lost packets. This feature applies only for drawing packets, because of their large number and the fact that the meaning of the picture would not be understood without all the pieces that the instructor or a student would have drawn. The necessity for this feature has been practically proven. When the testing of the application was conducted, many UDP datagrams had been lost during the communication. Every client that draws keeps the history of last ten drawing UDP datagrams. Every drawing datagram has its own ID, and if the server receives a datagram with ID that is larger from the last accepted at least for 2, then request for lost datagram with the known ID is sent. The server keeps history of last 100 drawing datagrams. If client's application doesn't receive some datagram (and datagram with larger number is received), the client application sends request to the server for the datagram with the precise ID. Similar management of non received datagrams is provided for uploading and downloading files.

The communication in the mobile blackboard system is realized with relatively simple scenario. The server receives UDP datagrams, checks them, and resends them to appropriate recipient(s). The files are kept on the server, so clients wouldn't spend their scarce memory. The server's activity diagram shows that the server application waits for incoming datagrams and initiates actions according to their contents. Datagrams come in simultaneously. The server has two interfaces. One interface serves the communication with the clients' applications. As in the client's applications, this interface is represented with the

procedures for receiving and sending datagrams. The server has one UDP socket on which receives and sends datagrams from and to all clients. The host's IP address, together with the Port number is the key parameter for communication with clients. The other interface is reserved for communication with the database. A proper connection string is needed for connecting to the database, where the files and the users' information are stored.

Voice conversation includes feature for recording and sending voice in real time, and the part for playing the voice. These features are set in the clients' applications, while the server has the special part which takes care of resending the voice data to the appropriate recipients.

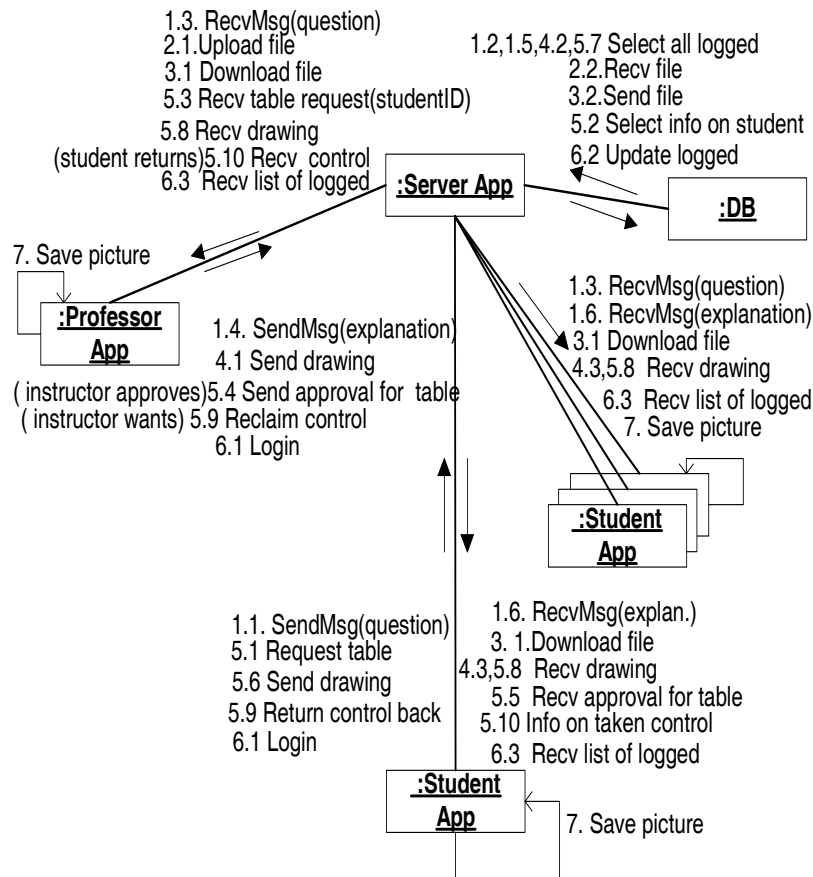


Figure 4. The mobile virtual blackboard collaboration diagram

Different aspects of collaboration, are of special interest in this paper, where our attention is focused on the forms and methods of communication that modern pocket PCs can offer, combined with development environments designed for them. The first aspect of collaboration is the communication between the instructor and the student. The Mobile virtual blackboard is made for providing better communication between these two communities, the community that has the knowledge, and the community that needs that knowledge. Another

aspect of collaboration is that more students participate in one consultation session. In this way, students have the opportunity to remind themselves to the things they know and deepen the knowledge on the known theme, or they can learn things they haven't thought of, in cases when the instructor answers other student's question. The medium that supports the Wireless mobile virtual blackboard consultation system is the Internet.

The collaboration diagram on the Figure 4 shows the interaction among the different applications used in our system.

The first number signifies the scenario, as question and answer through the chat (the lines that begin with 1), or drawing (lines begin with 4). The first scenario, posing question and answering begins with 1.1 SendMsg(question) which is sent by a certain student. The student's application sends this chat message to the server. The server queries the database, in order to get all logged clients(1.2). After the server application receives the list of all logged clients, it resends the message to all logged participants. The instructor also receives the question(1.3) and sends the explanation in a text message(1.4). The database is queried again for the logged clients(1.5) and the message with the explanation is resent to all logged clients(1.6). The database keeps the info on clients' logs. The clients can login/logout at any time, so checking of all logins is necessary before every resending of a message. Since only one person can draw at a time, it is made that the instructor controls the use of the blackboard. If a student has the necessity to draw some example that needs explanation, he/she can send request for the blackboard (5.1). The info on the student is provided from the database (5.2) and the request is resent to the instructor (5.3). If the instructor approves the student's request, on the press of the button, the message with the approval is sent to the student (5.4). The student can now draw on the virtual blackboard. Messages that contain points drawn from the student are sent to all logged clients (first to the server (5.6), and the server resends to all logged clients(5.8)). Instructor can upload a file. This kind of a communication is lead between the instructor's application, and the database, through the server application (2.1, 2.2). File download is the reverse process (3.1, 3.2). When login occurs (6.1), the server application checks in the database if there is a user with these credentials (6.2). If the login succeeds, the list of logged users is updated and sent to all participants (6.3). The last shown scenario is saving picture from the blackboard (7). The client can save the picture that is drawn on the virtual blackboard at any moment. This task doesn't require communication with the server or other clients. Clients may draw on the blackboard without anybody seeing their changes, if they don't have the control. When the client saves the picture, he actually saves his own version of the picture. In this way, a student may draw specific notes on his own picture and save it. It is worth of noticing that chat and drawing can be used simultaneously.

4. IMPLEMENTATION OF THE MOBILE VIRTUAL BLACKBOARD

The wireless virtual blackboard system is realized and functional. The Deployment Diagram of the Mobile Blackboard is given on Figure 5. Since all of the students are still not equipped with pocket PCs, the version of the virtual blackboard for desktop PCs is also implemented.

Applications for Wireless mobile virtual blackboard are made in C++ Visual Studio .NET 2005 development framework. Development of the pocket PC application is made in the

Compact Framework with help of the Emulator for Pocket PC, provided with the .NET environment and is tested on HP models. Operating system used on the pocket PCs is Windows Mobile 2003. The clients which reside on desktop PCs and the server use the normal .NET Framework. Operating system for desktop machines on which the application is practically deployed, is Windows XP SP2. The server uses Microsoft Access database.

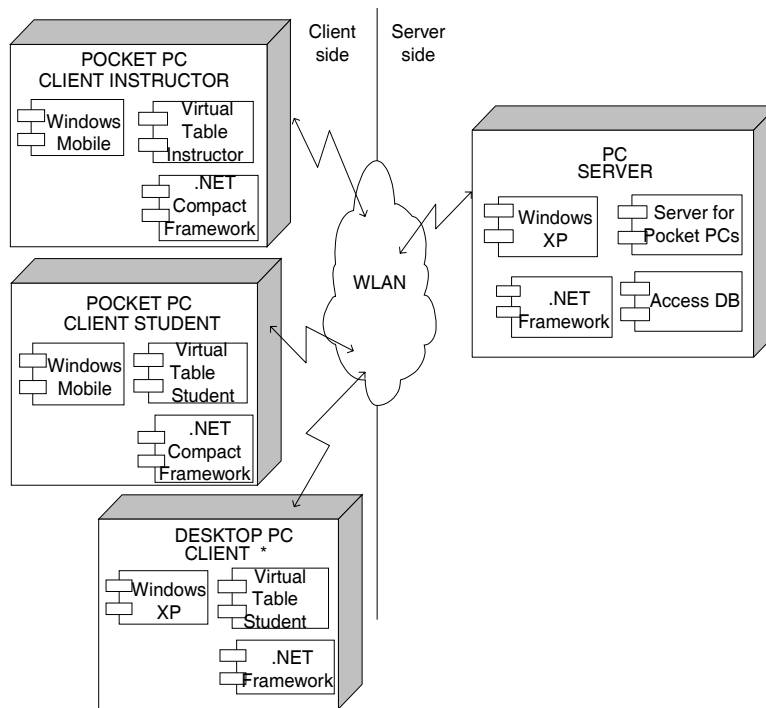


Figure 5. Mobile Blackboard Deployment diagram

The instructor’s interface is shown on the Figure 6. The control of the blackboard is represented with the button named “get control”. The chat module consists of the input text box, the display text box, where all chat messages are written, and the send button. The button named “Chat” enables seeing the chat on the full screen. The buttons named “fUp” and “fDown” serve for upload and download.

The place where the graphics is shown is called the virtual blackboard. This is the place where the downloaded files are opened and where notes can be added using colors and pens with different thicknesses. The “Clean” button serves for clearing the blackboard. With clicking on the “Save” button, the contents shown on the virtual blackboard can be saved as a bitmap file. This is the view of the instructor.

The student's user interface is very similar to the professor's, except that it has a button to send a drawing request, does not have the authority control, and does not have the ability for file upload.

Below the chat boxes, a combo box with logged students is shown in line with buttons for file upload. The rest of client's window is drawing area where a picture can be downloaded and opened. Pens with several colors and pen thicknesses can be used for drawing on the picture. There is also an eraser, for the entire picture or for parts of it. All these controls are set on the right side of the drawing area.

When a student wants to use the drawing area, he/she sends the drawing request to the instructor by clicking on the appropriate button.



Figure 6. Mobile virtual blackboard interface

5. EVALUATION OF THE MOBILE VIRTUAL BLACKBOARD

The mobile blackboard was evaluated by 14 students at their last year of undergraduate studies in Information Technologies. These students had prior knowledge of using information and communication technologies in their education. The students were asked whether the mobile blackboard would be useful for their studies. The questionnaire given to the students included three types of questions regarding: student experience in using mobile and DES technologies in education, interface usability, and features of mobile virtual blackboard. The summarized results of the assessment are given below.

The questions list that examines participants experience and acceptability of the Distance Education Systems are:

- 1) Do you own Pocket PC device?
- 2) Do you have any experience with Pocket PC devices?
- 3) Do you think that Distance Education System makes the learning process easier?
- 4) Have you used applications with similar purpose before?

The Y axis in figure 7 represents questions with the same number from questionnaire above.

Results show that most of the examinees have used and have previous experience with Pocket PC application. All of them agreed that DES could make learning process easier to them. The only think that concerns is than Pocket PCs are not yet that widely spread between the students (probably because their high price).

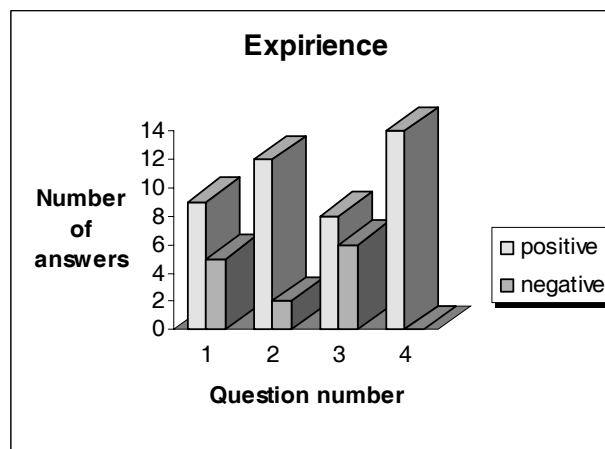


Figure 7. Results from experience part of questionnaire.

The questions that examine system interface usability and provide information for future upgrades are:

- 1) Are the colors from the drawing pens enough?
- 2) Are you satisfied with the way of presentation on the blackboard?
- 3) What do you think of giving drawing controls to more than one user?
- 4) What is your opinion on the logging concept on the system?
- 5) What is your opinion on the controls position on the user interface and do you have any suggestions about it?

The Y axis in figure 8 represents questions with the same number from questionnaire above.

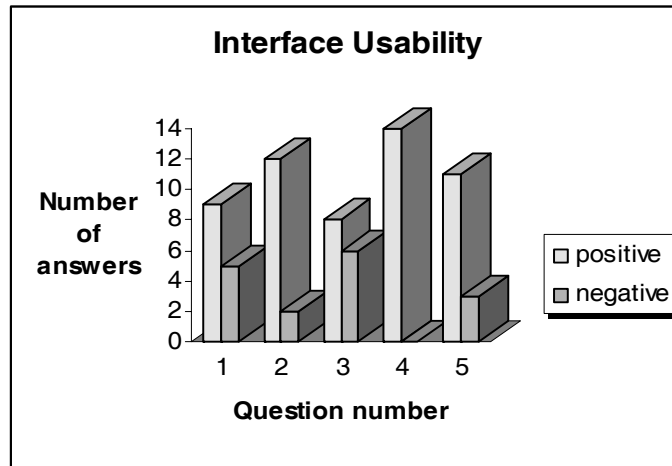


Figure 8. Results from interface usability part of questionnaire.

General opinion among participants for the interface usability is positive. Interface is functional and suggestions for controls position will be included in the future project. Option for more than one users to have drawing controls divided participants. The current system design left this option for instructor who can decide about number of drawing controls holders.

The questions used to provide information about new features of mobile blackboard and future directions are:

- 1) Do you think that an option for sending files should be provided?
- 2) Do you think that an option for VOIP communication should be provided?
- 3) Do you think that an option to save current image on the blackboard should be provided?
- 4) Do you think that an option to save chat history should be provided?
- 5) What is your opinion on providing communication between mobile phones and virtual blackboard using MMS and SMS messages?

The Y axis in figure 9 represents questions with the same number from questionnaire above.

The research on students' interest on adopting mobile devices in educational context shows that most of the students have positive thinking about the introduction of mobile virtual blackboard into the educational process. Parts of the suggestions and critics that cannot be represented graphically or tabular refer to the position of the chat visual components and the need for an option for drawing geometrical shapes. General opinion of all examinees was that virtual blackboard could increase effectiveness of the learning process.

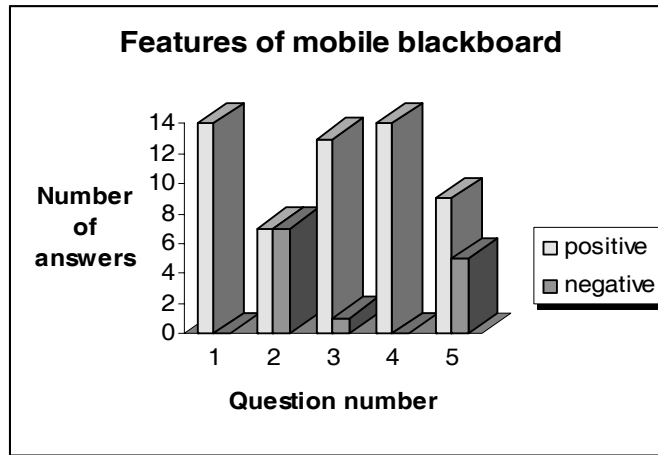


Figure 9. Results from “mobile blackboard features” part of questionnaire.

The information provided from research shows that there is place for new projects, like implementing MMS and SMS communication that will enable students with mobile phones to interact and be part of the virtual blackboard.

6. CONCLUSION

This paper presents our approach for incorporating m-Learning services into our existing web based DES. The mobile services will provide help in building of learning environments. In our opinion, most needed services for that purpose are communication services and services that ease access to educational materials.

The Wireless consultation system is designed to provide maximum interactivity; to ensure all the benefits that consultation “face to face” provides combining with the facilities that the modern technology and telecommunications can offer today.

The client side components are intended to deliver all aspects of communication at one time and high quality user interface so that usage of the system becomes easy and intuitive. Since the client application is intended for pocket PCs, a great concern is taken over spacing of the visual components.

General opinion among student examinees was that the mobile virtual blackboard is effective and useful tool in helping the students acquire the exact pieces of knowledge they need.

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