Suggested Collaborative Learning Conceptual Architecture and Applications for Mobile Devices

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Abstract. This paper describes the theoretical and technical foundations for designing and developing an effective mobile collaborative learning (MCL) environment. The paper suggests a prototype based on client-server side with the support of functional components and working procedures, which help users to obtain contents from a server to meet the pedagogical needs. The proposed prototype provides the best MCL environment for students who want to learn at home and working places through mobiles. Finally, to find valuable hidden issues, the paper introduces a new application, "group" in Android operating system, and then conducts usability test in order to facilitate users for accessing and obtaining the contents in collaboration learning procedures.

Keywords: Mobile Collaborative Learning (MCL) Environment, Optimization of Architecture, Client & Server side Prototypes for Collaboration.

1 Introduction

The trend of competition has been growing rapidly in global market with advent and deployment of new technologies. The latest technological revolution is the emergence of mobile wireless communication technology. Mobile devices have grown in popularity to become one of the most common consumer devices and ïcheaper hand held device which we can carry and use whole day everywhere. With incorporation of emerging hardware technologies in mobile devices; such as motion sensors, cameras, global positioning system, infra-red, Bluetooth and others supported by broadband connections, mobile devices began to support many different types of education applications. Now they are more flexible to integrate the existing services by employing web based interfaces, so that mobile devices become attractive tools to complete the demand for collaborative learning.

Collaboration has been getting more importance in educational environment and the focus of collaborative learning has been implanted from elementary to higher educational institutions. The concept of mobile-based learning (MCL) is completely different from classroom-based learning method. This pedagogical method of the learning provides many possibilities, such as providing the opportunities to group of people, working in same or different organizations to participate for accomplishment of specific goal using mobile devices.

A. Marcus (Ed.): Design, User Experience, and Usability, Pt I, HCII 2011, LNCS 6769, pp. 611–620, 2011.

Therefore, the demand of collaboration learning over the mobile device has been increasing as a major education element. Major research challenges are raised in developing MCL for education such as sharing knowledge, requesting for modified contents, fully accessing to enterprise data warehouse, delivering large rich multimedia contents (video-on-demand), selecting technological components in designing appropriate architecture and adapting application protocols. To support these issues, we propose client and server based prototypes with improving knowledge sharing process, providing access for all users to enterprise data warehouse, containing content-modification facility and delivering large rich multimedia contents. Our contribution will make the application easier for students to obtain succinct information and fast feedback through MCL.

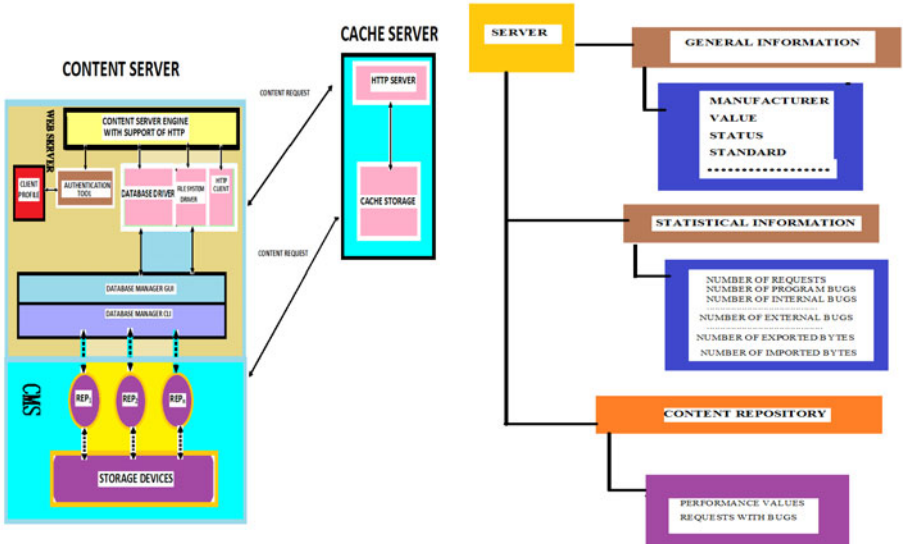
1.1 Background Works

Here, we discuss the salient features of related published work which are contributed to our work. Su, X., and others [1] propose four layer framework prototype for multimedia content generation in mobile collaborative systems. The proposed framework provides the support for users, devices and session management skill. This research offer a novel frame work for multimedia content generation, representation and delivery, for Mobile Collaboration, however the framework is not completely elaborated and lacks incorporation of many components. Zanev, V., Clark, R. [7] suggest the procedures for developing a prototype used for wireless course management system focusing on login and authentication, wireless syllabus, wireless calendar and wireless testing. Also it describes the course contents by explaining how a teacher can interact with students by using HTML interface. Lahner, F. and Nosekabel, H. [8] have implemented the program in University of Regensburg, Germany, which can support e-learning contents to be displayed on computers, and also the system structure provides users with the facility to obtain same contents via mobiles. Marcelo, M. and others [9] have designed C-note in University of Vaxjo in Sweden. Using C-note provides opportunity to collaborate for storing the notes and information in the database on their progressive project. The specialized C-Pen is used to scan the project research material with the support of C-note application.

Barbosa, J. and others [5] proposed the prototype for undergraduate course reference, Grefe, by using mobile and ubiquitous computing. Authors claimed that their approach will improve academic and learning activities. The prototype is based on user profile which stores the information regarding learning process and use location system, so it can identify user physical location and support learning procedures by generic architecture. However, the proposed prototype does not exactly provide the mobile collaborative learning, it suggests generic idea of online learning process. Druin, A. and others [10] have discussed the prototype for their ongoing participatory design project with intergenerational design group to create mobile application and integrate into iP Phone and ipod touch platforms. Bouras, C. and others [11] have introduced INVITE architecture and discussed the user requirements to meet the demand of e-learning in collaborative virtual environment. Even it does not lead to existence of any solid prototype; it can show the technology and standards required for designing MCL.

2 MCL Prototype Structure at Server

To make a successful collaboration system, we need to organize its architecture with latest technologies to meet our expectations. Client-server based prototypes provide smooth transaction of data exchange for collaborative learning environment. These prototypes give the information regarding the course materials, easy access to check the grades and use of labs. Among of various conceptual collaborative architectures have been proposed so for, four layered components of collaborative framework [1] was adapted for the basic structure of this research MCL framework. It consists of four major components, content generation layer, communication layer, content regeneration layer, and content visualization layer in which each layer has been assigned different responsibility. As seen in Fig. 1 (a), at the server side a content server is the main component of content generation layer which is based on content server engine (CSE).



(a) Server side operations (b) Function of server with repository

Fig. 1. Conceptual architecture for MCL

The basic engine of the prototype is implemented on Internet information server; so its function is to receive URLs, checks and triggers (stored procedures) process for the requests. The content server continues to watching the interface whether new request from clients is received or not. If the new request is displayed on web through template, then the rest of team members are informed through email, then the server forwards the requested content to CSE. To verify the status of the client, CSE sends the request to authentication tool to save the profile of legitimate clients and then check the client status. We propose HTTP client and integrate with CSE to save and retrieve data from database driver or file system driver.

Database Manager CLI tool in the server creates monitors, manages backups and restore the instance of database, furthermore the tool supports to interactive and background operations. By using Java, C++, XML and other programming languages, we can access the Database Manager CLI tool by creating the specific programming interfaces, module and documentation which are offered from the internal tool features. Database Manager GUI also supports different features on different types of mobile devices, and also it can basically provide user-friendly interfaces to remote mobile devices for the collaboration easily.

GUI and CLI promote to store and extract the contents forwarded from database or file system drivers by using different repositories. Content repositories receive a content request message from GUI and CLI, and search the requested content in the storage devices of content management system (CMS). The content repositories are also part of the CMS, which supports and functions like logical storage for different storage devices. Also the Repository can be helpful to store different kind of contents in single repository table such as comments, articles, questions, answers, news, tutorials. So, we can switch from Rep_1 to Rep_n in single table for finding the requested contents for the collaboration, and can monitor the performance of each repository with their respective servers as seen in Fig. 1 (b).

3 Proposed Group Application for MCL

MCL is a revolution for education, which allows users to obtain computer-based information through mobile devices. MCL provides various advantages such as context awareness, portability, connectivity and social interaction [2].

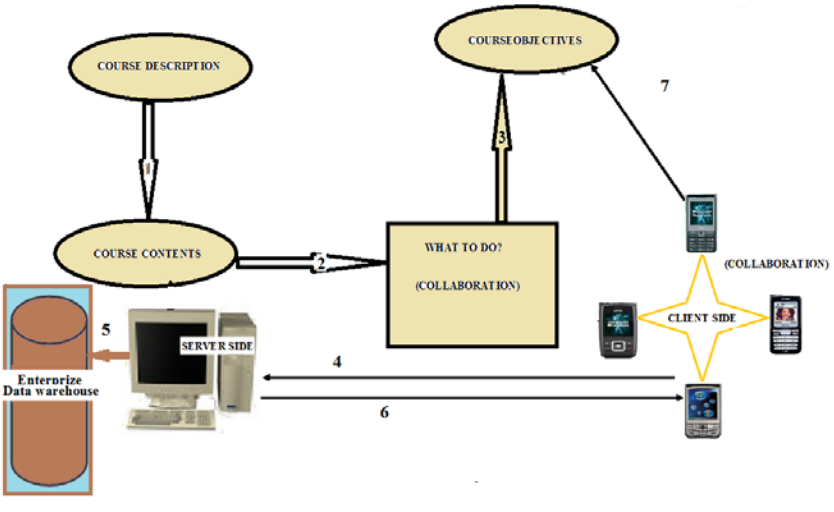


Fig. 2. Process for obtaining the course contents through MCL

Mobile can be a successful tool for the collaboration allowing students to share the information to achieve pedagogical activities. Our prototype for MCL can solve the deep dream of students to make the collaboration with mobile anywhere and anytime.

Our prototype application helps the students to obtain the required contents from enterprise database warehouse (EDW) to meet the course requirements. Suppose, a course "Decision Support System" is offered an online class from the University of Northern Virginia, and some students might not access to their computer during day times under some situation. Instead of using a computer, students can access the server to load their course contents by using mobile devices with MCL environment. Surely to meet the standard of course explained, they can receive class information stored in EDW. The information comprises of Textbook Information, Course Name, Course ID, Course description and others. Hence all these items can be obtained to complete the course by using MCL. Fig. 2 supports the process about the prototype.

To implement MCL prototype on Android mobile operating system which consists of software stack for mobile devices, we incorporate net News Wire software with RSS 2.0 and suggest the following supplementary instructions.

- Add new application with name "group" in application section by using Java programming.
- Resource Manager and Activity Manager should be extended and provided extra responsibilities to control different features of "group" application.
- Libraries section should be modified because it can make easy for structured data storage.
- Display Driver of Linux Kernel to support MCL activities.

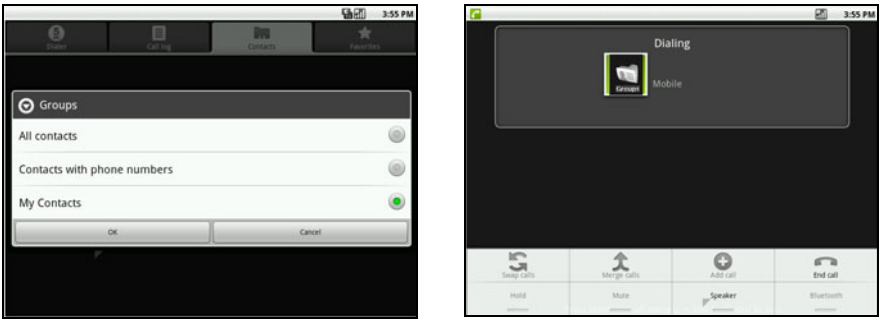


Fig. 3. Running group application and calling process on Android operating system

If these instructions are incorporated in Android, a new application "group" with new features will support to obtain the contents from a server to completion of MCL as seen in Fig. 3.

The application "group" is shown with Android OS consisting of control option and delivery option. The control option performs the functionalities of add new contact, delete contact, edit contact, existing collaborative group (C-G) and make new C-G. Delivery option executes the function of receiving and sending information. When clients take the requested contents from a server, they receive through delivery option and saves by using the store component given in Fig. 4.

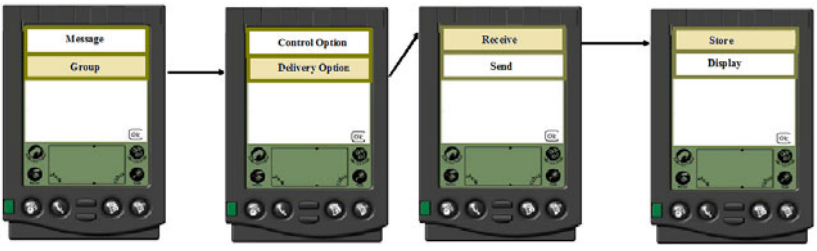


Fig. 4. Received contents from server are stored in client's mobile

When all of collaborative members of group complete the process of downloading the required contents from RSS feed of a requested client, they starts to follow the process for MCL given in Fig. 5.

Fig. 5. Sharing of file for Mobile Collaborative Learning

If participating members need a file for CL, then they can open the file to receive the knowledge of the contents with reading mode. If they need more information to clear their concept about the topic, then play the videos related information given process.

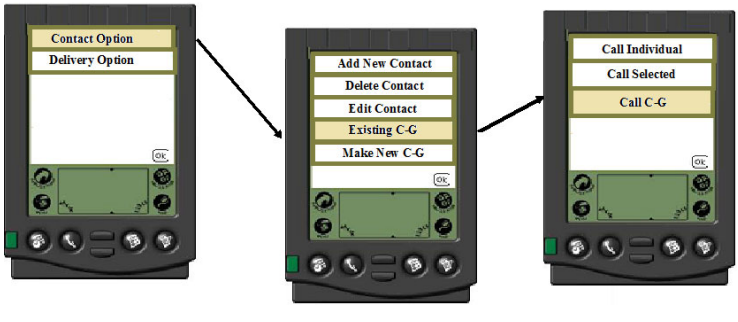


Fig. 6. Collaboration among the Mobile Collaborative group for achieving the objectives

The group option provides utility to manage the data with its respective options. If data is text based then it should be obtained by using file option, otherwise audio and

video options are used. When each of collaborative member receives awareness and obtains knowledge about the topic, subsequently a user start the process of collaboration by using existing collaborative group in Fig. 6.

The process can be supported with H.323 standard published by International Telecommunications Union Telecommunications (ITU-T) to facilitate the real-time audio and video communication. This protocol will help to collaborative members to discuss the contents after reading and watching the video of related information. With integration of "group" application in mobile devices, the course objectives can be met with MCL.

4 Empirical Results to Design Prototype for MCL

One of the highly challenging tasks for designing and developing prototype is to understand how the requirements of users are satisfied by the functionalities of application and architecture. To satisfy the requirements of users, usability testing method shall be conducted based on hybrid heuristic approach. To find meaningful items, we involve 106 users who are including 58 students, 23 teachers, 14 teaching assistants and 11 administrators.

4.1 Testing Conditions

In order to take valuable suggestions for efficient MCL structures, we've surveyed on previous literature and evaluation data [12][13] in first phase, then collect the necessary items through interviews and consult with experts. All items were selected based on the basic requirements of users to meet the pedagogical needs through MCL, then each item was evaluated based on the survey's questionnaire method by the above users.

Table 1. Survey questionnaire for each item

Description of Each Item	1	2	3	4	5
Should be easy to use	249	0	00	00	00
Asynchronous Collaboration	160	40	30	18	01
Synchronous Collaboration	161	39	29	19	01
To support multimodal MCL	233	13	03	00	00
To provide Archive updating	135	34	61	17	02
Should be User friendly interface	249	00	00	00	00
To give virtual support	139	72	21	10	07

Table 1. (*continued*)

The administrators should be provided the opportunities to record the collaborative activities of students and teachers during the whole session or any specific period of time.	234	06	09	00	00
To provide the opportunities for interactive and shard white board	190	32	22	05	00
Users may need short start time for collaboration	140	30	67	04	08
Server should provide content adoption service	142	28	64	09	06
The Students should have alternative choices in selecting any topic for discussion.	231	09	09	00	00
The Students should have access to check the comments given by teacher regarding their performance and grades.	230	11	08	00	00
The teacher should include critical notes for the performance of each student after completion of MCL session and provide the feedback to improve in future.	232	09	08	00	00
To provide audio and video communication only	192	10	18	19	20
To provide connectivity management support	195	12	32	08	02
To provide the support for session management	193	15	31	07	03
To provide the checking facilities to instructor to check the group members	202	22	14	08	03
To provide the freedom of thoughts to participating group members	211	19	12	07	00
Server should send the message of information updating	184	22	30	10	03
Client should give notification of his/ her availability	156	24	34	28	07
To provide the support for user role	123	43	45	32	06
Portfolio should be created in order to store an information regarding the course	129	56	39	24	01
To include group manager component	124	61	43	21	00
The methods of communication should be direct or mediated	121	60	56	10	02
Instructor should dedicate time to monitor the progress of participating members	201	23	22	03	00
To provide the support to handle the shared information	123	72	54	00	00
To provide privacy and safety	175	32	42	00	00
To provide the facility to contact and invite the participating for collaboration	137	63	49	00	00

Table 1. (*continued*)

The communication should be based on broadcast with support of multicasting	156	67	21	04	01
To make small participating group for collaboration	101	98	41	08	01
To provide support for floor control administration	111	45	52	37	04
To be flexible to collect and extract the data.	247	01	01	00	00
To provide text, graphs, images, audio and video services to meet the requirements of related course of study	245	03	01	00	00
The teachers should have complete access to administer their courses and evaluate the progress of students.	242	04	03	00	00

The way of collecting this basic information is using Face book, Vista survey and personal related group for four days. By using five-point Likert scale, we evaluated each requirement. The five-point Likert items in our questionnaire are specified Strongly Agree=1, Agree=2, Neutral/No Opinion=3, Disagree=4 and Strongly Disagree=5. The results analysis includes answers from all respondents who took your survey in the 3 days period. The items and scale description of is shown in Table 1. Based on the above results, for more testing procedures we will take all of the observations made by the tester, as well as the comments and questionnaire data of the participants, and categorized them. Also we plan to modify and redesign the prototype, and then conduct the final empirical testing on the new prototype again. All these testing procedures will be useful to understand the type of applications required for designing and developing the MCL application.

5 Conclusion and Future Works

The main objective of designing and developing the conceptual-based architectures is to obtain the learning materials on hand-held devices particularly on mobile devices. With applying the prototype architectures, we suggest students to take the contents of the course anywhere and anytime. Here we point out several contributions over the work. First, we have made significant modifications in the four layer architecture previously explained in [7]. Our four layer architecture can provide the efficient and fast way of delivering the contents to mobile node. As this characteristic of four-layered architecture gives fast provision of content to mobile node. Second, we have introduced the client and server based architectural prototype to support to MCL in education. The design and development of client and server based architecture can provide the faster method of delivering the contents to users. Also we have optimized the content server by integrating with a cache server in order to save the time for delivery of data. Third, we have proposed and implemented the prototype application, "group," and recommended some valuable suggestions to use Android operating system and explained the case study how to meet the course objective by using MCL. Finally, we have discussed the user requirements on the basis of survey to design and

develop the MCL based architecture to meet the pedagogical requirements of students, teachers, administrative and teacher assistant.

Although this approach is to devise a basic method for efficiently building MCL application, there are still uncovered problems of applying this approach to commercial mobile devices directly. However, our ïarchitecture will properly meet the challenge of MCL and we keep focusing on implementing the whole group application to meet the new needs. We look forward to continuing the research and developing the application according to the future progress of MCL, mobile software and hardware performance. Therefore, the biggest contribution of the paper is to provide a small step for how to design and implement MCL in order to meet ïthe pedagogical needs.

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