Collaborative architecture to support active learning

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Abstract. With the advent of new software tools for collaborative learning, collaborative work and E-Learning either synchronously or asynchronously have become an important part of our lives. File sharing and e-mail communication do not necessarily promote learning. Combining the learning methodologies with the appropriate software tools creates a collaborative architecture that promotes active learning. Hence, a collaborative architecture that integrates and administrates distributed web interactivity tools with learning methodologies is the focus of this paper. The paper reviews related work on active learning, problem based learning (PBL), project oriented learning (POL), collaborative software tools and collaborative virtual environments, highlighting the impact of a collaborative architecture that supports and promotes active learning.

Keywords: Collaborative architecture, Collaborative learning, Active learning, Problem based learning (PBL), Project oriented learning (POL), Long distance education.

1 Introduction

Software development and advances in telecommunications have radically changed the way of interaction between humans [1]. Internet has enabled the teamwork between members that are not necessarily located in the same physical place and, moreover, between members who may have not met personally.

Through collaborative tools like e-mail or virtual meetings, it has been possible to carry out activities beyond the physical place of work or study; some can even be made while moving from one geographical location to another.

It is common nowadays that people use e-mail to send papers, academic files, family pictures, etc. People are more aware about what happens in distant places and may get somehow involved in those remote locations. All these events are opening up endless possibilities for collaboration between people not only from distant places but also with different abilities, skills and situations.

Remote work in several disciplines has become a reality. Staff training has paid good dividends by taking advantage of new tools for remote collaboration. The courses offered by the Internet have proliferated, especially in developing countries, and communicating knowledge has spread among greater number of people and at a

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relatively less expensive way. These successful experiences in online personnel training motivate the idea of using these techniques and tools in education.

As is the case for any new human activity, remote collaboration will bring benefits but also problems to face and solve. The application of software and computers for learning is not only limited to sharing files, but it should evolve to become the main tool for interaction and collaboration generating knowledge through the work of all members with a well-defined common goal. The collaborative tools are emerging as an option for these teams to develop their projects as if they were in the same physical space.

2. Active Collaborative Learning

Active learning is about techniques developed such that students do more than simply listening to lecture. Students in an active learning environment perform extra tasks including discovery, processing and application of information [2]. Active learning is essentially the method that seeks to achieve the development of critical thinking skills as well as creative thinking. The learning activity is centered on the learner.

On the other hand, collaborative learning refers to an educational method in which there is a common goal and the students work together in small groups with one purpose: achieving that goal. Within each team students exchange information and work together on specific tasks therefore learning through collaboration. In other words, students are responsible for their own learning as well as the learning of each member of the team.

For the work presented in this paper, two active collaborative learning techniques were considered: Problem Based Learning (PBL) and Project Oriented Learning (POL); both described next.

2.1 Problem-based learning (PBL) [3], [4]

PBL is a learning-centered education method that challenges students to "learn how to learn", working collectively in groups to find solutions to real world problems. The problems are used to stimulate in students the curiosity and motivation to learn the subject matter. PBL prepares students to think critically and analytically, and find and use appropriate learning resources.

The aim of PBL is to provide students with learning skills tools so they become independent learners in their professional life. Hence, the teacher's responsibility is to provide educational materials (scenarios) and guidance that facilitate this type of learning.

Since PBL is based on real world problems that are often difficult and complex, students engage in discussions and critical thinking in every step. Because of this one would expect students acquire the practice and therefore the knowledge to solve future problems.

Basically, 7 steps and 3 documents compound PBL's methodology, as explained next.

Steps:

1. Presentation and reading comprehension stage
2. Defining the problem
3. Brainstorming
4. Classification of ideas
5. Formulating learning objectives
6. Research
7. Presentation and discussion of results

Documents:

1. Tutorial Guide
2. Scenarios
3. Assessment rubrics

2.2 Project-oriented learning (POL) [4]

Project-oriented learning seeks to train students for situations that lead them to not only understand and apply what they have learned in terms of tools to solve problems but also to be able propose improvements applicable to the communities where they operate.

This teaching strategy is an authentic instructional model in which students plan, implement and evaluate projects that have application in the real world beyond the classroom.

When using the project method as a strategy, students stimulate their strongest skills and develop new ones. They are encouraged in the interest of learning and to develop a sense of responsibility and effort.

The results of the learning process of students are not predetermined or fully predictable. This form of learning requires student´s research from many sources and disciplines that are necessary to solve problems or answer questions that are relevant. These experiences in which students are involved to learn to handle and use available resources, such as time and materials, promote they develop and polish academic skills, social and personal nature of the work through school and are situated in a context that is meaningful to them. Their projects often take place outside the classroom where they can interact with their communities, enriching all by the relationship.

The project's work distribution intent is to reduce competition among students, allowing them to collaborate rather than to compete among them. In addition, projects may change the approach to learning, leading from the simple memorization of facts to the exploration of ideas. POL's methodology has fundamental concepts and principles of the discipline of learning and selected topics based on student interest or facility that would lead to activities or results. This strategy may involve some presentations by the teacher and the student-driven work, however, these activities are not ends in themselves, but are generated and completed to achieve some goal or

solve a problem. The context in which students work is, if possible, a simulation of real life investigations, often with real difficulties to be faced with real feedback.

In summary, the organization of learning using the POL method, puts the student in front of a real problematic situation promoting learning that is more connected to the world outside school, which in turn allows one to acquire knowledge in a non-fragmented or isolated environment promoting collaborative work.

3. Collaborative Tools

The set of collaborative tools are software applications that are also called Collaborative Virtual Environments. These are information systems that integrate the work into a single project with many concurrent users at various workstations, connected through a network (Internet or Intranet) [5].

A group of people working together on a common task in the same environment using computers to generate learning is considered to be using CSCL (Computer Supported Collaborative Learning).

CSCL is a pedagogical approach where learning takes place during the interaction of team members using computational media over the Internet. This learning is characterized by the exchange of ideas to build knowledge among participants who use technology as their primary means of communication or as a common resource. Collaborative tools that have been applied to distance education could be classified into three groups:

3.1 Software applications for web conference

Web conferencing applications are useful for live meetings and presentations over the Internet with tools that facilitate the exchange of information, discussion and knowledge in an interactive (synchronous) collaboration, including:

- Data conferencing
- Conferences voice
- Conference video (or audio conference)
- Chat rooms or instant messaging
- Systems to facilitate meetings.

3.2 Learning content management systems (collaborative facilities)

These systems offer a set of functions that support the teaching activities. However, they are limited, as they do not offer full interaction like social networks or virtual rooms do. Nevertheless, these tools facilitate group activities, such as:

- Electronic calendars
- Management of projects

- Flow Control Systems Business
- Knowledge management systems
- Systems of social support networks

3.3 Generic collaborative environments

These are electronic communication tools used to send messages, files, data and documents between team members and facilitate the information sharing (asynchronous collaboration), including:

- Shared Files and Folders
- Discussion forums
- Chat
- Wikis
- Calendars
- Forms
- Track tasks and issues

Collaborative environments are organized into workspaces that activate the tools for collaboration mode according to specific needs. Among the most common tools we can find calendars, folders for storing documents, discussion forums and task management.

4. Collaborative learning architectures

The collaborative tools of the groups previously mentioned can be useful for collaborative work but these do not still provide a comprehensive collaborative virtual environment that promotes teaching and learning. It is necessary to have an architecture that integrates and administrates all these tools and functionalities. Hence, several research groups are developing architectures that can help active learning through collaborative virtual environments. Some representative works of these efforts are shown below.

4.1 Adding Process-Driven Collaboration Support in Moodle [6]

The collaborative facilities of Moodle are limited and do not ensure effective interaction among team members. Moodle in itself has no elements to identify if there exist an interactive collaboration among members, for example, how to ensure that the person interacting is indeed the one registered in the system.

In order to add this collaborative feedback functionality, Moodle involves a learning process administration through collaborative structures called “Learnflow”. This is just an extension of the information systems equivalent known as workflow.

In order to ensure effective collaboration, developers have integrated an oriented to learning activities workflow engine into Moodle. This engine's architecture has a service-oriented approach (SOA) to deal with the interaction of two information systems (Moodle and jBMP Workflow Engine). The functional control passes from Moodle to the workflow engine via Web Services calls.

The purpose of supporting collaboration through processes is to implement structures that manage the flow of activities, i.e. add functionality to keep track of team activities.

4.2 Framework for Collaborative Learning System Based on Knowledge Management [7]

According to the developers of the software, most collaborative virtual learning systems do not consider existing knowledge management for the collaborative process. Indicating that these systems have to support not only learning but also promote a gentle flow of knowledge among collaborative team members. The proposed framework integrates the technology of knowledge management into a system of collaborative learning. According to this, collaborative learning process via the Internet or Intranet can be more effective.

The framework is divided into five basic modules: Communication Tools, Knowledge Management, Workflow Management, Other Tools and an Area of Interaction / Learning. These are briefly described below.

Communication Tools. Due to the nature of the system it must provide some communication tools that meet the needs of information exchange, coordination of activities and scope of collaborative learning arrangements. These tools include, e-mail, wikis, blogs, BBS, Chat, videoconferencing, etc.

Knowledge Management. In collaborative work there is a massive amount of materials such as documents, records, web sites, repositories, knowledge flow, etc. In order to be able to mind them, one should count on tools for storing and access.

Workflow Management. This module administrates the tasks required for the teams to achieve all cooperative learning activities.

Other Tools. These are tools that assist in the analysis, semantic search and access in the material used for collaboration.

Interaction Area / Learning. It is the main area of knowledge sharing during the collaborative learning process. A typical collaborative learning process consists of four steps: question, discussion, verification and conclusion.

The developers created a prototype technology based on Service Oriented Architecture (SOA). They use J2EE technology with an application server (Jakarta Tomcat Server or JBoss), Java Server Pages (JSP), Servlets, JavaBeans and SQL 2000. Users enter the system-using HTTP through any browser such as Microsoft IE.

5. Problem

During the development of education using active learning techniques that are based on collaborative work "face to face meetings" for working sessions are necessary. Meetings are meant to share research advances, discuss the work that needs to be done and assign tasks for each member of the team based on published work to date.

However, in-person meetings are not always plausible either because there is conflict of agendas or because participants are in different and far away locations. Therefore, finding a CSCL architecture where students can interact continuously, regardless of location and also share documents if necessary, would open a great deal of opportunities for both academia and industry. In a scenario like this the teacher or group leader could have access to that system to monitor student work, communicate with them and participate in the discussion providing, where necessary, guidelines for the proper development of the project or problem depending on the case.

Even though there are several architectures for CSCL, as we have reviewed, they are still not suitable for active learning techniques such as PBL and POL. In this sense, the architecture proposed in this paper aims at facilitating the implementation of these teaching techniques.

6. ActivColLearn: An Active Collaborative Learning Architecture

For the implementation of a virtual collaborative work environment for active learning, we have initially proposed the design of an architecture based on SOA. For this, we have considered the implementation of three servers: a portal server, workflow server and repository server.

The portal server is the platform that hosts and serves a Web interface, publishing and managing content as well as adapting the view of the presentation.

The workflow server allows to structure tasks specifying how they should be performed, what their chronological order should be, how they are synchronized, how the information supporting the tasks flows and how the performance is tracked down.

The repository server accommodates the different scenarios developed by teachers as well as the activities performed and results developed by the students.

For clients considering the implementation of Web clients, smart clients (applications that allow you to work while disconnected from the server) and Web services for use by external applications are needed. A suggested architecture diagram can be seen in Figure 1.

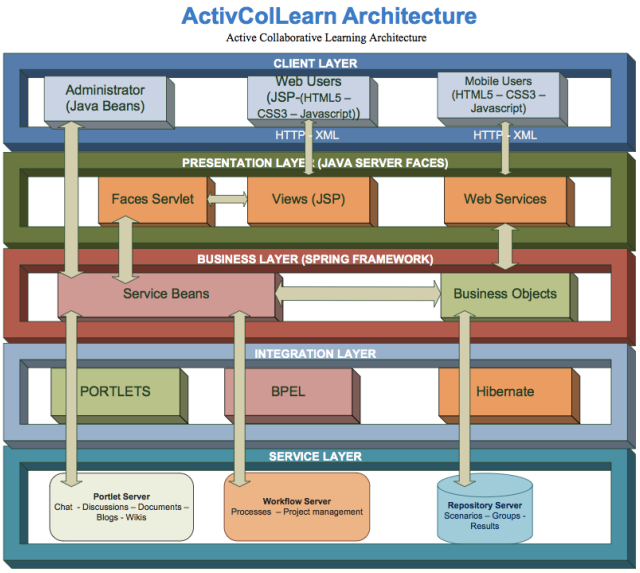

Fig. 1. Architecture Diagram

The proposed architecture is intended to provide the necessary services for remote collaboration among members during active learning work and monitoring tools to help teachers.

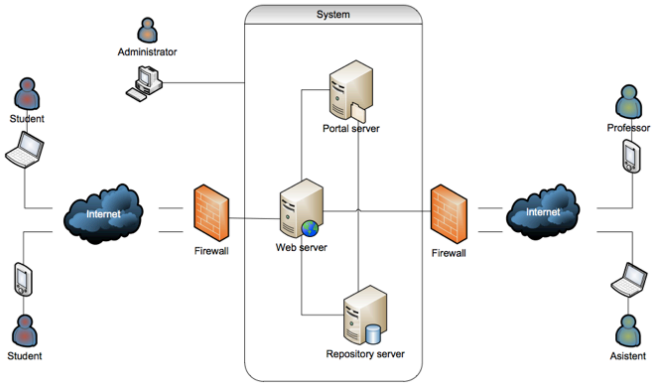

Fig. 2. Interaction Diagram

As shown in Figure 2, this architecture allows the implementation of a system that integrates collaborative, teaching, learning and monitoring activities.

The modules constituting the system will be:

1. Communication Module
    a. Collaborative tools (e-mail, Wikis, Blogs, etc.).
2. Teaching Module
    a. Problem Scenarios
    b. Reviews
    c. Intelligent system integration
3. Learning Module
    a. Managing workspaces
    b. Intelligent system for monitoring of cooperation
4. Project Management Module
    a. WBS
    b. Calendar of meetings and deliveries
    c. Workflow
5. System Management Module
    a. Defining Workspaces

Figure 3 shows a system block diagram for the proposed architecture:

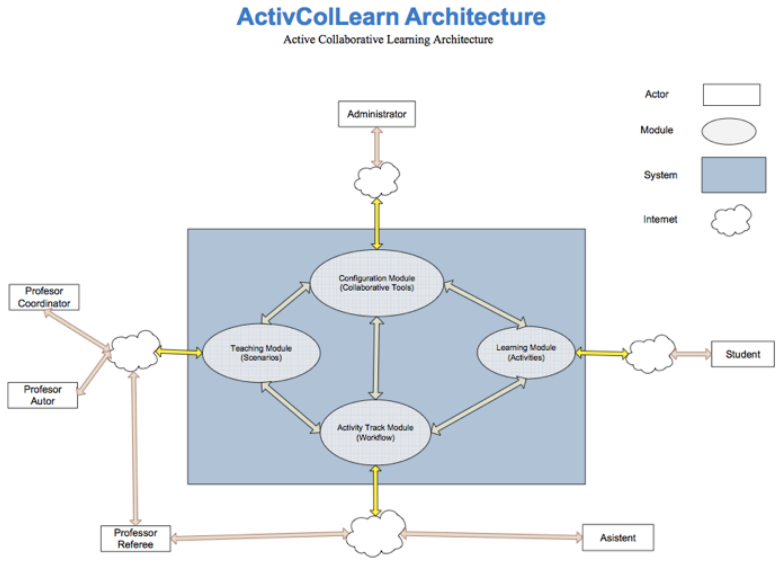

Fig. 3. System Block Diagram.

7. Discussion

Implementation of CSCL to education has not yet achieved a sufficient penetration in the learning process. One possible explanation for this fact could be that CSCL tools

are still not used at their fullest capability in terms of substituting a classroom teaching, as opposed to as an endorsement of such education. If properly applied as a support for classroom teaching, as well as with active learning activities, we believe that learning outcomes can be improved. We also consider that due to the nature of active learning techniques, they can be well adapted for the implementation of the proposed architecture.

8. Future Work

At present we have finished the basic research work and we are implementing this prototype system to work with focus and control groups of students. In a future research, we will try to improve the system and will use it in real active learning practices to assess their implications and impact on the actual student learning. In addition, we are currently working on integrating new technology and concepts into the system, such as M-Learning and Web 2.0, in order to make it accessible from different mobile devices as tables and smartphones.

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