Extending the Limits of CVE' s to Support Collaborative e-Learning Scenarios

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Abstract

This paper proposes the use of collaborative virtual environments in order to provide collaborative e-learning services in an efficient and cost effective way. On the one hand, we present the transformation of well known collaborative learning techniques to collaborative e-learning scenarios. The collaborative learning techniques, which are discussed in this paper, are brainstorming/roundtable, think pair share, jigsaw, quickwrites/microthemes, and structured academic controversies. On the other hand, we describe the necessary modifications of the collaborative virtual environments in order to support collaborative e-learning services and scenarios. Main proposals are the integration of more media to offer more awareness, the support of more people with different roles, and the definition of an integrated system architecture.

1. Introduction

It is well known that collaborative e-learning is a definite need nowadays. Much research and technological work has been done in order to support and/or to offer e-learning services. In the technological field there are technologies, commercial tools, and/or research prototypes to support e-learning [1], [3]. Theoretical frameworks and learning techniques have been presented for collaborative learning. Furthermore it is more difficult for both learners to learn and teachers to teach from distance. Thus, in order to provide collaborative e-learning services to the users in an effective way, it is needed to incorporate available or new technologies with learning theories and the user needs. Starting from the user requirements, we have realised that the main users' need is to be more aware about the actions of the rest of users in the collaborative e-learning groups. Systems, which satisfy this need and integrate the necessary tools for realising the collaborative e-learning techniques, have many possibilities to succeed. Furthermore, an effective e-learning system, which provides valuable learning experience, should combine pedagogy, learning content and community features, in an effective way [5]. If the focus is no longer content but rather the management of the learning experience, then the pedagogical process becomes the most important factor in the design and support of that experience. For this reason, this paper proposes to transfer well-known collaborative learning techniques into collaborative e-learning scenarios. In addition the emphasis of most e-learning platforms today has been on the accumulation, organization, and delivery of content. Thus, new solutions should be investigated for the contribution on the context of e-learning. The advantages of collaborative virtual environments, against the other technologies such as videoconferencing, regarding both the awareness and the collaborative features, motivate us to concentrate our research on providing collaborative e-learning services to the users using CVE's. However, CVE's cannot be used as they are in order to provide collaborative e-learning services. New network architectures should be investigated; new modules should be integrated in the CVE's in order to provide specific functionality and to exploit the main characteristics of CVE's as much as possible. In this case, the design of the 3D worlds is affected from the collaborative e-learning scenarios. For these reasons, this paper proposes some extensions in the CVE's in order to upgrade them into Educational Virtual Environments (EVE's) [2]. We initially describe the processes in order to realise these techniques using CVE's and more media.

Afterwards, we present our proposed extensions of the CVEs, and a system architecture.

2. Realizing collaborative learning techniques into a collaborative e-learning environment

The first step before the design of a system is to investigate well-known collaborative learning scenarios in order to transform them into e-learning techniques. The main collaborative learning techniques are: brainstorming/roundtable, think pair share, jigsaw, quickwrites/microthemes, and structured academic controversies. These techniques are not presented in this paper due to space limitations. More information is available at [7]. Here we present the processes in order to realise these techniques using CVE's. Before describing these processes we are describing specific functionality, which is derived from the collaborative learning techniques.

First of all, we propose the tutors and learners to use a 3D virtual classroom and supportive break-out session rooms for dividing the users in sub-groups (if the scenario requires that). The learners and tutors who participate in a virtual classroom are represented by avatars. The user's avatars should be able to make various types of gestures: expressing opinions (e.g. agree, disagree), expressing feelings, mimics (e.g. happy, sad), as well as showing actions (e.g. move learning content, pick learning content). The virtual classroom and the break-out session rooms should be supported by audio collaboration, application sharing and text chat functionality. Also they should have a specific place where the users can upload their content and show it to the other participants. This space can be a 3D presentation table. It should also provide (according to each scenario) more functionality such as shared whiteboard, or simulation of a brainstorming board. Both, the above functionality and the access rights on it, depend on the e-learning scenario. The transformation and the basic processes are described in the following paragraphs.

Brainstorming/Roundtable: The tutor asks a question using audio collaboration functionality (or alternatively text chat). Furthermore the tutor can write the question and upload it to the presentation table as a document. The learners can answer to the questions using the audio collaboration functionality (or alternatively text chat). Furthermore the learners can use the brainstorming tool in order to write and attach on it their ideas.

Think pair share: The tutor poses a question (or a problem) as a file on the presentation table or using audio/text chat and introduces the collaboration technique. After a short pause for reflecting, the learners turn into the whisper-mode with their neighbour and discuss in private the problem. Preferable way for whispering would be a private audio-channel within the classroom (audio-whisper function). Alternatively a private text chat can be used. After the assigned discussion time, the tutor gathers the attention of the learners by "ringing the bell" (sending a text message to all of the participants). At that time, the learners exit from the whispering mode, and then return to a group for discussion.

Jigsaw: The whole Jigsaw procedure can be handled within the virtual classroom, which has also 4 breakout session rooms. The tutor first introduces in short the procedure and then asks for the number of learners (good numbers are any multiple of four). For 16 learners the tutor suggests study groups of 4 and 4 sections. Then the tutor needs to formulate the sections: s/he divides the users in the sections and attaches the necessary learning content to each section. The tutor then assigns to the learners their role (group number and section number). Spontaneously, the learners will receive an automated message, which room they need to go to: there they find the section description on the presentation table and any study material the tutor might have assigned to the focus group. After that, the learners of each section participate all together in a section-shared place. The places can be virtual small classes (breakout session rooms) with audio collaboration, application, sharing, and text-chat functionality. The tutor can also assign documents to this section. These documents will be available to the learners in the breakout room. The learners can take material from the presentation table to their other session, by saving the material into his/her local PC and upload it again.

Quickwrites/Microthemes: The whole procedure for this technique can be handled within a 3D classroom, which also has 4 breakout session rooms. In the virtual classroom and the breakout out session rooms the users can use audio collaboration, application sharing and text chat functionality. The tutor presents to the learners the microthemes in the presentation table space. In addition s/he uploads and presents supporting documents on the shared space. The learners can open a notepad or other text editor for personal use; focus on the proposed documents and after completion of the assignment, can easily save their result on their local PC and upload it into the shared space. The tutor assigns to each group which themes should be discussed (2-4 persons). The learners move to the breakout-rooms pull their documents onto the presentation area, in those rooms, and discuss the outcomes. One person writes a protocol of the group discussion and saves the result back to his/her local PC and then upload it into the classrooms' shared space. The tutor can visit the groups in the breakout out session rooms and discuss the status of the work. Furthermore, the tutor has the capability to call the learners group to return back to the main classroom area, using text chat or by

visiting the breakout session rooms. In the main classroom area the groups present their results using application sharing and audio chat.

Structured academic controversies: The whole procedure for this technique can be handled within a 3D classroom, which has similarly 4 breakout session rooms in case of 16 learners. In the virtual classroom as well as the breakout out session rooms the users can use audio collaboration, application sharing and text chat functionality.

The tutor selects and uploads a topic in two different viewpoints on the presentation table. The learners form groups of 4 and divide into two pairs. Each pair goes to a breakout session room and the tutor uploads supportive documentation. Furthermore, the learners can upload their own content, which they think could be is supportive in formulating their assigned advocacy position. The pairs of learners have the possibility to visit breakout session rooms of the other pairs with the same positions. Each learner pair can prepare a short presentation using application sharing and collaboration on documents, and can upload this presentation in the original groups of four learners. Each pair presents its position to the other pair in their group using application sharing and audio chat. In this case there is no debate allowed and the tutor restricts the audio, application sharing, text chat, and gestures functionality from the opposite pair. Afterwards, the other pair presents its position, and then the learners debate and provide more evidence. Finally, learners drop their advocacy role and generate a consensus report addressing the original question posed using application sharing, collaboration on documents, and audio chat.

3. Proposed extension of CVE's

As we can realise from the above descriptions CVE' s should be extended in order to support e-learning services. Several extensions should be made in order to support a virtual e-learning community. These extensions are described in the following paragraphs.

3.1 Many people with different roles

An e-learning system should be able to be used concurrently by many users. These users should create an e-learning community. The users should have different roles and rights in this community. This implies the two following issues. The first one is that many concurrent users should be supported by the system. Actually the maximum number of participants in a course is 17 (16 learners and one tutor). This number of participants is derived from the e-learning scenarios described earlier. Furthermore the system should support many concurrent courses. This increases the number of concurrent users. The solution of this problem is to construct a virtual community of courses and learners and to assign the manipulation of groups of courses to responsible servers. Each of these servers should also be aware of the rest of the courses in other servers. Using this solution we can divide the processing load of hosting the courses and to support more concurrent courses and users.

The second issue is that the users should have different access rights on both the learning content and the levels of functionality. For example only the tutor should be able to assign the learners in breakout session rooms. This problem can be solved using customisable interfaces and 3D places according to the e-learning scenario, supported by a database which handles the users profiles. As a result we need to develop (a) templates for realising each collaborative e-learning scenario, and (b) an e-learning virtual community to support groups and sub-groups of users. This community should be supported by an extensible system architecture, which is described later in this paper.

3.2 More media - learning centric view

There are three approaches regarding CVE' s. The first one (VR-centric view) characterises CVE as systems that are based only on virtual reality and nothing else. The second approach, which is a step-up of the VR-centric view, is the mixed reality systems. In these systems the main user interface is VR and the users can interact with the system navigating only in the 3D world and accessing the rest of media only by using the 3D interface. The third approach (media centric view [8]) tends to integrate more media in a CVE system. Audio, text, documents, video, etc. are such media. However, in this approach, VR is not the access point for the rest of media, and it is regarded as one medium among the others.

Regarding e-learning the most suitable approach is the media centric view. However, this approach needs to be extended in order to realise the e-learning scenarios and to satisfy the users needs. In order to support a learning centric view we need to take into account the necessary media derived from the above-referred scenarios. Main features and media are the content (learning content), web, virtual reality, video, audio, application sharing and text chat. These media should be integrated in such a way that could help the user to learn and to use the system effectively. According to Figure 1, e-learning systems supported by collaborative virtual environments should be based on three main categories: Content, Learning Context and Communication Media. Both Web and VR are the suitable media to support the community and the e-learning context, giving the users the feeling that they are in the same place, in an easy way. Communication media (text and audio chat, application sharing, message board,

etc.) can operate as a mean to support the communication and interaction between the users. Content is the core media for learning and supporting learners to learn and tutors to teach. However in order to support collaborative e-learning effectively more tools for sharing information should be investigated and implemented, such as a presentation table where all users can present their own content and open it, view it and collaborate on it.

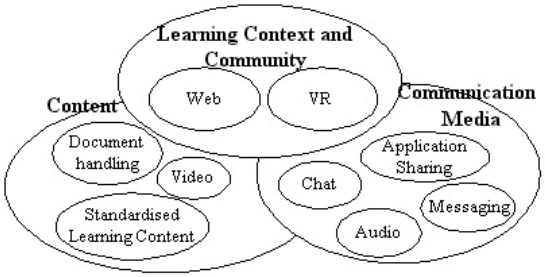

Figure 1. Learning centric view

3.3 More awareness

Not only the current e-learning systems but also collaborative virtual environments lack of awareness. There are two types of awareness: the awareness of other people and the awareness of objects. The suitable combination of these two types of awareness is very critical in e-learning environments in order for the users to be aware not only for the others and the content but also for the e-learning procedure. The target in order to satisfy the need for awareness is to concentrate on the visualization of the other users as well as the representation of their actions on objects which are common among the users. The collaborative virtual environments support the awareness of other people and their activity effectively. The avatars along with gestures and mimics represent not only the users but also they are making their activity shared to the rest of participants. In case of awareness of objects, collaborative virtual environments can support 3D objects and generally media that can be integrated in a 3D world such as pictures, audio and video. Furthermore, documents and/or learning content that cannot be displayed in the 3D should be supported in an e-learning platform. In addition, the participants should be aware of the number and identities of the users who view the document at a certain time. Also, the actions on the objects and the documents should be visible from the other users. This can be achieved with application sharing. Combining gestures, mimics, user representation, audio and text chat communication as well as application sharing the users can share their views and can show the object that they are talking about. In addition the other users can be aware about whom and for what they are talking.

3.4 More effective and user friendly technology

In order to integrate more media, people, and object in a CVE to support e-learning we can use well known technology. The issue of technology is not only what kind of technology to be used but also where and when we will use it. As we have described earlier in this paper, we need to offer e-learning services based on the learning-centric approach of a CVE. The main context would be a web/3D interface in order to offer awareness. Then we need to provide all the necessary services and tools in order to implement the collaborative e-learning scenarios. Basic services and tools are application sharing, voice and text chat, streaming video as well as users and content manipulation. Furthermore the overall solution should be characterised by scalability, consistency, openness and flexibility. The system architecture, which is shown in Figure 2, integrates the above features.

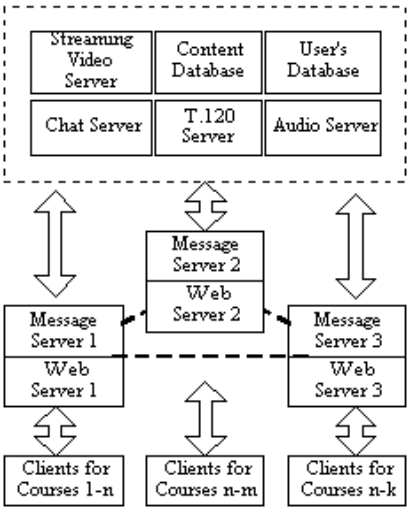

Figure 2. Proposed architecture

The basic idea of this architecture is to divide the processing load of necessary services of an e-learning platform (such as application sharing, chat and audio communication, educational content, etc.) in a set of servers aside from communication of users or management of the virtual worlds as described in other models [9]. For this reason the proposed architecture is based on the following different components: The Message Servers and the Application Servers. The message server has three main tasks: (a) to transmit virtual world content, (b) to offer scalability and stability to the system and (c) to keep the 3D world consistent by reflecting every shared event to all participants in the virtual world. The structure of an educational community implies a Virtual Environment (VE) that can be separated into smaller parts, which are VEs dedicated to a specific e-learning course. This provides a "segmentation" of the

virtual community that enables us to design a communication model that consists of a number of message servers. The message servers host the 3D virtual classrooms. Each message server is responsible for a part of the course in the 3D rooms, and in parallel can act as back-up server for the rest of them. As it is shown in Figure 2, the Message Server 1 is responsible for the clients for the first n courses, the second Message Server is responsible for the next m courses, and the third Message Server is responsible for the last k courses. The set of message servers constitutes a locus of control of the whole system. In order to provide specific functionality, we use dedicated application servers. According to previously described requirements the main applications that should be offered are text chat, audio communication, application sharing and content handling. For these reasons we use the following dedicated application servers: audio server, video streaming server, T.120 server (for application sharing), and a database for content and users' manipulation. We believe that this model is well suited for educational purposes because of the following reasons:

- It offers scalability due to the fact that the processing load is divided, and servers for additional services can be added, without affecting the end user
- It offers concerted management and authentication procedure
- Users do not have to possess excessive system or network characteristics
- There is no central point of failure
- It is flexible, because if the number of users is small, some of the servers dedicated to one service can be consolidate in a message server

The technological solutions for implementing the above described architecture and a protocol for the interaction between the components of this architecture, in order to support educational virtual environments are described in [4]. The main solutions are Virtual Reality Modeling Language (VRML) for the implementation of the 3D places and the functionality included in them. Furthermore, Java can be used in for the implementation of the message servers and the most of the application servers [6].

4. Conclusion-Future Work

In this paper we have presented the transformation of well known collaborative learning techniques to collaborative e-learning scenarios. In order to realize these scenarios we have also proposed some extensions in collaborative virtual environments based on an e-learning centric approach. As result, we can state that collaborative virtual environments have many possibilities to support e-learning communities and especially to realize effectively collaborative e-learning scenarios. This can be achieved by integrating in CVEs, supportive communication and collaboration tools and services, as well as effective manipulation of both the learning content and the users' roles and rights.

Our next step is to implement an integrated e-learning system, which is based on the proposed architecture and realizes the collaborative e-learning scenarios described in this paper. Furthermore, usability issues regarding the construction of the 3D training areas are very interesting and will be investigated after the development of the first prototype.

5. References

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