Designing Virtual Spaces to Support Learning Communities and e-Collaboration

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Abstract

In this paper, we present the design principles for virtual spaces and two different tools as solutions for supporting e-collaboration and multi-user communication in web-based learning communities. The first solution, called Virtual Conference, is designed and implemented in the framework of the VirRAD European project. It is a two-dimensional space where participants represented by their photos can use various e-collaboration tools. The second solution, called EVE Training Area, is a three-dimensional space where participants, represented by 3D humanoid avatars, can use a variety of e-collaboration tools. This paper describes the functionality provided by both tools, compares them, and proposes cases for exploiting each solution.

1. Introduction

Many tools and technologies have been developed and used for supporting learning communities and e-collaboration. The current components, tools and systems available can be divided into three different basic concepts as described in [6] and [5]: a) document-focused web-based training tools, b) meeting-focused tools, and c) 3D-centered multi-user tools.

The document-focused web-based training tools (e.g., WebCT, www.webct.com) focus on the management of documents and on individual learning.

The meeting-focused tools focalize on the support of synchronous communication of a user group, which is independent of place. These tools that can be separated into video conferencing tools (e.g., Microsoft's NetMeeting, www.microsoft.com) and synchronous training tools (e.g., Centra Symposium, www.centra.com), offer web-based communication support, where participants are represented with their name and live video picture. Some of the video conferencing tools were designed especially for the purpose of training situations. The approach of these tools is to virtually represent the concept of frontal learning. A general problem of these tools is the reduced social presence of the participants that are represented in windows, by means of live pictures.

The 3D-centered multi-user tools focus on letting each participant experience the existence and interaction of other participants. In 3D-centered tools the participants of a virtual session are represented as avatars, which can navigate through 3D environments, and all other participants can view the events of single participants as well. 3D-centered multi-user tools, used as communication media, can offer the advantage of creating proximity and social presence, thereby making participants aware of the communication and interaction processes with others.

It seems that 3D-centered multi-user tools as well as meeting-focused tools configured for e-collaboration could be used for supporting learning communities and e-collaboration. However, current e-learning applications have many limitations that should be overcome. Some of the limitations mainly involve the lack of peer contact and interaction of learners/users working alone and the need for flexible, available tutorial support. Furthermore, the main effort is focused on designing environments that could be characterized as "places" of interaction and not simple, plain spaces. Current user interfaces have been proven insufficient to enable the user to be fully creative. In the case of 3D-centered tools, the theoretical advantages of multi-user VR technology are not exploited in an extended manner as they mainly offer text chat communication and users' representation through avatars. For example, advanced communication features, as voice or user gestures are not commonly utilized.

The main goal of this paper is to facilitate the educational designers and developers by having a better basis for making decisions about whether or not

to incorporate 3D environments into the resources they develop as well as for extending their capabilities by integrating more functionality.

The remainder of this paper is structured as follows. In section 2 the design principles for tools and spaces aiming at supporting learning communities and e-collaboration are presented. Section 3 describes the functionality of a 2D tool for e-collaboration called VirRAD Virtual Conference. Section 4 is dedicated on the functionality of EVE Training area, which is a 3D centered multi-user tool offering similar functionality with VirRAD Virtual Conference. Following this a comparison between the above tools is elaborated taking into account the main principles presented in section 2. Finally, some concluding remarks and planned next steps are briefly described.

2. Design Principles

This section presents the design principles that should be taken into account by designers and developers when they are designing a virtual space for learning communities and e-collaboration.

In order to implement a functional and effective e-learning collaborative virtual environment, the first step is to investigate its main functional features. These functional features should differentiate an e-learning and collaborative environment from other virtual environments (3D or not), which are designed and implemented for general use. The virtual spaces should be designed according to the concepts introduced by Dourish and Harrison [1] about space and place: "A space is always what it is, but a place is how it's used". In addition, according to [1] we have to deal with some aspects of the "real world" which can be exploited by virtual spaces for collaboration and learning. The real-world value of the features listed below is that they provide critical cues, which allow individuals to organize their behavior accordingly (such as moving towards people to talk to them, or referring to objects so that others can find them). Every tool designed for supporting e-collaboration should exploit aspects of space and spatial mechanisms, such as providing identity, orientation, a locus for activity, and a mode of control, which can be considered as powerful tools for the design. These aspects are:

- Relational orientation and reciprocity: The spatial organization of the tools should be the same for all participants. Since people know that the world is physically structured for others in just the same way as it is for them, they can use this understanding to orient their own behavior for other people's use.
- Proximity and activity: People act, more or less, where they are. They pick up objects that are near, not at a distance; they carry things with them; and they get closer to things to view them clearly. An understanding of proximity helps relating people to activities and to each other. The learners/collaborators in the environment should not be passive, but should be able to interact.
- Partitioning: Following on from the notion of proximity and activity is a notion of partitioning. Since actions and interactions fall off with distance, this distance can be used to partition activities and the extent of interaction.
- Presence, awareness and support of users' representation: The sense of other people's presence and the ongoing awareness of activity allow them to structure their own activity, integrating communication and collaboration seamlessly, progressively and easily. The environment could be populated by concurrent users, who could be represented in the environment. The use of avatars (3D or 2D) for user representation in virtual environment is a key feature for supporting e-collaboration and collaborative e-learning. Therefore, it might be useful to represent the users by avatars that can support mimics and gestures, in order to support virtual and social presence as well as to enhance the ways of communication among the users with non-verbal communication.

Additional design elements of a virtual space, which is focused on e-collaboration and e-learning could be extracted by a generalization of the design elements presented in [6] (that are targeted on collaborative e-learning using only 3D virtual environments) and based on Dillenbourg's interpretation of collaborative learning [2], and Moshman's interpretation of dialectical constructivism [3]. These design elements are the following:

- Situated remote communication by supporting multiple communication channels such as avatar gestures, voice chat and text chat.
- Remote task collaboration: Distributed environments allowing the users to collaborate on tasks. This design element could be realized by:
    - Tools such as: shared objects, brainstorming board tool, locking /unlocking shared objects, user handling, as well as slide presentation and creation.
    - Supporting users who have different roles and rights when visiting the environment.
- Remote task support: Remote support by other learners, teachers, moderators and participants. This design element could be realized by uploading material in the virtual space and data sharing.

• Scaffolding tools: Tools that can support collaborative scenarios as well as to support the learners to undertake tasks in the virtual space. This design element could be formed by whiteboard, brainstorming and slide creation tools. For example the whiteboard tool could support the learner in making a presentation of a task that s/he has been undertaken. Similarly, both the brainstorming tool and slide creation could support the learners to exchange and collect ideas for a task that has been assigned to them by the tutor.

• Representation of the environment by various representation forms, which can range from simple text to 3D worlds.

3. VirRAD Virtual Conference Tool

This section presents the Virtual Conference (VC) tool, which has been designed and implemented in the framework of VirRAD (Virtual Radiopharmacy, http://www.virrad.eu.org/) European project. VirRAD is concerned with section III.2 of the IST 2001 work program "Education and Training". The general aim of the VirRAD environment is to provide a sustainable, user-driven web-based interface, which supports communication between all members of the worldwide Radiopharmaceutical community. The final prototype of the VirRAD system is available at http://community.virrad.eu.org.

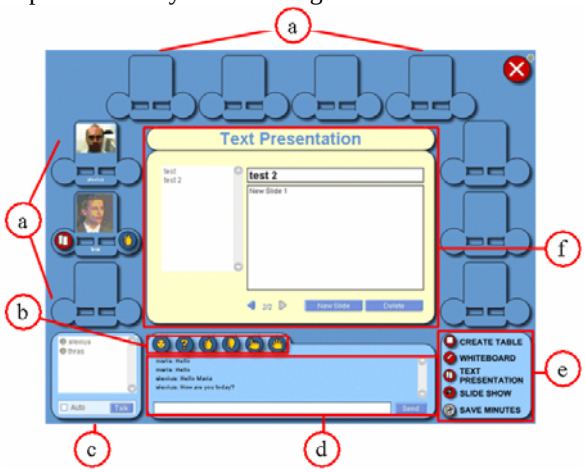

Figure 1: The Virtual Conference Room

The Virtual conference tool, as part of the VirRAD environment, has been designed and implemented in order to support virtual collaborative sessions supported by audio and text chat. The interface of the Virtual Conference tool is divided into six (6) areas as it is shown in Figure 1. These areas are:

• Collaborative Area (Figure 1f), where the users can share applications such as Share Whiteboard, Slide Show and Prepare Slides with other participants. The "shared whiteboard" tool supports the user in making various actions such as: to write text, draw lines/arrows, draw a rectangle, erase an object in the whiteboard, resize an object in the whiteboard and change colors. The “slide show" tool could be used for making shared Macromedia flash presentations. The “prepare slides” tool supports the users to collaboratively create an on-line presentation by using various features such as: viewing of ready slides, shared navigation, creation and deletion of a slide.

• Text Chat Area (Figure 1d), which provides to the user the opportunity to send and receive short messages to and from other members of the community respectively.

• Voice Chat Area (Figure 1c), where the user has the ability to talk with other members of the community.

• Gestures Area (Figure 1b), where the user can select an icon gesture (i.e. agree, disagree, bye, etc.) so as to make the conversation with other members more efficient and realistic. The gestures appear next to the member’s avatar image (Figure 2c).

• User Representation Area (Figure 1a), where a photo represents each user. Further features in this area inform the other participants about the shared tool that the user currently uses (Figure 2a and Figure 2b) as well as about her/his feeling represented by an icon-gesture (Figure 2c).

• Sharing Applications Area (Figure 1e), where the user can select an application (whiteboard, slide show and prepare slides) s/he want to share with other participants. In addition the last user who has remained in the virtual conference room has the ability to save the log files/minutes of the chat for the conference session.

a b c

Figure 2: User representation area

4. EVE Training Area

The EVE Training Area (http://ouranos.ceid.upatras.gr/vr) is designed and implemented in order to host synchronous e-learning and e-collaboration sessions. It combines 2D and 3D features in order to provide the users with the necessary communication and collaboration capabilities. The main feature of the EVE training area is the 3D representation of a multi-user virtual

classroom. The user interface of the training area is depicted in the Figure 3. The participants in the virtual classroom could have two different roles: tutor (only one participant) and students.

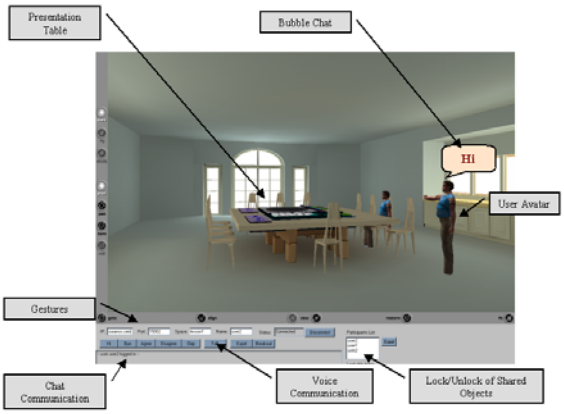

Figure 3: User interface of the training area

The users that participate in the virtual classroom are represented by humanoid articulated avatars, which can support animations (such as walking and sit down) and gestures for non-verbal interaction among the users. EVE's avatars support functions for not only representing a user but also for visualizing his/her actions to other participants in the virtual space. Available functions in EVE Training area are: Perception (the ability of a participant to see if anyone is around); Localization (the ability of a participant to see where the other person is located); Gestures (representation and visualization of others' actions and feelings. Examples are: "Hi", "Bye", "Agree", "Disagree", and "Applause"); Bubble chat (when a user sends a text message, a bubble containing the message appears over his/her avatar).

The virtual classroom is supported by various communication channels such as (a) audio chat, which is the main interaction channel, (b) 3D text/bubble chat, (c) non verbal communication using avatar gestures in order to provide a more realistic interaction among users, expressing, when needed, the emotion of each one to the others [7].

Furthermore, EVE Training Area supports manipulation of users and shared objects by integrating two specific tools: (a) expel learner/participant and (b) lock / unlock objects.EVE Training Area integrates a "presentation table", which is the central point in the virtual space, in order to provide specific collaboration tools. Using the functionality of this table the users can present their slides and ideas, can comment on slides, upload and view learning material as well as to view streaming video. The avatars of all participants in the virtual space can have a sit next to this table, viewing not only what is presented on the table but also the other participants. Furthermore, the user can change his/her viewpoint in order to zoom in and out on the presented material. The presentation table has the following functionality:

- 3D Whiteboard: The 3D whiteboard supports slide projection, line, circle and ellipsis drawing in a wide range of colors and text input in many sizes and colors. It also offers "undo last action" capability as well the erasure of all previous actions on the whiteboard.
- Brainstorming Board: The brainstorming board can be used in a range of collaborative learning techniques in order for the learners to present their ideas in a structured way. The users can create cards in three shapes (rectangle, circle and hexagon) and five colors attaching text on them. They also can move and delete a card.
- Video presenter: Video presenter is used in order for the user to attend streaming video presentation/movies inside the 3D environment. The users have the capability to start and stop the movie. Supported formats are rm mpeg, and avi.
- Library with drag and drop support: The users have the capability to drag and drop learning material on the table. This material is represented as a small icon on the backside of the table. When the user clicks on the icon and the corresponding file is opened either on the whiteboard (if the corresponding file is picture or VRML object), on the video presenter (if the corresponding file is a rm, mpeg or avi) or on a new pop-up window (if the corresponding file is not supported by the VRML format).

5. Comparison

In this section a comparison between Virtual Conference and EVE Training Area is elaborated taking into account the main principles presented in section 2. According to Table 1, where the comparison is summarized, it is clear that on the one hand, the EVE Training Area supports almost all the previous defined design elements and on the other hand the Virtual Collaboration application provides the necessary tools for collaboration and interaction but offers limited support for spatial metaphors in a virtual collaboration space. These limitations arise from the two dimensional substance of the Virtual Collaboration tool.

Therefore, the main result of this comparison is that even if the use of virtual reality technology is not a required feature a priori, it seems that the use of collaborative 3D virtual environments and humanoid

avatars along with supportive communication channels fit well as a solution for virtual collaboration spaces.

Design principle	EVE	VirRAD VC
Relational orientation and reciprocity	Yes	No
Proximity and activity	Yes	Partially
Partitioning	Partially	No
Presence, awareness, users representation	Yes	Partially
Situated remote communication	Yes	Yes
Remote task collaboration	Yes	Yes
Different roles & rights	Yes	No
Remote task support	Yes	Yes
Scaffolding tools	Yes	Yes
Various representation forms	Yes	Partially

Table 1: Comparison of Virtual Conference and EVE Training area

Humanoid avatars are a unique solution that 3D-centered tools offer to group communication and learning. It is a fact that persons participating in the virtual learning experience with human like full-body avatars feel more comfortable than in chat or audio-communication [6]. The main benefit of the avatars is the psychological feeling of a sense of 'presence'. The sense of 'presence' results in a suspension of disbelief and an increase in motivation and productivity [6]. There are a number of important attributes to this experience. The ability to make basic gestures along with a voice or text message strengthens the understanding of the communication context [4]. This feature is partially supported by the Virtual Collaboration tool but it is limited due to the fact that there is no support of relational orientation and reciprocity. Therefore, due to the fact that the user's awareness of the spatial proximity and orientation of others has a strong impact on the dynamics of group communication [4], we could say that 3D multi-user virtual spaces are more suitable for supporting learning communities and e-collaboration. In such an environment users feel as though they are working together as a group and tend to forget they are working independently.

A general problem of meeting focused tools, such as Virtual Conference tool, is the reduced social presence of the participants that are represented in windows by means of live pictures or photos. Thus, participants are rather given a feeling of distance than a feeling of proximity and group awareness.

The main advantage, of Virtual Conference tool is the limited requirements in terms of network bandwidth needed for participating in a collaborative session. Furthermore, the development of the Virtual Conference tool is not so time consuming as EVE three-dimensional space.

6. Conclusions and Future Work

This paper presented the design principles for virtual spaces and two different tools as solutions for supporting e-collaboration and multi-user communication in web-based learning communities. The comparison of these tools verifies that 3D multi-user virtual spaces are more suitable for supporting learning communities and e-collaboration. Concerning two-dimensional virtual places, we propose to use them for supporting virtual communities where the spatial metaphors and virtual presence is not a major requirement and also when there are budget and network bandwidth limitations.

Our next steps, concerning 3D virtual environments, are to support tele-presence in terms of haptic interfaces and holograms.

7. References

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