Social Awareness Mechanisms in Educational CVEs: Towards a New Characterization Framework

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ABSTRACT
In this paper, we look at how Collaborative Virtual Environments (CVEs) can support socializing and social awareness. We characterize educational CVEs in terms of learner, place and artifact and discuss corresponding social awareness mechanisms. To the end, we provide a background for a more generalized characterization framework.

Keywords
CVEs, social awareness mechanisms, characterization framework

1. INTRODUCTION
3D Collaborative Virtual Environments (CVEs) have promising potential for supporting socializing and learning in a university context because of their capability to provide a social arena where students and teachers can meet overcoming the barriers of the physical world [10]. In addition, the virtual space provides a dynamic and flexible environment where learners, especially distributed ones, can have and share experiences, forming the environment according to their needs. Therefore, we suggest using 3D CVEs for supporting social awareness (SA), which, we believe, can be beneficial for learning and socializing among university students (as learning is essentially a social activity). We define SA as awareness of the social situation in a group or community in a shared environment, including knowledge on learners’ resources, activities and social network. Short-term SA is awareness of a social situation at a certain moment. Long-term SA is awareness of the social situation in general.

To structure the discussion around the SA mechanisms offered by CVEs, we propose a characterization of CVEs inspired by the Activity Centered Design model [3], as it emphasizes the social nature of learning. In the center of this model are activities at different times. Around the activity, there are collaborative students groups, artifacts to mediate learners’ activities, and teacher (or more capable students). With time, learners progress through different activities as they move along their learning and participation trajectories. In accordance with this model, we need a CVE to provide a framework around an activity at a certain time. Therefore, we suggest to characterize the CVE, in which this activity takes places, in terms of learner, place where activities take place and mediating artifacts. The SA mechanisms offered by CVEs can be classified according to these dimensions. CVE applications are based on the same general awareness mechanisms as other CSCW applications (see e.g. [4]). In addition to the basic awareness mechanisms, more “high-level” mechanisms are needed to support social and learning activities, based on the low-level ones. Section 2 will therefore provide an overview of the 3 dimensions in educational CVEs and of associated high-level SA mechanisms, primary and secondary ones. The primary mechanisms for each dimension are structured according to the major dimensions of SA: resources, activities and social network, short-term and long-term SA. The secondary mechanisms provide support for the primary ones. Different elements of CVEs can be associated to primary or secondary mechanisms, or both, depending on the situation and context. Some of the elements presented in this section, are already discussed in [11,12], so here we present the latest and most structured characterization. The paper is concluded by Section 3, containing the discussion of this characterization framework and suggestion for a new, more unified and generic one.

2. SOCIAL AWARENESS MECHANISMS IN EDUCATIONAL CVEs
2.1 Learner
The learner is the user of the system. Elaborating on the classification proposed by Dickey [2] for users, the following main elements for constructing learners are identified: presence, embodiment and identity.

Presence. Hindmarsh et al. [5] distinguish between personal, social and environmental presence. Personal presence is defined as the extent to which one feels as if they are in a virtual world [5]. Social and environmental presence is defined, on the other hand, as the extent to which other beings in the world and the environment itself appear to exist and react to the user and his actions [5]. The sense of social presence can be supported by for example providing a list of persons online and indicating the mutual distances between users’ avatars, their position, orientation and grouping [7].

Embodiment. User embodiment is concerned with the provision of users with a representation to make others and themselves aware of their presence in a virtual space [9]. An important part of human communication in the physical world is body language like gestures and body postures, facial expression, direction of gaze [13], as well as clothes and make-up. Embodiment can be supported in different ways: choice of avatars, body language, as well as navigational and observational possibilities [2];
• **Avatars** represent the identity of users, their status and their accessibility [13]. The choice of avatars, functionality and modification possibilities vary among different systems.

• **Body language.** Some of CVEs, like Active Worlds, offer a number of predefined gestures like WAVE and DANCE. Mimics and gestures can be generated from audio channels (Onlive! Traveler) or key words in chat, e.g. LOL [13].

• **Navigation.** Depending on the embodiment chosen, the user can have different possibilities for navigation, like “drive”, “walk”, “fly” and “teleport”. In additional to the movement analogous to that in real life, the user can move along the topological ties in the space, for example following a link.

• **Observation.** In some systems the user is capable of observing the world from the 3rd person perspective, viewing different parts of the world from various altitudes, or acquire individually tailored views [8].

**Identity** is often tied to a user nick, avatar or a unique user number. It is primarily expressed in terms of communication and social reputation and created artifacts.

• **Communication and social reputation.** The identity is often associated with a reputation, a place in the social hierarchy in the virtual world [6] and to a significant degree is constructed through communication [1].

• **Created artifacts.** In many CVEs, identity is tightly coupled to the artifacts the user creates, such as personal pictures, houses, signs and links. Co-construction of environment is an important way of identity construction [15].

The learner dimension can therefore provide the following mechanisms for supporting SA among university students:

• **Resources:**
  o **Short-term SA.** Learners can express and obtain awareness of the each other’s resources by choice of avatar and real-time communication. For example, students can use an avatar such as “teacher” or “child” according to their level of expertise.
  o **Long-term SA.** Created artifacts (e.g. links to project files) and communication history (chat records of discussions) can also provide awareness of their skills and knowledge.

• **Social network:**
  o **Short-term SA.** The sense of presence, communication and embodiment can provide awareness of social network at the moment. This can e.g. be done by indicating who is around (overview of the avatars), whom they are talking to (grouping of avatars), and gestures made by the avatars. Also, students in the same group may use similar avatars and express social relations “verbally” through chat, e.g.: “We are going to the movies tonight”.
  o **Long-term SA.** Long-term awareness mechanisms include expression of social belonging through records of conversations and created artifacts, either explicitly, for example via a sign with a text (“I am in group 5”) or implicitly, by for example positioning of a virtual flower in a friend’s house.

• **Activities:**
  o **Short-term SA.** The awareness of activities can be achieved through observing directly what avatars are doing, who is participating and what they are talking about. For example, one can see who is gathered in a virtual meeting room (sense of presence and embodiment) and follow their communication and movements.
  o **Long-term SA.** One can also reflect upon information expressed in conversations or left in artifacts by users, for example a log of the meeting where a project was discussed, or a sign with the division of project tasks.

• **Secondary mechanisms for SA support.** Awareness information can be collected and expressed by choosing appropriate embodiment (“a bird”) with associated navigation functionality and thus easily moving between different awareness regions. The environment can also provide overview by mechanisms unattainable in real world such as a “sky view”. Personal and environmental presence also facilitates collection of awareness information as it makes being in the virtual world more realistic.

### 2.2 Place

The notion of place is important for SA support as the place has an important social function and provides a background for social events, user embodiments and artifacts. Virtual places can be classified along the dimensions outlook, structure, and role:

• **Outlook.** By the outlook of a virtual environment we refer to how it “looks like”. The design could be quite abstract or, on the contrary, seek to recreate a certain place as closely as possible, for example a campus or a building.

• **Structure.** By the structure we understand the mutual relations between different parts of the virtual environment, for example the mutual position of rooms within a virtual campus or the spatial organization of buildings in a 3D world. The structure can be predefined or created and modified by the users. Places can be structured both physically and topologically (through links), providing different possibilities for awareness management.

• **Role.** CVEs can play a number of roles, such as a meeting and working place [10, 15], an information space for accessing and sharing information [8], an environment for simulations and demonstrations of scientific concepts and art, and an arena for role-playing and story-telling. A CVE can have one major role or several overlapping, interleaving roles, intended by the designer or introduced by the user.

The place dimension can therefore support SA in following ways:

• **Resources:**
  o **Short-term SA.** is not very relevant in this context as examining and creating places (e.g. a house) to reveal and signalize resources is too time-consuming and therefore ineffective in the short-time perspective compared to signalizing such awareness through avatar, nick and chat.
  o **Long-term SA.** The design (outlook) of place can provide awareness of resources of the creator. For example, the complexity and design of a building may reveal the student’s mastering of a particular building toolset, general skills in design and architecture, areas of interest and expertise (e.g. place is formed as a spaceship).

• **Social network:**
  o **Short-term SA.** Place can play different roles and thus serve as an arena where mutual positions and orientations of the learner’s embodiments provide awareness of their availability and mutual social relations and social network. For example, two student avatars are standing together
apart from the others, indicating they are engaged in a private conversation.

- Long-term SA. Place can provide long-term awareness by its structure and outlook, such as by showing the borders between different group areas. For example, we can assume that students building their virtual houses with similar design or outlook and closely together are connected to each other in real life as well, such as being friends or a part of one working group.

- Activities:
  - Short-term SA. Place enhances awareness of up-to-moment activities by providing a framework for chance encounters and communication similar to what learners can experience in real life. To accomplish this, the virtual place can play a corresponding role, such as a meeting place or a virtual stage. For example, in a common meeting place, a user may bump into another user, observe what he is doing and start a conversation.
  - Long-term SA. Places can also provide awareness of past activities, both social and educational, as these activities leave their traces in the place and form it, modifying its role, outlook and structure. For example, students build collaboratively an "exhibition" hall for their project, so visitors can see how far they have come and what their project is about.

- Secondary mechanisms for SA support. The structure and outlook of places and its components can provide clues and functionalities for navigation and possible actions. For example, a user can see what is in his "line of sight" and in what direction he should therefore go. Constructions created by other people, such as buildings, virtual bridges and "teleportation" links suggest directions to follow, thus supporting social navigation [7]. Places of different types ("private" houses, "meeting" rooms) with associated facilities suggest the way to use these places and activities that can be hold there.

2.3 Artifact

An important aspect of interacting in the CVEs is manipulation of artifacts. When artifacts are shared, they become both the subject and the medium for communication [14]. Artifacts can serve communicational purposes (thus mediating awareness information) in following ways:

- Reflecting activities. An artifact can provide information about the activities performed on it. For example, users can observe the modification of the artifact directly, either in real time (animation of other users’ actions on artifact, pointers with the name of the modifier, highlighting etc.) or post factum, by reflecting on the change in the parameters (position, color, attached text etc.).

- Reflecting learners. An artifact can reflect the identity of the learner performing the activities. This information can be provided directly by observing avatars performing actions on artifacts or through its parameters, e.g. by leaving records on the artifact with the information on who changed it and when or positioning it in one’s house.

- Appearance and functionality. Artifacts can have different appearance and look like everything from whiteboards, 3D models of human body to documents and virtual furniture. Artifacts can also have different functions, such as serving as a web link or moving when activated. The appearance can in many cases be connected to the functionality, for example, an artifact that looks like a sign, has the ability to display text.

The artifact dimension can support SA in following ways:

- Resources:
  - Short-term SA is not very relevant in this context as examining and creating artifacts reflecting resources (e.g. a sign with corresponding information) is rather time-consuming and thus ineffective in the short-term perspective compared to e.g. direct communication.
  - Long-term SA. Artifacts can mediate long-term awareness of the resources (identity, knowledge, skills etc.) of the learners who own or change the artifact by reflecting their identity and activities. It can for example be done through user identification on the artifact such as nick (reflecting learners). It can also be done through the appearance of the artifact (picture of a UML diagram, indicating some expertise in UML), attached text (stating the programming skills explicitly), web links on the artifact to project documents or summer jobs (reflecting activities).

- Social network:
  - Short-term SA is not very relevant in this context as examining and creating artifacts reflecting social network (e.g. teleportation links connecting friends) is rather time-consuming and therefore not very effective in the short-term perspective compared to e.g. taking a glance at grouping of the learner avatars.
  - Long-term SA. Artifacts can mediate long-term awareness of the social network around the owner/creator by reflecting his/her identity and activities (thus indicating collaboration partners). It can e.g. be done by the artifact’s position (for example, located in the working group 5 area), the contained links (to friends and partners) and by traces of several people collaborating on it (such as user names of the students creating a virtual project presentation together).

- Activities:
  - Short-term SA. Artifacts can mediate short-term awareness of activities performed by the learners in real-time by synchronously changing their status and parameters such as shape, size, text. For example, one user can watch as another user creates a virtual house wall (and thus is building a house at this moment), thus reflecting his activities.
  - Long-term SA. Artifacts can convey long-term awareness of activities by keeping traces of activities in terms of permanently changed status and parameters. A user can find a new message on a white board left by another user before, for example "Who knows the answer to exercise question 27", indicating that this user is working on this question. Artifacts can also contain explicit references to activities such as links to projects in progress and logs of group discussions (reflecting learners and activities).

- Secondary mechanisms for SA support. Artifacts can provide functionality for a number of learning and social tasks. Examples include an online textbook or a set of lecture notes, a sign where a student can leave a question to the teacher or a picture holder to put in a party picture. Artifacts can encourage to collaborative and more effective usage by
indicating what tasks they can support: for example, signs for filling in text or leaving messages with attached explanatory text ("put your comments here") or links indicating by appearance what they are leading to (a “computer” with a link to computer science project).

3. DISCUSSION AND CONCLUSIONS
The characterization of CVEs presented above, provides a way for presenting and structuring social awareness mechanisms in CVEs. However, there is a need for a more unified characterization for the 3 dimensions. There are two main reasons for that. First, the 3 dimensions are tightly connected and interleaved, such as the learner and associated artifacts and the places and artifacts it contains. Second, as we have already argued in [12], virtual places and the user representation (avatars) in CVEs can in many cases be though of as artifacts, or tools for mediating human activities. This is because both virtual places, avatars and abstractions such as place in the social network can be easily and flexibly manipulated and altered as opposed to “real-life” places and appearance. Therefore, we suggest to extend the characterization used for the place dimension (outlook, structure and role), as the most generic one, to the 2 other dimensions:

For the place dimension the characterization is mostly the same. Structure dimension is extended to include the connection of different elements of place, including artifacts, contained in the place, traces left by users and parts of the place occupied by different users.

For the artifact dimension, the outlook will indicate the way it looks like, reflecting its creators and their activities and indicating functionality, such as a virtual sign displaying a message (functionality) about a planned meeting (reflecting activity) from its organizer (reflecting activity performer). The structure of the artifact may consist of “visible” connections between parts, such as graphics, text and smaller artifacts within the complex artifact (e.g. announcement board with a wall and individual announcements). In addition we can have invisible links such as teleportation and functional links (actions on one artifact propagate to another, e.g. pressing a virtual button open a virtual door). The artifact structure also includes more abstract connections to parts of user identity (e.g. the person or a group of persons who created the artifact and its parts, logical connection between artifacts created by the same user). The creation and visualization of all these connections requires a corresponding functionality, such as movement of artifact parts or programming links. Artifacts can also play a number of roles (decorative, link to context. The different roles and associated tasks are supported by the corresponding “privileges” and functionalities such as observational and navigational possibilities and personal and environmental presence.

In the discussion above we have tried to unify and refine the characterization of CVEs suggested earlier. Future work in this context will be adopting the new characterization framework for a more in-depth discussion of SA mechanisms supported by CVEs, as well as their educational potentials.

REFERENCES
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