Issues in Implementing Awareness in Collaborative Software for Blind People

Jaime Sánchez and Nelson Baloian

Department of Computer Science, University of Chile
{jsanchez, nbaloian}@dcc.uchile.cl

Abstract. There is no doubt among the members of the CSCW community that awareness is a key issue in the design of successful collaborative software. In many systems awareness mechanisms have been implemented through displaying graphic information over the system's interface. However, this strategy does not apply when the end users of the system are blind people. In this work we report the problems we encountered when implementing a collaborative game for supporting the learning of music and sound by blind people when trying to develop effective awareness mechanisms. The preliminary results have helped us to be "aware" about some characteristics awareness mechanisms should have for blind people which are not as prominent and problematic for sighted people.

1 Introduction

Many authors recognize that awareness is a cornerstone for designing effective collaborative software. One of the main goals of awareness is to give relevant information to the participants for the completion of a shared task (Gutwin and Greenberg, 1996). This has been recognized as a key issue to help participants to shift from working alone to working together (Collazos et al., 2002). Borges & Pino (1999) also mention that awareness mechanisms are crucial for group interactions. In another work, Gutwin and Greenberg (1996) state the importance of the awareness mechanisms to give up-to-the–minute knowledge of the situation, since most of the collaborative systems implement dynamic changing workspaces. In most cases, the awareness information is given graphically. However, graphical information is obviously not suitable for implementing awareness in groupware for blind people. Although there have been many efforts made for implementing Computer Supported Learning software for blind people, there is almost no information about the development of collaborative software for them. An exception is the work reported in (Sánchez et al., 2004) which presents a game involving sighted and non-sighted people. However, we think that people with visual disabilities can benefit as well as sighted people of this kind of software, not only for learning a certain subject matter such as mathematics, geography, and physics but also for developing their collaborative skills. In fact, traditional education for people with visual disabilities is aimed at developing individual skills only.

Software for people with visual disabilities tends to transform graphic information to a haptic format or audio. AudioDoom (Lumbreras & Sánchez, 1999) allows blind children to explore and interact with virtual worlds by using spatial sound. The game was based on the traditional Doom game where the player moves through corridors discovering the environment and solving problems simulated with objects and entities that inhabit a virtual world. This proved that sound-based virtual environments can help to develop tempo-spatial cognitive structures of blind children. Roth et al., 2000 presents a game for audio concentration. It consists of pairing different levels of geometric figures, basic, and derives. They constructed a bi-dimensional sound space to represent geometric figures graphically. This concept allows graphic representation such as icons to be represented by the perception of moving sounds in the spatial plane. Morley et al. (1998) through the use of non-speech sounds in a hypermedia interface observed that blind users developed special way of navigating through a known environment and represent spatial structure with cognitive difficulty. VirtualAurea (Sánchez, 2002) is a spatial sound tool editor that can be used by parents and teachers to design a wide variety of spatial maps such as the inner structure of a school, classrooms, corridors, and diverse structures of a house. Users can integrate different sounds by associating them to objects and entities in a story. Ressler & Antonishek (2001) designed integrated active tangible devices such as forcefeedback with a synthetic environment to support collaborative interaction between users.

Since there have been very few developments in collaborative software for blind people we refer to awareness issues developed by authors of software for sighted people. However, we think that if the way of implementing awareness for sighted people may be not feasible for blind people, the principles remain almost the same especially those referring to the knowledge users need to be able to collaborate in a better way. Awareness has been defined as "an understanding of activities of others, which provides context for your own activity" (Dourish & Belloti, 1992). It is especially important to remember that "awareness is a state of mind of a user…while awareness mechanisms are techniques employed by a system to achieve this state of mind" (Sohlenkamp, 1999).

Examples about how graphical information has been used for implementing awareness in CSCW system can be seen at (Gross & Prinz, 2003) and (Moran and Anderson, 1990). However, sound has already been used successfully for implementing awareness in systems for sighted people as reported in (Isaac et al., 2002) and (Cohen, 1994).

In this paper we describe software that implements a collaborative game for people with visual disabilities. We focus the description of this software on problems we found while trying to implement awareness in collaborative software for this type of users. We present our preliminary work on the awareness issue for collaborative software for blind children by highlighting the "awareness" issue in the community.

2 Camino Musical (Musical Path)

In the design of the game participated experts in education of people with visual disabilities. They elaborated the metaphor of the game in order to motivate the students. The metaphor is inspired in the life of Beethoven. The scenario of the game is the year 1826 when the musician suffers a pneumonia which triggers health difficulties. The players must help him to keep his music alive and learn about the musician. They have to try to reproduce his music with different instruments by recognizing different basic parameters of the sound: 1) tone, which corresponds to the note of the sound played by an instrument, 2) duration of the sound 3), volume (high, medium, low), and 4) instrument. Thus, the software teaches the user notions of rhythm and musical scale.

The game starts with the participants choosing their instruments. There are a number of instruments available and everyone has to choose a different one. If an instrument is chosen by one player it cannot be chosen by the others. The rest of the game is divided in two stages in which the players have to recognize the properties of a sound played by the instrument they have chosen. As they progress recognizing the properties of the sounds listened (like, tone, volume, and duration) they add more notes to the melody supposed to be reconstructed in order to play it with the rest of the group. They will have to recognize only one property of the sound in the beginning and more than one at advanced stages.

As soon as the instrument responds to questions learners can hear its improvements and suggest changes through face-to-face dialogs in the case they are playing in the same room. A virtual chat based on voice communication is still not implemented at this stage of development.

The first stage considers three types of questions: to recognize the intensity of sound, to recognize the pitch of the sound, and to recognize both parameters simultaneously. Sounds in this stage correspond to only one musical note. The second stage is conformed of recognizing rhythmic series. The goal in this stage consisted of learners to identify time (semibreve, half note, quarter note, and quaver) within a musical fragment. While learners recognize figures they have to place them in the corresponding order within the composition in such a way that they play in the same order as in the example provided.

At this stage the control panel is conformed of four time figures. They are placed on the inner border of the screen. The associated sounds to each figure are the interpretation of the figures performed by the selected instrument (by the learner) from the beginning of the game.

3 Awareness Issues in Collaborative Software for Blind People

The provision of shared virtual spaces is considered a facilitator of diverse processes between people that work in groups because it supports externalization that plays an important role in the organization and knowledge creation. This implies to support the transition from the tacit and individual to the group. As we stated above awareness mechanisms mostly implemented through visual elements are not effective in cases were users are blind. In such a case these interface awareness elements should be implemented through sounds.

Our application considers that relevant information for a user concerning the other users refers to what instrument others have chosen, in what stage of the software are them, when a player chooses an instrument, and when the player is focused on to perceive. A possibility is to provide sound-based information each time a change happens, that is, when a player choose an instrument and when passes through another stage. However audio information received when state changes are happening may have at least three drawbacks: First, the opportunity of the information. Audio information can arrive when the player is centered on to perceive other sounds then the information can be unnoticed or may alter the work on sound recognition. Second, the retention of information. Due to the fact that this information is volatile it could be not correctly retained by the player. Then it could probably happen that even though the information is perceived opportunistically by users they may not be able to remind it when taken decisions. Third, the validity of the information. Even though the information arrives opportunely and can be retained its validity is loosing throughout the time because the state of the game is changing. This should be reflected on new messages. This can impact drastically the sensation of awareness that the user can have. If the user perceives that understand what is happening to the other players, what they have done, in what stage of the software are them, etc.

Due to the aforementioned reasons the awareness information in this case should be given through audio but only when the user requires it to guarantee the opportunity. This information should reflect accurately what the user needs to know and should be short to promote its retention. To do this it is better to have audio information (earcon) clear and concise instead of an explanation through voice. Finally, the user should ask for the information anytime and it should reflect the up-to-date state.

In our system the awareness information was implemented in the following way: The user can require information about what instruments are in the game (which one were selected). To do this he can press a specific keystroke (F1) to receive information about each instrument at the time each time a keystroke is pressed. The system provides the information in the same order the instruments were selected and in a circular way. The information is a small music piece played by the instrument and its name at the end. We do not believe that it is important to know who is behind each instrument. To know in what stage is a player of an instrument, first, the player should select the instrument following the procedure mentioned and then press F2. After this the player receives a piece of music that has been constructed by other player of the instrument and the piece of sound that is actually analyzing.

4 Testing the Software

4.1 Usability Evaluation

We implemented diverse usability testing to the collaborative software. Two different evaluation methods were applied: usability of interface elements and user acceptance. The evaluation was applied five times during six months to 5 legally blind (three with residual vision and two totally blind) learners ages 10 to16, one girl and four boys, from 5th to 8th grade in the School for Blind Learners Santa Lucia, Santiago-Chile.

The first usability testing was applied to the multimedia resources of the game to select sounds and images to be implemented in the software. Learners identified what resources functioned better to and helped us to design an interface with icons that: convey meaning, be clear to them, avoid ambiguities, and be attractive. Most instruments and figures were clearly identified by learners. However instruments with many details confounded the learners. For instance, the contrabass in some cases was recognized as a violin or a guitar. We also had to improve the size of images in the interface for learners with residual vision. Bigger size icons and images worked very well for them. Colors were also tested and the best results were the combination of red over yellow and blue over yellow.

The second usability testing consisted of improving the interfaces of the game and polishing some deficiencies for the users. We applied usability questionnaires with questions such as do you like the game?, what instrument is playing on the screen?, what colors are you perceiving?, what keyboard strokes do you use and what are their purposes?, what do you would change to the game?, do you want to add something more to the game?. The third usability evaluation consisted of testing the screen with the selection of properties of the sound. For this we used an acceptance questionnaire for end-users.

The fourth usability testing considered testing the first stage of the game. This stage consisted of identifying intensities that can be high, medium, and low. They are randomly generated by the software. Each time the instrument plays, the learner had to identify the intensity and a feedback is provided. After this a new sound is produced by the instrument. For this testing we used an acceptance questionnaire for end-users. The fifth usability testing consisted of evaluating the interface of the menu for selecting instruments and the interfaces for the first and second stage of the game. The menu for selecting instruments contains two navigation buttons that allow moving back and forward through the list of instruments. To move through the menu learners use left and right arrows. To select the instruments they use the space bar. When moving through the menu the next or previous instrument can be shown. A melodic line interpreted by the shown instrument informs to the blind player about the type of instrument selected. When doing this a new interpretation of the instrument is played and a voice says “you have just selected an instrument”. In the other clients a voice informs about the selected instrument. If there are players that have not selected instruments the game “waits” until all of them choose an instrument. Meanwhile each time players having a selected instrument press a keystroke they are informed about the players left to start the game.

4.2 Results

Interaction. We evaluated the importance given by learners to learning with the software. We considered the following statements: “I will recommend the software to other players”, “I have learned with the software”, and “The software allows me to know new things”. Blind learners assigned higher scores to the statements showing that they value highly the learning of music contents through the interaction with the software. The statements related to the use of the software were: “I felt controlling the software”, “The software is easy to use” and “The software adapts to my pace”. At the beginning learners assigned lower scores to this parameter evidencing the complexities of user to manipulate and interact with the software. However once they understood the software the quality of the interaction increased.

Collaborative skills. The last testing included a questionnaire to evaluate the collaborative behaviors of learners and how the software helps to reinforce these behaviors. The following figures consider two basic aspects of collaboration. Figure 1displays positive interdependence through six statements with scores from 0 to 10 points: “I know clearly the objectives", " I know the importance of my role to attain the final goal", "I need to interact with others to attain the final goal", "The fact that each one has to develop specific tasks allow me to value the capacities of my peers", "I feel that the achievement of one of my peers is the achievement of all of us", and "The audio stimuli given by the software when solved correctly a task makes me feel happy even though I was not the one that implemented correctly the action". The average score of learners with residual vision was lower than the average of blind learners especially in terms of positive interdependence. Blind learners assigned more value to positive interdependence statements after collaborating with the computer-based game.

Figure 2 displays the average of the assigned score to personal and group skills answering to the following statements: "I respect the other's turn", "I help to my peer only when a help is required", "I give the necessary time to my peer to answer my questions". "I don't like that my peer does not answer to what I ask or say", "I evaluate my answers and the one of my peers to learn and understand what is going on in the program". Learners with residual vision assigned lower scores than blind learners to these statements. Blind learners really value personal and group skills as a result of interacting with a collaborative computer-based game.

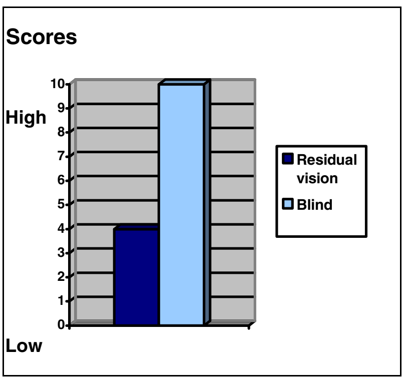

Fig. 1. Positive interdependence

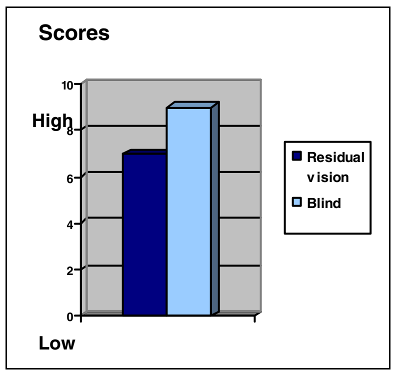

Fig. 2. Collaborative context

Awareness. Two statements during usability testing referred to awareness during interaction with the game: I knew what other players were doing and I knew what instrument had each player. Figure 3 displays the results concerning the first statement. Learners had a hard time figuring out what the other players were doing during the game. Two players could know "sometimes" what other players were doing and three of them definitively knew what other players were doing.

The results of the second statement are displayed in Figure 4. Three learners could "always" know what instrument had each player and two of them mentioned that "sometimes" knew who has what instrument. This is especially interesting because they could know the role and instrument of each participant but could not realize what the other players were doing.

I knew what other players were doing

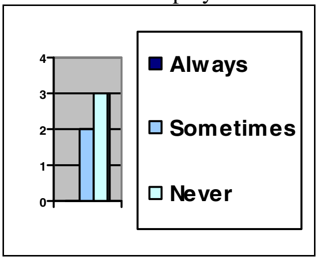

Fig. 3. Awareness of players

I knew what instrument had each player

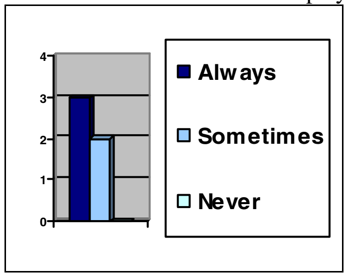

Fig. 4. Awareness of the players' instruments

5 Discussion

This study presents our preliminary work on problems encountered when implementing awareness in collaborative software for blind people. First, we have designed a collaborative application for learning music instruments. Second, we have usability tested the software with five learners evaluating the interfaces for both interaction and collaboration. Third, we have identified some unique problems in implementing awareness in collaborative software for blind learners.

Blind users interacted with the software, recommended improvements in the interfaces and highly accepted the interfaces probably because they mapped well their mental models. During usability we asked them about their knowledge about what the other players were doing but they could not figure out their tasks even though most of them could realize what music instrument had each player. We believe that this behavior can be explained because either the statement was not completely understood or the awareness mechanisms were not correctly implemented in the software.

Our preliminary results confirm our hypothesis about implementing awareness mechanisms in software for blind people. Implementing awareness for this people is not a trivial task. We need more testing to determine which one of the problems stated earlier in this paper, such as opportunity, retention, and validity should be approached differently in order to better fit the requirements of blind people. Our initial data is telling us that principles of identifying and implementing key awareness issues for sighted people should be taken into account but should not be transferred directly when implementing awareness mechanisms for people with visual disabilities. Awareness mechanisms for these people imply more complex problems that must be considered when designing collaborative software for them.

The next task is to fully understand the awareness needs of blind people when collaborating through virtual environments. We hope to achieve this by developing more collaborative applications and testing the awareness mechanisms we use. Especially, we have to investigate about the feeling users have about what is going on in the collaborative game and how do they use the information provided.

Acknowledgment

This report was funded by the Chilean National Fund of Science and Technology, Fondecyt, Project 1030158.

References

1. Borges, M., Pino, J. (1999).: Awareness mechanisms for coordination in asynchronous CSCW. Proc. Of the WITS'99 Conf. Charlotte, North Carolina, Dec 1999, pp. 69-74
2. Cohen, J. (1994).: Monitoring background activities. In G. Kramer (Ed.), Auditory display: Sonification, audification, and auditory interfaces. Reading, MA: Addison-Wesley, pp. 499-522
3. Collazos, C. Guerrero, L. Pino, J. Ochoa, S. (2002): Introducing shared-knowledge Awareness. Proceedings of the IASTED Conference Information and knowledge sharing. Nov. 2002, St Thomas, Virgin Islands, pp. 13-18
4. Dourish, P. Belloti V. (1992): Awareness and coordination in shared workspaces. Proceedings of CSCW'92, pp. 107-114
5. Gross, T., Prinz, W. (2003): Awareness in Context: A Light-Weight Approach, Proceedings of the European Conference on Computer-Supported Cooperative Work (E-CSCW), Helsinki, Finland, Sept. 2003, pp. 295-314
6. Gutwin, C. and S. Greenberg (1996): Workspace Awareness for Groupware. Proceedings of the Conference on Human Factors in Computing Systems. Vancouver, pp. 208–209
7. Isaacs, E., Walendowski, A. and Ranganathan, D.: (2002) Hubbub: A sound-enhanced mobile instant messenger that supports awareness and opportunistic interactions. Proceedings of the Conference Computer-Human Interaction (CHI), Minneapolis, MN, April, 2002, pp. 179-186
8. Lumbreras, M., & Sánchez, J. (1999): Interactive 3D Sound Hyperstories for Blind Children. Proceedings of the ACM CHI '99, Pittsburg PA, USA (1999), pp. 318-325
9. Moran, T., Anderson, J. (1990): The workaday World as a paradigm for CSCW Design. Proceedings of CSCW '90. October 1990, pp. 381-393
10. Morley, S., Petrie, H., O'Neill A.-M. & McNally, P. (1998): The use of non-speech sounds in a hypermedia interface for blind users, in Edwards, A.D.N., Arato, A., and Zagler, W.L.(Eds.)'Computers and Assistive Technology'. Proceedings of ICCHP'98. XV, IFIP World Computer Congress, pp. 205-214
11. Ressler, S. & Antonishek, B. (2001): Integrating Active Tangible Devices with a Synthetic Environment for Collaborative Engineering. Proceedings of the 2001 Web3D Symposium. Paderborn, Germany, February 19-22, pp. 93-100
12. Roth, P., Petrucci, L., Assimacopoulos, A. & Pun, Th. (2000): Concentration Game, an Audio Adaptation for the blind. CSUN 2000 Conference Proceedings, Los Angeles, USA, pp. 1-4
13. Sánchez, J. (2002). VirtualAurea: Perception through spatialized sound. Proceedings of the 4th International Conference on Disability, Virtual Reality and Associated Technologies, September 18-20, 2002,Veszprém, Hungary, pp. 67-73
14. Sánchez, J., Baloian, N. & Hassler, T. (2004). Blind to Sighted Children Interaction through Collaborative Environments. Proceedings of the CRIWG ´04. Lecture Notes in Computer Science 3198, Springer-Verlag, pp. 192-205
15. Sohlenkamp, M. Supporting group awareness in Multi-user environments through perceptualization. GMD research series No. 6 (1999), 172 pp