ASCIT sick children

Again at my School by fostering Communication through Interactive Technologies for long term sick children

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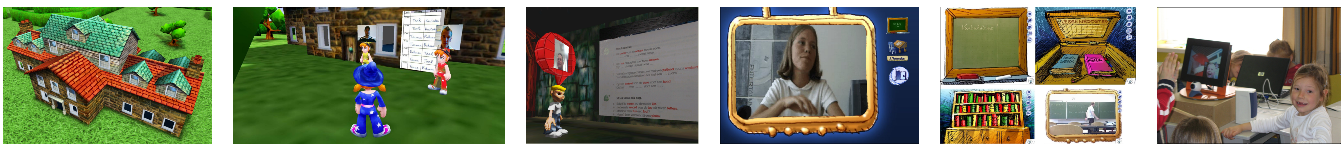


ABSTRACT

In this paper, we present the design, development, implementation and evaluation of a virtual learning environment that supports the learning process of long term sick children. We envision a solution that helps to establish high quality involvement of the long term sick children in a communication-based scenario between the place where the child stays/has been moved and the original classroom/school setting. Analysis of existing ICT-based solutions reveals weaknesses such as the exclusive focus on instruction (and absence of social involvement), the high cost of developing, and mobility issues. Our system, however, is based on concrete user needs, is educationally and socially sound and relevant, and offers a scalable and affordable solution. To this end we incorporate innovative hardware, software and connectivity features, set in a user friendly user interface based on 3D technologies.

KEY WORDS

E-Learning, E-Health, Edutainment, Collaborative Learning, Virtual Learning Environment, Virtual Interactive Communities

1 Introduction

Motivation. During the last decades, health-care has moved from an "intra muros" experience (hospital-based) to a rather "extra muros" treatment. While patients used to be hospitalized for extended periods in the past, currently the hospitalization periods are much briefer and treatments are increasingly carried out at home. When children are involved, this evolution not only affects health-care, but also education: the responsibility to provide long-term and chronically ill children with education shifts from the hospitals to the school that the children attended before school absence. Regular schools, however, are hardly able to set up high quality instruction for their home-based pupils.

Unfortunately, most efforts focus on the re-entry of the child in the community and school rather than preempting this process by bringing the community and school to him/her. Hence, our aim is to re-establish the communication link between sick pupils and their regular classrooms with regard to supporting high quality instructional scenarios during the whole period of school absence, not only at the moment of school re-entry.

Contribution. The present paper aims at clarifying the design, development and implementation of an ICT-solution that helps to establish high quality involvement of the long-term and chronically sick children in a communication-based scenario between the place where the child stays/has been moved and the original classroom/school setting. The conceptual model of Passerini and Granger [1] and the IDI-model for instructional design [2] were used as guiding frameworks for the design, development and implementation process. Through an iterative process five interacting steps were undertaken: (i) analysis of user needs, user characteristics and context factors, (ii) design (according to a functional analysis), (iii) development, (iv) evaluation, and (v) delivery.

2 Related Work

To date, a variety of solutions, based on the integrated use of information and communication technologies (ICT), has been developed, implemented and tested in several settings.

PEBBLES (Providing Education By Bringing Learning Environments to Students) is an advanced prototype solution developed in the USA and Canada [3]. It was launched as the world's first fully functional 'telepresence' application: a social and technological solution that virtually places a child within the classroom by putting a robot in the regular classroom. The robot is connected through a high-speed internet line to the hospital tool. This solution enables to recreate an authentic setting since video, audio and documents can be transmitted from both sides. However, it is unclear from the existing documentation what happens when the sick pupil is not able to follow lessons synchronously due to health-related problems such as tiredness, lack of concentration or therapies scheduled during the lessons. Furthermore, there is the issue of mobility of the ICT-based solution. Another critical issue, hardly mentioned in the literature, is the high cost of developing and maintaining the PEBBLES-provision.

A second remarkable ICT-tool to support children with health impairments is STARBRIGHT World (SBW), a safe and secure online community where these children can connect to each other. Children on SBW can chat, read and post to bulletin boards, email, search for friends with similar illnesses, participate in fun events and contests, surf pre-screen Web sites and play games [4]. Further analysis of the available papers on the use of SBW, however, pointed out that the communicative possibilities were rarely used by the children: only 3% to 15% of the time was spent on communication.

In Flanders, a type of video phone is already in use to support long-term sick children to stay in touch with their family and peers at school [5]. However, hospital personnel has experienced some problems with these tools: there is an asynchronous delivery of sound and images, they offer basic video connection capabilities of rather low quality and if it is often used, it is a rather expensive solution because of the payment per minute of talking. In addition, each use of a video phone involves extra costs.

Besides the use of this video phone device, electronic learning environments (ELE), through which the school, parents and pupils get in touch more regularly, are increasingly promoted. However, these tools build heavily on text-based input and communication and are therefore less suited for pupils of elementary school age.

3 User Needs and Task Analysis

Following the developmental model of Passerini and Granger [1] we started with the identification of children's and teachers' (end users) needs. These findings were completed with the needs felt by significant others in the environment of the child (e.g. parents and health care professionals). Semi-structured interviews were conducted from seven long-term or chronically ill elementary school children. The participating children complied with two criteria: (i) they were at home or in the hospital due to illness or revalidation at the time of the study, and (ii) they missed at least 21 continuous days of school or at least 50% of the regular lesson time in the school year 2005–2006. The interviews were conducted at the child's home or at the hospital, took approximately one hour and Mauthner's suggestions on data collection with children were taken into account: e.g., the children were interviewed privately [6]. Pictures and drawings were used to concretize the questions, as suggested by Borgers, De Leeuw and Hox [7]. The interviews were transcribed and analyzed by two independent coders in a systematic way, using the constant comparative method [8, 9]. Furthermore, 24 parents and 25 teachers who were confronted with such a child during the past three school years completed a survey. The survey questions were based on findings from an earlier interview study [10] and were statistically analyzed using SPSS 12.0 for Windows. Finally, ten two hour observations of individualized instruction moments at home or at a hospital school were conducted. Each observation was video-taped and completed with field notes.

Supported by the results of the interviews, the observations and the surveys, we assume that the most preliminary needs found were (i) to improve the socialization opportunities which children usually experience at school, and (ii) to supplement the current instruction these children have at home or at the hospital, in particular with regard to curriculum subjects and didactical strategies. In accordance to these findings we assume that, within the population of long-term and chronically ill children, continuation is needed regarding both informal and formal processes of going to school.

4 Functional Analysis

The functional analysis pointed out what the needs determined in the former research stage mean in terms of technology design requirements. When we asked teachers to think of an activity they did in the month before the interview (or an activity they are planning shortly) and they would have liked the child to participate in by means of an ICT-device, most of them thought of a project-based activity. Within these projects, they would use ICT-tools for (group-based) practical, hands-on activities, such as creating an exhibition and performing energy experiments. Furthermore, they would use an ICT-device for non-practical group activities, such as a group conversation and a meeting in order to accomplish a project. Less, but still a few teachers would also use an ICT-device for individual tasks and instruction. These results are in line with the needs for more group-based didactical strategies, as expressed by the participating children. With the participating children and teachers we searched for technical requirements the ICT-device has to meet, to fulfil these needs. The most important findings and related requirements are:

(i) qualitative video and audio streams allowing the sick children to see and hear what is going on in the classroom;

(ii) great communication opportunities for active participation (e.g., drawing attention and passing on notes, work pages, etc.);

(iii) asynchronous functionality (e.g., storage place to post all kinds of messages and content)

5 Virtual Learning Environment

In line with the formulated requirements, a virtual learning environment was developed. It consists of a virtual community that can be shared by many users including the sick pupil, the teacher and the classmates.

5.1 Virtual Interactive Community

Virtual Communities (VC) are defined as communities of people sharing the same interests or ideas who are remotely present through the internet. The virtual learning environment we develop consists of a 3D virtual community in which chronically ill pupils are still 'telepresent' in their classroom.

Our user needs analysis revealed that children and teachers want ICT to support both formal and informal learning processes. Moreover, children of elementary school age are assumed to prefer non-abstract environments with a limited amount of textual cues. Therefore, a 3D visualization of the child's classroom was chosen. It lends a more explorative, fun atmosphere to the learning environment. Interaction within this environment is assumed to be intuitive and natural, therefore, the virtual environment should support *communication* (e.g., instant messaging, file transfer, audio/video communication), *authentication* (e.g., to determine identification, rights management, privacy), *personalisation* (e.g., virtual profile, visual representation), and *presence* (e.g., contact of buddy lists, online status).

5.1.1 Virtual World

(a) (b)

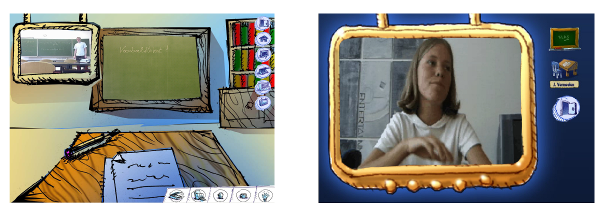
Figure 1. Snapshots of the virtual learning environment. a) View of the entire world. b) The use of video stream texturing on animated avatars.

Upon starting the tool, the user automatically ends up in the 3D virtual environment (see Figure 1). Navigating in this virtual world happens by means of a graphical personification of the user, also called an *avatar*. This corresponds to navigating in present-day games and on-line communities like 'Ice Age 2' and '(Teen) Second Life' and, therefore, fits in with their living environment. The environment also provides for *community support functions* like buddy lists (with classmates, teachers, parents), authentication and authorization functionalities providing the pupil with the same level of privacy, and rich presence (showing who is online, which mood he or she is in, what kind of activities one is pursuing). Furthermore, we integrated several synchronous communication components into the environment including audio conversation, video conferencing (with remotely controllable web cams), text chat and video-based avatars [11], illustrated by Figure 1(b).

5.1.2 The Pupil in the Virtual Classroom

By navigating through the virtual world and the school, pupils can enter the virtual classroom. Unlike the rest of the world, the classroom is represented by a fixed and static 3D view containing the most important elements of a real classroom, shown in Figure 2(a). Communication between the pupil and the class happens through video-chat, similar to using a teleconferencing system. Consequently, the pupil has to be equipped with a webcam and microphone. Furthermore, a pupil always can ask for attention by pressing a button at the child end of the tool which will flash a light and play a sound at the classroom end. However, no audio communication is possible unless the teacher accepts the request.

In order to exchange homework and corrections, a scanner and a printer are present at both ends of the tool. By clicking only one virtual button, homework and corrections can be printed, scanned or transmitted automatically. This is explained further in Section 5.2.



(a) (b)

Figure 2. a) Example view of the classroom as seen by the pupil. b) View of the pupil as seen by the teacher.

5.1.3 Teaching in the Virtual Classroom

Analogous to the pupil the teacher can enter the virtual classroom by navigating through the virtual environment. Contrary to the pupil's interface, less input is demanded from the teacher in order to not distract him/her from the regular teaching process (see Figure 2(b)). Consequently, audio and video-based techniques are employed as much as possible. At the classroom end of the tool, the function buttons are similar to the buttons at the sick child's end. In addition, the teacher has the possibility to capture and transmit the current content of the blackboard and record an audio/video message or even a part of a lesson. Each action is easy to perform by clicking the appropriate virtual button. More details on this matter are given in Section 5.2.

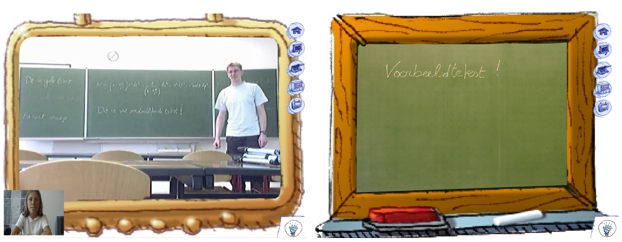
5.2 Functional Aspects

This section discusses the functional aspects of our virtual learning environment corresponding to the requirements described in Section 4.

5.2.1 Following Lessons Synchronously

One objective of our work is to re-establish the communication link between the sick pupils and the regular classroom. Consequently, two issues should be considered: (i) the pupil should be able to follow the class activities simultaneously with the fellow pupils, and (ii) the pupil himself/herself should be virtually present in the classroom.

The first issue is tackled by employing a microphone and one (or more) (controllable) webcams which are mounted in the classroom. By doing so, the pupil can watch the general instruction offered by its own teacher as shown in Figure 3(a). Whenever more detail is needed, for instance important information is written on the blackboard, the pupil or teacher can take a high resolution snapshot (Figure 3(b)) pushing only one button. Regarding the second issue, the child's setup is also equipped with a webcam and microphone in order to be heard and seen by its classmates and teacher, depicted in Figure 3(c).

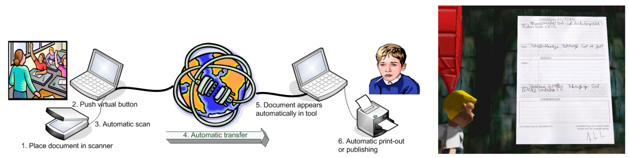


(a) (b)

Figure 3. a) Live view of the class as captured by the webcam present in the classroom. b) View of the blackboard. The inner part is a snapshot of the physical blackboard, taken by the digital camera or webcam present in the classroom.

5.2.2 Diary and School Timetable

It is important that a sick child exactly knows at what time each lesson is scheduled. In our system, the teacher can automatically transmit/publish a diary or a lesson schedule (see Figure 4(a)). The scan function allows a teacher without a digital agenda or schedule to do so too. Transmitted documents can be printed-out automatically and/or published in the virtual world. Furthermore, the print and scan functions allow the child to print the schedule and scan it again, indicating which courses he or she is planning to follow synchronously. Figure 4(b) depicts a sick child (represented by its avatar) consulting his timetable.



(a) (b)

Figure 4. a) Automatic scan, transfer, and print-out/publishing. b) 'Avatar' consulting a diary published in the virtual world.

5.2.3 Homework, Exercises, Tests and Marking

In a similar way as transmitting/publishing a diary, the sick child can make homework and exercises or perform tests. First, the teacher sends the assignment. Subsequently, the sick child accomplishes the assignment. The possibility of doing this at the same moment that the fellow pupils do it, is assumed to increase the feeling of being present in the class. Finally, the pupil sends the completed assignment back to the teacher. Besides making assignments, getting feedback is also an important issue for pupils. Our system offers the teacher the opportunity to correct these assignments on the printed version in the same way the assignments of regular pupils are corrected. Subsequently, with one click the corrections are sent back to the pupil using the system. If needful, video-chat can be used to provide complimenting face-to-face feedback.

5.2.4 Asynchronous Possibilities

(a) (b) (c)

Figure 5. Example view of the different virtual books. a) Class library used to store *public* virtual books. b) Pupil's personal desk containing *personal* books like diary and homework. c) Thumbing through a virtual book.

In order to exchange information asynchronously we employ the metaphor of virtual books to store and retrieve information. We distinguish between two types of virtual books: (i) *public* books which can be created or read by any user (e.g., to share pictures of the latest field trip), and (ii) *personal* books which only can be created or read by the sick child and the teacher (e.g., diary and homework) (see Figure 5).

5.2.5 Social Function

The user analysis also revealed that children miss the socialization opportunities offered at school. All functionalities mentioned earlier can contribute to support socialization. Most teachers and children interviewed, indicated that the synchronous functions of audio and video chat are enough to fulfil the social needs (e.g., people can share personal media (pictures and video) within their own community of interest). On top of this, we built a *classroom-present* device as well in order to foster social inclusion in the classroom as much as possible. The main design philosophy of this hardware device has been on giving a general feeling of presence of the remote child in the classroom (Figures 6(a–b)). It consists of an LCD screen (used to depict the sick child) and a webcam which are attached to a servomotor. Using a simple game controller, the sick child can rotate the device in order to look around.

(a) (b) (c)

Figure 6. a-b) Classroom-present tool. c) The outside virtual world represented as a 3D maze.

In addition, our system supports the opportunity to play by means of lifelike party games and links to online games, all set in a playful environment (see Figure 6(c)).

5.3 Network Architecture

This section describes all tasks and different responsible servers which make up the underlying network architecture of our system.

5.3.1 Tasks

Upon starting the software, *Session Management* comes into play. It mainly is responsible for logging on/off users and taking care of authentication. After logging on, the user can navigate through the virtual world by means of an avatar. At any moment, all users are being informed of each other's presence (i.e. position, mood, activity, . . .) but also of any obstacles in the world. This is managed by *VIC Interaction Management*. *Communication Management* is responsible for distributing multimedia content in synchronous mode (e.g., video-chat, attending classes). Given the real-time nature of these data streams, an obvious choice for the underlying protocol is the Real-Time Transmission Protocol or RTP [12], as it handles issues such as synchronization and packet ordering internally. Finally, *Data Transfer Management* handles the transportation of data in asynchronous mode (e.g., file transfer, audio/video mails).

5.3.2 Servers

All tasks are being handled by dedicated servers. The *session server* takes care of logging on/off and authenticating users. In addition, it is also being used to initialize A/V communication sessions and to set up file transfers. In order to manage all sessions, the 'Session Initiation Protocol' (SIP) [13] is being used. Whenever synchronous communication is needed between two parties, audio and video can be exchanged peer-to-peer. When multiple parties are involved one single stream is sent to the *communication server* which relays it to the different parties. The *VIC server* takes care of the entire 3D virtual environment. This involves transmitting the world itself, synchronization between the clients and always storing a persistent world. The *data server* is used for two categories of asynchronous data. On the one hand, it stores configuration files of the users containing personal information such as A/V parameters and address lists of the community. On the other hand, the server makes it possible to transmit and store (shared) media and files in asynchronous mode. To this end we employed Hypertext Transfer Protocol (HTTP) and File Transfer Protocol (FTP).

6 Results

In order to evaluate our system, field trials have been set up with sick children and their teachers at home, at a hospital or at school. This required a diversity of preparatory work: methodology, instrument development (observation, interview, questionnaires, logging of data flow, . . .), installation, establishing connectivity, introduction of the package, planning front-office support, data analysis and reporting. The first results indicate the usefulness of the tool for both formal and informal learning opportunities. Furthermore, teacher attitudes, the characteristics of a child's disease and technological problems seem to be the main preconditions for a successful implementation.

6.1 Hardware Recommendations

In the classroom, a *digital camera* is employed in order to take snapshots of the blackboard. The results clearly indicate (i) to use a resolution of 1600 x 1200 pixels (i.e. 2.1

Mpixel), (ii) to avoid using the flash, (iii) that colors look better on a blackboard than on a whiteboard, and (iv) to use a camera that can be controlled by software. Regarding the *webcam*, a resolution of 320 x 240 suffices to have a decent view and frame rate (25fps). Tests also pointed out that it is even possible to capture a film that is shown on the classroom television. Concerning audio, the pupil easily can make use of a headset or the *microphone* integrated into the webcam. The teacher is advised to use a wireless microphone together with fixed speakers. This requires the need for acoustic echo cancelation (AEC), either incorporated in the microphone or in the software. Finally, the personal computer itself can be a commercial off-the-shelf machine; it only needs to have a 3D accelerator graphics card in order to fluently visualize the 3D environment.

6.2 Network Capacity

Regarding bandwidth, the real bottleneck is streaming live audio and video. To keep network traffic to a minimum this should be compressed before streaming. Our tests pointed out that when using the H.263+ codec [14] for compressing video (comprised of 320 x 240 pixels at 25Hz), 128kb bandwidth is needed. This is quite acceptable as most people and schools in the Flemish setting own a xDSL or cable connection (download speed: 4.4Mb, upload: 192–256kb).

7 Conclusions

We presented a system to foster communication for long-term ill children, focusing on the re-entry of the child in the community and school. The system is based on concrete user needs; is assumed to be educationally sound and relevant for supporting both formal and informal processes; and offers a scalable and affordable solution. The communication provisions build on audio and video links, and help to support educational scenarios that support learning processes.

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