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# Assessing the use of low cost PC-based ISDN videoconferencing in hospital training

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**Abstract**

*A course on Italian safety rules and regulations has been delivered to the personnel of a University clinic using videoconferencing, based on an ISDN-2 connection through a multimedia PC. The goal was to evaluate the efficacy of this technology for the training of hospital personnel. To assess it, the trainees were divided into two groups, one at the trainer's site and the other in the University. Comparing the evaluating questionnaires that both groups were asked to complete at the end of each session (based on the comprehension of the subject taught), significant differences were found only when the quality of images was very poor (for technical reasons) or the level of interaction was low. The price/performance ratio was considered good, but there are some technical and psychological problems that must be taken in account before using videoconferencing for training.*

***Keywords***

Educational Technology; Education, Continuing; Computer Communication Networks; Distance Education; Computer Terminals; Telecommunications Instrumentation; Remote Consultation; Videoconferencing; Telemedicine

## Introduction

In a University hospital environment there is a need for continuous education of all the employees, both medical and non medical. New techniques, regulations, protocols, organizational issues, etc., require specific training sessions. Meanwhile, the personnel, especially the medical and paramedical staff, are always busy with the daily work and are generally unwilling to move to training rooms that are far from their place of work.

Special rooms with high level and costly equipment for videoconferencing can be a partial solution. To be fully functional, they need expert technicians and they cannot be set up everywhere in the hospital, because of space and economic constraints.

Within this project we have studied the effectiveness of a PC-based low-cost ISDN videoconference system for delivering a training course. The subject was the recent general Italian safety regulation, which every employee has to know. There was also a focusing on the specific health care environment regulations. The trainer was from Associazione Centro ELIS and the trainees were in the Libera Università "Campus Bio-medico" of Rome, a University with a Faculty of Medicine.

ISDN (Integrated Services Digital Network) defines a general digital telephone network specification. It extends the capabilities of telephone lines, to deliver higher quality transmission at faster speed. It is designed to operate either with special digital terminal equipment or with standard telephones or fax machines.

ISDN connections are widely available throughout Europe and in many countries all over the world. The EURO-ISDN specification guarantees a total interoperability among European countries. The standard defines a ISDN-2 (also called "basic" or BRI) which includes two ("B") channels at 64 Kb/s and one ("D") at 16 Kb/s, and a ISDN-30 (also called "primary") with 30 B-channels at 64 Kb/s and one D at 64 Kb/s, summing up to 2 Mb/s. In other countries, like the USA, the ISDN has some different specification, but it is possible to connect it to the EURO-ISDN.

The cost of transmission in many countries is the same as normal calls on the standard telephone network. This is why it is possible to set up a two-way video and audio transmission at the cost of a double normal telephone call (one for each channel, using ISDN-2). Our goal was to determine whether this can be widely used in a University hospital as a facility for training. Literature shows that ISDN connections are a good opportunity, but not always sufficiently reliable for purposes such as telemedicine [1], remote consulting [2], and teaching [3] [4].

We are aware that videoconferencing on the Internet [5] is moving rapidly to better quality, but it is still far from the ISDN or LAN, because of transmission speed constraints.

## Materials and Methods

The equipment on both sides was a VCON Armada 100 ISDN board on a Pentium 133 with 32 Mb RAM and 2Mb VRAM, running Windows 95 and MeetingPoint software. Each system was connected to a Multimedia Nokia 17" monitor, with built-in videocamera, microphone and loudspeakers. Each complete system was priced around 5,000 ECU in 1996.

We experimented with many technical solutions in search of the best, aiming to be simple and affordable. We used external videocameras, microphones, loudspeakers, amplifier and videoprojector. We used both half duplex voice transmission (i.e. only one person at a time may speak) and full duplex (i.e. you can talk and hear at the same time) which allowed much more interaction, but required some fine regulations to avoid echo (an echo cancellation device was too expensive). The connection was ISDN-2.

The training was given in three two-hour sessions, once every week. It was not easy to find a schedule suitable for everybody. By repeating the cycle (which was given in the normal working hours) four times we were able to train 35 persons. Our aim was much wider, in order to reach all the employees, but there were scheduling problems in enabling some of the nurses and most of the physicians to take part.

In order to assess the difference between the two groups (local, at the trainer's site, and remote, in the University Hospital), at the end of each session we provided a questionnaire to be answered immediately. It consisted of 14 questions with a true/ false choice.

The remote group had also to fill another form with free-text questions regarding the acceptance level and the quality of the videoconferencing facility.

The so called "local" group followed the lesson in front of the teacher, who explained the slides projected from a PC to a screen.

The text used by the teacher was produced in HTML format in order to be available to all the participants after the session [6].

To be able to show simultaneously the teacher explaining the subject and the slides he was projecting (using an Internet browser, either Netscape or Explorer), after a few attempts we decided to use the FarSite application-sharing software provided with the VCON board. This program has now been replaced by Microsoft NetMeeting, which has a better performance. If we had to use a more powerful presentation program (like PowerPoint) instead of a browser, we would have been compelled to avoid any transition effects (such as fading) between two slides, because the FarSite application would take an enormous amount of time to deliver every slight variation of the image during the transmission.

The remote group followed the training either in front of the 17" monitor or a 200x200 cm screen (BARCO videoprojector). On this screen two windows were opened: one containing the shared application (the browser, which was remotely manoeuvred by the teacher or his assistant) and a smaller one with the moving picture of the teacher. In some occasions the teacher's picture was enlarged to near-full screen to create a better "presence". This is sometimes called "telepresentation" and nowadays many software solutions are being developed to support it, especially on the Internet [7] [8]. In our case we wanted to emphasise the interaction between the trainer and the trainees, making a somehow collaborative telepresentation.

## Results

The quality of the pictures was considered good in the first two sessions and acceptable in the last two. The sound quality was considered good: there were difficulties when the trainer was using a distant microphone (so that he could talk hands-free) because of background noise. The best solution was therefore a pin-microphone.

The image quality can be improved by using more ISDN lines at the same time (for example three ISDN-2), but this increases the cost. The quality is better on a LAN, even though congestion can be provoked if the network is not properly configured, and you may need special "switching hubs".

The communication cost of a two-hour session was about 5 ECU, because the trainer was in the same town (Rome). However, it would have cost less than 150 ECU if the trainer were in New York and the trainees in Rome.

One of the main problems was the low interaction of the trainees with the trainer. The point was not technical, because in the first session the satisfaction of all the participants was high: on that occasion, the teacher interacted with the remote listeners, by asking them questions or allowing them to stop him while he was talking. In the other sessions he was more keen to keep to schedule, fitting all the training in the two hours and he did not devote time to talk to the participants.

The analysis of the questionnaires shows different results. In Tables 1 to 4, we list the mean values and the standard deviation of the number of correct answers (out of 14) for each group and for each subject. The "rem" (remote) group, with the specified number of persons (which varied sometimes during the training period: the number in that case is in brackets after the mean value), was also asked to grade (0 to 7) the efficacy and the technical quality of the first videoconference. In the other sessions their comments were textual.

*Table 1 - Group 1 number of correct answers out of 14*

| **Participants** | **P** | | **loc: 4** | **rem: 5** |
|---|---|---|---|---|
| Security | 0.82 | mean | 11.8 | 11.6 |
| | | std dev | 0.96 | 1.41 |
| *Efficacy (max. 7)* | | *mean* | | *6* |
| *Technical quality (max. 7)* | | *mean* | | *5.4* |
| Fire | 0.36 | mean | 11 | 10 |
| | | std dev | 1.41 | 1.58 |
| Risks | 0.36 | mean | 11.75 | 12.6 |
| | | std dev | 1.5 | 1.14 |

The P value comes out of the *Student* T-test between the "loc" (local) and the "rem" group. It can be noticed that there is no significant difference between the two groups. In some cases, it happened that the remote group answered better than the local one. In Group 4, in the Fire and in the Risk sessions, there is a significantly lower level of understanding by the remote group. We believe that this is due both to technical problems (interruption of the transmission while the teacher was continuing his

lesson without realizing that the remote listeners were not in contact) and the total lack of interactivity between the trainer and the trainees. The low efficacy values given by the participants are a clear result of these problems.

*Table 2 - Group 2 number of correct answers out of 14*

| **Participants** | **P** | | **loc: 3** | **rem: 4** |
|---|---|---|---|---|
| Security | 0.18 | mean | 10 (2) | 11 |
| | | std dev | 1.41 | 0 |
| *Efficacy (max. 7)* | | *mean* | | 4.8 |
| *Technical quality (max. 7)* | | *mean* | | 5.7 |
| Fire | 0.74 | mean | 11.3 | 10.5 (2) |
| | | std dev | 2.89 | 0.71 |
| Risks | 0.82 | mean | 10.5 | 10 (3) |
| | | std dev | 3.54 | 0 |

*Table 3 - Group 3 number of correct answers out of 14*

| **participants** | **P** | | **loc: 6** | **rem: 6** |
|---|---|---|---|---|
| Security | 0.05 | mean | 10.8 | 12 |
| | | std dev | 1.17 | 0.63 |
| *Efficacy (max. 7)* | | *mean* | | 3.4 |
| *Technical quality (max. 7)* | | *mean* | | 2.6 |
| Fire | 0.29 | mean | 10.83 | 8.8(5) |
| | | std dev | 3.19 | 2.78 |
| Risks | 0.48 | mean | 10.67 | 9.8(5) |
| | | std dev | 1.97 | 1.92 |

*Table 4 - Group 4 number of correct answers out of 14*

| **participants** | | | **loc: 4** | **rem: 3** |
|---|---|---|---|---|
| Security | 0.85 | mean | 9.25 | 9 |
| | | std dev | 2.06 | 0 |
| *Efficacy (max. 7)* | | *mean* | | 1 |
| *Technical quality (max. 7)* | | *mean* | | 2.3 |
| Fire | 0.016 | mean | 10 | 7 |
| | | std dev | 1.16 | 1 |
| Risks | 0.003 | mean | 9.33(3) | 6.33 |
| | | std dev | 0.58 | 0.58 |

The main conclusion is that the system works sufficiently well to achieve a good comprehension, and that there are not *a priori* impediments to the training being effective [9].

The remote trainees complained about tiredness and were easily distracted when the trainer was not interacting with them. We believe that this is the major point for videoconference-based training: the ability of the teacher to interact with the listeners, especially those on the remote site. He or she must be trained to use the system, from the technical point of view, to learn all its capabilities, but it is of paramount importance that he or she can follow a good didactic methodology. The efficacy rating and the mean correct answers of Group 4 show clearly that these sessions were worse than the previous ones.

The typical problems of audio-delay, bad synchronisation of audio and video, were not generally noticed, except for some short periods when the ISDN connection was not working properly (we found in other projects that there are still some failures of this network, especially on international links). We were not delivering a movie or a fast-paced video clip or a very sharp detailed image through the camera. If this were the case, we would have had some problems.

In the training we delivered, the main technical difficulty was presenting the teacher and the text at the same time. It is not possible to produce good results by pointing the camera at the teacher writing on a blackboard and expecting to obtain a remote sharp vision of the board. It is even worse if the teacher is writing or presenting slides on an overhead projector. Better results can be achieved using a dedicated camera focused on the slides or the text which is used by the teacher: in this case, you would need to switch between the two camera sources according to what you want to show. Our solution, based on the application sharing capabilities as described in the Materials and Methods, requires a little skill in using PC programs and it needs fully compatible systems on both sides. A double screen system with different transmission of the text and the trainer would undoubtedly be the best solution, but it requires more costly apparatus and more space.

We found that it is easier to train small groups (up to four people), because there is no need for external components beside the multimedia PC. In the case of larger groups, a good and very bright videoprojector should be used, to allow the room to be normally lit, because the teacher cannot see the students if the room is dimmed to enable the people to watch the projected image. This was actually a drawback of our implementation: the BARCO was not powerful enough to show images in a lighted room, so that the interaction between the teacher and the remote students was low (as in Groups 3 and 4).

Some trainees commented that, even though the quality of the PC monitor was very high, they felt a little eye-stress after watching it for a couple of hours. This is a well-known effect of concentrating the attention for a long period on a CRT monitor. It can be easily overcome by frequently closing the eyelids to avoid dryness of the cornea and by changing the sight point at intervals.

We conclude that in a wide hospital environment, the regular use of desktop videoconferencing (via LAN or via ISDN) can be really useful for short training. The LAN solution allows people in different buildings to interact immediately. The ISDN connection is valuable when the trainer cannot go to the hospital facilities or it would cost too much to have him or her physically present.

The wide availability of ISDN in many countries, and its interoperability also makes possible connections among different

hospitals at relatively low cost (in any case much lower than any travel cost even for one person only), for exchanging information, for continuing education or for remote consultation.

We have also arranged special training on fire extinguishing. The employers' fire brigade goes to a facility where a fire can be set up and extinguished. From the hospital, others can watch the event and interact with the brigade, by asking questions or proposing different behaviours to check whether they are more effective. The only technical problem is to take the ISDN line into the open air, but this is accomplished by a plain long telephone cable. In this case, the zooming capability of the external camera is very valuable.

The equipment cost will become lower in the future and there are already ways of reducing the overall cost, by using standard monitors and cameras instead of integrated ones.

We found that analogue cameras, while being more costly, deliver better quality and have more features than the typical desktop digital ones. Moreover they can be also used for other purposes, such as recording medical events.

Finally we can say that before starting any training via PC-based videoconferencing, at least these guidelines should be taken in account to guarantee good acceptance and effectiveness:

- have one person skilled in using the apparatus (not necessarily a technician) at both sites
- have groups of not more than five people if you are using a 17" monitor
- ensure that the trainer understands that the delivery of his or her training must be adapted to this modality
- if they do not know each other, have all the participants present themselves to those at the other site
- have the trainer frequently watch the camera and interact with the students (asking questions, etc.)
- avoid a noisy environment and maintain a good lighting
- use full-duplex (speak and hear at the same time) and an echo cancellation system, if available
- use a second document camera if you have to show written material which cannot be shared on the PC
- always accept the observations of the participants at the end and try to solve the problems they noticed
- prepare an alternative communication link with the trainer in case of failure of the videoconference

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