KUNGL TEKNISKA HÖGSKOLAN

Royal Institute of Technology
Numerical Analysis and Computing Science

Meetings in a Distributed Group of Experts Comparing Face-to-Face, Chat and Collaborative Virtual Environments

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Report number: TRITA-NA-D0003, CID-68

ISSN number: ISSN 1403-073X

Publication date: January 2000

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Abstract
Focus for this report is the Collaborative Virtual Environments potential to support work meetings for geographically distributed experts. Research question concerns the difference in face-to-face-, chat-, and CVE-meetings on efficiency, communication, technology, enjoyment and, competence development. A small group of experts were observed during their natural work meetings. Six of the groups scheduled meetings were held three times in a chat environment and three times in a CVE. Results point at that chat and CVE meetings are more task oriented than face-to-face meetings, that avatars support turn taking and are enjoyable.

Keywords: Distributed meetings, experts, efficiency, communication, enjoyment, competence development, CVE.

BACKGROUND

Technology enables today both distributed storing of information and communication. It is possible to build Collaborative Virtual Environments (CVE) which could include relevant information for a specific group i.e. experts in one domain. The future aim here is to build a CVE for distributed experts within the area of Human-Computer Interaction (HCI). Experts often sit very lonely in their organisation at work but still they have the need of meeting colleagues for discussions, knowledge exchange and competence development. Not many groups of experts use this technique today although it is available relatively easy. Before starting to build the planned CVE mentioned above more input regarding its usefulness was necessary. Questions like how is it to communicate i.e. have meetings in a CVE compared with real face-to-face meetings or chat environment, and, what is the role the different parts (chat facility, 3D-environment, avatar) of the CVE, were raised.

Knowledge and organisations

It is important to keep the knowledge in organisations independent of employees leaving or just moving around in the organisation. Computer databases are often used for "storing" this knowledge and aims at supporting mainly managers and project leaders with knowledge about specific domains or employees.

Wærn (1998) say that it also is beneficial for an organisation if people involved contribute to the common knowledge of the company. Current information technology can enable such sharing of knowledge and of information. Several questions for cognitive ergonomics are according to Wærn related to organisational learning. One important issue concerns how knowledge can be presented for future use - how can people later interpret what has been stored in various kinds of databases? We know that both concepts and terminology differ from person to person, how may then databases be built to be useful for common purposes? Knowledge and information might need to be marked with a label telling the user about the last date is should be used. And how important is the context? Can we transform knowledge without putting it in a context? The context where the knowledge is put into the databases obviously differs from the context where knowledge is to be used. How may people benefit from decontextualised knowledge? How are they able to recontextualise it? These questions have been raised by Bannon & Kuutti (1997) but, according to Wærn, are still not answered.

Wærn points out two concepts of importance, close co-operation and organised co-operation. Close co-operation concerns work towards a shared goal. During co-operation participants get to know each other, they feel like a team and trust each other. Project work in a design team or a decision making team belong to this type of situation. Organised co-operation is when there are many instances where people who work in an organisation without knowing each other personally can be said to co-operate through the organisation rather than directly with one another. In this kind, co-operation is institutionalised by tasks allocation as well as through routines for performing the work, transferring information and making decisions.

Collective learning is related to all such implicit rules, derived from a community of people. It concerns schooling as well as cultural traditions, common artefacts such as language or furniture as well as customs such as greetings and negotiations. Since computer artefacts currently are intertwined in our lives, it is obvious that it will go into our collective learning as well. Organisational learning has been conceived in attempts to make organisations more efficient.

Another way to enter learning is to view it on a group level, for instance as in the area of knowledge net. Here the purpose of storing knowledge in computer databases or even on a project group or individual's home page to find out about "who knows what" in an organisation (Groth, 1999).

Knowledge and communication in distributed groups

Many people work today in several groups and need to meet a number of different persons every day. Face-to-face meetings are very important initially in a new group but once the group is formed and the participants know each other a number of other media alternatives arise.

There are several solutions of support for distributed meetings today, i.e. advanced virtual reality meeting environments and video conferencing systems. They are often designed and accessible for a limited group of people due to too technically advanced solutions (both concerning e.g. knowledge in programming and cost of equipment).

By comparing how a distributed work group have meetings in natural settings (i.e. face-to-face, chat meetings and CVE meetings) will give a first understanding of the functionality needed in a virtual meeting place when the "common ground" (see Clark, 1996) is already established.

One group of experts who often work distributed and alter work group during a day is researchers. Hiltz and Turoff (1993) discuss group learning and memory for researchers. They mean that problems and bottlenecks in the traditional scientific communication process are isolation, immobility, travel, inter disciplinary research, information overload, need of joint authorship, and, other efforts during the research process. According to Hiltz and Turoff it is very unlikely that the researcher will find a single other researcher interested in their speciality at their teaching institution. To move to other universities could be to enable co-operation among researchers but most senior researchers find that they can not move to another institution and they lack communication facilities to the cross-disciplinary communication related to their work. The individual scientist must cope with an expanding number of scientific and technological publications. This leads to spending more time reading and searching than for original research and writing. Hiltz and Turoff say that if you add duties such as refereeing and keeping up with a broad contact net the experts really need co-operating with others in the same situation, preferably in the same domain of expertise.

Researchers are just one example of experts in a special work situation. Other groups working in similar ways are domain specific experts in large organisations for instance HCI experts in an organisation with offices around the world.

One vision could be the web as a platform for constructing places of information resources but also of knowledge where experts in a topic can be contacted. Schneiderman (1998) uses the term "genex" for describing the idea. He says that:

> *"appropriate genex design would enable problem solvers to locate and build on previous work easily, explore numerous alternatives rapidly, consult conveniently, and propagate solutions widely" (p.99).*

When discussing co-operation among experts the use of different media has to be mentioned. Our oldest way to communicate is verbally in face-to-face meetings. This serves as the bases for communication with which other media can be compared.

Adriansson and Hjemlquist (1991) have performed a study where the results points at the fact that it goes faster to reach a decision in a face-to-face meeting than using an electronic media. During communication via a computer the participants need to organise their communication to a higher level since the non-verbal signals are left out.

Face-to-face is so rich since it enable not only the spoken language and other verbal clues, but also body language. All taken together they give the included communicating parties a very rich base for understanding each other. When we try to communicate via other media the situation is not as rich with clues as the face-to-face situation is. In text based communication only the written word is transformed. To enrich the situation different codes for feelings such as angry, glad or surprised has been developed, so called smiles. During asynchronous communication several parallel conversations can go on as in email. This would be experienced as very rare if occurring in a face-to-face meeting but in email where the conversation is stored in a chronological order one person can take part in what has been said historically which is not the case in face-to-face meetings.

Text based communication takes longer time to perform than verbal real time communication (Lebie, Rhoades and MacGrath, 1996). In a study performed and described by Lebie et al (1996) the results showed that face-to-face meetings produced 2.6 times as many actions per time unit as the groups that

communicated electronically. One reason for this were said to be that it goes faster to speak and listen than to write and read from a screen.

In chat environments i.e. synchronous text based communication, a specific written language often develops which includes short terms for words to enable the communication to be fast, not easy to understand for an outsider though.

Empirical studies of Collaborative Virtual Environments
Not many studies have been performed on the usability of CVE but the area is growing quickly. Studies have often been performed in experimental settings, with students acting as subjects. The focus of the studies have been on presence, enjoyment, feelings of group accord, subjective reactions such as shyness and conflict (Slater, Sadagic, Usoh & Schröder, 1998) and, leadership (Tromp, Bullock, Steed, Sadagic, Slater & Frécon, 1998) but also on usability problems in virtual environments (see for instance Kaur Deol, Sutcliffe & Maiden, 1999). In a study of Bowers, Pycock and O'Brien (1996a) on CVE an interaction analysis with focus on nature of turn taking and how the embodiments are used in CVEs were performed. The embodiments seemed to have a social interaction role and not merely a role in determining the view an individual has of the CVE. Bowers et al concludes that the overall design of CVEs should be considered in terms of how they afford social interaction and not just in terms of navigability and capability of presenting masses of information.

Research questions
Is there any difference in face-to-face-, chat-, and CVE-meetings concerning experienced: efficiency in task performance, communication among the group members, technical problems, enjoyment, and, competence development.

THE EMPIRICAL STUDY
The variables used were media (face-to-face, chat and CVE) and experience (1 is a sum of earlier experience of face-to-face and the first time of using either chat or CVE, 2 and 3 is the second respectively the third time the media was used). The design of the conducted study is presented in Figure 1 below.

Media/ Experience	1	2	3
Face-to-face	x		
Chat	x	x	x
CVE	x	x	x

Figure 1. The design of the study involving group meetings face-to-face, in a chat and CVE, during three sessions.

Subjects and used media
The four participants (two female and two men) in the studied group are participants in a work group that continuously have work meetings and the participants work at different locations (on a distance of maximum 60 km). To participate in this work group is one of many work tasks for the involved persons. Their background is in research, consultancy and they are all engaged in the domain HCI. They had no previous experience in participating in meetings via chat or CVE. A simple chat environment enabling conversation via written text was used. It was accessed via one of the participant's home page on the Internet. For the meetings held in the CVE one of the existing environments on Active Worlds™ were used. Here a chat like facility, a 3D-environment and avatars representing the participants were used.

Procedure
In the studied work group an ordinary meeting is held face-to-face during about one hour. An agenda is distributed via email to the participants before the meeting starts. A retrospective summary of previous face-to-face meetings in the group was measured via a questionnaire. The meetings in the chat and CVE were held as a substitute to other previously scheduled meetings. The chair (always the same person) is using a computer as a place where important information is stored and notes are taken during the meeting. An agenda was distributed to the members of the group via email in advance to every meeting. Three chat meetings were held and after each a questionnaire was distributed via email. The questionnaire consisted of statement followed by a five graded rating scale (1 representing not at all correct, and, 5

correct to a high degree. The same procedure was used for the CVE meetings. The role of being chair during the chat and CVE meetings altered among three of the group members while the fourth person acted as a participating observer (which was known to the group).

RESULTS AND DISCUSSION

The structure of the presented results follow the research questions previously described, focusing on: efficiency, communication, technology problems, enjoyment and, competence development. The results are presented in figures showing mean values for the different variables measured over the two media used, always compared with face-to-face meetings. Added to this presentation are the group members comments given in connection to the specific ratings in the questionnaires.

Efficiency

In the questionnaire this variable were measured in three different ways; overall efficiency (Figure 2), task-oriented work (Figure 3), and, number of items handled on the agenda (Figure 4).

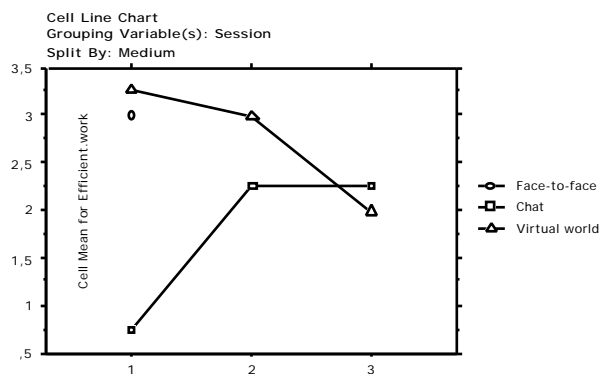### Overall efficiency

1.

Figure 2. Presentation of mean values of the ratings on the statement the group worked efficient.

Respondents' comments point at the fact that face-to-face meetings included a lot of complaining and discussions about definitions of concepts and about the work situation. The chat receives comments about that it is experienced to take too long time before the written comments are made visible in the chat. "It is frustrating to wait". Comments about meetings in the CVE show lack of information in the environment: " It would have been nice to have the agenda presented in the world".

The ratings for CVE is at about the same level as face-to-face meetings in the first session and then it drops, the opposite for the chat. Overall the three ways of having a meeting are rated low, only about 3.5 where the highest rating on the scale is 5.0.
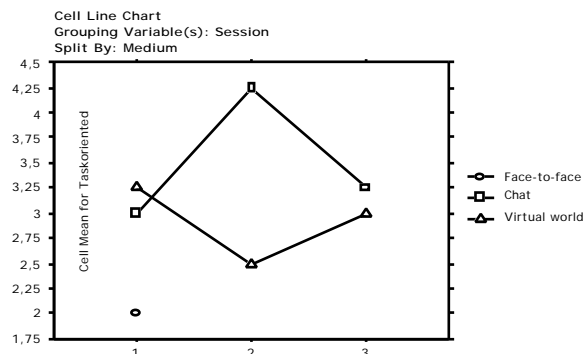
Task oriented work

Figure 3. Ratings on the statement the group worked very task oriented.

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The comments concerning tasks orientation and meetings in the chat tell us that the group tried to discuss one task at a time but did not manage to. The discussions were extremely narrow and no new topics were introduced.

The group members commented on CVE meetings that there was too much testing of the tool and too much talking which could have been done before the meeting.

The results show that both chat and CVEs are rated higher than face-to-face meetings. In session 2 the chat was rated as high as 4.25 but on the last session ratings of the chat drops. Chat and CVE seems to increase the groups focus on the tasks, which can be explained by that the two media do not support "social talk".
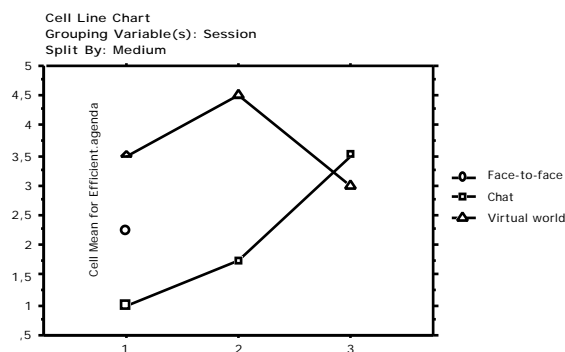
Topics on the agenda

Figure 4. Ratings on the statement when the meetings was over all topics on the agenda had been discussed.

The participant's comments on the three chat meetings were: "Unproductive, too much time spent on staring up the discussion…Extreme discipline is needed during a chat meeting and the discussions have to be controlled. Time between text contributions were about 30 seconds to two minutes".

Comments on the three meetings in the CVE were: "Not so efficient, waiting for responses were probably as long as in the chat but I did not experience it as dragged out as in the chat. Probably due to the ability to play with the "cone" (word for the avatar) during waiting time".

The participants thought that the topics discussed were narrow enough for face-to-face meetings but in the chat the topics discussed were suggested to be very limited such as on which hotel to stay during a visit to a conference. One participant said that "…all the used rules during the chat meeting made it very strict to its form and also boring".

This group do not handle all the topics on the agenda during their face-to-face meetings, nor do they during the meetings in the chat. Surprisingly they seem to be more focused on the tasks in the CVE. This is a contradiction if compared with the overall ratings of efficiency in the group's work. In the last session both media are rated higher than face-to-face which could be due to a learning effect i.e. the participants have learnt how to use the technology or the agenda include less topics for discussion. The last is happening during the chat meeting when a participant suggest that some of the questions should be discussed via email due to lack of time. Some of the topics on the agenda were moved to email or to face-to-face meeting.

Communication
A summary of the received comments concerning communicational aspects such as rules, turn taking and threads are presented below.

When one of the participants went lost in the first meeting in the CVE, written instructions were posed in order to help the lost person to find the meeting place commonly agreed upon. This did not work out so one of the participants went out and showed the lost person, with the help of the avatar, how to get to the meeting place. The other two participants waited at the meeting point and did not start the meeting until every body had arrived. This show a great importance of seeing each other or rather each others

avatars since the communication could have been performed via the chat without actually seeing the avatars.

The decision about a great steering, by using different rules about turn taking and handing over the word were taken. Rules about punishments were also decided on. This started with a suggestion, from the chair responsible for the meting in the chat during session one. The rules were discussed over e-mail and, after an agreement, used during the next meetings.

The chat meetings received a lot of comments from the participants. "Rules and turn taking highly controlled the meeting maybe too much. It is not possible to just follow the discussion in the same way as on a regular face-to-face meeting since the comments often are unsynchronised".

Comments given after the first chat meeting: "To write a comment longer than one line was stillborn. Then the discussion had already went far away". "Sometimes it was totally silent and everybody just waited on someone else to say something. Sometimes it was totally chaos since everybody were talking to everybody at the same time". "I wanted one thread to be handled at a time in the discussion but suddenly we had two threads going on. By bringing it up during the meeting I started a third tread which was not my intention at all".

Comments given after chat meeting two: "The meeting was better this time. Turn taking went fine but to use a summary and OK after each discussion was time consuming. Another thing that were irritating was that the response time were so long, often one minute to get an OK and ->" (over to next person). "The agenda were handled to a larger extent than before but everything were not finished".

Technology
Having meetings in a totally new environment/media brings a lot of comments concerning the technology used. Here are results concerning problems and disturbances experienced during the meetings.
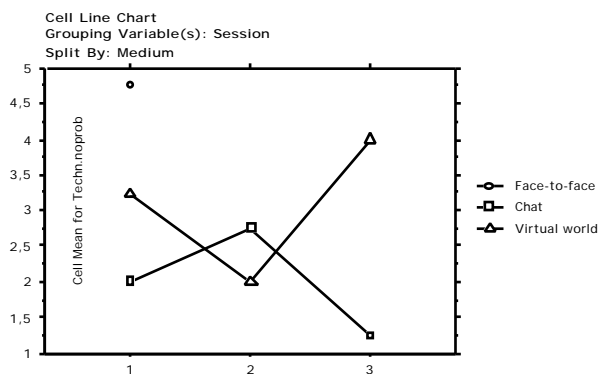

Figure 5. Rating on the statement the technical equipment functioned without any problems (1 representing many problems, and 5, representing no problems at all).

Comments given after the chat meetings were: "I had some problems with disappearing now and then. If I used the enter key for sending a message, the screen turned empty and I had to up date it. When I arrived again my message had either disappeared or being presented twice". "There was a problem, two participants names were mixed up and you did not know who were the person writing the comments in the text during that moment".

Comments received after the first CVE meetings were: "I had some problems with seeing and steering my "cone". "I lost you totally for a while".

After session two the comments to the CVE were:" It is totally meaningless to have a meeting in a CVE if there is not anything in the world that gives an added value. The only positive was the chat function is better than the chat we used earlier and this made it easier to talk".

The last meeting in the CVE received comments on: "We didn't have anything to gather around, a white board, an object or similar".

Problems with the chat environment are rated as being due to disturbances in the technology. There do occur disturbances during the meetings. These are rated as being between 2.8 and 3.5 over the different sessions and media. But what is disturbing? Are the problems only due to the technology used or can it also depend on the participants of the meetings?

Cell Line Chart
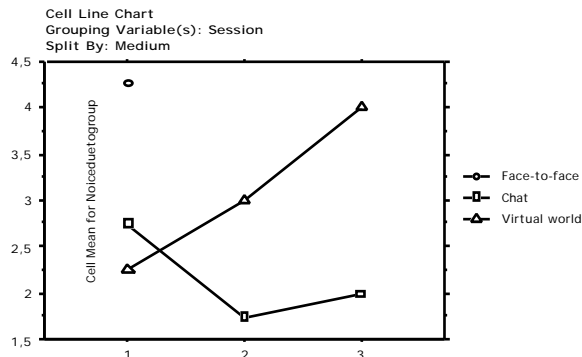Grouping Variable(s): Session
Split By: Medium

Figure 6. Ratings on the statement disturbances are due mainly to the members of the group.

The face-to-face meetings were commented on concerning the fact that these meetings often were disturbed by people walking by and stopping for a short chat. The meetings were often held at a cafe like meeting place were people at the work site passed by. The face-to-face meetings were also disturbed by the participants themselves who were talking about social aspects instead of focusing on the task to be performed for the moment.

Comments given after the chat meetings were: "It would go faster if the text already were written or if comments to the chairs topics for discussion were written before it is one owns turn". "Some took very long time to respond".

One comment to the meeting in the CVE, which point at a disturbing factor was "The avatars were highly misused by the participants in the meeting. It might be regarded as fun to through one self on the ground but I do not test new ways of expressing me via my face or via funny gestures during our real face-to-face meetings. How can you as a participant know when another participant is annoyed or just fascinated by the way to use the avatar which should have been possible to test before the meeting". The disturbances experienced while using CVE are rated as being due to the participants. For some it is an amusement and fun while for others it is very annoying.

Enjoyment
Not only measurements about efficiency, tasks, technology or communication is relevant to use when comparing different media for distributed meetings. The participant's subjective ratings of experienced enjoyment were also measured.

Cell Line Chart
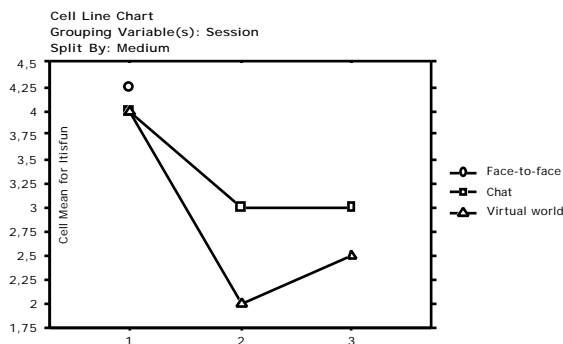Grouping Variable(s): Session
Split By: Medium

Figure 7. Rating on the statement it was fun to have meetings in face-to-face, chat, CVE.

After the chat meetings the following comments were received: "A lot of tittering from my side, my colleagues wondered what I was doing". "I tittered quite a lot on my own…that was the only good thing

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with it. I laughed quite a lot. It was more fun but more chaotic the previous time (not as fun as the first time)".

Comments received after the CVE meetings were. "Oh yes, unbelievably fun and the "cone" was so sweet when he was happy or angry. Maybe to funny - I had problems keeping serious". During the last meeting in the CVE the comment from the same participant was "…it was fun when the "cones" were jumping and bumping but except for that it was quite boring".

The participants appreciate face-to-face meetings and also the initial ratings of enjoyment experienced during the chat and CVE meetings are high. This can of course be charm of the novelty, and it decreases after the first session.

Competence development
To meet and co-operate in a group is not just about performing tasks or being social. One purpose with group meetings is often to increase and develop the competence in the group.
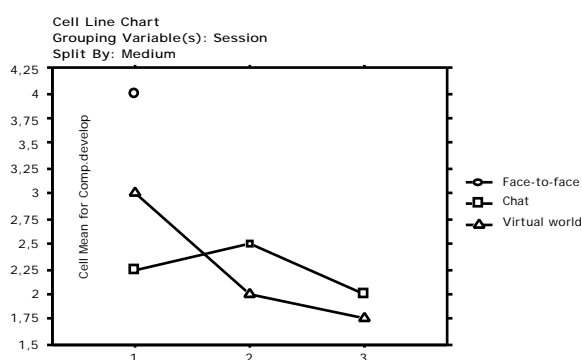

Figure 8. Ratings on the statement our meeting was competence developing.

The participants in the group experienced that competence development was occurring primarily during face-to-face meetings. A comment after a chat meeting explains that: "The discussion is too poor and does not allow new topics to be discussed during the meeting". The meetings in the chat and the CVE were also developing the competence but then only competence related to the technology used and not to the discussed topic it self.

GENERAL DISCUSSION
The common ground was already established in the described work group and our aim was to support a small group of experts already knowing each other and using CVE as a substitute for some of their face-to-face meetings.

Overall the participants were able to enter, navigate and communicate in the CVE even though they did not have any previous experience of using this particular technology. Using a common meeting spot and having material to gather around during the meeting in the CVE were preferred. All three ways to perform meetings were rated as enjoyable although it decreased for the chat and CVE after the first session. CVE meetings were experienced as more efficient overall than ordinary face-to-face meetings and both chat and CVE were experienced as having the highest efficiency in task oriented work.

Although the avatars were misused they also facilitated turn taking and were experienced as being fun to use. By exploring the functionality in the media before a meeting start the misuse could be decreased. The chat environment was very hard to communicate in. Extreme discipline was needed and a set of rules for how to communicate was developed. Only one thread of discussion was possible to follow and the rules were made to hinder several topics being discussed at the same time, thay also were needed in order to manage the turn taking. In the CVE the use of rules were not as important. By being represented as an avatar the position in relation to others subjects made turn taking automatic and discussing one topic at the time were made easier. Olson & Olson (1997) reported that groups that know each other well use shorthand language to communicate, and are much more successful than newly formed groups in communication over a variety of channels. In the results presented here this happened only in the chat for indicating turn taking.

A point made by Bowers, Pycock and O'Brien (1996b) is that some interruptions from the real world, for example when participants in the CVE are interrupted by telephone calls or by a visitor entering their real room is very interesting. In the here presented results we could see that it took a long time before comments were made visible to all participants and waiting time were experienced as very long. The waiting time was explained as a technological problem but could of course also be due to the fact that the participants were occupied with other duties which was invisible for the rest of the group. It is easy to start to read email, answer the telephone or someone knocking on the door, while waiting for the others comments to arrive.

So far the CVE do not seem to be of use for competence development. The participants first need to be familiar with the technology before we can study aspects of competence development. Once more material such as an agenda and shared documents are made available the co-operation and competence development might be easier to achieve. Using a CVE for meetings can be one way to store information in a context and there by make it more close to the concept of knowledge. It will be possible to use as knowledge for the organisation or for experts in a specific area. By using it in this narrow community the information will probably be interpretable since it do not have to be decontextualised. If marked with a label telling for instance when a specific discussion were taking part or when a text was written facilitates putting it into the right historical context.

Aspects of communication such as usage of rules, turn taking and parallel activities should be investigated further in new studies. Need of relevant information stored in the environment and audio as an alternative to the chat functionality should be further investigated. The results from such studies can shed some light on efficiency, technological problems, communication, enjoyment and competence development in collaborative virtual environments used as a complement to real face-to-face meetings.

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