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VIRTUAL ENVIRONMENT FOR
PROJECT BASED COLLABORATIVE LEARNING

"Learning cannot be designed; it can only be designed-for; that is - facilitated or frustrated".

(Wenger 1998, p229)

INTRODUCTION

A virtual environment for project based collaborative learning is not only a piece of technology consisting of software and computers. A virtual environment is situated in practice (Salomon, 1992; Pea, 1993). It includes people working together with the aim of solving a problem. It includes a curriculum to be studied. And it includes the pedagogical practice in which project work is founded as an activity of learning. All these aspects contribute to the understanding of the virtual environment and shape the practice that take place.

This chapter presents the study of a project group at Aalborg University that customized a groupware system and created a virtual project room which they shaped and furnished to support their own practice. The decision of using a virtual environment was made by the students alone. They did that without any imposition from either teacher or institution, and they shaped the virtual environment according to their own needs and ideas. The virtual project room was not only a generic *space* for sharing material, but a joint *place* inhabited and constructed by the students.

Rydberg and Ponti (2004, 2005) argue that *place-making* is an important aspect of supporting social interaction on the internet. They define *place* as the setting in which our intentions and behaviours become comprehensible and meaningful. It is a construction reflecting a social practice and it consists of reifications and shared experiences. Further they argue that "fostering a social context cannot be disjointed from developing a sense of *place* in networked environments." The challenge is however to design and organise environments that can support place-making.

The aim of this study is to reveal how the students in the Aalborg case used a groupware system to construct a *place* on the internet where they collaborated on solving a project. The aim is to understand how they used the virtual environment to successfully coordinate their work on a joint project, how they shared and circulated material, how they engaged in each other's contributions, and to understand the reifications of shared experiences that they created in the virtual environment and the meaning they played for collaboration.

Hopefully the findings discussed below will provide more knowledge in the field of designing virtual environments and to better understand how virtual environments can be organised to support project based learning.

THE CASE

I learned to know about this case during a workshop with students and teachers at Aalborg University. The subject of the workshop was different approaches towards using ICT for supporting project-based learning, and a group of students presented their experiences with using a groupware system called iGroups. Their presentation was particularly interesting, because they demonstrated how a virtual environment could be constructed in collaboration, and how the environment could be used to share knowledge and to coordinate the process of creating a joint project.

The students informed us that iGroups were being used by several student groups at the University of Aalborg in similar ways. This was not promoted by the institution, but chosen by the students themselves as a useful means to support their work with collaborative projects.

The group of students that demonstrated their experiences with iGroups had just finished their sixth semester project at Allborg University at the Institute of Humanistic Informatics. They had been four male students working together. The topic of their project was to design a prototype of a virtual learning environment that could be used in project based learning, and they had done empirical

research among their colleague students that included questionnaires, workshops and observation of other students using the groupware system iGroups.

Although they did not directly study their own experience as part of their project, it is natural to assume that their project had impact on their creation and utilisation of the virtual learning environment and vice versa.

In this case I consider the close relationship between the student's own project and their working methods as a strengthening of the case. It entails that the students had strong interests and motives in reflecting on the processes involved in project-based learning and for implementing a best practice in a virtual environment.

The students gave me access to their virtual environment where I was allowed to study their constructions and activities. In addition they gave me a copy of their project report that contained their own considerations and discussions of the topic.

The groupware system used by the students in this case is a free product called iGroups hosted by a Danish software developer. It is a flexible system where a group of users to a certain extent can shape and build an environment according to their own needs. The system offers a basic structure where one can add functionality from a set of provided tools in order to customize the virtual environment. The main feature in iGroup is that it provides a file-sharing environment where the students can organize and structure their shared documents. Another important feature is that new workspaces can be added on demand. These workspaces are simple editable spaces where all group members can add and edit text and hyperlinks. Furthermore iGroups provides tools like: internal message system, forum for asynchronous discussions, news forum, link collections, chat, photo album and mailing lists. The architecture of iGroups is open and easy to navigate and all links to available tools and workspaces are present in a left side menu bar.

However the purpose of this text is not to evaluate on iGroups, which by no means is the perfect system although it has several advantages. The purpose is to reveal and discuss how project based learning can be supported by a virtual environment, what activities and processes are central, and the demands it makes on technological solutions.

PROJECT BASED LEARNING AND POPP

Aalborg University is a project-organized university. The students learn to work in project groups from the day they arrive as freshmen, and 50 % of each semester is devoted to project work (Kjersdam & Enemark, 1994). Project based learning as it is practised at Aalborg University has its own pedagogical foundation called Problem Oriented Project Pedagogy (POPP). In order to understand the practice that the students in this case study involve themselves into, it is necessary to know the basic aims and principles of POPP.

A central aspect of POPP is the focus on problem orientation. The students are defining and formulating their own problems. They do not work on predefined tasks with known solutions, but engage themselves into real problems that they find meaningful to work with. In addition they are responsible for deciding which perspectives, theories and methods they want to use in the inquiry. The fact that the students have ownership of the problem and the inquiry is implicitly encouraging involvement and motivation

POPP is also a collaborative pedagogy and the students are mutually responsible for creating and conducting a joint project (Dirckinck-Holmfeld, 2002). They are not supposed to divide the project into discrete tasks that are worked on individually. Mutual responsibility means that they are responsible for their own leaning but also to engage in each others contributions and perspectives. The project work is integrating individual constructions of knowledge and the construction of a shared understanding through negotiations and confrontations. It is a dialectic process based on a social constructivist understanding of leaning (Dewey, 1966; Piaget, 1969; Vygotsky, 1978; Illeris, 1981)

THE RESEARCH STUDY

The study of the project group and their virtual environment was conducted as a qualitative case study (Stake, 1995). The aim of the inquiry was to understand the meaning of the constructions and processes that took place in the virtual environment and how it afforded collaboration and learning among the students.

The research questions were focused on how the students shaped the environment and used the technology to support project-based learning. Stake (1995) describes such a case study, driven by specific research questions, as an instrumental case study. The aim is not to understand the particular

2

case as such, but to get general understanding and insight into the research questions by studying a particular case.

The case was not selected in order to be representative for project groups at Aalborg University. It was selected because the group demonstrated a best practice, and it was assumed that it would provide valuable knowledge for understanding how a virtual environment can support learning and knowledge construction in a collaborative project.

Since the students had finished their project at the time I started to study them, the study of the virtual environment had the character of a retrospective observation where I tried to recapitulate the processes and activities that had taken place some months earlier. Although I did not directly observe the project as it evolved over time, the virtual environment gave access to lots of useful information: documents, discussions, task lists, structures, constructions of work spaces etc., which made it possible to recapitulate at least parts of the activities and processes that had taken place.

Based on findings from the retrospective observation I made an interview with one of the student participants. The interview was carried out as a semi structured qualitative research interview (Kvale, 1996). This means that it was an explorative interview, where interpretations were present in all phases of the process from the construction of the interview questions to the actual interview and in the resulting analysis. A computer showing the students' project environment was used during the interview to aid the informant to recapitulate and reflect the activities and processes that had taken place.

After the interview a preliminary analysis was sent to all participants in the project group including the informant for verification and further comments (Meriam, 1988). Three out of four students responded to the request for verification, and their comments were incorporated in the final analysis.

In addition I have used results from the research presented in the student's own project report as an additional resource in the analysis and discussions.

The analysis of the case study is organised into themes or concepts in order to understand activities and processes that the students engaged in. In the following text these themes are discussed and illustrated with examples from the virtual environment and statements from the informant.
The interview with the informant was done in Danish and all statements are therefore translated into English by the author.
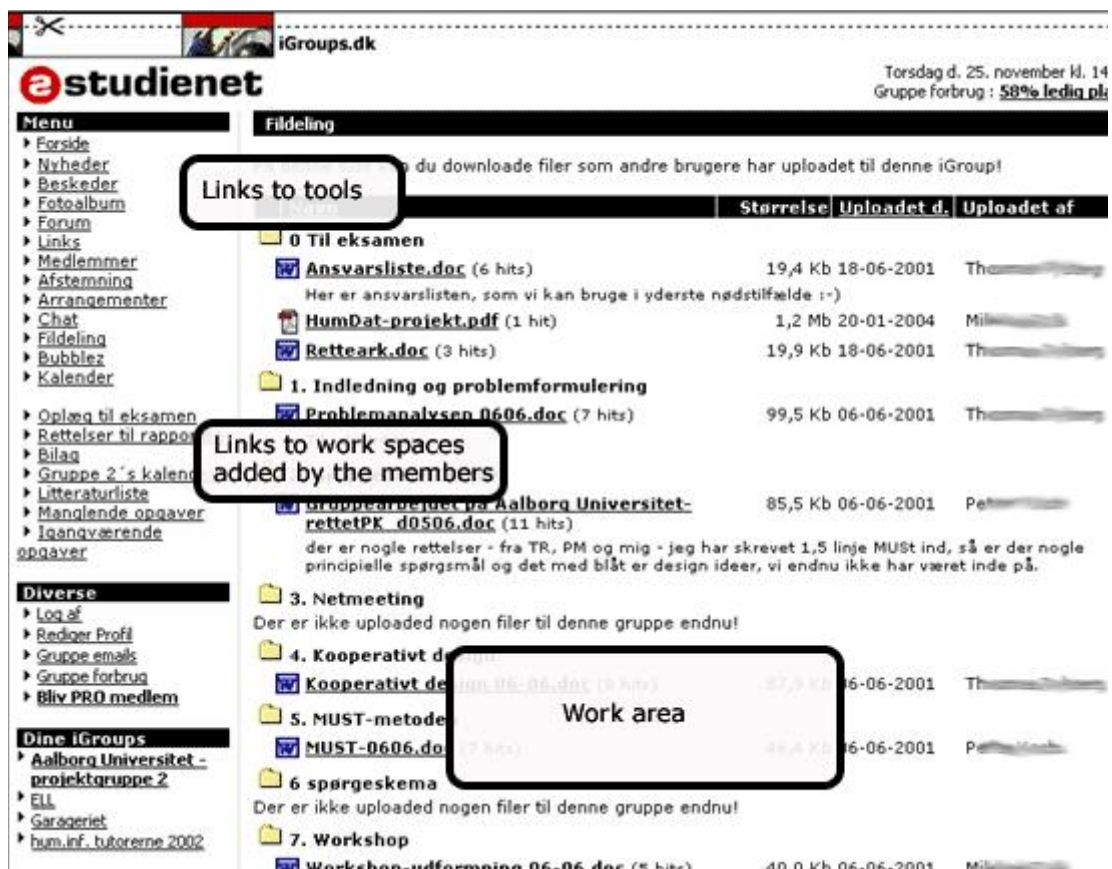

Figure 1. The virtual environment that the students furnished in iGroups.

A NEED FOR TOOLS THAT SUPPORT COLLABORATION

The informant describes two reasons why the project group chose to use a virtual environment as the working arena for their project. First of all they wanted to experience project-based learning with the aid of Internet based tools. This was the topic of their project. And although they did not investigate their own practice it gave them useful insight into the problem area.

Moreover they had experienced that working on a joint project can be both constructive and troublesome at the same time. In the introduction to their report, the students write the following about their experiences of project work:

"There are euphoric moments, where one as a student sees connections that were concealed earlier. But there are also moments where the group members glow of frustration because the project is about to collapse. Papers are not delivered in time, the members have divergent goals and expectations and deadlines are postponed."

They had experienced the benefits of working together on solving a problem, but they had also experienced the difficulties involved in maintaining and coordinating a joint project. Although students at Aalborg University can meet physically and discuss the projects, it can be difficult to overview the project and to coordinate the process of writing and sharing material. Therefore they chose a virtual environment in order to strengthen the collaborative processes, to support coordination of work and to represent and make visible the project as joint construction and enterprise.

COORDINATION

Coordination of work between the group members was a major reason for using a virtual project environment. The students were busy and occupied with different activities outside of the university. Some were active in sports, others were working beside their studies, and it was difficult to find time space for meetings on campus. The informant explained:

"We needed a virtual environment to coordinate our work. We could in fact not meet very often. So we thought that if we could place all our documents in a virtual group space, and make every one read them and comment on them. Then we could work at home and then once in a while meet in real life."

A project group is not a symbiotic union but it consists of individuals with individual lives, thoughts, beliefs and aims. From a constructivist perspective this is a prerequisite for project-based learning. Students bring with them their experiences into the project and a common understanding is reached through confrontations and negotiations of perspectives and beliefs (Dirckinck-Holmfeld, 2002).

However this is a fragile process that can easily be destroyed if participants have diverging interests and priorities. Coordination between the students involved is therefore an important factor in project based learning to stimulate and maintain the mutual engagement and interdependency that is necessary for a successful project.

It is not only tasks and meetings that need to be coordinated. The coordination involves the whole mutual process of planning, structuring and creating a common understanding.

The case study revealed two aspects of coordination that are present in a project: Coordination of project activities and coordination of knowledge construction. Coordination of project activities is more an administrative task while coordination of knowledge construction has to do with the interactive negotiation process of reaching a common understanding in the project.
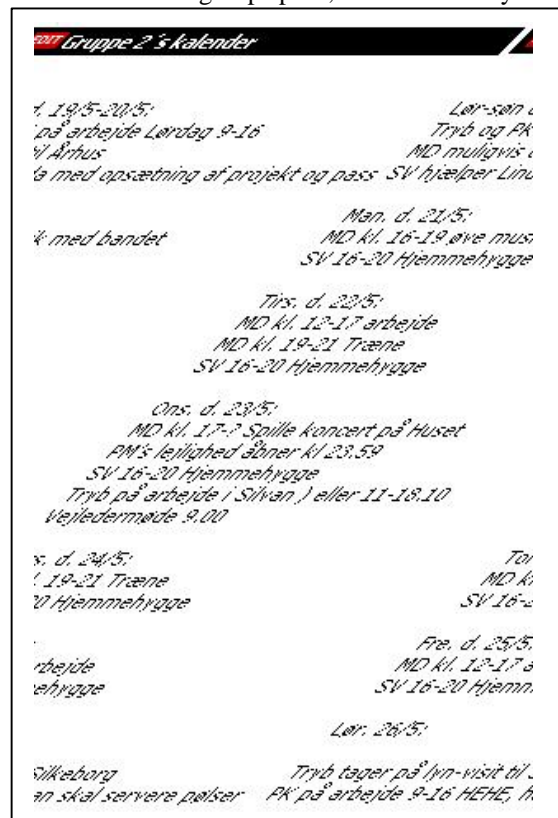

Figure 2. The shared calendar where the students wrote what they were doing at different dates.

4

Coordination of project activities

One aspect of activity coordination is to coordinate presence of the students and to arrange meetings.

All activities that the students were engaged in were registered in a calendar. Since iGroups did not provide a proper calendar tool, they created a shared workspace for this purpose, which every one had access to edit. The informant explained:

"We tried to write down what we were doing at different dates, because then we knew when to drop a meeting because a peer student was on vacation or working."

The main features of the calendar were that it was shared and accessible for everyone, and that it showed the activities of all the students simultaneously. When the students wanted to arrange a meeting, they used the calendar to find time slots where everyone was available, and then they used the message function in iGroups to negotiate the final time for a project meeting or a meeting with their tutor. The message tool is an appropriate tool for this purpose, because it is asynchronous, and a message will be available although the student is not logged on to iGroups.

Another aspect of activity coordination is identification, sharing and division of tasks. Which are the tasks that should be solved in the project, by whom and when, and what is the status of ongoing tasks. It is essential in a joint project to be acquainted with the progress of the project and the responsibilities.

The students created two shared workspaces where the project tasks were coordinated: One for ongoing tasks and one for tasks yet to be started. The students wrote and altered in the shared workspaces and tried to describe what the new tasks were, which tasks people were working on and the problems they were dealing with. Using shared workspaces for these purposes gave a dynamic overview of the process, and it became a forum for idea generation and negotiation of the tasks involved. The informant said:

"We used the shared workspaces to fill out what we were lacking and what we were on to. It is very important to know what people are on to, in relation to whom I can ask this question, who has had time to read this chapter, and who is actually responsible for the task now?"
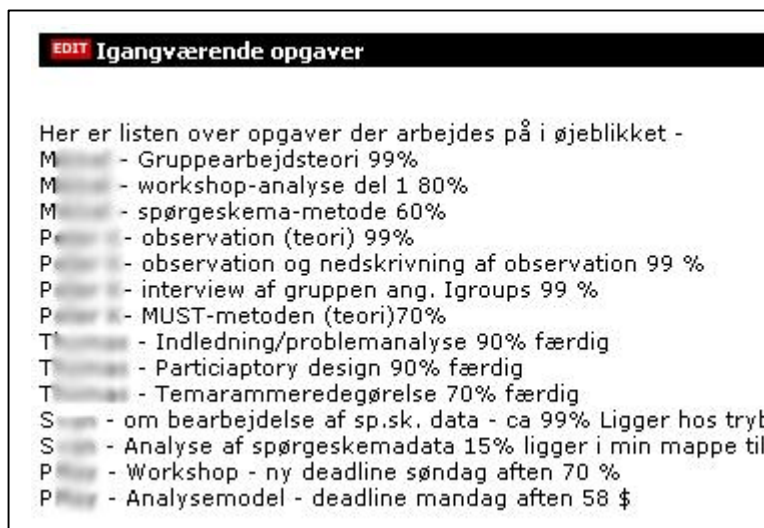

Figure 3. The shared workspace which the students created in order to register ongoing tasks and how far they had reached.

But as the informant further commented, it demands a certain discipline among the group members to maintain such information, and it was a task they didn't always fulfil. Hence the information became unimportant and they could not trust it. The informant thought that a proper tool for task administration was a decisive shortcoming in the virtual environment, because division of tasks and to know what the others are working on and how far they have come is important information in coordinating a project.

Coordination of knowledge construction

The essence of project-based learning is that the students will reach a common understanding and construct a shared knowledge. That does not exclude individual contributions and perspectives, but they are not supposed to divide the project into discrete tasks that are worked on separately and put together at the end. On the contrary they are supposed to engage in each others contributions and perspectives, to negotiate meaning and understanding, and to construct a joint project.

If a project is divided into discrete tasks, coordination is only required when assembling the partial results. On the other hand constructing a joint project through genuine collaboration involves a coordinated effort to solve the project together (Roschelle & Teasely, 1995) throughout the project period. It is an interactive process where all group members have to participate; share and negotiate,

and coordination is a central factor in this process of integrating individual contributions in a joint project.

iGroups provides a space for sharing uploaded files. This was the main arena for coordinating the construction of shared knowledge. The group members used the file-sharing space to upload documents, to comment on each other's documents and to rearrange the structure of the project. Although important decisions concerning the progress of the project were dealt with in physical group meetings, the file-sharing space was the arena for continuously co-writing and the negotiation of meaning throughout the project. Here they shared and discussed content simultaneously as they were writing.

iGroups provides feedback on who has uploaded a document. It also provides feedback on how many times a document has been downloaded, but not by whom and it does not record the purpose of the download. In order to coordinate this process they used the possibility in iGroups to write meta-information into each document link to inform the others what they had done to a document after correcting in it. The informant described the process:

> "We had to use the meta-texts in order to tell what we have done with the document, and who has done it and why, because it could be that two persons being physically separated, had downloaded the same document simultaneously and begun to correct it and later upload it. Then it became a mess. So it was a matter of coordinating the order the document should be corrected. This was a bit hard …and wasn't always done consistently."

A major quality provided by the file-sharing environment is that one can edit directly in a document of a peer student. In order to keep the corrections separated from the original text they used the track changes utility in Word. Documents that where downloaded for commenting and rewriting by other group members were uploaded as new versions, and thereby creating a document history. Finally the original owner of the document was given the task of reconstructing a new document based on the contributions from his peer students. The informant explained:

> "I download a document and start to change in it. I do that using the track changes utility in Word, and thereby the changes are placed directly in the document, and they can be accepted or rejected. … The owner of the document can download it, look at it and say these corrections are good and these are bad."

The file-sharing space was also the arena for more intensive negotiations where the content of documents was discussed. And the access to each others' documents was both a source of inspiration and a source for adjusting one's own writings to the joint project. The informant said:

> "We could be two or three persons playing ping-pong with a document, write corrections, refuse or accept them and quickly respond saying: thank you for the corrections, they were damn good. And if one got stuck while writing, or wondered where the project was heading, one always had access to what the others were writing, reasonably updated and simultaneously. Thereby it was also easier to adjust one's own writings according to the others."

In addition to iGroups they used Windows Messenger to send each other informal messages. It is faster than communicating in iGroups and they reported that it felt better for more spontaneous dialogues. Through a combination of asynchronous and synchronous forms of interaction they could confront each others' ideas and perspectives and establish a dialectic practice which has proven difficult to achieve in environments such as text based conference systems (Fjuk & Dirckinck-Holmfeld,1999; Dirckinck-Holmfeld 2002).

By using these various techniques, they coordinated the construction of a joint project through sharing and negotiation, and the informant described the process as far more manageable than the traditional way of using paper and pen. In an ordinary project it is normal to gather the whole project group and circulate the documents for comments and rewritings.

> "Some times it is very disciplinary", the informant said. "One sits together for a whole day and makes corrections in the documents, using five different pens with five different colours, and at the end you get a document with thousand of completely non transparent corrections. So it is a bit easier when you can do it directly."

According to Gutwin and Greenberg (2004, p 189) "coordinating actions in a collaborative activity means making them happen in the right order and at the right time to complete the task without conflicting with others in the group". But coordination in genuine collaboration, and as described in this case, also includes the coordination of thoughts and people negotiating their positions and their engaging in each other's contributions.

6

INTERDEPENDENCY AND COMMITMENT

The informant argued that coordinating the project in a virtual environment also created more interdependency mutual commitment to fellow students:

"I felt more affiliated" he said. "I got more interested in what the others were writing when I could go directly to a document in iGroups, correct in it and get immediate feedback on my comments from the owner. I believe it means a lot that I could say: Hi Fred, I have just added a correction, look at it and say what you think."

He argued further that an environment that supports a continuously sharing and negotiation of content commits to participation and thereby strengthens the group process:

"It creates more commitment and one is more likely to focus one's attention. Keeping an eye on the system one is continuously participating. If a document pops up, one look at it swiftly to see if there are any corrections, and send it back right away with new comments. In this way I believe one get to read more of the others' writings. People expect to get something back. And because it is fast, they expect to get a fast response. Commitments are created when one knows that others are checking what one has written."

The interaction between the students was improved by using Windows Messenger in combination with iGroups. They were synchronously writing their documents and maintain a dialogue or discussion with the rest of group. The informant considered the fast tempo in the interaction and the fact that they all were online, constantly monitoring and checking for new uploads and messages, as essential for the collaborative process. "It became sort of group room", he said. It was a virtual group room where belonging was demonstrated through continuously and concurrently participation, and where psychological factors such as interdependency and mutual engagement were nourished, in the sense that the students felt committed to share information, to complement each others contributions, and to focus on a joint project that they were all engaged in. "It worked well", he said, but then he added: " it is difficult to tell whether it is because of the system or the people you are working with."

Psychodynamic factors such as interdependency and mutual engagement are claimed to be crucial for genuine collaboration (Wenger,1998; Salomon, 1992 and Dirckinck-Holmfeld, 2002). If the group doesn't pull together, if they do not engage in the same problems and tasks, and if they do not feel mutually responsible for the process, the collaboration will not work.

However as the informant commented, the fact that they were collaborating so well could be due to factors other than the technology they were using. In fact it is not likely that technology alone can produce genuine collaboration, and according to Salomon (1992), factors such as interdependency and mutual engagement are concerning the orchestration of the whole learning environment, including curriculum, teachers' behaviour, collaborative tasks, learning goals and the like. This in addition to the fact that some of students knew each other, and had been collaborating earlier, laid the ground for successful collaboration.

This doesn't make the virtual environment less important. This case demonstrate to a certain extent that psychological factors as interdependency and mutual engagement can develop in a virtual environment and even be strengthened if there are necessary functionality available, and the design supports the processes necessary for the students to engage in a joint project. These processes will probably vary form case-to-case depending on curriculum, learning goals and the tasks the students engage in. But in project based learning the interactive negotiation process, where material is shared and discussed, will be essential, and in this case it was supported by fast interaction and feedback between the students, by visualisation of participation, reifications of ideas and concepts, and the growth of a joint project.

TRANSPARENCY

Transparency is an important factor in project based learning and probably in all kinds of collaboration. It is a matter of being able to overview the process, what the others are working on, and to be able to place oneself into that context. Transparency is important with respect to coordination and sharing of knowledge, but also in order to found psychological factors as interdependency and mutual engagement, and to avoid possible problems and conflicts.

Transparency is closely related to what Gutwin and Greenberg (2004) describe as workspace awareness in distributed collaborative environments. They define workspace awareness as: "the up-to-the-moment understanding of another person's interaction with the shared workspace". It is to know who is present and what they are doing where. Such information is taking for granted in the physical

world, but in a virtual environment the system designer must explicitly program in features that can gather awareness information.

In the file-sharing space the current project structure was visible for all members of the group. They could view what the others had done, how far they had come, and what they lacked. Furthermore, they could easily notice if someone in the group had problems with fulfilling their part of the project. The informant explained:

"It is quite satisfactory to be able to watch what the others are doing. Normally it is like this in group work, that people can tell that they are doing fine working on a task, and then they come two days before delivery with half a page of analysis and cry and say they that they can't come up with more. But here we had some control because one could at any time see what the others were up to and be included in their process. And even though we were sitting separately, we could see whether someone was having problems or not by reading his documents and we could say: OK, Fred I think you are on a wrong track regarding the aim of the project. …It was quite essential that we could see each others documents and pay attention to it."

The virtual environment provided a visual image of the member's participation by showing a spatial representation of their file sharing space. Further iGroups gives information about who is online or how long a time has passed since a group member was last logged in. The group used this information to assure themselves that no one had dropped out or became passive, and if someone had not been active in the virtual environment for several days, he was contacted and asked to explain why he was not participating.

The students also discussed transparency in their own project report as a central factor in net-based project work. They concluded that transparency is important at different levels at in relation to different actors. They concluded that transparency is necessary in order to maintain a mutual understanding of a project. It is a form of positive control that secures responsibility. Further they discussed the importance of opening the group process towards a tutor by giving him/her access to the virtual project room. This kind of transparency will provide the tutor with more insight into the project and probably improve the conditions for adequate guidance. A third aspect of transparency is in relation to other student projects. That former student projects are available in a digital form, for easy access and inspiration.

A FLEXIBLE AND EXTENDABLE INFRASTRUCURE

Student projects are never homogenous. The problems they are investigating and the tasks they engage in will vary from project to project. Choosing an appropriate virtual environment for project-based learning is therefore problematic. The students in this case considered using a dedicated project management tool, but these tools were found not to provide the necessary flexibility. The informant explained that in a dedicated project management tool:

"one had to start defining a lot of tasks and create a lot of documents before one could even start on the project … but when one starts on a project one does not have many ideas about where one is going."

Flexibility was the main reason for choosing iGroups as the virtual project environment. It didn't direct the students to work according to a certain model, but let the students develop their own structures for the project. In the file sharing space they could add new folders change the sequence and delete.

"I believe one should be allowed to create the structure because it may change. Tasks may change", the informant said and he described how they continuously were restructuring the folders in the file sharing space and defining new folders with new headers were documents could be placed. "This possibility that you continuously can enter (the environment) and change the structure gives an incredible flexibility. … One can see the structure develop, that the introduction and the problem formulation are about to be ready and what will follow next."

The environment was also extended by creating several new workspaces as they were needed. In iGroups you can create simple editable spaces where all group members can add and edit text and hyperlinks, and they were used for several purposes, for example link collections, literature list, exam preparations, idea generation etc. The informant said:

"The extendible work spaces were fantastic, because one can never foresee what people need. … We used them for example to maintain a literature list, which we could update during the project, and in the end we just copied it to project document."

By the simple means that iGroups provides the student created their own environment, and they structured the environment and extended the infrastructure according to their own needs. There was little pre-programmed structure that they were forced to follow. The system did not think for them, but afforded an environment, which the students could change and restructure so that it supported the activities that they engaged in.

AN IMAGE OF SHARED EXPERIENCES

The file sharing space where the students were interchanging documents functioned as more than a space for sharing knowledge. The project structure that was gradually emerging in the file-sharing space was also a dynamic representation of the progression, as it was developing over time, accumulating the experiences of the project group. The structures that emerged in the file sharing space provided an image of the experiences that they were sharing, and it was reflecting the accumulated results of working together on the project. The informant said:

"The file sharing space is where the project is placed and at any time one could enter and see, how far have we have come and how many pages we have got. It was a function that gathered the whole".

The structure in the file sharing space consisted of folders, documents and meta-texts, and the students were continuously changing it. It was structured in order to reflect the project and the understanding the group members had of the project at any time.

"The file sharing space was mirroring the structure in the project", the informant said. "As the structure wasn't known in the beginning, we did not have a structure to start with. At some point we had folders with our names on, where each and one could put their documents. But slowly and surely we realized that we had an introduction chapter and a problem formulation. And then we started to get more structure. But it was not before the end that the final sequence was lined up because the chapters were changing and their sequence also".

The possibility to visually see the project grow over time, and to get an overall picture of the project as a whole, had a major influence on the coordination of the writing and the continuous reconstruction of the project structure. It worked as a coordination artefact around which they could negotiate their contributions and their positions. The result of this negotiation was a dynamically developing project that had undergone several changes and transformations before reaching each final status.

There is an emerging understanding of cognition as distributed between mind and environment (Vygotsky, 1978; Säljö, 1995; Pea, 1993). Thinking is not exclusive an internal mental process but is an integral part of human practice (Säljö,1995) including use of tools both psychological tools and artefacts. We use tools to interact with the world, and we use tools to communicate, discuss and create

Figure 4. The file sharing space where the students shared files and jointly shaped the structure of the project.

understanding and knowledge. According to cultural historical theories language is considered the most important tool for thinking. Language is used to create meaningful concepts that we can share and discuss with other people. However technical artefacts including computer tools have a parallel function as mediators of knowledge and as such they can extend our ability to think, act and collaborate.

The understanding of cognition as distributed between mind and environment has consequences for the design of virtual environments and computer tools. It implies that in order to support cognitive demanding tasks such as problem solving, reflection, and negotiation of meaning the virtual environment must provide tools and structures that can help the users to think - alone and/or in collaboration with others.

In response to this Minken and Stenseth (1995) argue for the need to have elements in the user interface that can accumulate the user's experiences while interacting with the computer system. They call such elements *images of experiences*. These are objects, artefacts or structures that can aid the user to see how far one has come solving a problem and support him/her to find the further direction. The image of experiences that emerged in the file sharing space was only partly a result of what was afforded by the system. It was just as much a result of the social practices that the students engaged in. In fact the environment was quite simple and did not provide much interactivity and in order to restructure and change the sequence of the folders the students had to number each folder, and have iGroups to sort them. It is true that the environment afforded the students a possibility to represent a structure of the project, but the invention of the structure and the process of negotiating and restructuring the representation belonged to the students. It is obvious that the image of experiences did not reflect every aspect of the students' collaboration. However it did capture essential elements. It captured the emerging project as they were adding and correcting documents and restructuring their sequence. The focus was on the representation of the project structure and as they were changing it, it was also changing their own understanding and laid the ground for new experiences.

CONCLUSION

A single study like this has its limitations in order to explain collaboration and knowledge construction in a virtual environment. However the case of study was chosen because it appeared to be a best practice and because the students had chosen to use a virtual environment out of free will. It was not forced upon them, and they didn't know until later that their virtual practice would be a subject of investigation. Although it is a single case the fact that they constructed a learning environment based on their own needs and desires and without interference from teachers and supervisors makes this case particular interesting.

The students in this case showed a desire to collaborate. Although the virtual environment supported this desire, it was grounded in the Problem Oriented Project Pedagogy as they practice it at Aalborg University. The students were trained in collaborative learning and had several years of experiencing it. Dirckinck-Holmfeld (2002) argues that POPP is a well qualified method for Computer Supported Collaborative Learning (CSCL) because in enables genuine collaboration. This study emphasizes that using a virtual environment can contribute to strengthen group awareness and the construction of a joint project.

The aim of the study was to reveal how the student group used the virtual environment to successfully coordinate the working on a joint project, and how they together created a shared *space* which they inhabited and structured according to their own practice.

Coordination was one important argument put forward by the students for using a virtual environment and two types of coordination were identified; coordination of activities such as tasks and schedules and coordination of knowledge construction understood as the coordination of thoughts and people negotiating their positions and engaging in each other's contributions.

The extremely visible and interactive process of uploading, sharing and commenting on documents encouraged the students to be active in the virtual environment. They felt committed to engage in each others contributions. The group process was transparent, and the students could watch each other's participation in the project environment. They used it for continuously adjusting of the group process,. They tried to motivate each other and ensure that everyone was participating and no one was dropping out.

A flexible infrastructure made it possible for the students to shape and extend the environment after they own needs. The students were place-makers who constructed their own collaborative environment.

Finally the case demonstrated the signification of artefacts or *images of experiences* in the environment, objects and structures which can accumulate and reflect the shared experiences of the

10

participants, and aid them to abstract the problems that they are engaged in and to find the further direction.

Virtual learning environments are not neutral. They afford a certain practice (Norman, 1988; Pea, 1993. Dirckinck-Holmfeld et al, 2008), and one has to choose environment according to the practice one wants to support. It is in the nature of POPP that the virtual learning environment must be open and flexible. POPP is a flexible pedagogy (Dirckinck-Holmfeld, 2002) with a flexible curriculum where the students define problem, theory and research methods themselves. Therefore the virtual environment must not force the students to work according to a predefined structure. Instead it must afford the students to create their own knowledge constructions around which they can negotiate their contributions and positions. far one has come solving a problem and support him/her to find the further direction

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