Students Designing ICT Support for Collaborative Learning in Practice

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ABSTRACT

The aim of this paper is to present an understanding of student practice and needs in relation to ICT-based support for Problem Oriented Project Pedagogy (POPP). The paper combines a theoretical understanding of POPP and results from a case study. An important characteristic of the students in the case study is that they construct and reconstruct a learning environment of their own choice without intervention from other parties. The paper identifies coordination of activities, coordination of knowledge construction and creation of joint images of experiences as key activities that may very well be supported by ICT. It is also clear from the case study that students demand a flexible tool that can be altered as the project progresses and needs emerge.

Keywords
PBL, POPP, communities of practice, coordination, learning environment, design.

INTRODUCTION

Design is never just about ICT, but also about a smaller or larger change of practice somewhere. The Scandinavian tradition for systems development has brought our attention to the need for user involvement from early stages in the design process and onwards (Dahlbom & Mathiassen, 1993). Today, part of the philosophy behind the concept of democratic design of information technology is finding its way into collaborative learning environments. In the case we have studied, students in a highly collaborative environment chose to combine ICT provided by their university with free software from the Internet to design their own virtual learning environment. This is not simply a user involving process, but a process carried out and controlled by users made possible by the Internet and the amount of free software and services available. Therefore, the use of ICT in the case is to a very high degree grounded in needs experienced by users and user initiative, and not in order to meet needs in the organization. By studying this case, we intend to expand understanding of ICT support for project-based learning as seen from the learner's perspective. The aim is to understand the role of ICT-based settings in student collaboration and to outline requirements for such an environment.

A CASE OF STUDENT INITIATIVE

Human Centered Informatics
Human Centered Informatics is an educational program within the Faculty of Humanities at Aalborg University offering both bachelor (3 years) and master level (bachelor + 2 years) education. It combines communication, organization and ICT studies to provide students with the tools necessary to be critical, but constructive, participants in the evaluation and construction of ICT and new media. Students are exposed to software construction, internet technologies and programming. However, they are, in general, not regarded as skilled programmers, although they acquire some knowledge of programming during the course of their studies. In our case study, we included students that have not completed their bachelor, but are close to doing so (5th and 6th semester) and students that completed their bachelors and have just begun their master's degree (7th semester).

The technological platform
IGroups was the virtual environment chosen by the project groups we studied. It is a groupware system provided free via the Internet (http://www.igroups.dk). IGroups has an open-ended design and provides a flexible and customizable environment where users, to a certain degree, can decide for themselves the

composition and meaning of the available tools. The two most important tools used by the project groups in the case study were the file-sharing tool and the shared web documents. The files-sharing tool allows the members of the iGroup to upload and download documents in directories and to restructure the sequence in which they appear. The shared web documents make it possible to create new workspace on demand where the members can add content. In addition, iGroups provides tools such as calendars, conference forums, chat functions, SMS (at the time of the study), messenger services, e-mail lists, event managing, member managing, photo albums, voting, link lists and a game.

Problem Oriented Project Pedagogy

Problem Oriented Project Pedagogy (POPP) has been integrated in all programs at Aalborg University since it's opening in 1974. Human Centered Informatics and the students we studied are founded upon this tradition, as well. To understand what goes on in our unit of analysis, it is necessary to understand the basic aims and principles of POPP.

POPP builds on a constructivist understanding of learning that can be traced back to Piaget (1969) and Dewey (1966, 1997). Critical Sociology has also contributed significantly to the foundation of POPP (Dirckinck-Holmfeld, 2002, p. 35). Over the past years, Etienne Wenger has contributed with his understanding of *communities of practice* (Wenger, 1998). The aim of POPP is to educate students that can, through the use of a critical, analytic and constructive approach, contribute to elucidating and solving problems in society (Dirckinck-Holmfeld, 2002). Important principles are the formulation of problems and enquiries into those problems. Students are in charge of all processes in a project. They inquire into a problem they have formulated themselves. Students also decide which perspectives, theories and methods they want to include in the inquiry. To support the process, an advisor guides the students. This is strikingly different from problem-based learning (PBL) where teachers, to a certain extent, define the problem and students thus experience less ownership of the problem and project they work on. According to Illeris (1981, p. 102), this difference is significant because students need to experience real ownership of the problem and project to have the highest degree of motivation to go through the complex and sometimes painful reorganization of mental structures that learning is.

Communities of Practice

The theory of learning in communities of practice is relevant both when it comes to explain how POPP facilitates learning and when the target is to understand the role of ICT in POPP. Our focus in this brief introduction will be on central concepts that can be used in the analysis of our case.

Wenger describes practice as *about meaning as an experience of everyday life* (Wenger, 1998, p. 52). What goes on in practice is therefore negotiation of meaning understood as a duality of *participation* and *reification*. In our study, negotiation of meaning takes place in the group of students. Participation in the negotiation of meaning takes several forms including participation in discussions and production of contributions to the project. At the same time, documents, infrastructures for collaboration and so forth are reifications of the negotiation of meaning.

A community is constituted by mutual engagement, joint enterprise and a shared repertoire (Wenger, 1998, p. 73). All three dimensions are both subject to, and influence, the negotiation of meaning in the community. In POPP, mutual engagement is linked to the formation of the project group and maintenance of social relations within the group. Joint enterprise is related to the common project and negotiation of its target and content. Shared repertoire refers to shared artifacts as well as the shared academic and social history of project group members.

In short, learning is all of the above, meaning that learning at the individual level means engaging in and contributing to a community while learning at the community level is refinement of practice.

THE RESEARCH STUDY

The study is a traditional case study (Stake, 1995; Creswell, 1998) with one slight modification. Some of the teachers and students at Human Centered Informatics are also involved in an action-research (Baskerville & Pries-Heje 1999) project aimed at developing the courses and the coherence in administration and information through the use of ICT. Student-driven construction and use of ICT-based infrastructures to support their project collaboration is purposely kept out of the action-research project because we wanted to study student initiatives. However, the two processes are, of course, interrelated. Therefore, we involve teachers in the case study to estimate the broader impact of student decisions.

Data Sources and Timeframe

The study focuses on ICT support for students' own collaboration undertaken during one semester and involves 26 students divided into 5 project groups (3x6 students, 1x5 students and 1x3 students) and 4 teachers. This is all students from the 5th semester of Human Centered Informatics bachelor program and 1 group (the group of 5 students) from the 7th semester (1st semester of the corresponding masters program that follows the bachelor). We included the group from the master programme because it at first glance seemed to represent the same kind of developmental practice we saw emerge at the 5th semester and thus would either support or contrast our findings at the 5th semester.

Table 1. Data sources in the study.

	Students	*Teachers*
Interview/individual	x	x
Interview/groups	x	
Observations	(x)	(x)
ICT platform study	x	x

The category "ICT platform study" includes ICT infrastructures and virtual learning environments constructed by students and represents development over the course of a semester that is collected at the end of the semester. This is closely related to our use of observation because we do observations in the virtual collaborative spaces that also save traces of the process. Interviews were carried out in the last part of the semester and included discussion of data from observations and ICT platform studies.

Data Collection and Interpretation

All interviews were carried out as semi-structured qualitative research interviews (Kvale, 1996). This means that interpretations are present in all phases of the process from the construction of the interview questions to the actual interview to the resulting analysis. Furthermore we took information obtained in one interview to other interviews to test whether something was regarded a common theme or not. In one case we took conclusions back to a group of interviewees to include their feedback in our data. This approach recognizes that knowledge of social practice is constructed in social practice. Therefore, interviews are our primary source of data, meaning that we use the interview as a space for negotiation of meaning with the students or teachers we are talking to. Observations and ICT platform studies of different kinds are in the interviews used as artifacts representing aspects of the community of practice we are trying to understand.

The interview questions were constructed to uncover practice, tools, tasks, challenges and solutions in the collaborative process. It was done by drawing on our knowledge of POPP and communities of practice combined with the knowledge we prior to the interviews had about how the groups had used iGroups and other tools.

Table 2 represents the first level of analysis after the data are collected: A preliminary categorization that summarizes the construction and reconstruction made by each group of students in the study.

Table 2. Overview of the Data.

Group Size	Requirements expressed in tools	Construction Activity	Student Comments
6	File sharing, document version control, discussion forum, group e-mail, calendar.	Change of work and collaboration practice and reconstruction of iGroups.	ICT should help without creating an extra workload. Prefer to keep advisor out of collaborative space in iGroups, because they feel his presence may restrain their internal communication.
6	File sharing, version control for documents, news, calendar, access to see last login of other group members.	Change of work and collaboration practice and reconstruction of iGroups.	The same tool should support all activities so that users do not have to switch between different tools. The tool should be flexible to allow ongoing adaptation.

All members of the groups have high-speed flat rate internet access and uses on-line activities to maintain coordination of the group activities. |
| 6 | File sharing, discussion forum to share questions and ideas, group e-mail, meeting planner, literature list. | Change of work and collaboration practice and reconstruction of iGroups. | Too complex to use iGroups for simple file sharing. The upload procedure takes too long time to complete.

Did not invite the advisor into Igroups. Wants to keep a private room, but is also open to collaboration with advisor in an Igroups-like environment.

Finds it important to be able to sit at home and maintain on-line collaboration within the groups.

It was a coincidence that they choose iGroups. One of the students at the semester recommended it and they choose to use it in a course. After that the group decided to use it. |
| 3 | Mail, shared e-mail for external communication.

Har siddet hver for s | Change of work and collaboration practice. | The group was small and could easily keep track of everything without groupware. However the groups emphasizes that the free high speed internet connection at home they received through a research project meant a lot to the collaboration and changed it from earlier projects they had participated in. They found the new practice more collaborative due to better communication and coordination. |
| 5 | File sharing, discussion forum (synchronous and asynchronous), calendar. | Change of work and collaboration practice and reconstruction of iGroups. | High priority given to tools that made it possible to work distributed either synchronous (MS Messenger as tool) or asynchronous. Also focus on experiments with on-line support of collaborative knowledge building. |

The analysis build on the data as table 2 does, but focuses on themes that emerge from the overview in table 2 in the light of Wenger's theory of communities of practice and the knowledge of POPP we presented earlier.

ANALYSIS OF THE DESIGN AND IMPLEMENTATION PROCESS
The analysis is centered on three themes concerning processes that explain central aspects of how the students formed and used an ICT-based setting for collaboration: Choice of environment, reconstruction of environment

and work practice in the environment. The perspective of the analysis is not to give a complete picture of all the cases, but to discuss practice and eventually to identify good practice for ICT support of POPP.

Choice of environment

The university at the time of the study provided students with e-mail addresses, space for publication of web pages and shared web folders for project groups. Therefore, students that wanted a groupware to support their project process had to look somewhere else for a tool. They also had to clarify their needs to find an appropriate tool. One group considered using a dedicated project management tool, but these tools were found not to provide the necessary flexibility needed in a project where the overall aim is to learn and not to produce a specific product. One student explained: " *(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.* "

The project groups also considered possible consequences of their selection of an environment in relation to decisions made by the university. Official communication from teachers and administration was placed in newsgroups, teachers supported courses with different web-based materials and two teachers were trying out Lotus Learningspace as a possible future framework for delivery of material in courses under Human Centered Informatics. At the same time, 5th semester students had chosen iGroups as a platform for collaboration at semester level. The students were aware that this web of infrastructures was very complex already and that what they needed for the projects was something truly helping them and not just another piece of technology.

They chose iGroups because it did not force them to work according to a predefined project method, and because it provided the necessary flexibility to customize and reconstruct the environment themselves according to their own needs. On one hand, it is impossible to foresee the specific needs one has in a project and what tasks a system should support, they told. On the other hand, the project groups pointed out that they had project experience from earlier semesters and, therefore, a general idea about what is to be expected. Thus, they gave high priority to an open-ended structure in which one is allowed to create appropriate forums or spaces when they are needed.

Flexibility and reconstruction of the environment

The project groups did not put much effort into reconstructing their iGroups spaces when they started using them or early in the project process. The basic structure was considered sufficient for a start.

Reconstruction primarily took place in the file-sharing tool where the joint project was put together. The students explained that the tasks of the project were not defined when they started. They were ever changing and established through negotiation and collaboration. As a consequence, the project structure that was created using the file-sharing tool dynamically reflected the progress as they were continuously reconstructing it.

Another important tool for customizing the environment were the shared web documents that they could create on demand. The shared web documents provided an open functionality and were used for creating new workspaces where ideas were generated and exchanged. They were used for creating literature list and links to internet resources and identifying and managing new and ongoing tasks. They were used for all activities that needed to be negotiated and reified, and they were preferred to asynchronous conferences because they were highly editable and easy to overview.

Coordination

All groups cited coordination as a main reason for the project groups to choose a virtual project environment. Students are active people; therefore it is a challenge to coordinate their work in a project. But coordination implies more than planning project meetings and project tasks. Coordination involves the whole mutual process of planning, structuring and creating a joint project.

The case study revealed two aspects of coordination where iGroups were involved: Coordination of project activities and coordination of knowledge construction. These two coordination processes are not independent dimensions, but rather in a collaborative project they identify two different aims of using a virtual environment.

Coordination of activities

All groups explained that the members were busy occupied with different activities outside of the university. Some were active in sports, others were working beside their studies, and therefore it was difficult to find time for collective meetings on campus. IGroups (and in one group e-mail) was thus used to get an overview of

individual as well as collective activities. One group explained that they used the message function in iGroups to organize project meetings and to set up meetings with their advisor, and they had a shared calendar where the group members wrote down whether or not they where busy with external activities.

But coordination of activities is not merely a matter of organizing time; it is also a matter of identifying, sharing and managing new and ongoing tasks. The project groups used the shared web documents or a discussion forum for this purpose. They wrote and corrected and tried to describe what the missing tasks were, which tasks people were working on and the problems they were dealing with. Using shared web documents, which everyone could edit, for these purposes gave a dynamic overview of the process, and it became a forum for idea generation and negotiation of the tasks involved.

But as one of the students commented, it demands a certain discipline among the group members to maintain the shared web documents. There is nothing in the technology that encourages or reminds one to update them. It is a matter of trust because if one cannot rely on the information, it becomes insignificant and the updating may end.

Coordination of knowledge construction

Coordination of knowledge construction is a central process in POPP. Students are not supposed to divide the project into discrete tasks, but, rather, they are supposed to engage in the process as a whole and to learn through confrontation and negotiation of perspectives and beliefs (Dirckinck-Holmfeld, 2002). This involves a lot of coordination between the group members.
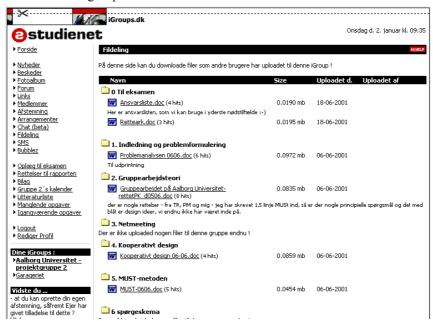

Figure 1: The file-sharing environment in iGroups taken from one of the study's project groups.

An important feature of the file-sharing tool in iGroups is the possibility to view all links to the uploaded documents in different directories simultaneously and as a whole. This may appear an unimportant design detail, but it makes it possible to easily get a complete overview of the project development process. This visual feedback can be described as a joint image of experience reflecting the shared experiences of the project group.

However, the shared construction of knowledge in project-based learning only becomes visible for the members through the material that they produce. This made the file-sharing function in iGroups the central tool for the coordination of knowledge. The project groups used the file-sharing tool to upload documents, to comment on each other's documents and to rearrange the structure of the project.

The file-sharing tool made the process and the project structure visible for all the of the group members. They could continuously 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 uploaded documents were downloaded by the others for commenting or further writing. This process needed a careful coordination. IGroups provides feedback on how many times a document has been downloaded, but not by whom and not the purpose of the download. One solution to that problem was to write

meta-information to each document to inform the others of who had downloaded the document and why. Using this technique, the group members could coordinate the co-writing process and thereby avoid that more than one student commented or worked on the same document. Documents critiqued or rewritten by others were uploaded as new versions, thereby creating a document history, and the original owner of the document was finally given the task of reconstructing the new document.

The students argued that this coordination process created more mutual engagement and more mutual dependency in the project: "*I got more interested in what the others were writing when I could go directly to a document in iGroups, correct it and get immediate feedback on my comments from the owner*" "*... and if one got stuck while writing, or wondered where the project was heading, one always had access to what the others were writing.*"

Boundary object and a joint image of experience

The file-sharing tool in iGroups functioned as more than a place for sharing documents. The project structure that was gradually emerging in the file-sharing tool was also a dynamic image of the progression, as it was developing over time, accumulating and reflecting the experience of the project group in creating a joint project.

One project group explained that, in the beginning, the file-sharing environment had one directory for each member of the group, where they downloaded their documents. The structure of the project was not apparent. It was something that developed over time. Gradually the structure of the project became more visible. New directories where added; first one for the problem formulation and one for the introduction. Later on, other directories where added or deleted and the order in which they appeared was changed until the file-sharing environment comprised the final project, but that was at the very end of the project.

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 contribution and their position. The result of this negotiation was a dynamically developing project that before reaching each final status had undergone several changes and transformations.

This usage of the emerging project structure as a coordination artifact has similarities with what the sociologist Susan Leigh Star (1989) describes as a boundary object - an object that inhabits several communities of practice and has informational value in all of them. However we do not find the notion of the boundary object adequate when the focus is on a group of students constructing a dynamic artifact to enhance their collaboration. That is why we call this reification a joint image of experience - a joint image of an emergent structure that is both a result of past negotiations and input to future negotiation of meaning. When we broaden the scope and integrate more groups of students and advisors in our perspective it is, however, appropriate to understand the project-structure in the file-sharing tool as a boundary object. No groups had significant collaboration with advisor or other groups in iGroups, but all groups that used iGroups had considered it. The content-structure then had the potential to become a boundary object that continuously informs the advisor or other students with similar interests of the direction and progress of the project.

CONCLUSIONS AND PERSPECTIVES

The students in our case study had a practice highly influenced by their prior experience within the POPP tradition and the technological setting they chose to use. They formed communities of practice where iGroups supported the negotiation of meaning and the maintenance of the community. A POPP project is based on participant control, responsibility, problem orientation and collaboration (Dirckinck-Holmfeld, 2002). It is a complex process composed of several tasks and phases linked together. In order to support that with ICT, the technology has to be flexible and allow ongoing reconstruction along with the growth of the project. The case study shows ICT itself is subject to negotiation when students integrate it in a POPP project. They rearrange the environment and add new workspaces when needed. It is a matter of control over the virtual environment. If technology cannot be negotiated and reconstructed as part of the process, there is a risk that the technology will control instead of support the process, and thereby conflict with the central principles of POPP.

The demands for flexibility identified here are centred on different dimensions of coordination. Project groups need support for coordinating knowledge construction as the project evolves and meaning has to be negotiated. In addition they need flexible support for coordinating activities, organizing time and identifying, sharing and managing project tasks. The third dimension identified is linked to openness and transparency. IGroups made it possible for the students to open the project process, and to create an image of the emerging project structure around which they could negotiate their contribution, and their position. This was to a lesser extent used to open

the project process to either a advisor or other students, but fully implemented this would strengthen the element of collaboration in POPP by enhancing collaboration between groups.

The findings in this case suggest a need to expand the understanding of the relationship between structure and openness in ICT used to support learning. Learning creates emergent structures (Wenger, 1998) and can best be supported in an environment where these structures are allowed to grow according to the needs and goals of the learners.

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