Distance Education in Information Technology, a case study

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***Abstract* – Project organized problem based learning is a successful concept for on-campus education at Aalborg University. The "Aalborg concept" has been used in networked distance education as well. This paper describes a project from the first year of our Master of Information Technology education organized with Internet-mediated project work. A group of 4 students carried out a project dependent on knowledge from two firms where two of the group members are working, making this a kind of Worked Based Learning (WBL). The project was formulated as a traditional on-campus type of project with the same complexity, and the designed solution should be implemented on a test rig. In spite of this, the group fulfilled the goals satisfactorily, and made an impressive project. The main conclusions are, that the project work is a strong learning motivator, enhancing peer collaboration, for off-campus students as well. However, it is much more risky if the on-campus model is transferred directly to off-campus learning. The main reasons are that the students must communicate electronically, and that they are under a fierce time strain, studying part time and typically with a full time job and a family. Experiences with this type of project in group-organized distance education, are described and commented by three of the group members, and some possible solutions for more appropriate types of projects are listed[1].**

I. INTRODUCTION

Project organized problem based learning in groups has been the foundation for the educational system at Aalborg University from its start 28 years ago. Since then, experience has proven this a very successful innovation in higher education [8], [10]. The duration of each student project is normally one semester, and the students spend 50% of their time working on the project in groups of typically 5–6 persons, 25% is spend on project oriented courses and the remaining 25% on general courses. The learning concept has many merits, e.g. increased motivation, excellent development of analytical skills, and experience in coping with complex real-life problems. Furthermore it gives a high degree of completion.

Consequently, our distance educations are based on the project study form as well, expecting the same merits as mentioned above. Traditionally, however, distance education has been characterized by one-way communication and self-study, whereas the project study form is based on collaboration and dialogue. The project work in distance education therefore requires extensive utilisation of new information and communication technology to enhance discussions, information exchange and create a feeling of being in virtual group room.

There are only a limited number of references on project-organized learning in networked distance education available, e.g. [4], [5], [6], [12], [13], so our concept is build on experience from on-campus education, and is constantly being modified as new off-campus experience is obtained [11].

The project groups communicated by:

- Document exchange via web
- Asynchronous communication using news, e-mail and discussion fora
- Synchronous communication using net meeting fora (voice and text mediated chat) and phone
- Face-to-face meetings during seminars

During the first year with part time studies the students make two projects, a short pilot project [1], [2] and a main project, one of which is reported here as a case study.

II. THE MASTER OF INFORMATION TECHNOLOGY EDUCATION

The Master Education in IT Engineering (MII) is a supplementary education, established by the Institute of Electronic Systems at Aalborg University, Denmark. URL: *http://www.mii.itorg.auc.dk*.

The MII education leads to one of 5 professional specializations, sharing a common first year education. The content of this year is primarily basic theories and skills in: Data Networking, Object Oriented System Development, the Client-Server paradigm, Databases, Human Computer Interaction and Web-tools.

The second and third year the students are studying IT concerning their own profession, attending courses of particular interest and making projects about the chosen subject of special study. The MII offers specializations in:

The Building Process, Industrial Manufacture, Control Engineering, Distributed Real Time Systems and Network Maintenance.

[1] The project was reported in "Ingeniøren" the weekly-distributed newspaper for engineers in Denmark.

III. THE GROUP

It is important to know the group member's background since this may be of importance for the success of the project.

- The four group members already hold a bachelors degree in electric engineering, power engineering and chemical engineering
- They are of almost same age and they form a group that is not as inhomogeneous as often seen in distance education
- They all have limited spare time for studying
- They have varying levels of IT-skills. Two of the students could take the lead in the project because of their work.
- Two of the group members have their bachelor's degree from Aalborg University. They therefore know the Aalborg model

The group members intend to follow three different specializations in the following semester. As three of the group member's professional background is electrical engineering they naturally took the lead in implementation of the test rig. The last one was an expert in databases so he concentrated on this and the courses and documentation. As one left the master education only three group members join this paper.

IV. THE PROJECT AND COURSES

It is very important that the students feel responsible for their project to be a success. On campus this often mean that the project should come from every day life. As the group has two members employed at respectively Grundfos A/S making all kinds of pumps and pump control, and Siemens A/S making and programming mobile phones using e.g. SMS via GSM, the idea of a project proposal involving interests from these two firms was evident.

The general supervisor proposed concept for the project is shown in Fig. 1.

The project must include a client, a server and a database. The connection between the client and server should be/could be Internet HTTP/POST or another interface.

The students should program the client as an applet, the drivers for the connection, and the server, and they should design and implement a database for supervision and historical reason.

If this general frame was fulfilled the students were free to formulate projects that could be of main interest for them self, for their firms or a third part.

A. The reported project.

As two of the firms could have interest in the project, the students proposed a project with the title: "Embedded web", *A water pump placed in a well on a field for pumping drinking water should be supervised. Flow and pressure must be recorded. The data are stored in a database. It shall be possible to show the data graphically on the Internet with a standard web browser*. As the electrical equipment is placed far away from stationary communication lines it is obvious to use mobile phones for the communication. The project then can be illustrated in Fig 2.

The general concept is not quite fulfilled since the applet requirement at the pump is not programmed with an interactive user interface. But as the client should be programmed in Java in an object based solution, this is satisfactory. In addition, the solution requires detailed knowledge about pumps and the special data to the pump controller. The group could get this knowledge from Grundfos. Also the connection, programming and transforming of data to the mobile phone was needed. The connection and data transformation from SMS to web could be established at Siemens. What could not be found anywhere was how to construct and build a Tiny Client to be placed at the pump. As often seen in on-campus projects, the project is in some instant covered by the given courses but in the solution other aspects must be considered and the students themselves must seek information from library and/or industrial applications from the Internet. Certainly this is also the case here. To build the client the group had to seek for a hardware solution on the net and fortunately found the board DS-TINI-1. (Tiny InterNet Interface. This is a small board with the DS80C390 micro controller exposed through Java™ API's with extensive I/O possibilities. It is well suited for the project because of the Java Virtual Machine (JVM) providing the core Java packages: Java.lang, Java.io, Java.net and Java.util).
(http://www.ibutton.com/TINI/index.html)

B. Courses.

From the very start of the main project the students are offered the following courses to be applied for their problem solutions: Object Oriented Analyses, Modelling and Syntheses short: OO*. A course in Client/Server was offered as well as a course in Databases and the language Java. At the beginning of the semester the students had a study course in Computer Networks.

Accomplishment of the courses are planned to be in the first half of the main project period from November to first of March and the main effort on the project is intended to be in the remaining period of time March to the beginning of June see Fig. 3. As will be concluded it is very difficult to give priority to both the courses and the project.

V. COLLABORATION METHODS AND TECHNOLOGY

Collaborative project work in a distributed environment is difficult due to lack of a physical group room, where communication, document handling and timing are important activities - not to forget the social affairs.

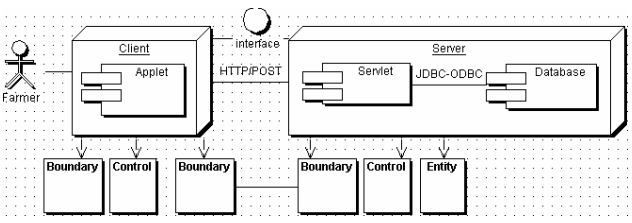

Fig. 1. General project concept

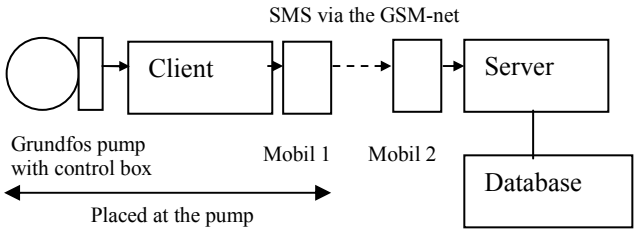

Fig. 2. Structure for the Embedded Web project

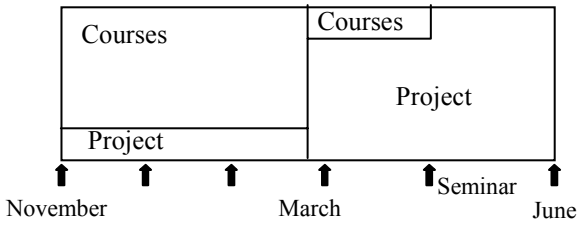

Fig. 3. Planned intensity of courses and project supported by seminars

A virtual group room was established and the activities defined. Documents were produced and processed by the group members and all documents were stored on a centrally placed computer at the university. All members of the group were able to download, read, review and upload documents, backed up and fairly organized. Responsibility, deadlines, and progress information were visible as well.

As tool for remote teaching and collaboration, the group was offered the commercial program LUVIT®.

A. Document handling

The project documents are organized in a tree structure in LUVIT, reflecting the final report contents, see Fig. 4 and an university developed spreadsheet for documentation of responsible, reviewer, version control and time schedule, see Fig.5 [1].

VI. EXPERIENCES WITH THE PROJECT WORK

In this paper the focus is on the experiences from the reported project, especially: distance group work experiences, distance project work experiences, technology experiences and seminar experiences, all from the supervisors and three of the four group member's point of view.

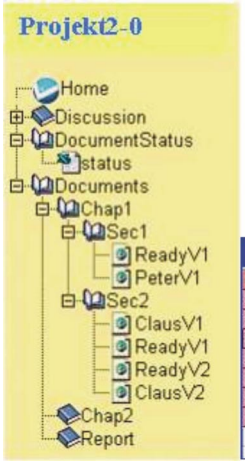

Fig. 4. LUVIT-tree

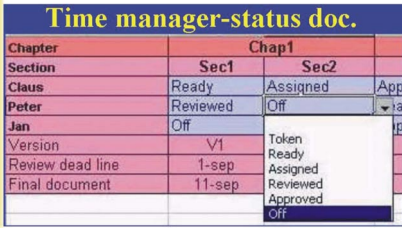

Fig. 5. Spreadsheet for version control

A. Distance group work experiences

Collaboration, communication and planning are the main processes in group work. The intension is that the group collaborate about the courses, solution of exercises and the project work. The work intensity should be approximately 20 hours a week. The students are facing many kinds of problems, social as well as professional, to get the group work done properly. It is a challenge to give both the courses and the project precedence. In the virtual group room the students communicate through chat (writing, audio), telephone (synchronous), news, e-mail and fax (asynchronous).

1) Supervisor observations: In this group it was experienced that the collaboration in courses were nearly absent and that most of the group effort was on the project. At the same time the collaboration intensity was very varying with shorter periods of zero activity. The intensity was highest in the weeks after a seminar and in the week just before a seminar. When the group communicated through chat meetings they used a well-structured agenda but the chats were not very successful when the problems were too difficult or complex. These kinds of problems were postponed to the following seminar. It was registered that even minor problems could stop the students for a longer period of time. Even if the group used best practice [11] with well planed and structured weekly chat meetings, a minor obstacle, e.g. that a member failed to appear at a chat meeting, impeded the progress and was first caught up on the following seminar. Planning could appear through chat, but plan suggestions were often made through mails. Between the weekly chat there was a growing flow of mails between the group members as the semester progressed.

2) Student's comments:

JB: Synchronous communication at regular intervals is very useful, but as we had problems with audio chats it was very time consuming. For asynchronous communication e-mail was by far the most efficient method, but to limit the possible time delay, all group members had to check their e-mail at least once a day. The collaboration was organised so that every task was assigned to one responsible and one standby/sparring-partner. Having two group members working together with a task, made it easier to make synchronous audio communication via standard telephones. A project leader was assigned to take care of the follow up on the agreed time schedule. A close follow up is more needed for distant work.

SM: In the beginning we had technical starting problems and therefore used more time on equipment and software to get connection over the net than how to communicate. This was because of different PC's, operating systems and not too well functioning net-providers. When after all the net was used, the netmeetings sharing function was especially useful for showing minor demos of subtask solutions.

RA: The chat meetings are not good enough for complex problems. It is not easy to grab a problem at the root and

solve it in a virtually environment. It is always easier to talk around a subject or even not answer a question when you cannot see the persons you are "talking" to.

3) Suggestions: The group agreed that regular chats with audio are necessary and can be used with success in group work. Though it is time consuming it gave the students the feeling of group solidarity. To keep up the pace between the seminars the group recommends that they should follow their planned milestones in a more disciplinary way. Even if the group work was flexible the group members felt responsibility because of mutually dependency. The group work should have been better planned and so detailed that they all were able to contribute even if one was not able to take part in one or more chats. It is very important that the stops in progress be as short as possible.

B. Distance Project work experiences

The Project work deals with design and implementation of well-defined tasks/subtasks, task planning and time planning. The group as autonomous entity must define common plans. Every student should be confident with the plan and know all about tasks/subtasks and when they are supposed to be solved.

1) Supervisor observations: The project work was based on solving interdisciplinary problems using not only the offered courses but also firm based knowledge. Besides, the group decided to implement their solution on a test rig from Grundfos see Fig. 6. and Fig. 7.. The project work had both clear and unclear tasks and subtasks. This normally is imbedded in problem based project work, but in distance educations this can split the students and become very problematic, as continued discussions is not possible. As the solution should be programmed the group had to make an abstract model of the problem area clarifying classes, functions and time sequences. This was very difficult. It took a long time and extra self-organized face-to-face meetings to get a common understanding of the required abstractions. It is obvious that two or more of the students had to meet to make the practical implementation on the test rig. This shows that technical project of this kind cannot be made on the net alone. The ambitious students made it possible to fulfil this demanding project, and the supervisor was not at any time involved in the practical implementation.

2) Student's comments:

JB: Coming from Grundfos it was important that I could contribute with how to get the data from the pump controller. As Grundfos also contributed with the test rig the connection from controller to TINI board was my responsibility. We sheared programming of the TINI board and it was essential that we agreed upon tasks/subtasks and that all took part in the detailed programming using JAVA. At the integration test of the whole system it was necessary to arrange extra face-to-face meetings where all the equipment was available. At these meetings all programmed modules were tested, debugged and integrated.

SM: Coming from Siemens my special duty was to get information and knowledge about programming the two mobile phones. As an experienced programmer I also more easily could get an overview of the delivered support software tools for programming the TINI board. This was useful because every one should have the same and necessary software tools when programming subtasks. We all had the responsibility for programming the special hardware as well as programming the central placed server.

RA: The group agreed in the beginning of the project period to be very active in the programming courses. The experienced programmers helped the inexperienced. This really paid of in the last hectic implementation phase.

3) Suggestions: If the analysis in the beginning of the project period should give an overview of the whole project compared to an estimated need of time, it is necessary that the project is much simpler. The following definition of subtasks and the detailed time schedule can only be expected for smaller projects. If the time schedule should be flexible enough to catch fluctuation in the group members available work time, this also requires projects of limited size. The students and the supervisor agreed that the time schedule always is a topic in the chat and seminar agenda. It is important that all group members have almost the same level of ambition. Methods and procedures for forming homogeneous groups must be developed. At the same time it is very important that the possibility in project work to combine different disciplines from the courses to solve complex problems is improved.

As the project work possibly level the professional skill on campus, it should be possible to organize courses and project work in distance education with the same quality. A mechanism that tells where and why group members have problems so that other members can help and discuss these problems is needed. This will be helpful both for the members and for the progress in the project.

4) Benefits: Project of this kind really makes the students work together in solving the problems. The realistic problem area enhanced motivation and the need for information based on the two firms provoked the two of the students to take further responsibility. The pedagogical project oriented model also enhanced peer collaboration.

C. Technology experiences

Virtual group work is dependent on: synchronous and asynchronous communication, exchange of documents, version control of documents and track keeping of the time planning [1], [2].

1) Communication: Was mainly obtained via e-mails and chats based on text and/or audio. In LUVIT the students can create fora for project and course discussions. News was intensively used in the beginning of the project to keep information in paralleled created threads. It is somewhat easier than uploading to LUVIT. This changed as the projects progressed. From the middle of the semester all documents were uploaded to LUVIT.

2) Exchange of documents, version control and time planning: LUVIT seems not to be robust enough. It was not so easy to maintain the different documents and the reviewed versions of the documents. It was easy to build up the content in the project but a kind of spreadsheet for total status view was missing.

D. Seminar experience

1) Supervisor observations: The seminars were really

needed. It was very clear that important project progress mainly happened there. Even if only a few hours were free from courses it was helpful. Especially for the complex and difficult part of the project, where important decisions should be made, face-to-face group work was needed. Also it was observed that the project managing had a very high priority and that the sessions were used as milestones for the project state. It also was a very needed opportunity for the project supervisor to discuss with the students.

2) Student's comments:

JB: Seminars were absolutely needed for project planning and coordination. Also needed for face-to-face meeting with the supervisor. The seminars were not so much just for project work. The time was used for task planning and discussion on needed interfaces and tools for design and implementation. Face-face meetings with extensive use of drawings on a white-board, at strategic dates, were vital, especially for system tests.

SM: Seminars were specially used to share out the work. For all tasks and subtasks it was decided which software tools to use. In this way every one could themselves start to design and program their assignments. If one had problems the experienced programmers were used as consultants.

RA: The seminars are very important for the project work. All the complex problems were solved at the seminars. In the beginning of the project we had some professional starting problems and because the distance between us was less then 150 kilometers it was possible to arrange an extra face-to-face meeting lasting a full day, to solve these problems.

VII. CONCLUSION

The conclusions from this project, based on experiences, are rather clear:

- The project work, and in particular this realistic and useful project, was a unique learning motivator.
- The peer collaboration in the project work was especially enhancing between the students because they had the same level of ambition.
- Face-to-face meetings were very important for the project work because of the project complexity.
- On-campus types of projects are risky and difficult to implement as distance education projects.
- Projects should normally not be dependent on physical test rigs.

It is recommended that the groups as their main project work with a project of less complexity then the project reported. Well-planned projects, which are more closely connected to the courses are preferred. For the project the analysis, task design and problem solutions could be part of course exercises. Even though this project has been a success there should be no free project choice the first year.

VIII. FUTURE WORK

Based on experiences from this and other projects a new portal was created and primary results were reported in [10] but the following questions are still unanswered:

- How can benefits from the on-campus project based learning be transformed more effectively to distance education?
- How do we form groups whose members have the same level of ambition?
- How should on-campus supervising methods be adjusted for improved supervision of distance project work?
- How do we utilize the new information and communication technology better for Web-based group organized project work?

IX. ACKNOWLEDGMENT

The supervisors thank the students for their willingness to take part in this documentation, using the results and experiences from their first year.

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Fig. 6. Pump system, client and phone

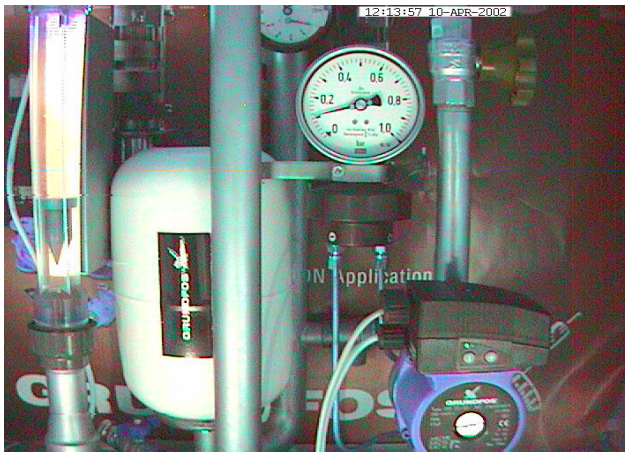

Fig. 7. Supervised test rig

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