

DAL and MAL - two projects to improve distance learning in the technical field in Sweden

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Both projects, DAL and MAL, have been led from Uppsala University, and were supported by a managerial body consisting of representatives from the following institutions of higher education: Uppsala University (chairman, project manager), Blekinge Institute of Technology, Karlstad University, Luleå University of Technology, Lund University, Umeå University and Mid Sweden University.

One of the cornerstones of modern technological society is a well educated public. One way of achieving this is to emphasize distance learning and Life Long Learning (LLL).

LLL

Swedish universities and colleges with engineering programs are aware of this demand and have started a cooperation to remedy the situation. A LLL-project was formed with participants from all universities and colleges with science and engineering programs. Funding of more than 100 000 Euro was obtained from the Swedish Knowledge Foundation (*KK-stiftelsen*). The first phase of the project is now finished and a second is planned. The project group met regularly and discussed common problems. Pedagogical platforms for distance learning (*WebCT*, *LUVIT* and *FirstClass*) were studied and tested. Existing distance education courses developed in Sweden and internationally were catalogued. The idea of a computerised system for merit portfolios was also developed.

Three pilot projects were financed. New distance learning courses were developed and used in more than one university:

- a digital signal processor (DSP-lab9) was constructed to be used in computer based laboratory work;
- a course in data communication to be used for professional development of technical media personnel; and
- a course in automation in production.

DAL

Members of the LLL-group saw the need to better prepare teachers for distance education. The group received a 250 kEuro grant from the Swedish Agency for Distance Education (Distum). The aim was to develop a model to educate university teachers in IT and distance learning pedagogy so that they could in turn produce courses for distance learning. Another aim was that the experiences from the project could also be used in fields other than science and technology.

A pilot course for teachers was produced and given to teachers from seven universities. As those who participated in the course were highly qualified and experienced teachers we planned to use teacher feedback in order to improve the course each time it was given. It was especially important to find models of how laboratory work can be done at a distance. It was also essential to develop new distance learning courses for technical students or employed engineers.

Each participating university team formed a small group of teachers within the team who helped each other during the course. In total around twenty teachers participated when the course was given for the first time. The course consisted of five credits (an eighth of a full university study year) and had four parts:

- basic views on pedagogy, techniques and methodology for distance education;
- media for communication and dialogue;
- tests, examination and evaluation in distance teaching; and
- a project in organising a distance course and producing a study guide and study material.

In short, the aim of the course participants was to acquire knowledge of a good environment for distance learning and about adequate distance techniques, and to be trained to produce a distance course in the technical field. The course was itself a distance course and was spread over 6 months. The course contained lectures, individual assignments, group work, study of literature and projects. A few meetings with all the participants were held and the team at each university met more often. The individual work was combined with interactions on the Internet with other participants.

The examination of the participants was done by written contributions they sent in and by active participation in the local team and by the project work.

The project work was done in new groups (cross groups) with participants from at least two universities working on the same project. This meant that each participant belonged to two groups, the local and the cross group. Communication within these nonlocal cross groups was made primarily using email, although some visits to group members were made. The subjects for the projects are listed in Table 1.

The evaluation during the course was extensive, especially because the course would be redesigned for next time. The participants were quite satisfied with the course and the organisation of the DAL project. The course was held a second time with some alterations. The participants of the first course are supposed to be mentors and also help spread information about the distance courses that result from the project work. So far our experience shows that it is unfortunately difficult to attract the interest of other teachers. New methods of facilitating this diffusion are being investigated.

The main problem that was encountered during the course was the lack of time. The participating teachers had full workload in addition to their own study and there were many examples where participants overestimated the time investment needed for many elements of the course. There were different opinions about how to optimally spend time in projects like DAL, in the local

team, emailing (and mutually visiting) the colleagues in the cross groups, meeting nationally or sitting alone using the Internet.

<i>The effects of environmental toxins on biological systems</i>	See below under MAL.
<i>Weather station</i>	The aim is to give a basic knowledge in analogue and digital measure techniques with an overall connection to the area of communication with the use of an easily-built, low budget weather station that is powered by solar energy. The parameters that are studied are speed and direction of the wind, precipitation, temperature, atmospheric humidity and sun-hours.
<i>Analogue electronics</i>	A preparatory basic course for those who want to test their ability and interest. <i>WebCT</i> and CD-ROM were used and there was also a focus on examination.
<i>Building static's Quality assurance with chemometry</i>	An existing course was adapted for distance education.
<i>Antennas</i>	See below under MAL.
<i>Chemistry</i>	The web site used was based on <i>Dreamweaver</i> . A portable chemistry kit was utilised for home experiments.
<i>Automatization technique</i>	This distance course contained laboratory work including simulation and robot steering.

Table 1. Subjects for the projects

MAL

In the **DAL** project, laboratory work was identified as a major obstacle when trying to arrange distance education in the natural sciences and technical subjects. It is therefore necessary to find methods of doing laboratory experiments at home or in a school where there is no special equipment.

Laboratory work is a multi faceted concept. There are at least three types of laboratory work, which need to be developed in connection with distance learning:

- conventional laboratory experiments within science (examples are interactive laboratory work in biology);

- experimenting in technical subjects which could be labelled as applied science and performed in a laboratory (examples are experimenting in micro computing; circuit theory and data based measurement theory); and
- experiments also within the technical field, which are even more applied and close to industrial work (examples are building of automatized cells for industrial applications by using simulation or tele-picture transmission; programming and controlling robots at a distance).

The examples above of the three types are chosen because the MAL project actually came to work within these domains.

When the same group of persons who worked within the DAL project applied for more funding from Distum they were positively treated because of the good experiences from DAL. Over 200 000 Euro was granted.

There are several reasons why laboratory work is necessary to include in almost all science and technical education. They are compulsory for the understanding of the concepts and for how the subject is applied. In some subjects laboratory work is a minor part but in others it is the major one and the very heart of the education.

In the subjects in the DAL project (as in almost all distance learning projects) laboratory work is performed universally in a traditional way. The student leaves home and has to spend some time at the university which may well be many thousand kilometres away. The laboratory work is also often strictly bounded in time and space, which is an extra difficulty.

There are different ways to cope with laboratory work in distance learning. Equipment could be duplicated (if it is not too large and expensive) and sent to the student's home or to a local study centre. One problem that remains is however the supervision and tutoring. Examples of such procedures will be found in the MAL project. The problem of how to write and convey instructions to the students must also be treated.

Equipment could be controlled and managed from a distance. The industry of today has thousands of examples of distance controlled instruments. The pedagogy to do that simultaneously by a group of distance students who may be in different places needs to be investigated.

Simulations could be used. They save costs for both universities and in industry. There are debates about the pedagogical value of simulations when learning concepts. Must you not have seen and done the experiments in reality before you can benefit from simulation? You miss, for instance, the problem of interference of noise.

The outcome of the MAL project is hoped to be:

- to facilitate the establishing of distance education in subjects where laboratory work is pertinent;
- to produce new experiments with the methods employed;

- to give distance education in science and technical subjects a more flexible organisation;
- results that can be used both in continuing education and at campus;
- courses that make international exchange easier;
- increased cooperation between Swedish universities; and
- an intensified cooperation with industry concerning flexible distance education.

Seven subprojects were formed each with a responsible person at each of seven universities. In addition at least one other university was involved in each subproject. They communicated via email but also on a few occasions visited each other. The MAL project also encompasses a couple of national meetings with opportunities for exchange.

The subprojects are listed together with short explanatory descriptions.

Circuit theory

The objective of this project is to improve access to laboratory experiments by making remote experimentation accessible by use of the Internet. Anyone can now do experiments in Circuit Theory from anywhere using a client PC connected to a laboratory server at the Blekinge Institute of Technology. Further information and client software can be downloaded from <http://www.its.bth.se/courses/eta014/distanslabbar/english/>.

Computer based measurement technique

For several years this course has been given from Uppsala as a distance course. Now a web run laboratory has been developed based on *LabView's* Internet toolkit. The purpose is that the method used could be applied also in laboratory work in Physics and other technical subjects.

The effects of environmental toxins on biological systems

The aim of this project was to develop a virtual laboratory experiment for distance education in biology. Theory, equipment, measurements and raw data from experiments with microalgae was presented on the Web. From this material, the students will be able to calculate various parameters themselves. Since the experiment deals with living organisms, and the conditions for manipulating the cultures can be difficult, it was decided not to let the experiment be interactive (i.e. no way of manipulating the experiment by means of the Web). The course and the laboratory work are presented on <http://www.nature.kau.se/pers/hansolof/tox/ekotox.htm>. An additional experiment, for studying allele frequencies in the same organisms is also presented here, however neither this or the home page for the course is completed.

Using a commercial micro controller kit in distance learning

The objective of the project is to find a suitable micro controller kit with good web-based documentation and to let some students test this equipment in a distance learning situation.

Antenna course using *Marratech Pro*

The course combined distance education with laboratory work on the campus. It was a cooperation between Monash University and Luleå Technical University. Lectures were relayed from Australia using *Marratech Pro*.

Remote control of a robot

This is a way to program a robot at a distance, online, in real-time. The robot is monitored with a camera. The programming is made in a program that is designed to look like the actual teach pendant. The problems met during the project were mainly the same as those described above in the DAL project, especially the lack of time and little interest from colleagues.

Remote control of an automatic production unit

This is a way of programming a production cell as if one were right beside it. This includes programming a PLC and a robot to communicate with each other and work together. The students are not obliged to go to school but can still accomplish the experiment.

The projects are described at the web page <http://www.dal.ingprog.uu.se/MAL/>

In addition to these seven subprojects a 'Building net project' has started. It is a cooperation between four universities and the aim is to make university teachers and students more competent in using distance learning techniques. The course material is on the Web and tutoring is done partly locally and partly on the Web.

It should be mentioned that 93 communities have organised local so-called study centres (the NITUS project) with rich technical equipment and tutors where university studies could be performed on distance, examinations held, etc.

During a national conference measures were discussed how to make colleagues both within the home university and elsewhere interested in the results. Identifying those in the field in question at other universities, who ought to be interested, approach them personally also using the Web and inviting them to visit you were suggestions. Besides presenting the subprojects on the Web professional journals should be used and even daily newspapers particularly when the results are striking, for instance: 'students on an island controlled robots 1000 km away'. The participants found the team work with colleagues very intriguing and wanted to take their own subprojects further and embark on new ones. Targets for new projects mentioned were teachers in primary and secondary schools who could perform experiments on distance in their own classroom. Both these teachers and prospective university students could be stimulated 'at home' for science and technical studies. Distance courses on a preparatory level could be produced making them qualified to enter an engineering education, to help in recruiting more students in this field.

Another goal suggested for the future was to make projects like this more 'scientific' by involving pedagogical research expertise, publishing scientific papers to be presented at seminars and establish formal doctoral programs.

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