IMPLEMENTING ICT IN EDUCATION: TOWARDS AN IMPLEMENTATION METHOD

Maarten van de Ven (m.j.j.m.vandeven@tbm.tudelft.nl)
Simon Peerdeman (s.a.g.peerdeman@tbm.tudelft.nl)

André van Peppen (a.j.vanpeppen@tbm.tudelft.nl)

Willem van Valkenburg (willem@vanvalkenburg.nl)

Delft University of Technology, Faculty of Technology, Policy and Management (TPM)
Delft, The Netherlands

At the end of 1999 the faculty of TPM decided to implement ICT in education throughout the faculty. Since the beginning of this academic year, which was in September 2000, all courses are taught using an electronic learning environment (ELE). This paper describes the implementation process.

The starting point for the implementation lies within university-wide activities. In September 1999 Blackboard CourseInfo was made available for all teachers and faculties of the Delft University of Technology. The faculty of TPM decided to use this platform as a basis for a faculty-wide implementation of ICT in Education.

The implementation plan for the first year consisted of three lines of activities. The first line of activities was technology oriented. The aim of this first line is to create smooth connections between the different computer systems and data that are used in the educational processes.

The second line of activities was aimed at creating and using a web-site in Blackboard for each course taught. These web-sites contain at least detailed descriptions of the course and course materials. Furthermore, all teachers could attend a two-hour introduction to the Blackboard system.

Line three activities were scheduled to support a limited number of teachers in developing and using new ways of teaching, based upon possibilities offered by these new technologies. As of January 2000 each teacher out of a group of five teachers first re-designed one of their courses and then four of them taught their course in the new format. The design and the evaluations of two of these courses will be presented in other papers on this seminar.

1 INTRODUCTION

The TPM faculty has a wide range of educational products: the full-time TP course, the part-time course, the MSc course, the interfaculty training, the UNITECH exchange programme and the Postgraduate School for Teacher Education.

International education, part-time and dual training are actually begging for ICT-orientated training. It is therefore not surprising that the TPM faculty has for some time given ICT a central role in education.

The growing interest in ICT in education can be divided into three phases: The first phase started around 1998, due to student dissatisfaction regarding the number of computers available for doing their homework and various practical training applications. A working group consisting of students, teachers and educational consultants developed ideas and made recommendations to management. This phase is characterized by its "bottom up" initiative.

During the second phase, from 1999 onwards, those ideas were streamlined into three development lines, namely:

1st   Supplying information to students and teachers with the help of ICT, e.g. a Student Gateway;

2nd   Supporting the educational programme with the help of an electronic learning environment;

3rd   Applying innovative didactical methods with the aid of computers.

The faculty's management facilitated the activities within these three areas to a limited degree. Due, amongst others, also to these limited financial incentives, the enthusiasm of the students and teachers grew.

Because of the facultative interest in ICT in education, a small faculty delegation undertook a field trip to a number of prominent American universities: Indiana State University in Bloomington, Carnegie Mellon in Pittsburg, George Mason University in Washington, Georgia Tech. University and Georgia State University in Atlanta. Research into the development of ICT in education at these universities, has resulted in the faculty's agenda for ICT in education.

This agenda is based on 3 premises:

- Students should be regarded as knowledge and information intensive workers and should be facilitated accordingly;

- A standard Electronic Learning Environment (ELE) is essential for both students and teachers;

- In an ICT-rich environment, educational renewal and improvement are a challenge, but not a matter of course.

A number of developments within the TU Delft also corresponded well with these three premises. The introduction of the new Volg+ Grade Administration System, the Digital Study Guide, the XML Course Project, and the development of a Student Gateway, all support the idea of viewing students as information intensive workers. Characteristic features of this phase are: stimulate, determine boundaries, and facilitate to a limited degree.

The result of all this, is that now, in phase three, a project plan has been drawn up to work out the three developmental lines mentioned above, into a completely facilitated project. At present we are under starter's orders, ready to implement ICT in education with even more dedication, manpower and means once the plan has been approved, which will probably be early in March, 2001.

1.1 Implementation Strategies

In general, there are four main approaches to implementing innovations: diffusive, directive, interactive and developmental (Van der Zee, 1997).

The choice of implementation strategy is largely dependent on the nature of the innovation and the organizational context. The diffusive and directive approaches have the advantage that they are explicit processes with a beginning and an end. However, where staff are expected to play a creative role, to be involved, or are even expected to take part in decision making, these approaches are insufficient, and the importance of an interactive and developmental approach to changes increases. In such a case, outlining the final objective is no longer possible, but is replaced by acceptance of and participation in the change. Co-operation with the members of staff involved is essential to success.

The first phase of the implementation process of ICT in education at TPM follows the interactive approach. However, there is a deliberate transition to the developmental approach during the second and third phases.

The following is a short description of these two methods.

1.1.1 The Interactive Approach

The most important aspect of the Interactive Approach is that people can not just be the implementers of policies devised by others. The basic concept is that people will only feel responsible for their work when they can also influence the process. With this approach, ideas for change coming from above or outside should be initiated in such a way that the people involved are ultimately made responsible for their development, implementation and consolidation within the organization. In doing so, one has to take into account the fact that the actual implementation may deviate from the original idea. The advantage is that this direction will then certainly be accepted. The problem rather than the solution forms the starting point that needs to be tackled with a bottom-up approach.

The management fixes the boundaries or marks out the playing field within which the change is to take place. The keywords here are "interaction", "bargaining" and "mutual adjustment".

By using this approach, each process of change will look different. Great demands are made on the perseverance and inventiveness of the project leader, who will have to put a great deal of energy into building up goodwill and a network of connections. Above all, the project leader must not think that he is able to control the process.

1.1.2 The Developmental Approach

Here again, the starting point with the Developmental Approach is not the solution, but the problem. With an interactive change project, the accent is placed on looking for solutions to an existing problem, whereas with a developmental change project it is placed on strengthening competencies. The objective here is to create the conditions for self-sustaining development.

Developmental change is the interaction between design and accident, of trying over and over, of grasping the initiative and relinquishing it again. The ultimate objective is to increase the staff's competencies, and thereby also increasing their problem solving abilities.

This is not a process that goes according to plan. The keywords of this process are: challenge, changing key competencies, to inspire, to become the problem owner, maturing and experimenting, an enquiring mind, exchanging knowledge and experience, improvising.

The first three approaches can be said to apply to controlled changes; there is no question of control with this approach, but of stimulating and facilitating.

The Diffusive and Directive Approaches can be described as the classic models for organizational development, where divisions are drawn between thinking = diagnosing and doing = implementing (Wierdsma, 1999).

Wierdsma compares these implementation processes with a "packaged tour", where the "destination" is more or less known and is reached via established routes. This is contrary to a "migration", during which the participants are constantly debating what their destination is and how they are going to get there. Thinking and doing alternate more often. According to Wierdsma, the model of an implementation trajectory designed to increase collective competencies should look like a "migration".

2 DESCRIPTION OF THE DEVELOPMENT LINES

2.1 *Development Line 1: Providing information to students and teachers with the aid of ICT*

The objective of this line is:

- Facultative application of a functional link between Blackboard, Volg+, TAS and the Digital Study Guide.
- The faculty makes student-orientated educational, organizational and administrative information available in such a way that the student can extract the information necessary for his/her study (planning) him/herself.
- The faculty makes teacher-orientated educational, organizational and administrative information available in such a way that the teacher can find the information he needs.
- For the purpose of the SEFI seminar on ICT, a publication will be written describing the development and implementation of the results of the work package.

A pilot will be set up with the aid of centralized tools and links, to provide student-orientated information via Blackboard and/or the Internet, thereby recognizing the principle that the faculty views its students as information and knowledge intensive workers.

With regard to improving the provision of information to students with information and communication technology, TPM is especially seeking to improve the links with the Digital Study Guide recently started in the Civil Engineering and Geophysics Faculty and with the Electronic Learning Environment/Student Gateway project of the Department for Technical Support. Efforts are already being made to provide students with as much information as possible via the Web. The faculty's Web-site is now being renovated for this purpose.

Within the next 2 years, the faculty expects the Study Guide to be completely digital, with links to TAS and Volg+, so that:

1.   Administrative student information such as grades, etc. are available to the students and teachers via the Internet;

2.   Accurate information concerning courses and organizational aspects can be accessed by students and teachers, e.g. Study Guide, Examination Registration System, Timetables, Course News, etc.

The results of the work package are designed for SEPA's full-time, part-time and MSc courses, as well as for the interfaculty courses at TPM.

The faculty already started on parts of this project in June 2000. The faculty Web-site is much improved, and the faculty's intranet has recently become available. Blackboard's course information already utilizes the module descriptions of the Digital Study Guide. Completion of this work package is expected in December 2001, when the Study Guides for the academic year 2002/2003 will be available in digital form.

Various presentations will be held for teachers and students to keep the faculty members informed of progress. During these meetings, results will be presented and discussed. The results will also be presented as interim reports to the project management.

Ultimately, a final report of the results will be produced which will be published throughout the university.

2.2   Development line 2: Faculty-WIDE use of Blackboard

The second line of activities is aimed at creating and using a Web-site in Blackboard for each course taught at the faculty of TPM, which includes the SEPA school and interfaculty teaching for the other faculties of the university. Many of the teachers at the faculty already use the web to publish their slides and course information, but it wasn't clear to the students where they could find the information. Blackboard provides a clear starting point for the students.

Faculty-wide use of Blackboard means that for each course taught at the faculty there is at least one web site containing the following components:

- *Announcements*:
  - Announcements regarding new information on the Web-site

- Schedule changes
- *Course Information*:
    - Course descriptions
    - Examination requirements
    - Course schedule
- *Course Documents*:
    - Slides of the lectures
    - Background information
    - Additional information
    - Practice material (e.g. old examinations)
- *Assignments*:
    - Assignments that students have to complete
- *Communication*:
    - The teacher uses the e-mail facilities within Blackboard to inform students.

In September 2001, all courses will be in Blackboard with the above specifications. But how did we reach this goal?

A group of four students and a couple of enthusiastic teachers started using Blackboard in the beginning of 2000. In February, they organized a meeting to inform other teachers about their experiences and the possibilities of Blackboard. During this meeting, three teachers talked about their experiences with ICT in Education, and one of the students talked about the use of Blackboard. This resulted in some of the new courses being taught in Blackboard.

In May 2000, the University Board officially announced Blackboard as the ICTE tool for the next three years. This was the start of the rapidly increasing use of Blackboard by teachers and students. In September 2000, the new freshmen were instructed how to use Blackboard, but the teachers also had to be taught how to use it. The four students therefore developed a two-hour introduction to Blackboard. This introduction course is taught every couple of weeks to a group of not more than twenty faculty members. The faculty members therefore have ample opportunity to attend the introduction.

The course consists of a short introduction to ICT in Education, an explanation of the use of Blackboard, and a number of exercises for the participants. The exercises are essential to the

course, because they overcome the faculty members' initial fears. There are two main aspects that discourage teachers from using Blackboard:

- *Firstly, they say that it is too difficult for them, and that they don't know anything about HTML.*

  Blackboard has been developed to be used without any prior knowledge of HTML. However, with knowledge of HTML, Blackboard can offer some additional functionality.

- *Secondly, they say that they don't have enough time to use it.*

  It is faster to place a document in Blackboard, than to place it on a regular Web-site. You only need a Web Browser to access Blackboard.

After completing the exercises, all the participants are convinced that Blackboard is a good and easy-to-use system for communicating with their students.

The introduction course is the teachers' first step towards using Blackboard. The following step is for them to actually use it for one of their courses. An important issue is that there is good and fast support.

The teachers receive a lot of information in the introduction course, but are unable to remember it all, especially if they are not very experienced computer users.

Therefore, once they start using Blackboard, they have all kinds of questions about it. The four students are available to answer their questions. If a teacher mails the students, they usually react as quickly as possible by mail, or stop by the teacher's office to show him how to solve the problem.

Altogether they spend about 15 hours a week supporting the teachers, and a further 5 hours on other activities, such as the introduction course and meetings.

Support is an essential part of the total implementation. Without this fast support, the faculty members would not be so enthusiastic about Blackboard, nor would they be able to use the system to its full extent.

2.3 Development line 3: Developing learning environments for courses

In January 2000, a two-hour seminar on the use of Information and Communication Technology in Education (ICTE) was organized for the teaching staff of TPM. Some TPM

teachers demonstrated and discussed good ICTE practices in their courses. An ICTE expert also presented the experiences of other users. The seminar ended with an invitation to the participants to take part in an ICTE project.

In February 2000, the third line of the TPM ICTE Programme was started. Five TPM teachers were involved in this activity, supported by an educational consultant, two members of the faculty's educational administration unit, and two student assistants. The primary goals of Line 3 were to design and develop an electronic learning environment for each of five courses, and to gain knowledge and expertise in online education. Electronic learning environment was to be one of the elements of the course, alongside face-to-face activities such as lectures or group meetings. The secondary goals were to develop a design for a train-the-trainer programme and to create a Web-site on ICTE.

In Line 3, the individual teachers redesigned their own courses. The courses differ in target group (initial full-time students or initial part-time students) and content (Systems Engineering and Policy Analysis or Social Studies). The teachers discussed each other's designs and solutions during group meetings, giving feedback and sharing their expertise. They were supported in this process by the educational consultant, who is an ICTE expert. In addition, the teaching assistants of Line 2 assisted them by actually creating ELEs in the university's Blackboard system.

Monthly meetings were scheduled during this past first year of Line 3. Between meetings the teachers carried out the main activities. These activities were scheduled as follows:

1. *Descriptions of current teaching practices.* Amongst others, these descriptions contain learning goals, educational formats, educational activities of the teacher and learning activities of the students.

2. *Identification of problems and wishes.* In this phase, the teacher describes the problems that accompany the current teaching practices and/or the aspects he wishes to change about them. He also pinpoints who is experiencing these problems and what is causing them.

3. *Choosing a solution.* The teacher searches the Internet or literature for available knowledge or expertise of other teachers who have experienced similar problems, for example in descriptions of Good Practices. Then he thinks of a number of possible solutions. For each solution he identifies its shortcomings and gains. Finally, he chooses the best solution.

4. *Writing an Action Plan.* This plan starts with a description of the new course, especially concerning educational format, and methods and patterns of communication. It also contains a

list of new teaching materials, for example educational multimedia applications. The Action Plan contains a detailed plan for the development of the new course and, where appropriate, the new teaching materials. The first implementation of the new course should also be planned.

5. *Evaluation of the new approach*. The cycle of redesigning the course ends with an evaluation of the results. This evaluation should be carefully planned, which means that a list of the people involved should be available, possibly a number of questionnaires should be developed and taken, also a number of interviews should be held, and an evaluation report should be written.

At the time of writing this paper, the Line 3 activities have been in progress for one year. One full cycle of design, development, implementation and evaluation has been carried out for four courses. Each of the electronic learning environments that have been developed is very different from the rest. In Quantitative Dynamic System Modelling, lectures are substituted by interactive Microsoft PowerPoint presentations that are studied by each student individually. In Design Engineering, Problem Formulation videos of lectures and other meetings are exchanged between DUT in the Netherlands and Carnegie Mellon in the USA, and the students discuss these videos in their own language group. In Systematic Problem Solving, a section on report-writing is available completely online, and includes assignments in which students co-operate in writing reports, using tools in Microsoft Word such as 'Insert Comments' and 'Track Changes'. In Management of ICT-oriented Organisations, individual students can access video clips of parts of the lectures, and can join electronic discussions on statements provided by the lecturer in groups of 5 or 6. Each of the first three courses is presented individually in this seminar, including the results of student evaluations.

Although the solutions chosen for each course are completely different, the teachers found the discussion of their solutions and Action Plans within the Line 3 meetings very useful for two reasons. The first reason is that they received many useful comments on their own material from other teachers in practice. They especially appreciated the practical do's and don'ts from teachers who are familiar with their students. The second reason is that they learned much from discussing their colleagues' material. They learned new ways of teaching and new approaches to the educational problems they have in common.

Also, they appreciated the structured way of tackling the redesigning of their own courses. On their own, they would probably not have adopted such a systematic approach. Furthermore,

they are enthusiastic about the availability of an ICTE expert. For example, when asked the right questions, he was able to point out the critical aspects of their preliminary designs and Action Plans.

The results and experiences of the Line 3 activities were presented in the second two-hour seminar which took place in January 2001. The attending TPM teaching staff was very enthusiastic about these results. It was decided that the Line 3 activities be continued for a further two years, as part of a TPM-wide ICTE project. Some of the Line 3 teachers will be involved in this new project, and some new teachers will be added to the group.

3   CONCLUSIONS

The implementation processes described in this paper seem to fit into an academic organization. An important aspect is to give employees influence in these processes, first by letting them think of solutions themselves, then by stimulating them and enabling them to realize this solution. This approach can only be successful if the management is willing to allow its employees to co-operate in steering these processes.

In this case, implementation is divided along three lines, which has proved to be very successful. The first line is directed towards the availability of technical facilities, for which this faculty relied on the university-wide ICTE programme. The second line is aimed at using these facilities to realize a broad, faculty-wide learning environment. This environment includes all courses, and aims to substitute face-to-face teaching practices with a format that includes educational technology. The third line is directed towards using technology in greater depth, in order to realize new innovative educational formats.

During the next two years, the implementation process will focus upon the third line: using the technical facilities to innovate teaching in this faculty.

Literature (in Dutch)

1.	Zee, H.J.M. van der (1997), *Denken over dienstverlening*. Deventer: Kluwer Bedrijfsinformatie
2.	Wierdsma, André (1999), *Co-creatie van verandering.* Delft: Eburon
3.	Peerdeman, S.A.G., e.a., (2000), *IMAGO*. Projectvoorstel TU-Delft.