DESIGNING FOR FLEXIBILITY: IMPLEMENTATION OF ELECTRONIC EXAMINATION CONCEPT

Sami Hautakangas[1], Juha Holma[2] and Olli Savolainen[3]
[1] Department of Academic and International Affairs, University of Tampere, 33014 University of Tampere, Finland - [2] Faculty of Social Sciences, University of Tampere, 33014 University of Tampere, Finland - [3] Computer Centre, University of Tampere, 33014 University of Tampere, Finland
sami.hautakangas@uta.fi

Background of the development project

The idea of on-demand examination was presented by students as early as ten years ago and there were already plans how the service should generally work. However, the questions of authentication and control, among other practical issues, remained unsolved at that time. Part of the problem was that the available technology was not adequate for the purpose.

The guiding principle in the IT strategy of University of Tampere on web services is that the developed services must have demonstrable benefits for both students and staff. In the early years, the expected benefits for the students were already quite easy to recognize: the improved flexibility for the student to organise his studies would help him in advancing in the studies in personal pace and more even distribution of exams would increase the access to the course literature in the library. However, the proposed solutions to organise the examination process was deemed too burdensome for the staff, and the subsequent development was restricted to the electronic support for signing up to the examinations that was integrated into the student information system by the year 2004. By the year 2004 University's IT infrastructure in general had developed to such level that the resurfaced idea of on-demand examination was taken into closer inspection after negotiations between the university and the student representatives.

The challenge has been to identify the expected benefits for the staff and evaluate whether they can be realised with reasonable costs. The examinations arranged in traditional paper form can be singled out as one of the most laborious recurring tasks in the everyday practice of the university. The arrangements of the examinations involve a large number of different actors from teachers and administrative staff to persons delivering internal mail. Currently more than half of the departments are using the electronic signing up and there were 36 000 sign ups in the year 2006.

The potential benefits in cutting down the amount of routine work are apparent if the new solutions can help in organising even a quite modest proportion of the bulk of the exams. Thus the main idea has been to develop solutions that can be utilised in general examination processes and web-based courses, not only in the on-demand examination. On the other hand, designing new practices that complement or replace existing modes of work in such a basic task is demanding and requires taking into account multiple perspectives. In the years 2005-2007 the electronic examination concept has been developed, implemented and taken into restricted use for a limited number of exams. The experiences from this testing phase will be presented in this case-study.

Setting up the project – organizational considerations

The socio-organizational issues are often decisive regarding a successful adoption of information systems. It has been shown, that frequently the projects fail, because people who are doing the work are not getting the benefits of the system (Dix et al. 2004). The same idea has been reflected in the IT strategy for web services in the University of Tampere, which says: "Web services must have demonstrable benefit for the client as well as for the service provider. This means, for example, that one does not design nor implement such web services in the University of Tampere, which requires officers to repeat client's work. Services accepted to be implemented must be useful throughout the whole process. For the service provider the benefits must be realized as decreasing workload and improve the efficiency of information transfer. For the client the benefits must make information seeking and transactions easier."

Because in the first time the idea of flexible on-demand examination did not take off, the organizational issues have been all the more important to take into account. When the preparation of the project was started afresh, special attention was paid to ensure that the planned project would yield some beneficial results in any case. The first challenge was to find a basic model that would be so acceptable for teachers that active teachers could be recruited to participate in the project.

The project started with a preliminary study in the academic year 2004-2005. This study was conducted by a small working group with representatives from the Department of Academic and International Affairs, Student Union, Computer Centre, Learning Technology Centre and the Faculty of Social Sciences. The key issue from the teacher perspective that was addressed earlier was that the work would be fragmented if students could choose the time of the examination individually. In the general case the university regulations require the exams to be evaluated within two weeks from the examination date. At this stage a consensus was reached with the Student Union on the basic principle that teachers could collect the individual answers from a longer period of time and process them periodically, for example once a month.

Another important aim of the preliminary study was to investigate whether the available technology would fit the needs of electronic examination. In the academic year 2003-2004 Moodle course management system was successfully taken into use in the University of Tampere. To the surprise of the supporting units the teachers and students were very content with Moodle and needed very little help or instruction in starting to use it. The number of users increased very rapidly reaching 10 000 in 2005. The technology of Moodle turned out to be reliable in everyday use, and while it already had many essential features needed in electronic examination (authentication, authorization for a specific course unit, basic tools for making quizzes and tests), this open source software was agreed to be an appropriate choice for the basis of the examination concept. The group reviewed the other pilot projects in other universities in Finland, which were based on examination room for one student with traditional recording video surveillance system.

At this point, the opinion of the working group was that if the examination room would be just for one student, the student could as well be identified by help desk personnel that could escort the student to the examination room. It was seen that the development of the examination tools will help the ordinary Moodle use, and the flexible on-demand examination, if it would take off, would be a surplus.

As the evaluation of information system investment is a notoriously complex area, there is a danger to either not to invest in a useful IS because the direct benefits in term of costs cannot be shown, or invest as an "act of faith" (Gunasekarana et al. 2006). In this case, it was easy to show the minimum benefit that can be realised with relatively low development costs. In most successful case the saved time from routine tasks would be substantial. If only one minute would be saved in processing an individual exam, the yearly time saving would be close to a man year.

The organisation of the project

In essentials, the development project has been run along the lines of the methodology called participatory design. This means that the users and the developers have been working closely together throughout the design process and the users have been refining the system requirements iteratively (Dix et al. 2004). The more detailed project planning was kicked off in September 2005 by arranging a workshop as a part of a larger internal seminar held at the University where the issues of examination in general were discussed. This workshop proved to be a successful way to recruit motivated members of staff to participate in the project, and the subgroups have remained active throughout the project.

The project was organised in the autumn 2005 and the first cases that were selected to be piloting the developed system were pre-test for the basic course in Swedish language by Language Centre and the exam for the course on the acquisition of information by the University Library. Because part of the University budget was earmarked for the development projects of eLearning, the development of the specific exams that were both developed in national cooperation and the development of the centralized electronic examination service were funded and the actual project started before the end of the year 2005, the project manager coming from the Faculty of Social Sciences.

The project organisation was arranged to fit the different perspectives and to engage the different stakeholders to the development. The common project group had representatives from all stakeholders and was used to steer and schedule the development. The actual work was done by the members of the five subgroups that were titled: Processes, Rules and Norms, Moodle, Examination Room and Pilots. The main idea has been to minimize the risks by step-by-step proceeding. This has meant that the new ideas and their implementations have been checked from the perspective of each subgroup in each iteration, if relevant.

The aims of the electronic examination were articulated in the group discussions and the dialogue between the groups was facilitated by project manager participating in each group and some of the group members participating in more than on group. The explication of one of the basic requirements is an example how the project work progressed from broad picture to more detailed descriptions.

1. In Pilot group there was recognized the need to organize flexibly the exam for several hundred of students within a relatively short time period in the beginning of the term.
2. In Examination Room group it became evident that there was need to scale up the basic concept for the examination room, because of the peak volumes. This, in turn, meant that the controlled environment would have to be organised by using several techniques, including video surveillance system to reach a level of control comparable to the traditional book examination settings.

3. In Rules and Norms group it had to be checked how the legislation, such as Privacy Act, and University regulations would require the surveillance to be organised and who could be responsible to administrate the access to the recording system. The surveillance would require that the students should not be allowed to have any extra materials or equipment with them.
4. The Process group analysed how an individual student could be identified in different phases from booking the exam to accessing the examination room, the specified workstation and the examination system and how this information could be used.
5. The Moodle group specified how the workstations, web-browsers and Moodle should be configured to enable safe taking of the exam, and how the booking should work.
6. The common project group discussed the new requirements and came into conclusion that the examination room should include 10 workstations or more to make the mass testing possible within the time constraints. On the other hand, the room should be available for other uses outside of the peak times, and the booking system should support that. The need for the video surveillance system that records also audio, was decided on and the preparation for extra budget was started as the subgroups can specify what is needed more thoroughly.
7. The Pilot group noted that there is a need to randomize the selection of the specific computer for the student so that two students cannot book seats next to each other, and that this should be taken into account in the booking system. [and so on]

The topics between the groups were interrelated and some of the discussions were overlapping. The key issue has been that the project manager keeps the focus on correct things and that the documentation concentrated on the essential issues, so that after each group meeting there is agreement and decision on the next step. The core documents for the whole project have been process descriptions, prototypes of the system and the guides for the students and staff that make the different aspects of the processes concrete. Additionally, there has been more detailed documentation and the schedule of the project and the minutes of the meetings in the Moodle workspace for the project.

As a result of the work the main processes to be developed were identified as the following ones:

- The preparation of the exams
- The booking of the exams
- The examination as a physical process (arrangements of the room and facilities)
- Taking the exam on the system
- Control and surveillance of the exams
- Procedures in the case of disturbances or other problems

Technical design & Moodle

The implementation of the electronic exam service was launched in June 2006. We started by gathering the requirements for the software. After initial planning we found that in addition to Moodle, the basics for the reservation system's logic were already present in the open source program MRBS. We use Trac for documenting the software implementation and keeping track of tasks, along with Subversion for version control.

In the software itself, we use PEAR HTML_QuickForm, PEAR HTML QuickForm_Controller and Smarty for constructing the HTML-based GUI, as well as PHP iCalendar for importing holidays in iCal format to the reservation system.

The first hopes to get the entire software into full use by autumn 2006 were soon found to be too optimistic. Along the lines presented in the previous section, the initial requirements soon changed as different stakeholders saw the actual product in action. Some of the areas where the requirements have seen the most change during the project are presented in the next sections.

Students' exam service

We designed a simple wizard-style graphical user interface (GUI) to aid students in making reservations to exam classes. The students are also able to review the reservations they have on the front page of the service and to cancel them. The service has also been designed for accessibility, relying on validated XHTML 1.0 Strict, and CSS for formatting and layout. We also plan to provide accessibility features such as high-contrast themes. The service also includes both text- and Flash-format help for students for each phase of the exam process.

Due to time limitations, the GUI was usability tested in a relatively informal test setting with only two female university students belonging to the target group. In the test, we had a set of nine tasks which the students carried out. Also, some even more informal tests were implemented at different stages of development. Although a number of non-critical issues were found and addressed, in general all of the test subjects performed well in the tests and thus we decided to carry on with the implementation.

The reservation process consists of (1.) course selection, (2.) class and time selection, (3.) entering information about which parts of the exam are to be carried out by the student and (4.) confirmation. In the confirmation phase, students also need to state their approval of the terms and conditions of the service, as well as their approval of sending them confirmation, reminder and result e-mails related to the exam.

The initial implementation allowed only one- or two-hour exams. It was later found that in order to get the system into wider use, also four-hour exams would have to be supported. Because the students must be treated equally regardless of the examination media, the electronic examination must also have the same time limit as a traditional book exam and follow the same university regulations. However, most students would probably not need that long a time to finish most exams. Also, the number of computers in use for taking exams is limited. Currently there are plans to let students choose themselves how long a reservation to make, however the implementation of this feature is currently being postponed. Also, initially the software supported no individual opening times for different classes but they all had to be opened at the same time.

In the exam itself an auto-save feature is also planned, in case of technical or other problems interrupting the exam. Currently Moodle quiz only saves students' answers when they change pages during the exam, as exams are usually divided on multiple pages with no more than one to five questions per page.

Teachers' service for managing exams

It is a central goal of the project that since the service is designed for wide use in the university, it should be possible for teachers to manage their exams as independently as possible. As the design progressed we found that many parts of Moodle had to be simplified

and customized to make it simple enough to use for teachers; most features except the quiz module were hidden. We added some data fields to facilitate setting up properties such as the length of the reservations students can make and the parts of the exam which students can select for carrying out in the exam. Grading the exams in Moodle with sufficient accuracy and sending the results directly to students and to the registry are features yet to be implemented.

The greatest hurdle however in making the exam management easy enough for teachers is the current Moodle GUI for creating the actual questions and adding them to the exam. We are redesigning and implementing this part of Moodle during summer 2007, in as close as possible cooperation with the moodle.org community. In May 2007 the new design's paper prototypes are being tested.

Future considerations

Because the examination service is essentially an extension to Moodle, the most obvious issue is cooperation with the moodle.org community in a manner that all parties can benefit of each other's work. We have already submitted some small blocks of code to the moodle.org forum for integrating Moodle and MRBS, and unless other, more crucial aims conflict with this, the general goal is to keep the code on a general enough level to be submitted back to Moodle core. MRBS code is so heavily modified that even if MRBS may have new versions, we will be very unlikely to upgrade. Smarty and the PEAR libraries will be kept up-to-date at least in terms of security fixes.

On the other hand, as our electronic exam contains modified Moodle 1.6 code, any upgrades will be challenges, or at least a lot of work. The amount of work has to be balanced with benefits gained in terms of security and new features. Our service is also currently running on PHP 4, which is getting old. A migration to PHP version 5 is planned to be realized at some point.

The experiences from the piloting phase

The main features of the resulting electronic examination service in the University of Tampere are: 1) The student makes a booking for an exam from calendar system and receives a confirmation with examination details. 2) In due time the student accesses the examination room with his key card and takes the exam with randomized questions by using the Moodle-based system on the computer designated for the student. 3) The examination room has IP-based video surveillance system that records both video and audio and can be used to investigate suspected cases of cheating 4) The examiner receives the reports on attempts from the examination system by email reports and has an extended time frame to fit the marking of a larger amount of exams to his schedule. 5) The student can subscribe for the marks and feed back to be delivered by email immediately after the examiner has finished his task. 6) The teachers can use the system also in preparing and arranging the traditional exams and the features developed into Moodle can also be used as parts of ordinary web-based coursework, even if the experiences have indicated more potential benefits which require integration work to the student administration systems.

Of these features first 3 have been implemented and are currently tested with real exams. The features 4-6 are under development and will be implemented and tested during summer 2007.

This spring the electronic examination service has been in restricted testing phase and the main findings can be summarized as follows.

- The use of the examination system from the student perspective has turned out to be quite simple
- The teacher's user interface for the examination preparation is currently too complex, and suits only teachers with longer experience with Moodle. The decision was made to set up the exams for the piloting teachers in the system in the Learning Technology Centre.
- The high no-show rate in some examinations, especially in summer examinations, has increased the interest of teachers in the electronic examination, where only the real attempts come to the teacher.
- The amount of exams in spring have been limited so the piloting will continue in summer examinations to have enough testing before wider launch
- The iterative design process has been slower than anticipated, but the step-by-step approach has made it possible to make changes in the schedule that are accepted by all of the stakeholders.
- University regulations have been general enough to allow the testing phase, but the transition to permanent practice requires modifications to regulations to make the terms of use clear for all parties.

References

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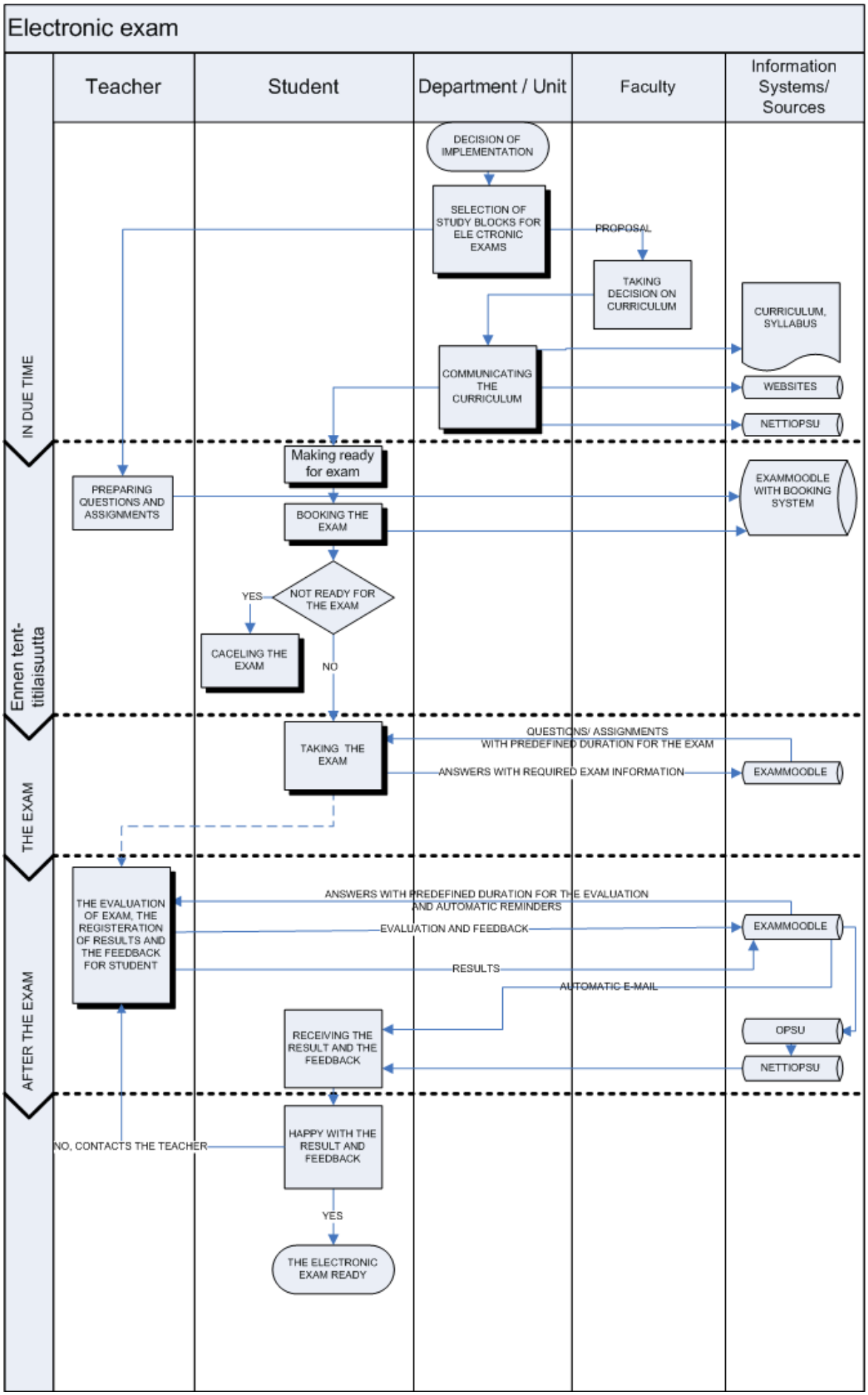
Electronic exam
Teacher
Student
Department / Unit
Faculty
Information Systems/ Sources
IN DUE TIME
Ennen tent-titilaisuutta
THE EXAM
AFTER THE EXAM
DECISION OF IMPLEMENTATION
SELECTION OF STUDY BLOCKS FOR ELE CTRONIC EXAMS
PROPOSAL
TAKING DECISION ON CURRICULUM
CURRICULUM, SYLLABUS
COMMUNICATING THE CURRICULUM
WEBSITES
NETTIOPSU
Making ready for exam
PREPARING QUESTIONS AND ASSIGNMENTS
EXAMMOODLE WITH BOOKING SYSTEM
BOOKING THE EXAM
YES
NOT READY FOR THE EXAM
CACELING THE EXAM
NO
TAKING THE EXAM
QUESTIONS/ ASSIGNMENTS WITH PREDEFINED DURATION FOR THE EXAM
ANSWERS WITH REQUIRED EXAM INFORMATION
EXAMMOODLE
THE EVALUATION OF EXAM, THE REGISTERATION OF RESULTS AND THE FEEDBACK FOR STUDENT
ANSWERS WITH PREDEFINED DURATION FOR THE EVALUATION AND AUTOMATIC REMINDERS
EVALUATION AND FEEDBACK
EXAMMOODLE
RESULTS
AUTOMATIC E-MAIL
RECEIVING THE RESULT AND THE FEEDBACK
OPSU
NETTIOPSU
HAPPY WITH THE RESULT AND FEEDBACK
NO, CONTACTS THE TEACHER
YES
THE ELECTRONIC EXAM READY