

Students' appreciation of an online lab-experiment – A case study

Dick van Schenk Brill, Bert van Gestel

Information Technology Department, Fontys University of Applied Sciences, 5600 AH Eindhoven, The Netherlands (d.vanschekbrill@fontys.nl)

Abstract

This paper describes the results of an investigation in the appreciation of distance learning, limited to a case study with an online lab-experiment. Together with other educational institutes and companies Fontys University of Applied Sciences participated in a number of projects in which distance learning courses were developed. Some courses have been integrated in the regular curriculum. Our study was set up to get insight into the appreciation of students for this way of learning, especially concerning online lab-experiments. By using surveys and interviews after the students accomplished either a regular course or a distance learning course on the same object we tried to get a better understanding of how students used the course and appreciated it. Also we wanted to know whether an online lab-experiment is more or less effective than a regular one. Preliminary data analyses have shown that the appreciation of an online lab-experiment is dependent on a number of items, like the educational contents of the experiment itself, the way accompanying theory is presented, possibilities of doing the experiment in an alternative way, the organization around the experiment etc. It appears also that students give serious suggestions on developing other online lab-experiments.

Keywords: Distance learning, e-learning, remote labs, online lab-experiments

1. INTRODUCTION

1.1 Project involved

In 2006 and 2007 Fontys University of Applied Sciences participated in two projects in which distance learning courses were developed. There was taken part in a project called “Process4MKB” [1]. The general aim of this project was to improve the international competition possibilities of small and medium enterprises (SMEs) in the field of batch process industry. Eight institutes in higher and secondary technical education took part in this project. Together, students and teachers of those institutes gathered knowledge based on the needs of industry and translated this into web-based learning modules. Although our investigation also involved those modules, we will focus on online lab-experiments in this paper. The second project Fontys contributed to was called “Labs on Line” [2], a project initiated by the *Digitale Universiteit*, in which a number of Dutch universities co-operate. Participating institutes in this project were the *Universiteit van Amsterdam*, the *Vrije Universiteit*, *Fontys Hogescholen*, the *Hogeschool Utrecht* and the *Haagse Hogeschool/TH Rijswijk*. “Labs on Line” continued the development of two earlier projects at Dutch universities; first the project FlexLab [3], in which the *Hogeschool Utrecht* and the *Technische Hogeschool Rijswijk* created a number of remote labs and second the project eXperimenteren+ [4], in which the *Universiteit van Amsterdam*, the *Vrije Universiteit*, the *Universiteit Twente* and *Fontys Hogescholen* have developed comparable products. Both projects delivered an operational, prototypical online lab infrastructure. The configuration of the platforms, the knowledge domains of the available labs and the organization of operations show marked differences however. In quite general terms the objectives of “Labs on line” have been the enabling for large groups of students to use remote laboratories flexibly, efficiently and universally. This had to be achieved by integrating the technical solutions of the earlier projects, increasing the number and diversity of available experiments, creating a pedagogical framework for online experiments, enabling other groups of users and other groups of providers to use the same platform of online labs and creating a community of users and a model for continuity and feasible exploitation. Summarizing the ambition of the project “Labs on Line” was to create a model for remote experimenting that could grow into an (inter)national standard for online labs, a standard that other projects and initiatives can easily adopt. By now most of the objectives of the project have been realised. The distance learning case that has been derived from

this project is the case “Cube measurement” which is carried out by using vision techniques. It will be described in the next paragraph.

1.2 A distance learning case

The web-based exercise “Cube measurement”, also called “Vision experiment” has the educational objective to introduce basics of vision technology to students. Specially the influence of illumination and most common image processing functions are dealt with. The technical objectives of the experiment are to determine the colours and measurements of a cube with the use of a camera and a computer. In order to make all coloured faces of the cube visible a robot is used to throw the cube several times in a visible field. The student has a reasonable degree of freedom in controlling the corresponding processes. During the execution of the experiment the student is provided with tasks that he or she has to fulfil in order to be able to proceed. The experiment is set up in such a way, that a teacher can formulate different assignments, depending on the level of the students. The experiment creates an environment in which the assignments can be carried out. There is no evaluation or grading system included but log files are generated with information on the actions that the students have taken. These log files can be used by a teacher to evaluate an assignment. In figure 1 the experiment set-up is shown.

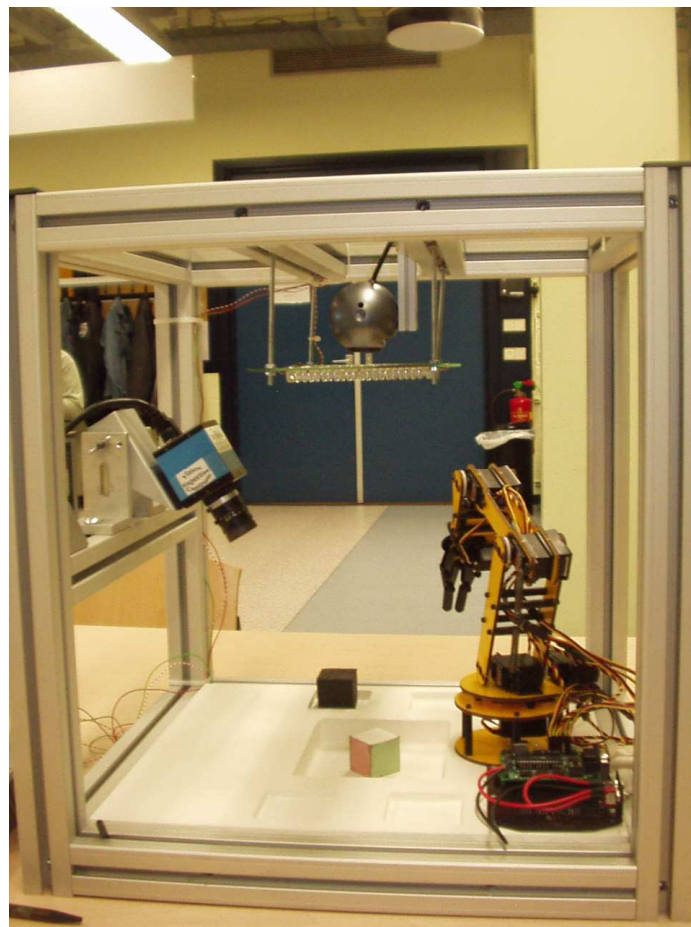


FIGURE 1. Vision experiment

In the picture the vision camera that is used for image processing is visible in blue. Also a webcam can be seen with which the student can follow the actual movements of the robot and see the position of the cubes. Beneath the webcam led illumination is mounted, which can be switched on in segments by the student. The students can get access to the experiment by using a reservation system. The way this reservation system is built is described in [5]. This article also describes the solution found for the problems involved with integrating the two different reservation systems, outcome of the projects e-Xperimenteren+ and Labs-on-Line.

2. PURPOSE OF THE INVESTIGATION

The purpose of our investigation was to determine the appreciation of students for distance learning, not in general but for a well known case that is used within our own institute; the web-based lab experiment. For this case some comparison could be done, as the lab experiment is also available without using the control through Internet. We wanted to know whether the experiment was as effective as it promised to be and what possible difficulties students could meet when executing it. These results can be used to advice the management on a possible continuation or extension of this kind of experiments and the creators on improvements in the existing experiment. It is also desirable to know what factors can influence the appreciation of students for the web-based experiment. Parts of these questions we hope to answer in this paper.

3. APPROACH OF THE INVESTIGATION

In order to find out what the appreciation of students for web-based experimenting is (in this particular case), we have been monitoring students for one year. All students that took part in the course had to fill out a questionnaire. Also online evaluation forms were included in the course but the accompanying questions were more directed to the contents of the courses and filling out these evaluation forms was voluntary. Another difficulty was, that only twelve students did the online vision experiment. However also four students did the vision experiment directly on the system, they can serve as a reference group. These numbers are too low to draw solid conclusions from, but they give an indication for further research. In order to retrieve more information all the students were interviewed. Results will be discussed in the next chapter. As the vision experiment was carried out in two different ways a preliminary comparison could be made. The interviews gave us more insight in the students' ideas of pro's and con's of web-based experimenting. In order to have a base for our investigation, we did some desk research in advance. E.g. the effectiveness of e-learning was reported in [6]. Also a search was done to find comparable cases for our online lab experiment. It was interesting to learn, that throughout the world lots of people are developing these kind of experiments and also make them available to a broad public. E.g. a recent publication [7] describes a real electro-technical experiment conducted in a laboratory, remotely controlled and monitored by web-based tools. Earlier work is done at the University of Siena (see e.g. [8]), where an automatic control lab [9] has been developed, which can be accessed from everywhere and was even found in a recent curriculum of the Yeditepe University in Turkey [10,11]. Finally an online experiment was found that showed great similarity with ours [12]. It made use of lots of similar components as applied in our case. E.g. LabVIEW was used both to control hardware and a camera as well as to create a web-interface.

4. RESULTS OF THE INVESTIGATION

In the questionnaire students were asked to rate the contents and the concept of this learning module. It was also asked whether they found this concept suitable for this module. Further questions concerned the sufficiency of earlier knowledge and the need for additional explanation. The particular questions together with the average rating given by students are given in Table 1. The ratings are expressed on a scale from 1 to 5; 1 meaning the most unsatisfied with this item and 5 most satisfied.

1	Rate the contents of this assignment	3.3
2	Rate the concept of this assignment	3.5
3	Rate the suitability of the assignment for this concept	3
4	Rate the sufficiency of your knowledge for this assignment	3.5
5	Rate the usefulness of the supplied additional information	3.5
6	Rate the way this information was supplied to you	3.5

TABLE 1. Students' rating for web-based lab experiment

The students that performed the lab experiment directly on the system (they can be seen as our reference group) only were more satisfied with the suitability and rated this way with an average of 3.5. All on a scale of 1 to 5. In the interviews afterwards we tried to find out the reasons for this. Most of the times it was mentioned that the system reacted too slow and sometimes produced errors that could only be solved by a system manager. Also the web-based lab-experiment group was asked to mention advantages and disadvantages. Besides suggestions for

improvement of the content and the navigation the most important pro's and con's came up in the interviews. Almost everyone mentioned as biggest advantage the possibility to schedule an experiment whenever they wanted. Also the possibility to do this at home was mentioned. The biggest disadvantage was, that there was no direct possibility to put questions when things were not clear; they preferred more direct feedback. Additionally it was mentioned, that it was just an interesting way to perform a lab-experiment, that they became aware of the difficulties of controlling systems through the internet and accompanying communication. The most important disadvantage that was mentioned was failure of the system with the impossibility to resolve this from a distance. Besides slowness also the fact that they could not actually see the robot move was mentioned as a disadvantage. This could not be compensated with the "life" pictures of the webcam, that is integrated in the system. Some students mentioned the fact that they first had to install some software (this was when using their own laptop) before they could start performing the actual assignment. Another outcome of the interviews was that students did serious recommendations for improvements of the assignment and gave suggestions for making more experiments, that are part of their curriculum, available through internet.

From the students that performed the web-based lab experiment eight also filled out the online questionnaire. It is interesting to know, that for all the experiments that are accessible via the reservation system (# 18) these questionnaires are available. Since the reservation system is operational some 46 students filled out a form, so a more reliable average can be derived. Questions that are interesting in the scope of this paper are

- *would you have done the experiment if it had been available only during office hours?* The average of our students was 4.12 compared to a total of 4.17 (1 being completely no, 5 for yes).
- *do you find performing experiments on internet useful by itself, seen apart from this specific experiment?* rated 4.38 for our students compared to 3.87 for the whole population.
- *do you find the subject of the experiment interesting?* Was rated with an average of 4.57 for our experiment (3.95 for all experiments)
- *did you gain more insight in the subject of the experiment by performing it?* 3.43 to 3.26 for all experiments.

In the next section we will try to draw some conclusions from this figures and interviews.

5. CONCLUSIONS

The student ratings for the web-based lab experiment give a positive view. This was supported by the figures from the online inquiry for all experiments available through the reservation system. It gives a base for doing some recommendations to the management about enlarging the availability of web-based experiments. We were strengthened in this opinion by the outcome of the interviews in which students gave suggestions for other lab-experiments that might be suitable for a web-based version. Other conclusions from the interviews are that the web-based lab experiments become more acceptable when the reliability has improved. This can be achieved by using more robust equipment and better data connections. Also the speed of connection has to be improved as well as the quality and the grade of reality of webcam pictures. As most important advantages the independence of place and time to perform an assignment were identified. However this will be limited by the fact that in the near future more students can make a reservation for using the experiment. Also one of the questions in the online questionnaire referred to this item; it appeared that 90% of the students were able to make the reservation at the time they wanted to. From the institute's point of view we can add that using a web-based version of a lab experiment is a perfect solution for the problems that arise when students are ill or handicapped. For institutes with departments that are spread out over a city or a region there is no need to have more than one laboratory at a site. The determined disadvantages were most in the field of functionality of the used systems. Remains one important issue which is the impossibility to put questions to a teacher during performing the experiment. Several solutions can be found to cope (a little) with this disadvantage. We could think of a lab-assistant with whom students can communicate with the use of a webcam or any e-meeting system. Experiments in this field are described in [13]. The disadvantage is of course that such an assistant is only available at office hours. Other possible solutions are creating a workspace with FAQ's, starting msn-like communication for students to be able to help each other and building in more help suggestions in the system itself.

6. FURTHER RESEARCH

As the investigations were performed with a limited number of students we only have preliminary answers to our research questions. Further research is needed with larger groups of students. With this research more emphasis can be laid on the factors that might influence the appreciation, like educational context, possible earlier experiences with distance learning, background of students and their expectations about their education. Also it is interesting to find out whether improvements on the systems influence the ratings that students give for the

different items. In interviews more suggestions can be asked to cope with the problem of the need for direct answers to questions that rise during the execution of the experiment.

In the “Labs on Line” project [2], initiated by the *Digitale Universiteit* the ambition was to create a model for remote experimenting that could grow into an (inter)national standard for online labs. The latter might have been “one bridge too far”, but a lot of the objectives of the project have been realised by now. However the *Digitale Universiteit* has ceased their existence and we are looking for a platform to continue the community of institutes that use, support and maintain the online lab experiments. When this community grows more experiments on each others’ sites can be carried out and more data comes available in order to determine the appreciation of students and to continuously improve the quality of these courses. Interested parties are encouraged to contact us!

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Curricula

Ir. Dick van Schenk Brill is senior lecturer at the department of Information Technology of Fontys University of Applied Sciences, where he has been working since 1981. He graduated in Electronic Engineering at the Delft University of Technology in 1978. Besides lecturing, he is involved in many organisational tasks, mainly in the field of Technical Informatics. His research activities are in the fields of Integrated Product Development, Industrial Automation and of Education in Technology. He took part in the project as mentioned in 1.1 and was intensively involved in developing the web-based lab experiment “Cube measurement”.

Ir. Bert van Gestel is senior lecturer at the department of Information Technology of Fontys University of Applied Sciences. He graduated in 1983 in mathematics and informatics at the Eindhoven University of Technology. Since his graduation he worked at Fontys University of Applied Sciences. He teaches students in software programming, image processing, mathematics and testing of software. Other tasks are coaching of students, during their complete studies, supervision of internship and graduate students. He also took part in the project "Cube measurement".