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STUDENTS' PERCEPTIONS OF A PHYSICS LABORATORY IMMERSION

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In order to facilitate flexible learning in engineering and science laboratory education, we have developed a specific laboratory course design: laboratory immersion. This concept is a combination of three other lab styles: hands-on, virtual and remote labs. The physics laboratory immersion is implemented and evaluated by students and teaching staff. This new method has some strengths such as increased flexibility and student activity, but it also needs some improvements such as teamwork and informal practicing.

Keywords: blended learning, laboratory.

INTRODUCTION

Nowadays, much effort is done to facilitate higher education to non-traditional students (working students, students with disabilities, etc.). In engineering and scientific higher education flexible learning is restricted because of the laboratories being organized on campus at scheduled moments. This prevents non-traditional students from enrolling.

Several possible solutions are designed, such as virtual or remote laboratories [3,4]. Both are valuable but they cannot replace the hands-on classical lab classes. Simulations and remote labs enable activities that would otherwise remain out of reach because of limited lab access [5]. Hands-on laboratories place a strong emphasis on design and investigation skills and on conceptual understanding [3].

In the first part, a new concept of a laboratory course is presented. We call it laboratory immersion. It consists of a blend of hands-on activities on campus and off-campus e-learning, home experiments, simulations etc.

In the second part, we focus on the non-traditional student. We present the results of students interviews and an e-questionnaire that focused on the needs of these students. The initial interest in laboratory immersions was not very high. We give an overview of the most probable reasons for this lack of enthusiasm and collect the critical elements that should be taken into account.

The main focus of this paper is on the perceptions of traditional students, after having finished a laboratory immersion in the physics lab, and on the opinions of the staff members who have developed the physics laboratory immersion. The student's opinions are collected with an electronic survey, the staff members participated in a focus group discussion. The results of this study are discussed in part three of this paper.

THE CONCEPT

A laboratory immersion is a short, very intensive on-campus lab preceded by and finished with distance learning activities [1]. In fact, the three phases in the experimental work are consciously divided: the prelab phase at home focusing on preparation (literature, simulation, tests, etc.), the on-site laboratory session for the hands-on activities and the remote postlab for reflection and reporting. Everything that can be disconnected from the effective presence in a lab will be organized with e-learning making it time and place independent.

Moreover, the on-site laboratory session is organized in a multi-campus setting. It is organized at the campus with the best infrastructure, enabling students of different campuses to make use of this laboratory environment. For the teaching staff this reduces the work load since the non-traditional students of several institutions are gathered and forced to work together on a fixed moment (in a weekend or an evening or any other moment they prefer).

THE INITIAL INTEREST OF NON-TRADITIONAL STUDENTS

At the beginning of the whole project, we organized interviews and an e-questionnaire to find out the needs of these non-traditional students in term of laboratories. We also collected the opinions of these students about our possible solution, i.e. laboratory immersion [2].

25% of the students in the Group Science and Technology in the Association K.U.Leuven are non-traditional (in October 2008). 137 students of these non-traditional students completed the e-questionnaire.

It seems that 44% of these students have problems attending all the scheduled lab sessions. Several solutions are found, but most of the time this means that the students and the teaching staff create flexible solutions that are not always of high quality. These results were an extra motivation to develop the new concept.

The enthusiasm of these non-traditional students for our flexible tool, was however not very high. A possible reason is that the students prefer to walk the track of lowest resistance. The individual replacement tasks that are constructed for the moment, such as writing a paper or doing some simulations at home, are much more easy than working together with unknown students of another institution and moving to another campus for the on-site laboratory.

These non-traditional students advised us to take into account the following elements in order to make laboratory immersion more attractive:

- The students should be able to work in team;
- The hands-on phase is an important element which should not be skipped;
- The total study time needs to be comparable to the regular labs;
- The coaching is an important element. Students fear less support and larger responsibility in a flexible alternative;
- The alternative should become a flexible tool with respect to time, and location. This profit should exceed all the disadvantages;
- Non-traditional students are in need of contacts with traditional students. In case they do not have this opportunity during the lab session, other occasions must be created. It is important to remind that non-traditional students have a greater withdrawal. Laing [6] has shown that providing a helpful and well informed teaching environment is one of the essential emergent properties.

THE EXPERIMENT

We took into account the above advices, developed a physics laboratory immersion [1] and implemented it during the academic year 2009-2010 in the curriculum of first-year engineering and pharmacy students.

Although the method is originally designed for non-traditional students, we tested the concept with traditional students and implemented the concept in a non multi-campus setting, because of the limited number of non-traditional students. These traditional students performed the hands-on phase at their home institution. By consequence, we were not able to evaluate the multi-campus aspect of this methodology.

72 first-year students participated in the physics laboratory immersion and evaluated this new working method. The methodology is based on (electronic) surveys and study time measurements.

We have collected the opinions of the teaching staff by using a focus group interview.

THE RESULTS

The study time measurement reveals that on average the students spent 15 hours in total on the physics laboratory immersion. This measurement also indicates that the pre- and postlab each require 40% of the total study time, such that the hands-on phase takes only one fifth of the total time.

The survey forced the participating students to give their opinion on several topics. We got the following general results:

1. 55% of the students confirmed they learned more during the laboratory immersion than during a classical lab because of a better preparation;
2. 55% of the students prefered the laboratory immersion over a classical lab;
3. 62% of the students thought that the laboratory immersion is more efficient;
4. 71% of the students loved the fact that they can work when en where they wanted;
5. 77% of the students had no problems with the increased responsibility they have entrusted;
6. 85% of the students were convinced that the laboratory immersion demanded more than a classical lab.

The students compiled an inventory of the following benefits:

1. Students learn to work independently;
2. Students can go through everything at their own pace;
3. Students learn more since they are forced to prepare the lab before doing the hands-on phase. Students learn more since they focus on one topic and study it in detail (the common thread is clear);
4. Students are forced to study actively;
5. Students can use professional equipment;

The students gave us the following inventory of disadvantages:

1. It takes more time;

2. Students cannot ask so many questions;
3. Students do not have an informal practice moment.

As mentioned in the beginning this new concept is introduced to first-year engineering and pharmacy students. We noticed a tremendous difference in the perceptions and appreciations between these two groups (see Table 1).

Statement	**In general**	**engineering students**	**pharmacy students**
I have learned more because of a better preparation.	55%	71%	43%
I am willing to move to another campus to do the hands-on.	45%	86%	14%
I think that laboratory immersion is a more efficient methodology.	62%	89%	59%
I prefer the laboratory immersion over a classical lab.	55%	70%	43%

Table 1. The differences in perceptions of engineering and pharmacy students.

The focus group interview was organised at the end of the project. The teaching staff was free to talk in an interactive group setting of four people. It reveals that the teaching staff noticed the following:

1. It is important to develop the laboratory immersion in a multi-campus setting in order to minimize the preparation time and to benefit from each other’s experience in the context of questioning things you are doing already for years. Moreover it’s fun to work together;
2. The staff needs technical support when the pre- and postlabs are developed;
3. The students were better prepared than in a classical lab;
4. It is better to analyse thoroughly one experiment than superficial handling three different experiments;
5. The students have the perception that they have learned a lot. This is good for their motivation;
6. The quality of the reports was better.

The teaching staff has collected the following advantages:

1. The multi-campus setting is a strength;
2. The developed material can be reused in other settings.

The teaching staff gave the following disadvantages:

1. It will be difficult to supervise big groups with this methodology;
2. Students don’t get enough opportunities to practice;
3. There was not enough teamwork.

DISCUSSION

We were afraid that the developed laboratory immersion would be a too heavy burden on the students. The study time measurements however indicate that the invested study time is just within the acceptable limits since the ECTS points for this lab are 0,5, meaning 12,5 to 15 hours of study time.

The study time measurement reveals that the students spent a lot of time on preparation and reporting (pre- and postlab). In a classical laboratory setting this is surely less than 80%. This methodology apparently forces the students to prepare the hands-on phase in a very profound way and to take care of the reports. The teaching staff also has noticed the effects of this increased work at home (see later).

Almost all students have the perception the laboratory immersion was demanding. although the time measurement does not reveal they spent too much time. This contradiction is probably a result of the fact that in a classical lab, the presence in the lab is the most important. Time spent at home is minimal. In this experiment it is just vice versa. Moreover students are forced to study actively, as they reported.

Many students have the perception they learned in a more efficient way. The teaching staff also remarked the better preparation and an enhanced quality of the reports. We succeeded apparently in motivating students to work at home in a qualitative and efficient way. A possible reason for this success is the test at the beginning of the hands-on moment. A student who does not pass the test, is not allowed to enter the lab. A second possible reason for the success is the focus on one topic during the laboratory immersion, whereas in a classical laboratory setting several elements are studied during succeeding lab sessions. Students reported a clear common thread.

It’s not clear whether the students have learned more. But it’s obvious they learned other things like working independently and writing a report. Moreover they really enjoyed the possibility of working when and where they want. We should remark that we worked with first-year students, so older students will surely appreciate this even more.

Students and teaching staff remark that students have little opportunity to practice. The time spent in the lab is that limited that failure has profound implications. A possible solution is to offer students virtual and remote lab possibilities, but this requires a large investment in equipment and time and increases even more the need for technical support.

Students and teaching staff believe that teamwork should be encouraged. The students complained that they couldn’t ask so many questions. Maybe this also can be resolved by introducing social contact during pre- and postlab.

The multi-campus aspect of laboratory immersion is only evaluated by the staff since the students were not faced with this element. The perceptions of the staff are exclusively positive. A possible explanation is the spontaneous formation of the group and the history of collaboration.

The differences in perceptions and appreciations of the engineering and pharmacy students (Table 1) is possibly a consequence of the following elements:

- Engineering students love, in general, physics more than pharmacy students;
- The engineering students were freshmen whereas the pharmacy students were students who took the physics course for the second time;

- The pharmacy students knew that the year before nobody was forced to do the laboratory again whereas they were obliged to take the laboratory immersion.

This systematic deviation and the possible explanation, justifies probably a more positive interpretation of the general perceptions of the students. This is interesting to know, but does not change anything on our conclusions.

CONCLUSIONS

We have developed a new method in laboratory-based courses: the traditional hands-on lab, the simulated lab and the remote lab are combined into 'laboratory immersion'. The latter is a blend of several methods, including hands-on. We have tested the concept with 72 students and evaluated the perceptions and opinions of students and staff members. In general the students feel positive about laboratory immersion. The greatest advantages are, first of all the increased flexibility, while hands-on practical skills training is still included and secondly we are proud to report that the students were better prepared and wrote more complete reports. Students learn in a different way, more active but also individual. The latter needs further development in near future, as well as the possibilities to practice in an informal way.

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