Acceptance, Usability and Usefulness of WebLab-Deusto from Students Point of View

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Abstract

In the engineering curriculum, remote labs are becoming a popular learning tool. The advantages of these laboratories and the different deployments have been analyzed many times, but in this paper we want to show the results of the evaluation of WebLab-Deusto as a learning tool. This work is focused on the subjects Programmable Logic (PL) in the third year of Automation and Electronics Engineering and in Electronics Design (ED) of the fifth year of the same degree. The paper presents the results of the surveys done by students since 2004. This survey consists of fifteen questions and its main objective is to measure the acceptance, usability and usefulness of the remote laboratory developed at University of Deusto.

1. Introduction

Using a remote laboratory –called WebLab, iLab, etc.– the students can complete a practical exercise or experiment in the same way as if they were in a real laboratory. They can access the remote lab from their houses or from anywhere with an Internet connection. A WebLab gives the students total control over the experiment: they can control its logic, the can wire components and activate inputs and show the outputs. Usually client-server architecture is used.

Since 2000, a huge number of remote laboratories have been designed, implemented and set up over the world. Papers and books about remote labs focus on their advantages/disadvantages [1-2], technologies [3], didactic [4], etc. have been also published. Those papers, books, and articles show us the interdisciplinarity of this research area. Most of those works are focused on the technology and a few articles are focused on the utility of the remote labs as a didactic tool.

The present work analyzes the student's opinion about the acceptance, quality, usability and usefulness of the WebLab-Deusto. All the aspects related to the academic performance, marks, and so on, are not considered.

The paper is organized in seven sections. Section 2 describes the academic scenario of this work, and section 3 explains the survey that the students must fill when they finish their work with Weblab-Deusto. Section 4 analyzes the results of the subject Programmable Logic during 2004/05/06/07. Section 5 describes the results of the subject Electronic Design during 2005/06/07/08. Section 6 compares the two previous sections. The conclusions are presented in section 7.

2. Scenario

The Faculty of Engineering of the University of Deusto designed and implemented the first remote lab in the year 2002/03. During the year 2003/04 WebLab-Deusto was accessible for the students and since the academic courses 2004/05 and 2005/06 surveys about WebLab-Deusto-PLD and WebLab-Deusto-FPGA are available, respectively. WebLab-Deusto-PLD is used in the subject Programmable Logic (5 ECTS) and WebLab-Deusto-FPGA is used in the subject Electronics Design (6 ECTS). In both subjects, practical exercises are similar:

- The student reads the outline of the practice and programs the solution using VHDL. Then, he simulates the program to test if it runs well.
- Files .jed or .bit are generated. These files contain the logic of the practice.
- The student connects to remote lab using the web site http://weblab.deusto.es. After logging/authentication he can download the .jed or .bit file into the programmable device through internet.
- The system assigns 200 seconds to the student, he can activate the inputs by clicking at the

switches and buttons located on the web site. The outputs (LEDs and 7 segments displays) are shown in the Weblab-DEUSTO site using a webcam.

- The student has 200 seconds to work with the weblab to confirm if the practice he has implemented is correct. It is enough in general, but if the student needs more time, he must to access again to the weblab. The system manages the students' queue.
- The student analyzes the results and then he finishes the practical exercise. He can repeat the process all the times that he wants.
- In the subject Programmable Logic the students use the real lab and the remote lab, but in Electronics Design they use only the remote lab.

3. Survey

The survey consists on fifteen questions and it is filled by the students at the end of the semester. Table 1 shows the results of the survey since 2004 until 2008 for the subjects Programmable Logic (PL) and Electronics Design (ED). The minimum value is 1 and the maximum is 5: 1 is "I totally disagree" and 5 is "I totally agree". The answers of the questions 4, 13-15 are quantities.

Question 13 asks the student about the queue of weblab. If a student wants to access the weblab and it is occupied, then the system will queue him. When the weblab is free, the system will give the control to the first student in the queue, and so on.

At the beginning, the questions were in order from 1 to 15, but in the presented table, they are grouped in Acceptance and Usefulness of the WebLab, Usability of the WebLab and Problems in the WebLab. Questions 4 and 15 are not used for further analysis.

Table 2 describes the survey in the different years. It describes how many students were in the course, how many students completed the survey and how many times was the weblab accessed by the students.

4. Analysis of the results in the subject Programmable Logic

Figure 1 shows that the answers for the questions —"Has WebLab helped you with the subject?", "Did you feel that you were in a better position by having been in the WebLab group?" and "What is your global satisfaction with WebLab?— are similar all the years and they are near to 4. It can be interpreted as the weblab is useful for the students for years. In the first years, the score was the greatest, but it could be due to the newness of the WebLab in the Faculty.

**Table 1. Results of the surveys proposed to the students 2004/08**

Acceptance and usefulness	1	2	3	4	5	6
1. Has WebLab helped you with the subject?	4,6	4,1	3,8	3,8	3,7	3,5
2. Did you feel that you were in a better position by having been in the WebLab group?	4,7	3,9	3,9	3,7	3,7	3,8
12. What is your global satisfaction with WebLab?	4,7	3,9	3,7	3,7	4	3,7
3. Do you think it is a good idea if this WebLab experiment is extended to all the students?	4,7	4,6	4,2	4,1	4,1	4,2
11. Would you like to use WebLab in other subjects?	4,3	4	3,9	3,8	4,1	3,7
Usability						
4. How many prototypes do you think are needed to support 50 students?		4,4	3,7	2,5	3,3	2,3
5. Is it easy to use?	4,4	4,4	3,9	3,6	3,9	4,1
6. How is the quality of the WebCam?	3,2	2,4	2,7	2,9	2,5	3,2
7. Did you feel at ease managing the inputs?	3,7	3,1	3	3,5	3,1	3,4
9. What do you think about the inputs/outputs implemented?	3,8	3,2	3,4	3,4	3,5	3,7
8. What do you think about the time assigned to each connection?	3,7	2,7	3,1	3,2	2,4	3,8
10. Being far from the prototype, Have you felt yourself to be in control?	4,1	3,7	3,6	3,6	3,7	3,7
Problems						
14. How many times was the server down?		3,1	2,2	2,5	2,1	2,7
13. How many times did you wait for using it?		2,5	2,1	2,5	2	2,6
15. Do you know anybody who uses a WebLab in another University?	0	0	0	0	0	0

1-3-5. Results of Programmable Logic on 04/05, 05/06 and 06/07
2-4-6. Results of Electronics Design on 05/06, 06/07 and 07/08

Table 2. Description of the surveys

	Students	Surveys	Accesses
ED 05/06	31	17	495
ED 06/07	42	39	1.985
ED 07/08	33	28	1.147
PL 04/05	90	10	1.706
PL 05/06	58	40	632
PL 06/07	37	33	1.012

PL: Programmable Logic, ED: Electronics Design
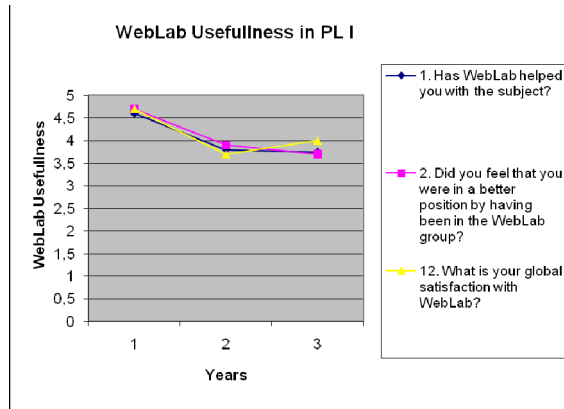

Figure 1. WebLab Usefulness in PL I

Figure 2 shows the answers of the students when they are asked about if they would like to use the WebLab in other subjects and if they think that would be interesting to extend the use of the WebLab to other students — "Do you think it is a good idea if this WebLab experiment is extended to all the students?" and "Would you like to use WebLab in other subjects?"—. The opinion of the students is a little bit higher than 4, so we can think that they would like to use the WebLab again because it is useful for the subjects and for themselves. It is a curiosity to observe that the students think that weblab is better for the other students than for themselves.
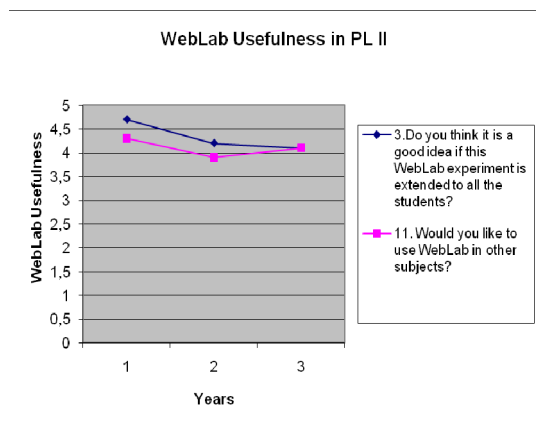
Figure 2. WebLab Usefulness in PL II

Figure 3 shows the opinion of the students about the Quality/Usability of service of the WebLab — "Is it easy to use?", "How is the quality of the webcam?", "Did you feel at ease managing the inputs?"," What do you think about the inputs/outputs implemented?", "What do you think about the time assigned to each connection?", "Being far from the prototype, have you felt yourself to be in control?"—.
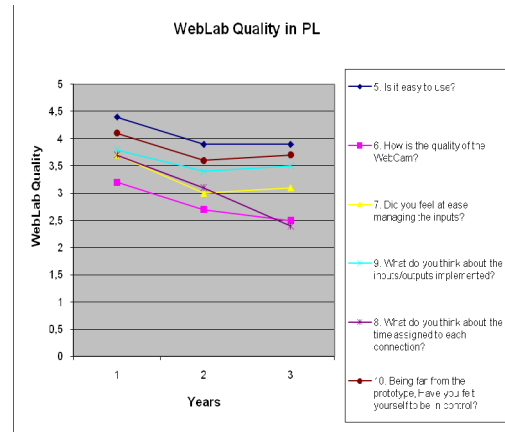

Figure 3. WebLab Quality in PL

The results of Figure 3 have to be analyzed question by question:

- The students say that WebLab is easy to use. The result is 4.
- About the quality of the webcam, the results are not good (less than 3), and it is worse year after year. Likely the problem is due to the lighting of the room in which the WebLab's hardware is located because the actual webcam is better than the first webcam. The problem is more concerned with the students' bandwith than with the quality of the webcam.
- About the inputs management, the students' opinion is positive (3.5). The inputs are: 10 switches, 4 buttons and a variable frequency clock.
- Time assigned to each connection receives the worst score (less than 3), and year after year the score is worse. This time has been changed every years. At the beginning it was 60 seconds and now it is 150 seconds. The solution is to increase the connection time (see in section 5 the opinion of ED students)
- The question "Being far from the prototype, have you felt yourself to be in control?" is a basic question [5] about the psychological perception of the WebLab by the student. If the student does not feel that through the WebLab he has the control over the experiment, the WebLab is not useful. In the WebLab-Deusto case, the students' answer is that they felt that they had the control over the experiment.

Figure 4 shows the problems with the use of the WebLab only during 2005/06 and 2006/07 —"How many times was the server down?", "How long did you wait for using it?"—. In both cases, the student had to wait for the server 2 times and the server was down twice too.
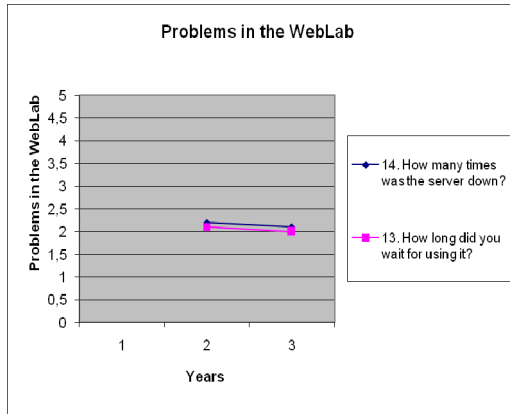

Figure 4. Problems in the WebLab in PL

It is important to remark that during the last year, 2006/07, connection time was increased from 100 to 150 seconds. In this situation, the waiting queue was reduced. It can be explained if it is thought that the students were able to finish the analyze in only one connection with the WebLab. It reduces the risk of a large queue.

5. Analysis of the results in the subject Electronic Design

Figure 5 shows the students' opinion about usefulness of the WebLab-Deusto — "Has WebLab helped you with the subject?" , "Did you feel that you were in a better position by having been in the WebLab group?" , "What is your global satisfaction with WebLab?"—. Students are satisfied and the score is around 4 along the years 2005/06, 2006/07 and 2007/08.
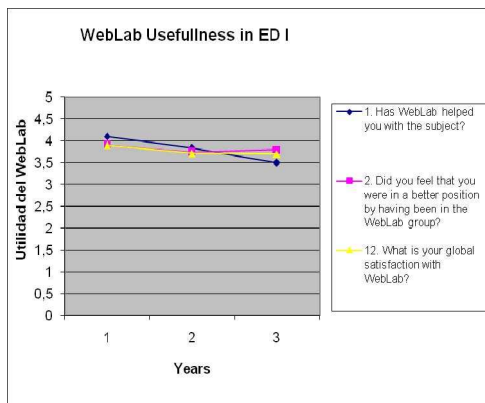
Figure 5. WebLab Usefulness in ED I

Figure 6 captures the students' answers to questions about the use of WebLab again, — "Do you think it is a good idea if this WebLab experiment is extended to all the students?", "Would you like to use WebLab in other subjects?" —.The answers are positive and the students agree to work again using this remote lab.
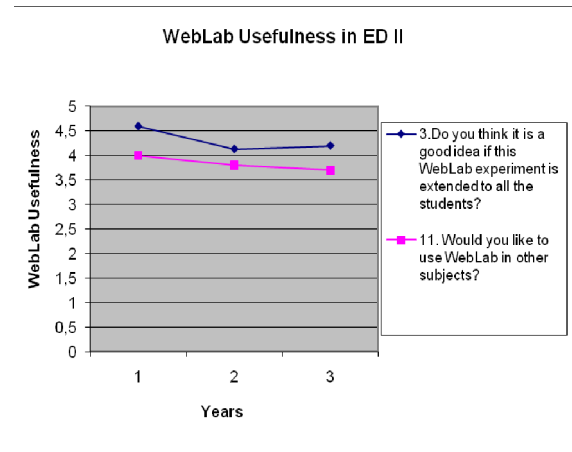
Figure 6. WebLab Usefulness in ED II

Figure 7 represents the students' opinion regarding the quality of WebLab. For each questions, the opinion is different:

- Students think WebLab is easy to use. The score is around 4.
- Students remark that the quality of the webcam is not good, but the score in this question improves year by year, thanks to a better lighting of the WebLab's hardware.
- Students' opinion about inputs management is positive (higher than 3).
- The evaluation of time assigned to each connection improves year by year (from 2.7 to 3.8). In the year 2007/08, this question has increased 20% thanks to the increase of time connection to 200 seconds.
- Last question is focused on the student's control feeling. His answer is positive and stable along the years (higher than 3.5).

Figure 8 shows the problems in the use of the WebLab — "How many times was the server down?", "How long did you wait for using it?"—. For both questions the score is near to 2.5. It can be taken as an acceptable value. It may be deduced that although the connection time has been increased, the times that the students had to wait for the service did not increase.
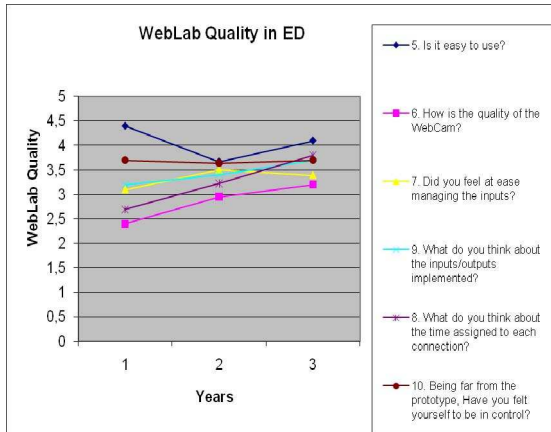
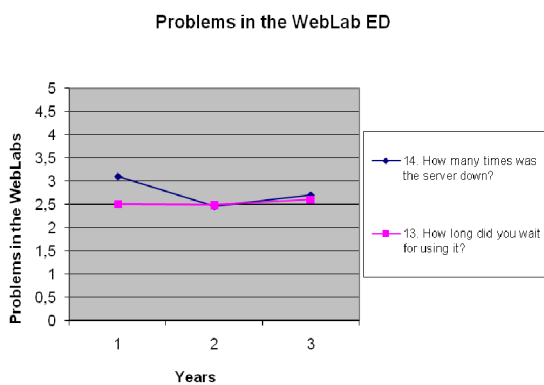**Figure 7. WebLab Quality in ED**

Figure 8. Problems in the WebLab ED

6. Comparison between Programmable Logic and Electronic Design

Following figures integrate the obtained results for both subjects. The objective is to establish the differences and similarities between them. In Figures 9-12, odd elements are related to PL subject and even elements to ED subject. In this way, the elements are arranged in the time: 1. PL 2004/05, 2.ED 2005/06, 3. PL 2005/06, 4. ED 2006/07. 5. PL 2006/07, 6. ED 2007/08.

Figure 9 shows clearly that the usefulness of the WebLab is marked very well. It is 4 points on average. This score is constant during the years in both subjects, except for year 2004/05 in PL.

Figure 10 represents that the students agree to work again using this remote lab and they propose the use of the WebLab in other subjects. This value is stable during the time periods again.

Figure 11 reflects that the students, in different years and/or subjects, do not agree in evaluating the quality of the WebLab. The differences among lines are very significant when students are asked for their opinion about time connection and the quality of the webcam. In both cases, the students from ED give more importance to the quality of the webcam. And

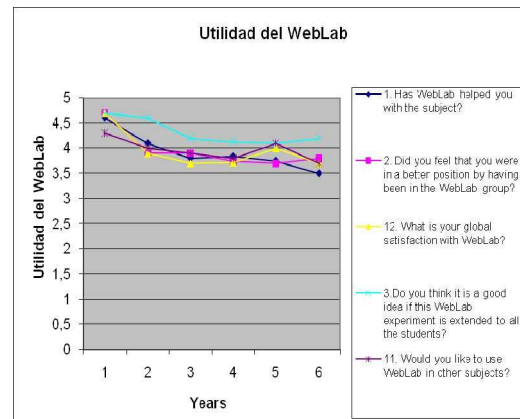in the first case, the evolution is positive and in the second one, it is negative.

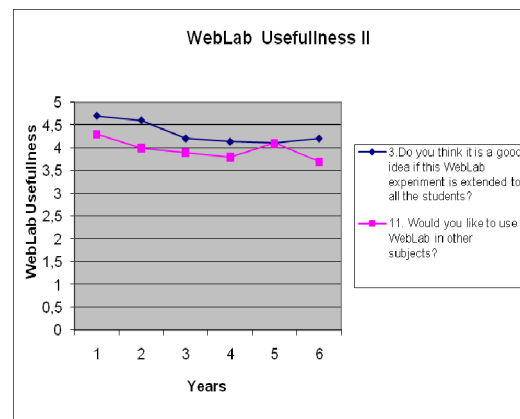**Figure 9. Comparison between ED and PL (I)**

Figure 10. Comparison between ED and PL (II)

Figure 11 reflects that the students, in different years and/or subjects, do not agree in evaluating the quality of the WebLab. The differences among lines are very significant when students are asked for their opinion about time connection and the quality of the webcam. In both cases, the students from ED give more importance to the quality of the webcam. And in the first case, the evolution is positive and in the second one, it is negative.

Anyway, the most important question of this group is related to the control felling. In both subjects, students feel that they control the experiment and its evolution depends on users commands.

Figure 12 shows clearly that the questions' score related to the times the server was down and the waiting queue is around 2 points during all the years.

7. Conclusions and future work

The first conclusion is that the obtained values are constant along the years and in the two subjects. Other conclusions are:

- Remote laboratories have to be considered as a useful learning tool in the engineering courses.
- Remote laboratories are not for substituting the traditional labs. They are a complement.
- The students think that remote laboratories are useful in the subjects Programmable Logic and Electronics Design.
- Students agree to use again remote labs in other subjects and they propose to be used by other students.
- The quality of WebLab-Deusto is good but it must be improved.

Future work is focused on deploying the remote labs in new subjects and using new inputs/outputs. Also measuring the academic results of the students would be necessary.
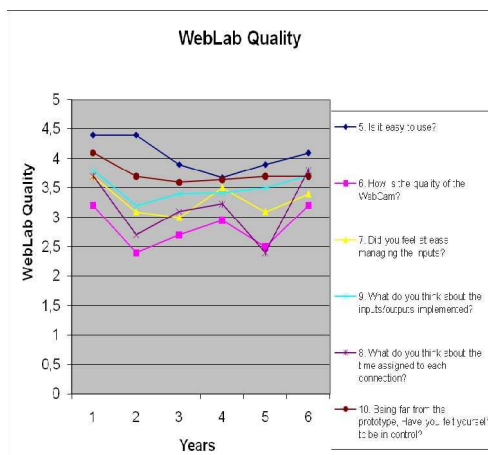
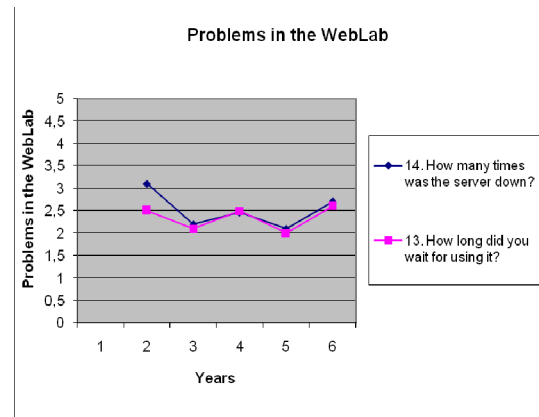**Figure 11. Comparisonwith respect to WebLab Quality**

Figure 12. Comparison with respect to WebLab Problems

8. References

[1] Gomes, L. and Garcia-Zubia, J. eds. *Advances on remote laboratories and e-learning experiences*, Ed. University of Deusto, ISBN: 978-84-9830-077-2, Bilbao, 2007.

[2] Gobbo, F. and Vaccari, M. "Open standards for higher education in robotics by immersive telelaboratories" *Learning Technology Newsletter* (IEEE Computer Society), VOL 7, Nº 3, 2005

[3] Indrusiak, L.S.; Glesner, M.; Reis, R. "On the Evolution of Remote Laboratories for Prototyping Digital Electronic Systems" *IEEE Trans. on Industrial Electronics*, VOL: 54 , Issue: 6, Dec. 2007

[4] Ma, J. and Nickerson, J.V., "Hands-on, simulated, and remote laboratories: A comparative literature review", *ACM Computing Surveys*, Vol. 38, Nº 3, 2006

[5] Soysal, O. "Computer Integrated Experimentation in Electrical Engineering Education over Distance" *Proceedings of ASEE 2000 Annual Conference*, Saint Louis, MO, 2000