INDEPENDENT LEARNING IN A VIRTUAL ENVIRONMENT

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Abstract
In this paper we will describe a Virtual Learning Environment designed to promote self-directed learning. We will analyse the results of the opinion survey and evaluation of the activity developed in the environment. This activity was performed by students without teacher intervention and it is part of a classroom course of Electromagnetism in the second year of Industrial and Chemical Engineering. In this particular case it deals with the concepts related to electrical circuits by applying Kirchhoff's laws.

Introduction

During the 2004–2005 academic year we began to restructure the Electromagnetism course, which is taught as a face-to-face subject at the Escola Tècnica Superior d'Enginyeria Industrial de Barcelona (Universitat Politècnica de Catalunya). The aim was to make a real change to the teaching methodology to make it student-centred, adapting the course to the guidelines of the *European Higher Education Area*. We planned a teaching-learning process in which students are given clear instructions as to what they need to do to ensure that they learn Electromagnetism (Bohigas, Jaén, Periago, & Pejuan, 2009).

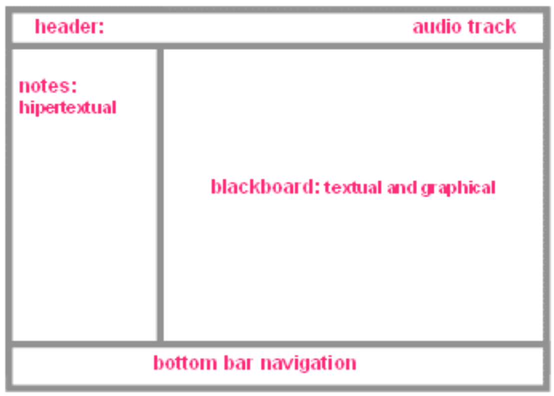
In the course plan we included several generic objectives, such as the ability to work in groups and self-directed learning skills, which are considered important in engineering work (Felder & Brent, 2003).

This presentation is about an activity that is designed to enhance self-directed learning (McKinney, Dyck, & Luber, 2009; Savoy, Proctor, & Salvendy, 2009; Susskind, 2008). We designed a Virtual Learning Environment (Jaén, Novell, & Bohigas, 2008) for an activity that the students must carry out without the intervention of the teacher. It is a directed activity with suggested actions that students must follow to learn the concepts related to solving circuits with Kirchhoff's laws. When the students had completed the activity, they were asked to answer a questionnaire.

The Virtual Learning Environment

The Virtual Learning Environment (VLE) for this project is modelled on an already existing environment, *la baldufa* (http://baldufa.upc.edu), which has enabled us to integrate many of the tools already offered there. The VLE is divided into four areas, with each one giving access to different types of material, as shown in Figure 1. The VLE can be used from any browser (Mozilla, IExplorer, etc.).

Figure 1: Structure of the VLE



The "Blackboard"

The Blackboard occupies most of the screen and shows the theoretical concepts, formulas and solved problems. The PowerPoint-type slides can be downloaded in a PDF document suitable for printing.

The Header

In the Header are the tools that are provided throughout the *la baldufa* learning environment. From there, one can access simulations that are related to the content displayed on the blackboard, PDF downloads and more general tools such as a calculator. In the upper right of the Header is the Audio Track.

The Audio Track

Unlike the activities we have designed up until now, this one includes audio commentary on slides that present theoretical concepts. The audio commentary includes more exhaustive explanations of the concepts and formulae that appear on the slide, as well as advice and recommendations that would have been difficult to fit into a written text. Access to the audio tracks is at the top of the page in the bar above the slides, and the student can pause and play the track at will. The audio system includes an indicator of the duration of the track, as well as a timer to show the time that has elapsed since the start of the track.

The Notes

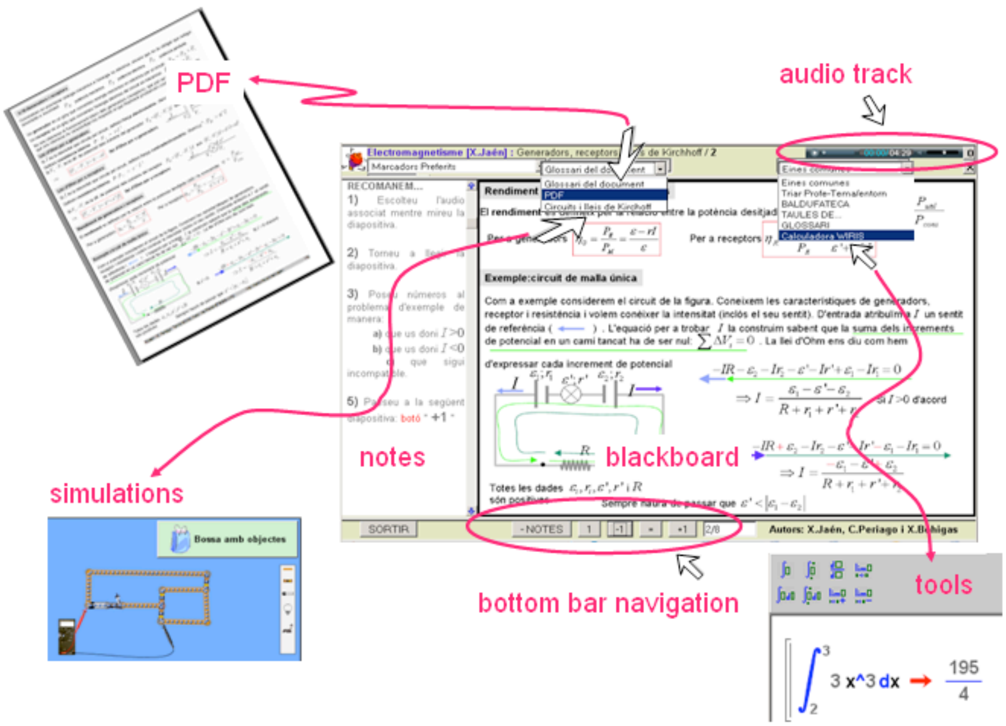
This hypertextual space is very helpful in giving advice on the "blackboard". This area includes notes and tips related to each slide and guidelines to get through the activity.

The Bottom Bar Navigation

The bottom bar navigation includes some buttons (forward, reverse, start, etc..,) to navigate through the slides.

Some examples of the materials that can be accessed from the VLE can be seen in Figure 2.

Figure 2: The VLE is designed to host the various elements that make up the contents of a classroom



The Opinion Survey

When the students had completed the self-directed learning activity, they were asked to answer a questionnaire about the activity they had just carried out. A total of 50 questionnaires were collected and processed.

The first five questions covered general academic information, while the other nine questions referred specifically to the activity. At the end of the questionnaire was an open question asking students to comment on some aspect of the activity that they felt was noteworthy.

The nine specific questions about the activity and the results obtained in each category are shown below.

Q6: "Overall, I feel that the activity was well designed and suitable for the course."

***1** (poor)* ***2** (fair)* ***3** (neutral)* ***4** (good)* ***5** (very good)*

The aim of this question was to obtain a general assessment of the activity, without getting into specifics, which we would ask about later on. The overall response was favourable, since the great majority of students considered it good (60%) or very good (22%).

The following questions were designed to ask the students about the usefulness for their learning process of the different resources used in the activity.

Questions **Q7** to **Q12** are structured in the same way:

"My learning was aided (. . .)"

***1** (not at all)* ***2** (a little)* ***3** (neutral)* ***4** (quite a lot)* ***5** (very much)*

Q7: "(. . .) by the audio explanations."

Of the students, 40% answered that the audio commentary helped them quite a lot or very much, 36% of them were undecided on the matter and 24% felt that they did not help much, including students who added comments at the end about the technical problems that prevented them from listening to the audio files.

We include three of these comments because we believe they reflect the polarised opinions that we found:

- I wasn't able to use the audio because the window [of the browser] did not give me the option.
- I didn't use the audio because it is very slow and boring.
- I think the audio is very useful, as are the example problems, the proposed exercises and the questions. [. . .] The audio is very helpful because it enhances the information on the slides. To be honest, I didn't like the idea but I was very surprised (in a positive way).

Q8: "(…) by the theoretical explanations on the slides."

Q9: "(…) by the problems explained on the slides."

We grouped these two questions together because we wanted to ascertain the usefulness of the theoretical explanations and the solved problems that appear on the slides. The content presented on the slides is not very different to the material that can be found in a textbook or in lecture notes.

Most students said that the explanations had helped them quite a lot or very much (74% in Q8 and 92% in Q9). This result was expected as it was similar to the results of other surveys carried out in the past about the usefulness of complementary material such as notes in PDF format and HTML pages (Periago, Pejuan, Jaén, & Bohigas, 2009)

Q10: "(. . .) by the recommendation of problems for practice."

Q11: "(. . .) by answering the questions indicated."

Q12: '(. . .) by the recommendations made online, even though I downloaded the slides in PDF format."

We grouped these three questions together because we wanted to obtain a specific assessment of the usefulness of the Notes area. Based on our experience in other activities that we had designed earlier, we assumed that many students would download the document containing the slides in PDF format (Periago et al., 2009). However, on this occasion we wanted to know whether, in spite of this, the students felt that the inclusion of these recommendations in the environment was useful.

Students responded quite favourably, although less so than in the case of the two previous questions (Q8 and Q9). The percentage of students that considered the recommendations to be helpful or very helpful was 84% for Q10, 76% for Q11 and only 54% for Q12. The most noteworthy aspect was the high percentage for Q10, which together with the high percentage for Q9 can give us an idea of the great importance that students place on problem solving in their learning process.

Q13: "I agree that it is possible to learn this topic without the explanations of the lecturer in the classroom."

1 *(not at all)* ***2*** *(a little)* ***3*** *(neutral)* ***4*** *(quite a lot)* ***5*** *(very much)*

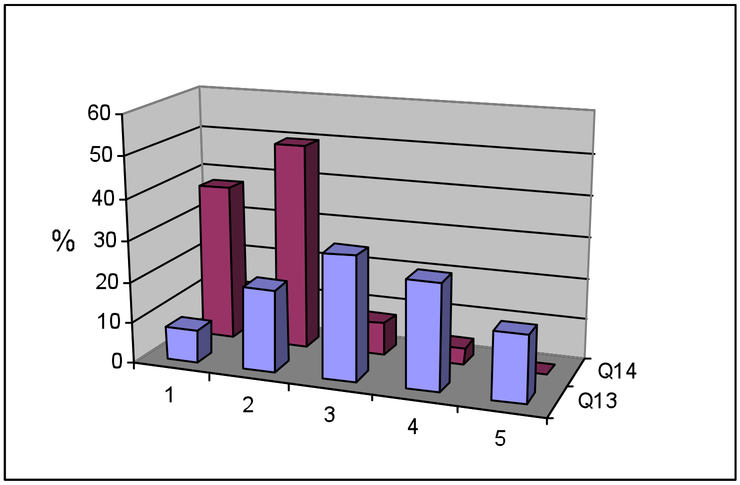
Q14: "It would be useful to study a part (as a %) of the subject in this way":

1 *(0%)* ***2*** *(25%)* ***3*** *(50%)* ***4*** *(75%)* ***5*** *(100%)*

We decided to group the last two questions together because our analysis of the results showed a close correlation between them.

Figure 3 shows the percentages obtained for these two questions (Q13 and Q14).

Figure 3: Results for questions Q13 and Q14



Few students, only 8%, consider the explanations of the lecturer in class to be essential to learning this topic. The rest, to a greater or lesser degree, agree that they are not necessary. However, when they were asked about the proportion of the syllabus that could be studied using this self-directed learning method, the response was almost unanimous: fairly little, at the most 25%.

In order to analyse the correlation between the answers to Q13 and Q14, we decided to calculate a cross-tabulation table. The cross-tabulation table shows the number of students' answers to each question falling into each category

Table 1 shows the frequency of each combination of answers.

Table 1: Cross-tabulation table for questions Q13 and Q14

		Q14					**Total**
		1	**2**	**3**	**4**	**5**	
Q13	**1**	8%	0%	0%	0%	0%	8%
	2	12%	8%	0%	0%	0%	20%
	3	16%	14%	0%	0%	0%	30%
	4	0%	22%	2%	2%	0%	26%
	5	2%	6%	6%	2%	0%	16%
Total		38%	50%	8%	4%	0%	100%

From the cross-tabulation table alone, it is impossible to tell whether the differences in the number of cases in each category are real or due to chance variation. The chi-square tests measure the discrepancy between the cell counts observed and what one would expect if the rows and columns were unrelated. Table 2 shows the results obtained in the chi-square test.

Table 2: Chi-square test

Pearson's chi-square	Value	Significance level
	32,23	0,001 (0,1%)

The low significance level for the Pearson's chi-square value (less than 5%) indicates that there is a strong relationship between the answers to Q13 and Q14.

This correlation is also supported by explicit comments:

- I think that learning Kirchhoff's laws with this method is feasible, but that does not mean that it is better than traditional classes. I think it is easier to learn in class. Even so, I think everything was very clear and understandable.

- This system is great and should be used for all topics, but we cannot do without the explanations in class. Although it is very good, it should not be used all the time for all topics, but rather as a complementary tool.

Conclusions

Taking into account all of the results collected and processed, we can conclude that the self-directed learning activity was very well received by the students, because they considered the incorporation of new guided support material in different formats to be very useful. From the results for questions Q13 and Q14, it can be inferred that the great majority of students prefer face-to-face sessions in which the teacher explains the content and solves problems.

More unusual formats such as audio generate a disparity of opinions that will need to be looked at more closely in the future. The criticisms by some students should help us to improve the script for the activity and make it more effective.

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