



## fisic@web: a blended learning project to motivate engineering students to classical physics

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This contribution explores the implementation of **fisic@web**, a Physics Blended Learning project among nearly 120 students attending the 1<sup>st</sup> year on Chemical Engineering. This 4-years-old experience at the *Física I* discipline is currently being undertaken and developed by the authors, teachers at the Physics Department of ISEP – *Instituto Superior de Engenharia do Porto*. Built upon WebCT software, this course associates different physics teaching/learning strategies to the new Information and Communication Technologies (ICT). The impact of (i) using new information and communication technologies, (ii) introducing new pedagogical practices, (iii) the students' response to a web-based environment and (iv) the change of the relation teacher/student is discussed. The performance and feedback from students of this engineering school are analysed.

**Keywords** Blended Learning; Teaching/learning strategies; Improving classroom teaching.

### 1. Introduction

In the last one or two decades, universities and polytechnic institutes invested part of their resources to introduce computers and technology into the classroom, but the great majority of professors still uses these media only as an extension of the chalkboard or overhead projector [1], and relies upon traditional testing procedures to evaluate students.

As the impact of the Information and Communication Technologies (ICT) on education increases, with more and more programmes of online learning being developed in all educational domains, these traditional institutions have to face the incorporation of e-Learning advances and techniques into conventional classroom-instruction practices. In particular, the implementation of *blended-learning* approaches, integrating face-to-face tuition with e-Learning, offers new possibilities to organize education and opens new innovative perspectives for pedagogy. This hybrid approach, a special combination of conventional classroom learning and online learning, takes advantage of the best each strategy can offer [2].

The project presented here, **fisic@web**, is one of the responses to an invitation set by ISEP, which started to change its traditional vision of education, seizing the opportunity to create computer-based and web-based educational environments.

Being a *blended-learning* project, these engineering students meet their teachers in the classroom, attending theoretical (1h/week), practical (1.5h/week) and laboratory (2h/week) classes. This traditional part of *Física I*, a nuclear discipline, is complemented with the online course, where classical physics is presented in a more attractive and active way, not only by the addition, to the usual materials, of related links on the web, animated simulations, communication tools, and an important set of information available *via* Internet, but also by an additional perspective of teacher/student relation and a different pedagogical approach [3].

This was a challenge for the teachers, who became simultaneously tutors, coordinating and helping to solve problems, teaching how to learn, assessing processes and correcting working lines. Was also a challenge for students, without prior experience with internet based formal education, requiring new skills, time management, thinking about their own thinking [4] and self-awareness of the process of and learning styles on an online course.

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## 2. The project

### 2.1 General approach and main objectives

The easier access to the sources of information is usually connected with the “constructivist approach” [5], which emphasize the active role of the learner in the creation of new knowledge. Students are expected to think, to build up and challenge the knowledge offered to them. But the actual huge information flow, accessible to a growing number of students *via* Internet, is not being transformed, as we might expect, in comprehensive knowledge, because most of them have no means, skills and abilities to choose, evaluate, unify, judge, or to refute and forget information [5]. And this is particularly true in vast areas of knowledge such as physics, and in 1<sup>st</sup> year of engineering students as the ones involved in this project.

A good balance between their orientation and the release of relevant information in the right proportion to a given context was one of the main concerns during the conception and implementation of **fisic@web**. That led also to the perception that this project should maintain the idea of the teacher’s physical presence, a characteristic of the traditional lecture-based courses. Both on-campus and web-based versions were integrated in the discipline, resulting in a hybrid instructional format – blended learning. Its implementation was directed to the course of chemical engineering, either to young students and mature working-students in nocturnal regimen.

Physics teachers responsible for this prototype got previously the required formation on *WebCT Learning Management System* to implement the course, and used their own experience on other software applications to completely build its contents. Students received the access key to its site at the beginning of the semester, and during a first public presentation, they were able to see its structure and contents, and to learn its rudimentary navigation.

The whole research, study and development of **fisic@web** were focused in four basic goals, whose achievement will be discussed later:

**A. Use of new information and communication technologies** to provide students with additional resources online – theory, practical exercises with detailed resolution, simulations of several important phenomena, links, sites and articles related with the embraced topics, information concerning the laboratory classes (an important part of the discipline), etc.. This materials were meant (i) to stimulate the student in his own self-study, giving him a more attractive presentation of the physics subjects, and (ii) to induce meaningful instead of superficial learning.

**B. Introduce new pedagogical practices** and a method of continuous student’s evaluation, using Internet, replacing the usual unique and final exam by a more parcelled estimation of the achieved knowledge. According to some educators [6], the change from an “instruction paradigm” to a “learning paradigm” in universities implies a shift in pedagogical practices, where the quality of learning should be evaluated continuously.

**C. Examine the response** that students give to this kind of web-based learning environment, namely the change of their usual tendency to a passive behaviour towards learning. To discourage students from this attitude [7], course activities and assessment should provide opportunities to establish new and effective approaches to learning.

**D. To check whether the relation teacher/student is changed** with this kind of teaching, through the promotion of the interactivity, collaboration and communication offered by this project.

### 2.2 Contents

The contents of the course were divided in modules, according to the program of the discipline. Their release was gradual so the student always had just the necessary information accompanying the topics treated in class. With a clear structure, the great majority of students showed no difficulty of starting to explore the main groups:

1 **Course Guide** gathers all available details and tools a student would need to get the physics course ac-  
2 complished - objectives, programme, bibliography, teachers schedule, contacts and professional details,  
3 printable and downloadable material.

4 **Physics modules** presents, in every chapter (accompanying classroom timing), a summary of the impor-  
5 tant goals to be achieved, exercises with detailed solutions, self-tests and assignments that will constitute  
6 the continuous evaluation item for students final grade.

7 **Utilities** assembles a glossary, a collection of past exams, FAQ's, updated news from physics, topics on  
8 modern physics, websites, online science exhibitions, and a variety of simulations concerning the class-  
9 room. This is a big field to explore! Students can play with a projectile, observe collisions, create waves  
10 and even work with instruments before going to the laboratory. Teachers can also "play" with simula-  
11 tions to lead the students in a way they can dissipate classical mistakes.

12 **Class Group** has available different kinds of information concerning laboratories, student's personal  
13 homepages and pictures of events, and this year, a special page devoted to the World Year of Physics  
14 2005 – *Annus Mirabilis*. This is the theme of the most popular of their evaluation tasks. But students can  
15 also analyse their own trail through the history of content pages visited along the semester in "My pro-  
16 gress" tool, and "My grades" allows them to see all grades obtained in quizzes and assignments already  
17 submitted.

18 **Communication** clusters some of the WebCT collaborative tools, contributing to a wide open learning  
19 process: access to discussions within *virtual classrooms* and *forums* (chat rooms), view of the personal  
20 homepages of students, and direct contacts *via* e-mail, either to the teacher – a very personal and indi-  
21 vidualized way of relation – or to the colleagues.

22 The selection of all these contents was made by teachers carefully, with quality and confidence always as  
23 base criteria, once the students still don't have the necessary background to always make the right  
24 choice. This variety of materials and tools was meant to help developing the "learn-by-reading", "learn-  
25 by-discovering", "learn-by-doing" and "cooperative learning" [8] which provide the students to gain  
26 different skills while they learn.

### 27 28 2.3 Students' evaluation

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30 Test and assessment mechanisms, both formative and summative, are crucial aspects on the learning  
31 experience, particularly when a final grade is involved, and they provide essential feedback on the pro-  
32 gresses made to both teachers and students.

33 The formal evaluation to ensure that students achieved mastery of the learning material took profit of the  
34 tools and possibilities offered by WebCT. During the semester, there were at least five different types of  
35 evaluation elements, once the continuity of the process was one of the goals to be achieved:

36 **(i) using "assignments"**, a particular task was proposed to the student. As an example, the comment of a  
37 selected physics' article or "playing" with a simulation in order to be able to answer to specific ques-  
38 tions. These were prepared to overcome the usual difficulty associated with the traditional learning,  
39 where students have to imagine what would happen in a specific situation;

40 **(ii) doing quizzes**, students had a limited period of time to answer multiple-choice problem types. Its  
41 period of release was known in advance, and they were graded immediately after submission;

42 **(iii) working in groups**, the submission of reports or research works developed during a longer period of  
43 time, one or two weeks, was asked. This supports collaborative learning and the communication between  
44 students and teachers, optimizing the construction of knowledge;

45 **(iv) preparing a poster presentation**, celebrating the Year of Physics 2005 – *Annus Mirabilis*. This  
46 year, fourteen different themes about the life and achievements of Albert Einstein were proposed.

47 Except for the quizzes and poster, all these were electronic assignments, sent *via* e-mail to the teacher or  
48 to the virtual classroom within WebCT.

49 An important part of this process of evaluation accounted for the student's interest in consulting all mate-  
50 rials available, the time spent navigating and exploring the course and specially the frequency of accesses  
51 during all the semester. This type of evaluation resources was possible through a set of tools available to  
52

1 the teacher within WebCT, giving him individual statistical data, important to build the all image of the  
2 evolution and progress of each student and the entire class.

### 3 **3. fisic@web: students' feedback**

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6 Each year, at the conclusion of the course, the students were asked to reflect upon the online experience.  
7 A complete questionnaire was distributed among students in order to get important feedback concerning  
8 their own opinion about the different aspects involved. They were asked to grade all parameters analysed  
9 in a 1-5 scale of evaluation, and as a global appreciation, a set of questions were to be answered *yes* or  
10 *no*. Finally, a list of the course contents should be classified according to its interest, and both sugges-  
11 tions and comments were welcome. The general ideas will be resumed in the next paragraphs.

12 **1. access and exposure to ICT.** The first set of questions was related with the use and access of ICT and  
13 with WebCT software appreciation. Most students referred "*increase of information literacy skills*", and  
14 "*access to and successful experience with new technologies*" as the main learning benefits. Most of them  
15 "*discovered a new world*" on the other side of the screen, and they "*acquired new habits and routines*"  
16 that helped them not only in this discipline but in other areas. They chose "*visual appearance*" and "*use-*  
17 *fulness of applications at disposal*" as some of the most positive aspects concerning WebCT; the ease of  
18 work submission as one of the less positive.

19 **2. course contents and self-awareness of the learning process.** Quality, clearness, adequacy to the  
20 discipline, amount and interest of the information available, aid of simulations to the study of subjects,  
21 etc. –, where also evaluated by students. The most positive aspects were the clearness and aid of simula-  
22 tions to the understanding of subjects. The idea that theoretical modules or resumes should be included  
23 still revealed their tendency to a passive behaviour towards learning, not completely overcame. Some  
24 students discovered that they had to "*change their learning habits*", mentioning that the course "*required*  
25 *a higher level of discipline*" and even "*harder and tiring work*", forcing them to spend more hours with  
26 physics, studying and "*reflecting upon the different subjects more deeply than usual*".

27 **3. blended-learning and teacher/student relation.** Another important aspect of this project, being a  
28 hybrid solution, was the evaluation of the coordination and communication items such as articulation  
29 between *e-Learning* and ordinary classes, contents released in time, ease of communication between  
30 student/teacher, disposal of teacher *via* e-mail, advantages of personalized and direct access to the  
31 teacher, and the usefulness of contact *via* e-mail with colleagues. Students' feedback showed a clear,  
32 unique and special direct bond with the instructors, expressing the feeling that they had "*always someone*  
33 *to help them*" and "*ready to talk with them whenever they needed*". For working-students, the possibility  
34 to navigate and contact the teacher during the day, from their working places, or even at weekends or late  
35 at night, was one of the main advantages (there were about 900 e-mails registered by WebCT). The use-  
36 fulness of contact *via* e-mail with colleagues was a less positive aspect, perhaps because they meet eve-  
37 ryday at school.

38 **d. online evaluation.** One of the most important goals of **fisic@web**, continuous evaluation, was also  
39 inquired. The usefulness of versatility of possible evaluations, of immediate grading and self-tests in  
40 their study, as well as the adequacy of the different evaluations and the level of work required were some  
41 of the items to be tested. Students considered the usefulness of "*immediate grading*" one of the most  
42 positive aspects and the usefulness of "*versatility of possible evaluations*" the less positive. Here again  
43 some resistance to evaluation, whatever it may be. The possibility to "*work and interact in group*" was  
44 well received, as well as having the chance to "*choose the better moment to be evaluated*".

45 **e. global appreciation.** Students were asked to make a global appreciation of the e-Learning component  
46 with yes/no type of answers and to list the applications they found more interesting. These last results  
47 depicted a still very traditional student, with the usual applications given at classes as the more interest-  
48 ing ones, with more than 50% of the choices: theory, practical exercises and their resolutions, and former  
49 exams. They included in this group also "new" items: simulations and self-tests, but the inherent WebCT  
50 tools and the online communications facilities were still released to a "second plan" by some of them.  
51 They found the course "*a new and challenging form of learning*", "*more motivating*", "*more intense and*  
52 *harder*" and many of them recognized they didn't profit all the possibilities by lack of time.

#### 4. Conclusions and remarks

The concepts and new approaches involved in this project were received with great enthusiasm among students of the course, and most of them recognized that this “hybrid formula” was more interactive and “forced” them to study physics during the all semester. This extra work and hours spent in this physics environment had a positive effect at the final exam, and the percentage of failure decreased significantly. The teacher’s role was fundamental in the work of implementing these new learning technologies, both in the design of the learning environment as well as in the daily contact with all students *via* Internet.

Back to the main goals of this project, the analysis of response, performance and feedback from students drives us to the conclusion that all of them were actually achieved with different levels of depth.

**A.** The use of new technologies stimulated students in their own self-study, and in some of them induced clearly meaningful instead of superficial learning, though not in a very large expression. **fisic@web** achieved the interest and participation in all the domains expected, making believe that this project was a precious auxiliary for their studies. The more active participants reach to the end of the semester with a better preparation for the final exam.

**B.** New pedagogical practices were introduced, in an attempt to change from an “instruction paradigm” to a “learning paradigm”. This aspect was perhaps the most sensitive, because students still behave with some resistance towards any kind of evaluation. The final exam represents for them and perhaps for the teachers too, yet a crucial moment of evaluation. A more parcelled estimation of achieved knowledge was implemented with evident benefits to the students.

**C.** The response to a web-based learning environment changed effectively in most students their usual tendency to a passive behaviour towards learning, although that change was not very deeply “absorbed” by them. Their list of “more interesting” topics revealed a certain tendency to select the information needed to “overcome” the exam and not to learn the subjects. But their participation and search of information, even just for the assignments asked during the semester, contrasts with the traditional passive attitude. We believe the assumption that a major part of Physics subjects is much more “understandable” when first “seen and interacted” is true.

**D.** The relation teacher/student was completely changed. Interactivity, collaboration and communication were constant through the all semester. As the project had also a strong teacher’s presence, being a hybrid format, learning became more personal and individualized. It shouldn’t be forgotten that the time over Internet was an extra time teachers had with the students and *vice versa*. With this project, the curricular time for theoretical, practical and laboratory classes remain unchanged, but the real time was greatly increased, with benefits to all the intervenient.

This conclusions and remarks make the authors confident and continuously working to better explore all possibilities of **fisic@web**, trying to improve it and to achieve the goals proposed from the beginning.

#### References

- [1] J. M. O. Yazon, J. A. Mayer-Smith, R. J. Redfield, *Computers & Education*, **38**, 267, (2002).
- [2] J. Reis Lima, Zélia Capitão, *E-Learning e e-Conteúdos. Aplicações das teorias tradicionais e modernas de ensino e aprendizagem à organização e estruturação de e-cursos*, Centro Atlântico, Lisboa, 2003.
- [3] M. H. Braga, A. A. Amorim, A. L. Nunes, C. V. Carvalho, *Proceedings of International Conference on Information & Communication Technologies in Education*, Porto, Portugal, 19-22 June 2002, pp. 407-414.
- [4] B. S. Spector, R. S. Burkett and C. O. Steffen, *Journal of Educational Technology Systems*, **30**, (2002).
- [5] J. Holma, P. Lappalainen, *Proceedings of International Conference on Information & Communication Technologies in Education*, Porto, Portugal, 19-22 June 2002, pp. 84-98.
- [6] R. B. Barr, J. Tagg, *Change*, **27**, 12 (1995).
- [7] D. R. Garrison, *Distance Education*, **14**, 199 (1993).
- [8] E. Cloete, *Computers & Education*, **36**, 171 (2001).