

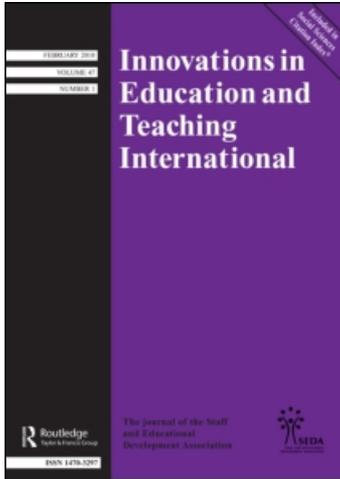
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Some Internet-based strategies that help solve the problem of teaching large groups of engineering students

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With this article, we wish to transmit some key factors of success that we have used personally when faced with the structuring of a teaching programme based on e-learning. In particular, this paper reflects the experience of the authors in the usage of Internet tools in their teaching duties at university, in order to solve several problems that usually diminished learning quality. The most important difficulty was that class groups were very big (100). The key factor of success was to get students in the mood for collaborative learning, by using simple and regular Internet tools.

Keywords: collaborative work; educational technology; engineering education; unsupervised learning

Introduction

The aim of the present paper is to transmit our experience regarding the use of Internet space in the context of traditional courses, within the usual subjects of a university, where the groups of students are large (i.e. 100) and it is only possible (or considered convenient) to group the students for only a few face-to-face classes. This context is really the challenge towards which universities are moving in the adaptation of their organisation when considering the directives marked by the agreements of Bologna for the transformation and harmonisation of the European educational space.

Where does our experience come from? Although formal research in e-learning inside an inter-disciplinary university research group has been performed since the early days of e-learning, the most valuable input for the authors' teaching labour today was obtained when one of them badly broke his ankle and necessarily needed to put into practice all the knowledge developed in the past. His problem was that he was not allowed to go to the classroom, so distance learning was absolutely necessary in that case.

Up to then, he had been teaching a subject called 'Telecommunication Services for Small Companies' for several years. The teaching strategy consisted of 15 four-hour sessions (one session each week) in which traditional teacher lecturing and classroom exercises took place. Lectures were given to groups of 100 students, and classroom exercises to groups of 40 students. Such large group size had never allowed high-quality learning, but everybody accepted that it was a physical drawback that was

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impossible to cope with. But it was possible; the remainder of this article is devoted to explaining how e-learning managed to solve the problem.

The problem of low performance in large groups of students, in higher education, has been studied by the teaching profession on the basis of the *resolution of problems* (Lohman & Finkelstein, 2000), that is, when the learning process is based on the use of teaching cases that are solved by groups of students; the conclusion has been reached that additional tools are necessary for guiding the work of large groups. To this effect, Gulpinar and Yegen (2005) have used tools of active learning, which serve as a basis for the approach to, and resolution of, problems in large lecture halls, in this way reducing many of the weaknesses. Similar techniques have been proposed by Cantillon (2003) or Nierenberg (1998), such as buzz groups, brainstorming, mini-assessments, or encouraging whispering during the class. The advantage of introducing dynamism into the lectures has unquestionable advantages, the most important being to emphasise 'learning' rather than 'teaching'. To this effect, Tarnvik (2002) affirms that dynamic classes are able to reduce the risk of the professor becoming 'burnt out' where groups of students are very large.

Our teaching experience is that collaborative learning seems to improve learning outcomes when groups are very large (100 students). With respect to collaborative learning used in large groups, interesting experiences exist such as that of Hedin, Bendix, and Magnusson (2005) which have managed to overcome the problem of what is apparently inevitable, scant participation of certain components of laboratory practice groups in projects of software development. Heiden proposes the introduction of professional methodologies for the design of collaborative learning under the leadership of older students joining the groups as managers. We agree with that. Indeed, most of our proposed strategies are also based on the assumption that collaborative learning should be encouraged when groups are very large, that is, the goal is that students do not need a close leadership of the teacher but help each other as they will do in their future professional life when working in a team basis.

Although the problem of teaching large groups has been discussed in the literature, as indicated in the references previously mentioned, few specific arguments about the use of e-learning as an improvement in the teaching of large student groups (e.g. 100 students) are to be found, even though this size is frequent in many of the universities in the world. Two early articles exist, warning of such a possibility (Barker, Banerji, Richards, & Tan, 1995; Jones, 2003), as well as more recent revealing research on the use of e-learning for communication among students and with their professors (McConnell, 2005; Webb, Jones, Barker, & Van Schaik, 2004; Warnecke, Ostermayer, & Koklu, 2004; Watkins, Hall, Chandrashekhara, & Baker, 2004).

The analysis carried out by some authors is also revealing regarding the acceptance or rejection of e-learning tools on the part of students and teachers in universities, which suggests the necessity of greater research aimed at obtaining a valid framework for the introduction of e-learning as a regular tool in traditional faculties (Dirckinck-Holmfeld & Lorentsen, 2003; Gupta, White, & Walmsley, 2004; Van Der Merwe & Mouton, 2005).

In addition, numerous experiences exist concerning the construction of tools and methodologies for collaborative learning with computers, generally based on the Web or other systems of learning supported by information technologies, as well as Open University teaching experiences (virtual not traditional universities) which apply the new Internet technologies. Therefore, we can consider that a sufficient framework of

knowledge exists for the creation of material able to be used by students in their own personal computers.

Context of our practical experience

However many pilot trials are made for checking a concept, model, theory or technology, there is nothing like putting it into practice in real situations of authentic necessity.

The necessity arose when, during a quiet country walk, Rafael had the misfortune to fall and badly break an ankle, requiring an immediate and fortunately successful operation. However, the odyssey had only just begun.

In effect, Rafael was unable to return to the classroom until seven months later, and the worst was that such a long unforeseen recuperation meant that he had not taken the precaution to find a substitute to take charge of his subjects during that time, thinking that in a couple of months he would be able to resume his usual activity in the classroom. It was then, that from necessity, we suddenly became addicts to the use of e-learning platforms as a teaching aid.

It is fair to say that before the ankle accident we were already fervent defenders of the new virtual space for teaching that had been provided for us by information and telecommunications technologies. At that time, we had already been doing research for six years in e-learning (forming a team with researchers from the Faculty of Education of the University of Salamanca), searching for the advantages that any inter-disciplinary vision (engineering combined with sciences of education) could give to the research of disciplines relative to e-learning.

Internet-based strategies for teaching large groups

As a result of our experience, we would dare to emphasise the essential aspects that, in our opinion, an e-learning platform should offer, focusing on the assistance to university teaching for large groups of students. We have been applying such strategies for six years. Students were about 23 years old and were in their last year of the telecommunications engineering degree.

The relationship between the modules that comprise our strategies is depicted in Figure 1.

Document warehouse

When we use the word ‘warehouse’ we do so intentionally. In effect, in the area of university teaching it is essential that students have access to a great quantity of documents with information which is sufficiently ordered and listed by importance.

The type of document, order, or hierarchy should be extremely flexible so that the teacher can establish both the most adequate contents to the area of knowledge that he or she is teaching and the style of teaching of the specific activity that is being carried out.

For this, the most reasonable is to establish a directory of documents in tree style with directories and sub-directories, in which the teacher can deposit any documents in whatever format (computerised, slide presentations, links to Web pages, photos, videos, laboratory simulations, collaborative role plays etc.). In the case of any of the teacher’s documents being a hyper-text (Web page), it should be possible to deposit

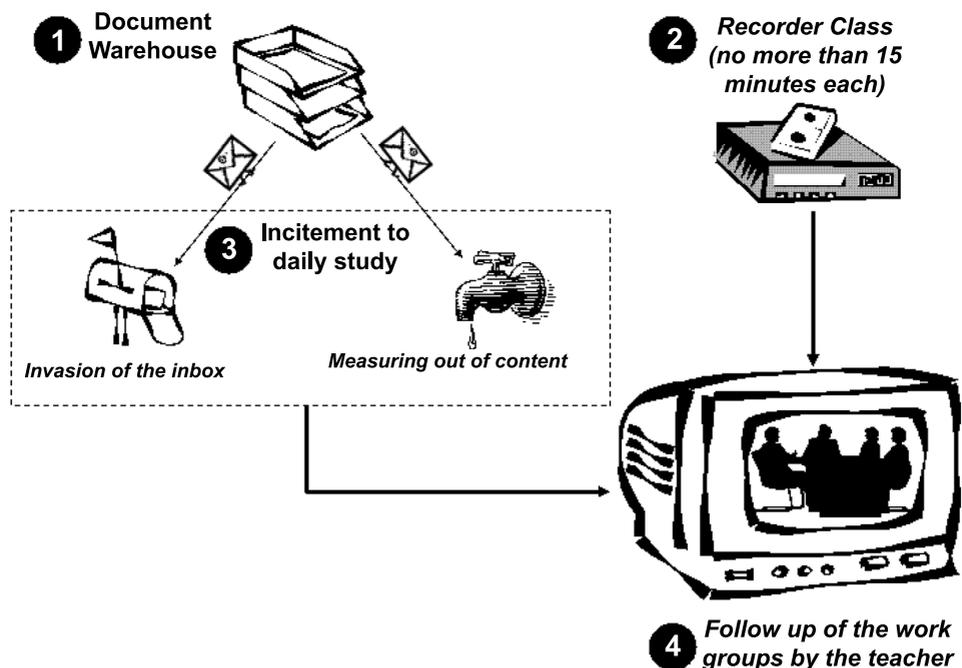


Figure 1. Teaching strategies based on Internet tools.

the documents in such a format. For this, the tool of e-learning should take this fact into account in its programming. The treatment of a hyper-textual document is different from any other conventional document, as it may constitute various documents at the same time, related to each other.

Incitement to daily study

The relevant aspect which permits e-learning, and which is not easy to establish with the traditional system of classes, is the engagement of the students to daily study. To obtain this objective in practice the following tactics gave very good results.

Measuring out of content by means of e-mail

This consists of not giving the students all the content at the beginning of each subject, but in reserving some for sending by e-mail at the moment in which, according to the rhythm of study of an average student, it would be beneficial to his or her studies to receive. Really, in this way, what is achieved is a degree of dynamism in the studies.

Invasion of the inbox of the student's mail

Study is also incited by the fact that the student receives in his or her e-mail, in almost real time, the doubts that his or her classmates have presented to the teacher, as well as the interventions that have been produced in the discussion forums. We are speaking about the use of e-mail as a means of communication in a mail account that the student habitually reads several times a day when he or she is working in front of

the computer. A 'call effect' is produced, that is, that the student tends to emulate his or her classmates and tries to be at their level both in rhythm of personal study and in the type of questions, interventions or reflections made. The first year we applied this strategy students were obliged to post e-mails, but the following years we told them that posting e-mails was optional. Surprisingly, students were more committed to use e-mail for discussions when it was not compulsory, that is, discussions were much richer. Nevertheless, we recommend selecting some good students and encourage them to begin e-mail discussions. The 'call effect' makes the rest.

Follow up of the work groups by the teacher

Personally, we are convinced of the usefulness of the teaching case as a pedagogic tool that can be applied to a great number of disciplines. The teaching case has been popularised by business schools, but is not exclusive in its application for this teaching area.

The new tendencies in university education resulting from the processes of convergence of teaching and qualification in the European area highlights the necessity (or obligation) to reach an agreement in the application of an educative model which stimulates the active role of autonomous learning of the student.

The challenge of the new teaching scene proposed by the European Union is to form the student in knowledge, skills, competences, and abilities which will permit him or her to enter fully into the labour market. In that scenario, a young man or woman at the age of 22 would already have the necessary training to be useful in the labour market. Later, a professional career is a question of continuous training. Each person is free to focus it as he or she wishes, in each moment of his or her professional life.

The teaching case methodology is very adequate as a pedagogic tool, but it requires a maturity on the part of the student for efficient teamwork, something frequently lacking in a substantial part of university students. For this, the teacher should monitor the work of the groups. How can this monitoring be carried out when the number of students is so high? A possible solution is to encourage the groups to realise part of their discussions in private discussion forums within the e-learning tool. In this way, the teacher can monitor and intervene when considered necessary. At the same time, a perception of vigilance is produced on the part of the teacher, which assists students in questions of self-discipline.

A lecturer in a prestigious business school recognised that a much more intense participation by the students is obtained when following the semi-physical attendance version of a Master's course. According to him, he observed that the participation in discussions of the groups was much more meditated (writing aids reflection), and also, all the members of each team probably felt the moral obligation to force themselves to participate, as the interventions (or not) were objectively reflected.

Recorded classes that do not lend themselves to sleepiness

Recorded classes are a fundamental element when there is very little (or no) time for the training project in physically attended classes.

Where there is a possibility of the majority of the students attending a significant number of classes, this circumstance must be taken advantage of. When this is not possible, recorded classes can satisfactorily solve the role of theoretical classes

explained by the lecturer. When we speak of recorded classes not lending themselves to sleepiness, we are referring as much to the teacher as to the student. It is disheartening when the yawning of a lecturer dictating his or her lesson is reflected on video.

Regarding the student, a great capacity of abstraction and concentration is required in order not to be distracted after 10 minutes of listening to a video without any rhythm. We are not dealing with an interesting documentary of the National Geographic Channel. Neither does the comfortable possibility exist of stopping the lecturer and asking a question halfway through. For this, it is advisable not to use video sequences of more than eight or 10 minutes. In order to determine the length of such sequences, one can make a simple trial which consists of playing a recorded lesson in the classroom and observing students' reactions. In our case (i.e. in the case of our subjects), students became distracted after eight or 10 minutes. In fact, they only were able to answer questions accurately from this initial period of the recorded lesson.

The videos, if possible, should be supported by transparencies, preferably dynamic ones (the basic means provided by Microsoft Power Point, for example, are sufficient), and between video and video, activities can be established. To see four 10-minute videos, one each day from Monday to Thursday, is much more productive than seeing a video of 40 minutes on Monday and spending the rest of the week digesting the information received.

The technical means for the recording do not need to be very spectacular. A Web Cam and the presentations recording service of Microsoft Power Point can be sufficient when dealing with short presentations (10 minutes). The sound and the transparencies are the most important. However, when making a video one should try to focus the camera in such a way that the screen is only and exclusively occupied by the lecturer's face. If the video is of sufficient quality (256 kbps for example), the expressions of the face and the movement of the hands, positioned at the height of the face give some really interesting possibilities of communication.

Conclusion: learning in community

We propose to the scientific community the opening of a debate concerning the use of e-learning for the transformation of the teaching which, at present, takes place in large groups of students in universities. We do this not only from the conviction that the technologies of e-learning help to obtain a more efficient learning, but also on account of the opportunities that open up for solving some of the psychological and emotional problems of teaching/learning in large groups, as pointed out by Hogan and Kwiatkowski (1998); for instance, our experience is that the use of e-mail usually allows us to detect students that need special emotional attention, and also a few e-mail conversations are enough to solve those emotional problems. We agree with Hogan and Kwiatkowski in that more research is needed in such a field.

In addition, Europe has to make its higher education compatible with the new requirements derived from the Bologna agreements. Brainstorming will be necessary for the emergence of good ideas in this respect.

The greatest successes, when applying the practical use of e-learning, are based on complicity between lecturer and student, and among the students themselves. In fact, non-specialists often relate 'e-learning' to 'self-learning' and this latter concept with that of 'teaching oneself', namely the traditional correspondence courses of the past.

This in fact is not so. E-learning and Learning-by-One's-Self are not equivalent concepts. Although not terribly different, they are simply not comparable.

Allow us to put the following question to the reader for his or her reflection: would it not be certain that self-learning would be more efficient and stimulating if shared with one's peers? If the answer is affirmative, the aim would then be to create a space in which the students, with the lecturer, could establish a close relationship and even emotional communication.

In the past, this space would have been impossible to create, at least in a realistic form from the point of view of viability. Now, on the contrary, in a virtual world (the world of the Internet) these spaces possess a name, virtual communities. They are one of the pillars on which the concept of the Internet is based. Think a little and you will see how in your daily use of the Internet the element virtual community frequently appears.

In fact, it is curious to observe that modern technological solutions giving support to the activity of virtual communities, already oriented towards great consumption, such as the portals PHP-NUKE (quite simple to set up by oneself) serve perfectly as a personal e-learning tool for a teacher with no access to the great e-learning platforms. This means that it is not necessary for the teacher to have a complex and costly platform. It is possible to do e-learning with the simple tools of the Internet; the important thing is to dominate the new space of communication.

In effect, the Virtual Community triumph is when communication is 'all for all' ... and telecommunications are communication. For this, undoubtedly, the new European University space for education will have to develop in the Internet area. Finally, after many centuries the board and chalk are no use.

At the most, in university teaching, the blackboard is already only a compliment to e-learning, and not the opposite as many nostalgic colleagues still believe. Given time...

Notes on contributors

Rafael Momo is the director of the Electronic and Communications Department at the European University of Madrid – Laureate International Universities. He has a PhD in telecommunications engineering and a Master's in marketing and sales management from the IE Business School. His main professional goal is to foster young engineer abilities and education towards technology-based and market-based innovations. His objectives are also extended to organisations that need some help to foster their innovation abilities. His fields of experience are Internet services, e-learning, novel broadband telecommunication systems, and helping governments in the promotion of an Information Society.

Judith Redoli is currently a telecommunications teacher at the University of Alcalá (Madrid, Spain), and a university researcher. She has a PhD in telecommunications engineering. In the past she worked as a university professor while researching for a technological centre, and a cable operator, that is, developing and introducing innovations in enterprises. Now her research activities are devoted to searching new methodologies for the entrepreneurial education of young telecommunication engineers. She began to research in e-learning in the early days of this technology (1995). The research team was always interdisciplinary, that is, there was a close relationship between engineers and education specialists.

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