The Impact of E-Learning in University Education: An Empirical Analysis in a Classroom Teaching Context

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Abstract. The goal of this chapter is to analyze the impact of e-learning technologies and tools as a support for teacher-led courses in the performance (efficiency) of teaching as well as in the learner's acceptance. It also aims at analyzing and determining the moderating factors which have an influence on the process. The paper is based on the data which has been accumulated during an academic year at a large Spanish university offering 2500 courses (with support of e learning) and employing 1800 professors.

Keywords: e learning supporting teacher led courses, e learning facilitators**.**

1   Introduction

This paper will try to answer various research questions. Is e-learning an effective tool as a support in traditional face-to-face classrooms? What are the moderating factors which influence e-learning adoption by teachers? Do e-learning tools have a positive impact on learning performance and student satisfaction? If so, what are the most promising tools? Does e-learning facilitate networked learning?

The paper presents the impact of e-learning as a support for traditional teaching activities. The paper will present the results of the analysis of e-learning data for an academic year at the Universidad Politecnica de Valencia (UPV). It will cross-reference the results of e-learning with the course performance and student satisfaction surveys at the UPV.

The paper has been organized as follows. A first section deals with the background and state of the art. Following the various e learning platforms for university support are described and their dissemination discussed. A third section examines whether e-learning efficiency in higher education can be measured. The fourth section describes the research methodology. Subsequently, the results are analyzed and discussed and, finally, the conclusions of the research are presented.

2   Background

The relationship between IT and learning has been studied by Leidner and Jarvenpaa (1995) and been associated with the principal learning schools and model theories. Figure 1 relates both schools and theories with the main IT-based learning models and tools. According to these authors IT based learning contributes, not only to the creation of knowledge by learners but to its sharing and dissemination as well. Its contribution to knowledge experience is low but it can provide a certain degree of context realism. Additionally, it provides opportunities for sharing and group work.

Additionally, other authors have highlighted the utilisation of e-learning and the use of Internet technologies, with its broad array of learning tools, for enhancing the learner knowledge and performance. These authors support the evidence that these tools have an impact on the effectiveness and acceptance of e-learning within the medical education community, especially when combined with traditional teacher-guided activities in a blended-learning educational experience (Ruiz et al, 2006).
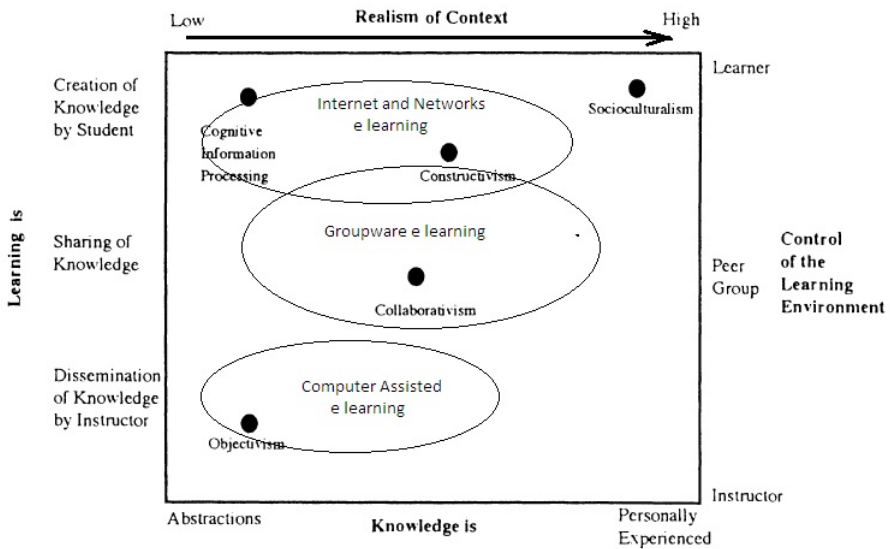

Fig. 1. IT-based e-learning models and tools (based on Leidner and Jarvenpaa, 1995)

Various studies have consistently demonstrated the satisfaction of students with e-learning methods. Learner satisfaction rates increase with e-learning usage as compared to traditional learning, together with a perceived ease of use and access, navigation, interactivity, and user friendly interface design. Interestingly, students do not see e-learning as replacing traditional teacher-led instruction but as a complement to it, forming part of a blended-learning strategy (Gibbons and Fairweather, 2000; Chumley-Jones et al, 2002). Its comparison and complementarity with classroom education has been also reviewed (Bernard et al, 2004; Letterie, 2003) as well as its constant and wide expansion (Martínez and Gallego, 2007).

On the other hand, little has been done to understand why, despite the crucial role e-learning plays in current education methods, many users discontinue their online-learning after their initial experience (Martínez and Gallego, 2007; Marshall and Mitchell, 2003, De la Cruz, 2005, Liaw, 2008). However, as has been demonstrated, e-learning technologies represent a good opportunity to ensure faster and higher development trends (Campanella et al, 2008).

Sun et al. (2008) studied six factors affecting a user's e-learning satisfaction within a wide range of factors that include learners, instructors, courses, technology, design, and environment aspects. They found that learner computer anxiety, instructor attitude toward e-learning, e-learning course flexibility, e-learning course quality, perceived usefulness, perceived ease of use, and diversity in assessments are the critical factors affecting a learner's perceived satisfaction.

Marshall and Mitchell (2003) studied the main problems found when introducing an e-learning system. In their opinion, in most situations, a personalized system is needed for each situation. Despite these findings, they propose a general model composed of six basic steps, the so called E-*learning Maturity Model* (see Figure 2), where the levels are not concerned with how the particular tasks are done, but rather with how well the process is performed and controlled.

Level	Focus
5: Optimising	*Continual improvement in all aspects of the e-Learning process*
4: Managed	*Ensuring the quality of both the e-learning resources and student learning outcomes*
3: Defined	*Defined process for development and support of e-Learning*
2: Planned	*Clear and measurable objectives for e-learning projects*
1: Initial	*Ad-hoc processes*
0: Not performed	*Not done at all*

Fig. 2. E-learning Maturity Model (source   Marshall and Mitchell, (2003)

Littlejohn et al. (2006) identified twelve key characteristics, as shown in Figure 3, of learning resources that may promote changes in e-learning practice. These authors not only identified what types of resources are effective in the e-learning process, but conclude that what is most important is their use in context (Littlejohn et al., 2006, Littlejohn and McGill, 2004).

Many companies and universities are using e-learning systems to provide improved results but there are still various problems and barriers related to e-learning activities that require solutions (Cook et al., 2009, Campanella, et al, 2008, Littlejohn et al., 2006). It is especially relevant to show academic institutions how to improve learner satisfaction and further strengthen their e-learning implementation (Sun et al., 2008).
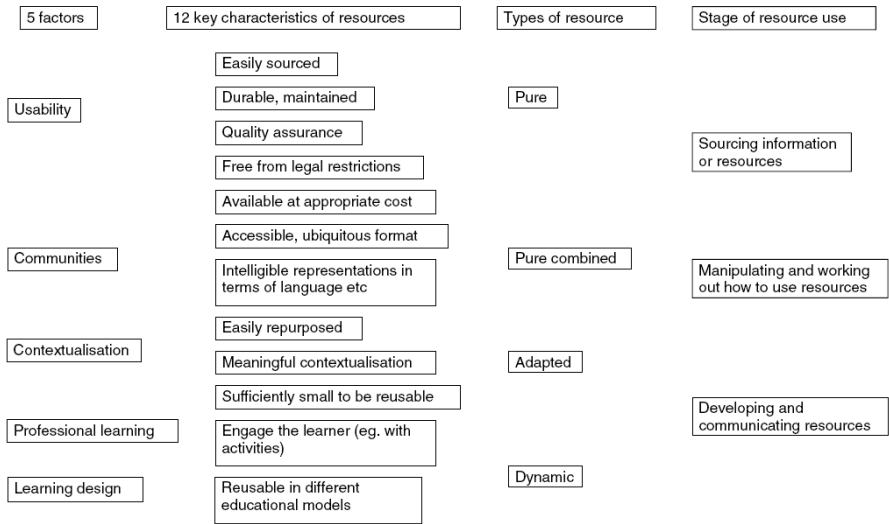
Fig. 3. Factors likely to have a positive influence on the use of a resource (source Littlejohn et al, 2006)

3   Open Course Platforms

Several universities have adopted e-learning platforms following the ICT dynamism (Correa and Paredes, 2009). Higher education institutions are involved in this *new technologies* movement which requires a complex blend of technological, pedagogical and organizational components (McPherson and Nunest, 2008).

On the other hand, there are some universities such as the Open University (UK) and the Universitat Oberta de Cataluyna (UOC, Spain) that have only e-learning platforms, that don't need to change their resources and are not suffering an adaptation process (Sclater, 2008).

Staff training courses, which try to prevent some of the main problems detected, are a common tool in several universities (see Figure 4), (Littlejohn, 2006, Mahdizadeh, 2008, Cook, 2009).

The financial effort to develop an e-learning platform is considerable, involving changes in pedagogic methods, communication methods, technological processes, and skills development. (Sclater, 2008). Therefore, the evaluation of the model and the evidence that the e-learning experience is fulfilling all the goals becomes crucial for the institution as well as for the learners involved.

According to Babo and Acevedo (2009) the most widely- used platforms in universities are Moodle, Blackboard, Webct and Sakai (see Figure 5). Graf and List (2005) have evaluated nine open-learning platforms: ATutor, Dokeos, dotLRN (based on OpenACS), ILIAS, LON-CAPA, Moodle, OpenUSS (Freestyle-learning), Sakai, and Spaghettilearning of which Sakai and Moodle are currently the most popular. These platforms were evaluated according to eight categories: communication tools, learning objects, management of user data, usability, adaptation, technical aspects,

University	Course name	Page link
University of Wisconsin	ADA statement-E-learning evaluation teaching course	http://www.uwstout.edu/static/profdev/elearning/syllabus.html
University of Georgia	E-learning evaluation syllabus	http://www.coe.uga.edu/syllabus/edit/EDIT_8350_ReevesT_FA08.pdf
The UNC School of Education	e-Learning for Educators - Designing a Virtual Field Trip: Online course syllabus	http://www.learnnc.org/lp/pages/6501
Free University of Berlin	Using e-learning for social sciences: practical lessons from the	www.elearningeuropa.info/files/media/media11894.pdf

Fig. 4. E-learning staff courses (source authors)

administration, and course management. These categories included several subcategories which were utilised in a survey to evaluate the platforms. Moodle dominated the evaluation by achieving the best value five times. The strengths of Moodle were the realization of communication tools, and the creation and administration of learning objects. Sakai was penalized since it had not been fully developed at that time; today it has a community of 200 worldwide university users and developers. Moodle clearly has a wider extension with 50.000 users and a broader user profile, including various types of learning centres. In Spain, only 3 universities utilise Sakai while Moodle has more than thirty users.

4   Measure of E-Learning Efficiency in Higher Education

In this new context, the profiles of professors of higher education should change, especially with the expectation that education researchers will become more interdisciplinary, maintaining awareness of the topics, frameworks, and techniques that characterize related research in other disciplines; openness to sharing and learning from research outside their domains; and collective reflection on their practices (Greenhow et al., 2010). Despite the crucial importance of this issue, little research has been found concerning best practices and teacher characteristics which would facilitate e-learning processes in universities.

Campanella et al. (2008) analysed the e-learning platforms in Italian universities, studying 49 universities and using an evaluation model that considered five general aspects: system parameters, administration facilities, interaction support, teacher services, and learner services, comparing the Learning Management Systems (LMSs) adopted by each centre, but without considering learner or teacher abilities or competences.

In this respect, though learning processes have evolved from the post-industrial to an information technology and knowledge era, younger individuals, born after the 1980s, also labelled *digital natives*, learn in a different manner than older people. This digital divide has had a clear impact on the e-learning evolution (Prenski, 2001).

New environments, tools, and information input will have a stronger and more frequent impact. The amount of information available to human being, thanks to the Internet, would have been considered science fiction twenty years ago, and it increases exponentially every year. Instantaneity has arrived through search engines
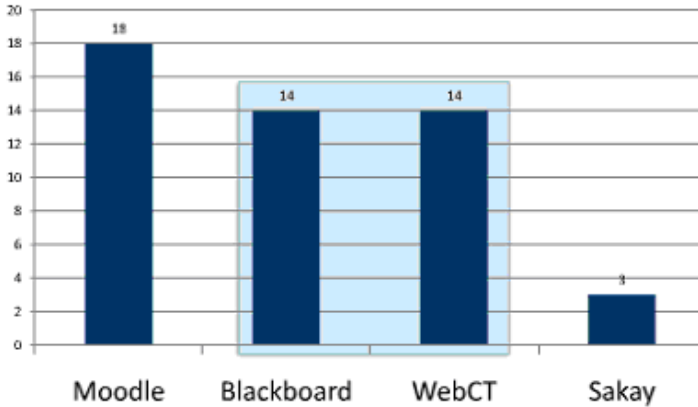
Fig. 5. utilisation of Open-course platforms as learning, management systems (Source Babo and Acevedo, 2009)

such as Google and repositories such as Wikipedia (Sharples 2000). The question on which we focussed deals with these aspects, and attempts to unlock understanding of the way a professor´s profile determinants: age, knowledge background or academic seniority, affect the teaching-learning process in e-learning environments.

On the other hand, several authors have analysed the main problems that institutions have to deal with when implementing e-learning platforms (Martínez and Gallego, 2007; Marshall and Mitchell, 2003, De la Cruz, 2005, Liaw, 2008, Campanella et al, 2008, Sun et al., 2008), but we have not yet found any reference to subject efficiency and student valorisation when comparing e-learning and classical classroom teaching.

5   Research Methodology

5.1   Objectives and Research Hypotheses

The study is the result of the collaboration between researchers and the UPV IT department leaders. The research hypotheses were:

H1. E-learning requires a new context for learning.
H2. The digital divide is a barrier for e-learning development and, therefore, it will be influenced by the generation differences of professors and their context (age, knowledge background or academic seniority).
H3. E-learning has a positive effect on learning impact and efficiency.

5.2   Data

Five years ago the UPV adopted the Sakai platform and some models of Open Course Ware to develop their e learning platform model denominated *Poliformat* as an e-learning support of physical attendance education. The analysis used is based on the

data considering the results of 300^1 courses and relates the utilisation of various *Poliformat* tools by professors with their teaching efficiency ratios as well as with the student satisfaction reports for each subject. A number of moderating variables have been taken into account such as: professor age, status and seniority, subject area knowledge, course level (undergraduate, post graduate or life long learning) and other context factors. The analysis has been based on the UPV database corresponding to the 2008-09 academic year.

The data has been selected for the 288 courses, of which there was detailed information about the professor's profile and subject circumstances. Furthermore, the analysis took into account the results of the survey carried out during 2008 achieving responses from 315 teachers (out of 2600) and 432 students (out of 36.012).

6   Survey and Data Analysis Results

6.1   Survey Results

The majority of courses running at the UPV (97.5 %) are based on classroom learning methodology with e-learning acting as a support tool while only 2.5 % are partially based on online courses.

The first part of the survey addressed the opinions of the university students and faculty on the usefulness of e-learning tools. The replies have been summarized in Figure 6. The first block of six questions deals with the experience of students and staff with e-learning tools (social networks, SMS, news/ RSS, multimedia and websites), and their evaluation of their usefulness. The first outstanding result is that students have clearly had more experience with e-learning tools (approximately, an average 75 %) than their professors (an average of 50%). Among the students, SMS, websites and web tests are popular while the relevance of social networks must be emphasized. These results show a clear digital divide between students and faculty.

On the other hand, the second part of the survey addressed the use of the open course Poliformat platform and tools. Here the differences between students and faculty are lower since this platform was initiated five years ago by the university and various programs have been offered to motivate students and professors to its utilisation as well as reinforcement of its utilisation for academic evaluation. Still, students do find Poliformat more useful than their professors. PDAs, messages and calendars are more popular among students than faculty. Finally, though Google docs and blogs are less popular among students, these tools are found more useful by the students that by their professors. We could conclude here that although Poliformat is, in general, used by the faculty, students find it more useful and therefore, there would be more potential for the tools if the faculty would extend their usage.

Figure 7 shows the results of the survey concerning the opinions of students and faculty on the impact of e-learning tools. It shows that a majority of professors (approximately 70%) think that e-learning tools clearly contribute to improving teaching. Curiously, the opinions of students differ slightly, but that could be

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[1] There are 2500 courses in the database but only 300 register one sole professor and his/her characteristics (age, seniority) can therefore be identified.

attributed to the fact that the teaching orientation of the professor is not completely changed by e-learning. The opinions related to learning are slightly different with 88 % of students believe that e-learning contributes to improved learning while this opinion is held by approximately 73% of the faculty members. Again this could be a result of the expectations of the generations within the digital divide proposed by Prenski (2001).

Teaching efficiency seems to be improved by e-learning tools and this opinion, again, is more strongly held by students than professors. The students are more accustomed to digital media and therefore, these tools are better adapted to their culture. The same applies to improving communication, though again, with some restrictions since digital tools cannot substitute for physical communication.
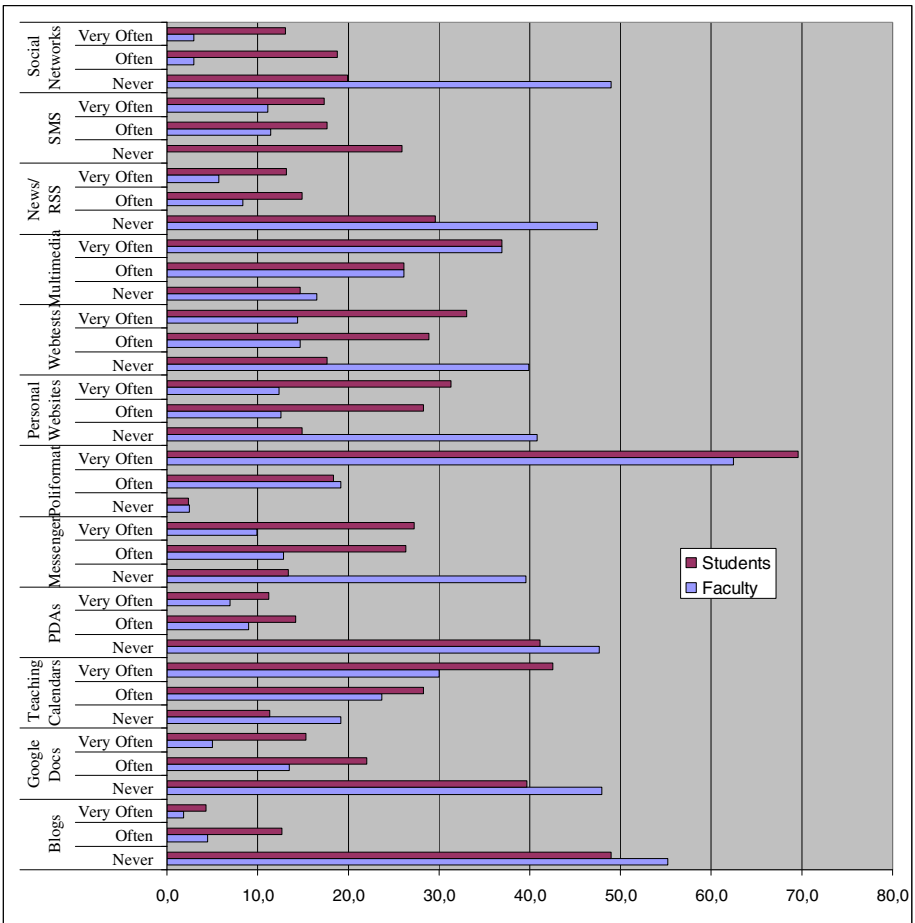

Fig. 6. Opinions of university students and faculty on the usefulness of e-learning tools

Finally, and this is an outstanding conclusion, there are large differences between students and faculty regarding the role of e-learning for improving team work. These results coincide with the previous analysis related to the opinions on the usefulness of e-learning tools as regarding social networks. Previous research has shown certain reluctance within the academic context to social networking (Albors and Ramos, 2008).
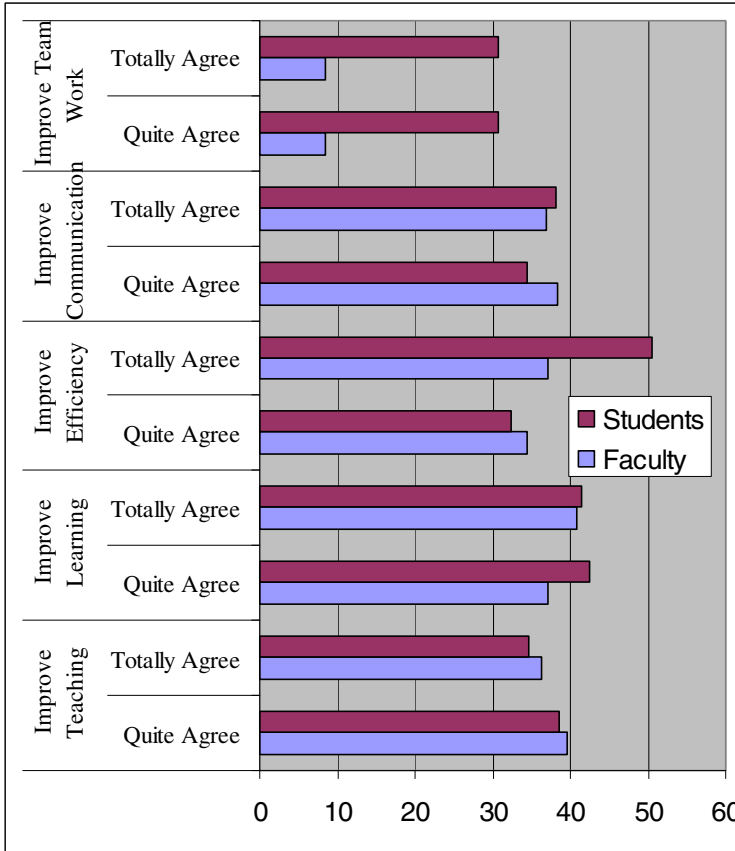

Fig. 7. Opinions of students and faculty on the impact of e-learning tools

6.3   Database Analysis Results

As has been pointed out, the researchers have had access to a database of 2500 subjects which were taught with the support of *Poliformat*. Of these, only 310 were selected since individual professors were identified as the one responsible for the subject and therefore their profile could be analysed. Though meaningful data were lost, it would have been a very complex task to identify groups by professors and filter all the relevant data. That exercise has been left for future research.

Table 1 shows the data that was taken into account in the analysis. It has to be mentioned that for our purposes the utilisation of electronic learning tools was an independent variable while teaching excellence (student satisfaction) and teaching efficiency, measuring learning indirectly, were dependent variables. The rest of the variables: e-learning training, professor age, professor category, seniority, subject type and number of registered students have been considered moderating factors.

Table 1. Utilised data and associated variables for the analysis

Variable	Meaning
Teachexcel	Results of student annual evaluation of faculty (range 1-10)
Training	Number of courses followed by faculty on e -learning
Age	Age of the Professor
Subj. Type	1: IT Engineering and Science; 2: Engineering; 3: Social sciences and Arts
Teach Categ	Professor Category: from 4, Full Professor to 1, Jr. Associate Prof.
Seniority	Years in the category
Efficiency	% of students passing the subject in the first call
Utilelteach	Utilisation of Poliformat tools (by number)
Matriculados	Number of registered students in the course

A first factor analysis has grouped these variables as shown in Table 2 with an explained variance of 70.7%. Thus, both independent and dependent variables have been grouped in component 2 while the moderating factors have been included in components 1, 3 and 4. Subject Type always has a negative sign, which is explained by the fact that IT subjects are taught by faculty with a background in digital learning while the highest number (3), assigned to liberal arts and social sciences subjects, signifies an opposite behaviour.

Table 2. Rotated components matrix

	Component			
	1	2	3	4
Teachexcel		,726		
Training			,804	
Age	,891			
SubjType				-,891
Teach Categ	,636			
Seniority	,810			
Efficiency		,799		
Utilelteach		,641		,
Matriculados			702	

Varimax Rotation with Kaiser Coefficient KMO= 0,656
Variance explained 70, 7 %.

A correlation exercise showed that Age is positively correlated with Professor Category and Seniority, which is logical. It is not, however, correlated with any dependent variable. Teaching Excellence is positively correlated with e-Learning training, Efficiency and e-Learning utilisation but negatively with Subject type.

When trying to build a regression model that could explain both teaching excellence and efficiency, the following models were obtained.

Table 3. Regression model explaining Teaching Excellence

Model	Standardized Coefficients	Sig.
	Beta	
(Constant)		,000
Utilelteach	,289	,000
Efficiency	,175	,005
SubjType	-,157	,009

$R^2 = 0,451.$

The model shown in Table 3 indicates that Teaching Excellence (student satisfaction) can be explained by the grade of utilization of e-learning tools, the efficiency of the subject taught and the subject type, favouring subjects in the area of IT and engineering.

On the other hand, the model shown in Table 4 indicates that teaching efficiency can be explained by the grade of utilization of e-learning tools, the student satisfaction level and the subject type, favouring subjects in the area of IT and engineering. Additionally, the teaching category appears as an influencing factor.

Table 4. Regression model explaining Teaching Efficiency

Model	Standarized Coefficients	Sig.
(Constant)		,000
Utilelteach	,378	,000
SubjType	-,277	,000
Teachexcel	,158	,007
TeachCateg	,151	,007

$R^2 = 0,327.$

Finally, and following the Baron and Kenny (1986) paradigm for mediating variables, the authors built a model which could explain the utilisation of e-learning tools. The model shown in Table 5 indicates that the utilisation of e-learning tools can be explained by Training in e-learning tools, the number of students registered in the subject, the professor's category and the subject type, favouring subjects in the area of IT. It is interesting to note that seniority appears as a negative factor in explaining the digital divide.

Table 5. Regression model explaining utilisation of e-learning tools

Model	Standarized Coefficients	Sig.
(Constant)		,957
Training	,220	,000
SubjType	,239	,000
Matriculados	,153	,010
Seniority	-,129	,021

R^2=0,319.

7   Conclusions

It was possible to validate H1 partially since e-learning seems to develop at a higher level in a context where information and communication technologies prevail, and training facilitates a new background for e-learning.

There was insufficient evidence to validate H2. The digital divide seems to be a barrier for e-learning development and, therefore, will be influenced by the difference in the generations of the professors and their context (age, knowledge background or academic seniority). Though the mediating model showed seniority as a barrier for utilization of e-learning tools, the sample composition, excessively composed of senior professors did not provide sufficient information in this direction.
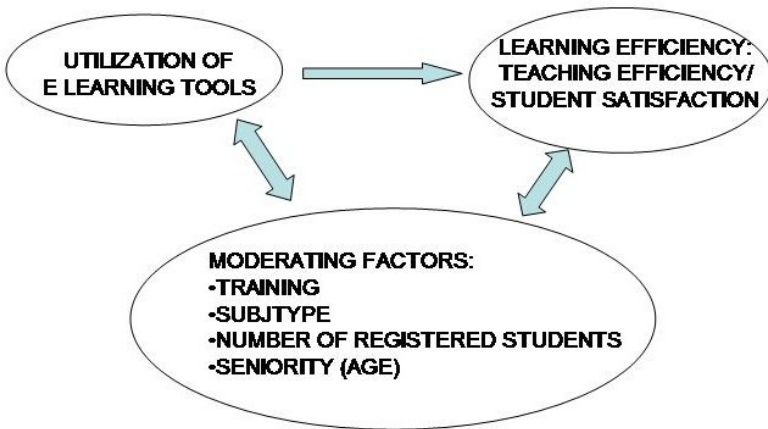

Fig. 8. Construct explaining impact of e-learning on higher teaching and the moderating factors influencing it

Finally it has been demonstrated that e-learning has a positive effect in the learning impact and teaching efficiency, thus providing evidence for validating H3.

It has to be mentioned that e-learning seems to provide support for those courses with a higher number of students registered by facilitating communication between professor and students.

Figure 8 shows the construct that was built from the research findings.

The utilisation of e-learning tools has a positive effect on learning efficiency as explained by student satisfaction and teaching efficiency. A number of moderating factors such as training in e-learning, context of IT, the number of registered students, have been found that somehow facilitates or motivates students and professors to take advantage of the e-learning tools. Finally, the research pointed out that seniority appears as a barrier for the utilization of e-learning tools. Further research should analyse more deeply the characteristics of this apparent digital divide.

Acknowledgements

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