B-Learning at Universities in Andalusia (Spain): From Traditional to Student-Centred Learning

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ABSTRACT

In this paper, the authors examine the rates at which blended learning (b-learning) has been adopted at universities in the region of Andalusia (Spain), as well as the educational model applied to its usage. The authors explore the influence of teachers' perceptions of their competence in the use they make of digital material and to measure institutional support for teachers in this area. The methodology consists of an ad hoc questionnaire designed for a representative sample from four universities and the application of Multiple Correspondence Analysis (MCA) and Structural Equation Modelling (SEM). The results show that the use of Learning Management Systems (LMS) in universities in Andalusia is common but there is little sign of educational innovation, except in a minority of teachers. In addition, it was found that teachers' perceptions of their technological competence influenced their use of LMS but not the pedagogical model. The university pedagogical model must be reconceptualised, with a shift in traditional university values toward innovation, cooperation, and a shared construction of knowledge.

Keywords: *Blended Learning, Higher Education, Information Technology, Innovation, Learning Management Systems (LMS), Technology Adoption, Technology Integration, University*

1. INTRODUCTION

The new professional competences required by business and the economy today, such as skills to negotiate meanings and viewpoints, reasoning, problem solving in interdisciplinary teams and lifelong training throughout the professional cycle, make considerable demands on the university education system (Kirschner, 2005; Condie & Livingston, 2007). The literature highlights the importance of the constructivist approach and the awareness of the benefits of cooperative learning in this context (Fisher, 1995; Perkins, 2001; Slavin, 1996).

Learning Management Systems (LMS) allow b-learning development and provide tools to develop the new educational models.

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However, the potential application in higher education remains low.

In this work, a study is presented with the aim to analyze the implementation of LMS in four universities in the region of Andalusia together with the analysis of this system's new and more complete learning processes, different from the traditional education models based on information assimilation.

In the second part of this paper, the literature review and the descriptive models by Rogers (1962/1995) and Zemsky and Massy (2004) are presented in order to describe the level of adoption of b-learning with the support of LMS. Other variables linked to the potential use of technology among teachers are also analyzed.

The hypotheses and derivative objectives are described in the third section. An evaluation has been carried out to consider the validity of the adoption models for the implementation of b-learning in universities and the analysis of direct and indirect influence of internal and external factors concerning teachers on b-learning adoption.

The fourth section focuses on the method. The method used in this study consists of an ad-hoc questionnaire based on variables described on the second section of this paper. This questionnaire was applied to a random sample of 495 teachers during the academic year 2009-2010. There are two different techniques included: Multiple Correspondence Analysis (MCA) and Structural Equation Modeling (SEM). The MCA seeks to validate the Rogers model (1962/1995) applied to the use of b-learning through LMS, identifying clusters depending on the frequency of use, technological competence, pedagogical style and institutional support strategies. The second analysis, the SEM, initially presents a factorial reduction, which implies a validity limit for the drawing of conclusions: Its aim is to approach the confirmation of the effect of teachers' self perception concerning their technological competence about the educational use style and the potential use of digital resources integrated in the LMS.

The fifth section of this paper is divided into the MCA and the SEM. The MCA presents four clusters similar to the adoption cycles identified by Zemsky and Massy (2004) and in similar proportions to the innovation curve presented by Rogers (1962/1995). These clusters are analyzed and interpreted. Through the Structural Equation Modeling, some results interpreted by the MCA are confirmed. Among these statements: the fact that the self perception of technological competence of university professors has an influence on the frequency of use of digital resources, but does not determine the instructive style. The results also confirm the influence of the support measures on the self perception of professors' competence.

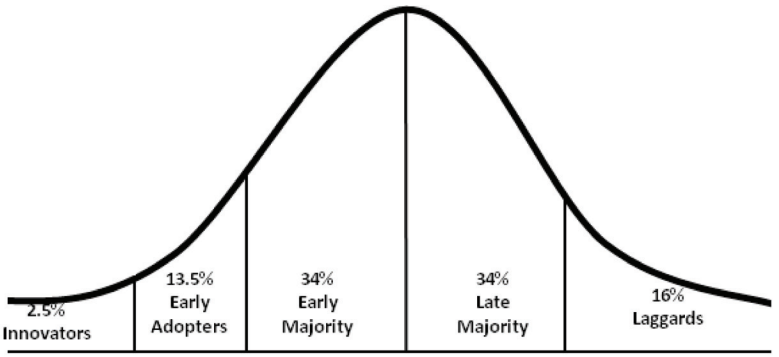
In the sixth section appear the conclusions. Among these conclusions, confirming the validity of Zemsky and Massy (2004) and Roger's models (1995) to describe the processes of adoption of b-learning in universities. According to the results obtained in this research, the implementation of b-learning in public universities in the region of Andalusia is in a transitional phase, from the cycle two (with the incorporation of LMS) towards more innovative pedagogical models that are being used by a minority of professors («innovative professors»). This minority, thanks to the use of LMS is developing new cooperative and constructive models of b-learning.

2. LITERATURE REVIEW

2.1. E-Learning Models at Universities

E-learning as applied to tertiary education is embodied in three different approaches: the conventional model, the mixed model (blended learning) and the distance learning model (Zhao, 2009; Zhao & Jiang, 2010). Blended learning (b-learning) refers to the integration of virtual and face-to-face teaching using Learning Management Systems (LMS). In this sense, it is possible to develop an increasing number of new ways of integration of virtual and face-to-face education (Garrison & Vaughan, 2008; Mortera-Gutierrez, 2006). For example, class teaching takes the traditional form, while

Figure 1. Innovation curve (adapted from Rogers, 1962/1995)



the technology is used after class to stimulate discussion, present tasks and provide didactic material, etc. Therefore, online classes can are combined with face to face sessions and predefined online discussions.

This article presents the results of a study that analyses the uptake of b-learning at universities in Andalusia, and the pedagogical models and materials used in the teaching.

2.2. The Adoption of Blended Learning (B-Learning)

Two references were used in this study of blended e-learning adoption at universities in Andalusia. The first is the diffusion of innovations model developed by Rogers (1962/1995) (Figure 1), in which the spread of the adoption of innovations over the timeline is represented by a normal, bell-shaped curve where the first stage (2.5%) represents the innovators, the second (13.5%), the early adopters, followed by the early majority (34%) situated between the mean time for adoption and the mean minus one standard deviation, and the late majority (34%), the stage that occurs between the mean time for adoption and the mean plus one standard deviation. The final 16% Rogers describes as laggards, referring to those who are resistant to change.

According to some empiric data obtained in a study carried out in universities in NZ, USA and UK (Elgort, 2005) and related to the adoption of e-learning, we can confirm that many of these universities have completed the early stages in the adoption of LMS. In another study carried out in 102 higher education institutions in UK (JISC & UCISA, 2003), 86% of these institutions use virtual learning environments. Some researches carried out, such as Mitchell et al. (2005) in universities in NZ focusing on 18 technological institutes have shown that all of them use LMS. Similar results were found in the NCODE LMS Survey (2002), in which the 33 participant universities appeared to use LMS (either commercially- or in-house-developed). In the project FLLinNZ, the interviewed participants stated that the adoption of e-learning in their institutions has been possible, at some extent, thanks to the introduction of LMS, such as Blackboard, WebCT or Moodle. This seems to reduce the curve developed by Rogers (1962/1995) for technically less prepared professors (Mitchell, Clayton, Gower, Barr, & Bright, 2005, p. 7).

The second reference is Zemsky and Massy (2004) that after a study based on interviews to six colleges and universities and six enterprises in USA during 15 months, with the aim to know what happened with e-learning identified four cycles of e-learning adoption, each requiring a different level of change in the instructional culture.

The first cycle is described as the strengthening of the traditional course / program and requires the least change in terms of institutional teaching and learning processes. In the second

cycle LMS are introduced, followed by a third cycle in which imported resources such as multimedia applications and interactive simulations are used. The fourth cycle sees a reorganization of the teaching-learning processes by taking full advantage of new technologies; active learning and the reconfiguration of the roles of teachers and students are essential in this final phase.

The conclusions obtained from the report by Zemsky and Massy (2004) are somehow disappointing given the fact that the cycles three and four remain in the innovative segment (Zemsky & Massy, 2004, p. 57). (Zemsky & Massy, 2004, p. 57) conclude that the problems related to e-learning were the result of an attempt to compress the innovation process. As a result, the e-learning disappeared before people learned how to use it. Taking the educational innovation into account, the researchers stated that professors, despite of the new technological tools did not change their teaching model. They only realize the potential use of e-learning after modifying their teaching practices. The Marshall study (2005) carried out in New Zealand reveals that there is no connection between e-learning technologies provided by universities and the educational goals, which were often not described or focused only on memorizing and understanding contents instead of analyzing, summarizing or assessing information.

2.3. Teacher Involvement

Teachers' willingness is the ultimate key for educational change. One factor associated to teachers' willingness is their confidence in the use of Information and Communication Technologies (ICT), the necessary skill level they perceive to be necessary for regular ICT use and the training received (Jones, 2004). The development of pedagogical competences is needed if the teaching potential of ICT is to be realized (McCarney, 2004; Reynolds, Treharne, & Tripp, 2003; Condi & Livingston, 2007; Hinojo, Aznar, & Cáceres, 2009; Salmerón, Rodríguez, & Gutiérrez, 2010).

The gap between the uptake of technology and pedagogical innovation is best explained in research on theories of teaching and teachers' beliefs (Kember, 1997; Ramsden, 2003). In this sense, innovation must be compatible with the socio-cultural values and beliefs of those who adhere to them (Rogers, 1962/1995, pp. 225-226). Research by Robertson (2004) indicates that university teachers use ICT tools only when they fit in with their beliefs on education. Therefore, the blended e-learning model adopted in tertiary education is explained by the pedagogical approaches of the teachers who take up that model, often as a result of their teaching ideas (Kember, 1997). Yet teachers' ideas are not inflexible. Studies such as that by Lewin and Wadmany (2008) reveal the complex relation between the changes that occur in teachers' opinions and the way they work as a result of experiences in a teaching environment enriched by technology.

2.4. Institutional Impulse Measures

Many studies have analyzed the importance of the main factors playing a role in the process of integration of technology (Owen, 2006; Fletcher, 2006). Among these factors:

Access to technology: universities, schools and homes in the western countries easily access to technology today. This factor is no longer a barrier for technology integration due to the increasing availability of equipment, networks, Internet access everywhere; and also due to the effort made by the government at all educational levels.

Facilities for technological training for teachers: any reform in education requires an adaptation period. In order to train teachers to efficiently integrate technologies in their teaching practices, it is necessary to offer opportunities and creative alternatives for them to take part in workshops, conferences, seminars and work groups (Byrom, 1998; Ertmer, 1999).

Lifelong professional training: the educative systems should include long term professional development programs. The centers where professional training is seen as an occasional action would not be able to develop educational reforms (Bybee & Loucks-Horsley,

2000). Professional training should also seek for pedagogical improvements. In fact, training programs based on coaching appear to be efficient for the integration of technology in the classroom (Pedroni, 2004).

Available resources: the institutions should be aware of the influence of technology in pedagogical processes in their educative systems (Roberts, 1998), and, as a consequence, they should allocate part of the budget for technological and pedagogical development of teachers in order to reach educational goals (Byrom, 1998).

Support staff: apart from institutional support, teachers should be also assisted by support staff with the aim to ease the integration of technology. This factor is meant to be essential to overcome first and second barriers for the integration of technologies in education (Hofer, Chamberlin, & Scot, 2004). Among the different suggested terms to designate these people, we can find 'computer coordinator', 'information technology coordinator', 'technology facilitator', 'educational technologist' (Hofer et al., 2004). Ronnokvist, Dexter, and Anderson (2000) distinguished two different types of support: technical and pedagogical support. Technical support includes aspects referred to technology such as software or hardware related problems. Pedagogical support includes didactic strategies and implementation of different teaching practices. In this sense, the coordinator acts as a trainer or stimulus in training programs for teachers.

3. HYPOTHESES AND OBJECTIVES

The incorporation of LMS and its different variants is becoming more and more frequent in universities. However, there is still no evidence of pedagogical use, teaching style and frequency of use among professors. Despite the existing studies on the influence of internal and external factors on the pedagogical use of technology, not many of these studies include an evolutionary interpretation of the process, similar to the models presented by Rogers (1962/1995) and Zemsky and Massy (2004).

According to this, this paper presents the following hypotheses:

- The expansion of didactical innovation with the support of LMS follows a similar pattern to the diffusion model presented by Rogers (1962/1995) and to the cycles identified by Zemsky and Massy (2004).
- The adoption of LMS by professors (second cycle of Zemsky & Massy, 2004), is at the stage of 'late majority', so, the majority of professors use these systems.
- However, the fourth cycle associated to a reorganization of the teaching-learning processes by taking full advantage of new technologies appears in the first stages identified by Rogers (1962/1995), which represents the innovators and the early adopters.
- Teachers' perception of their own technological capabilities has a direct influence on the didactical use of digital material although it is insufficient to affect the development of student-centred educational models.
- There is a direct influence between the existing support policies and the support for b-learning in the didactical use of digital material.

Taking into account the hypotheses above, this study presents the following objectives:

- To identify the rates of adoption of b-learning at universities in Andalusia.
- To indentify cycles of blended learning adoption, linked to institutional support conditions and to teachers' perception of their competences.
- To identify the presence of student-centred teaching models in the use of b-learning at the universities.
- To verify the key factor of teachers' perception of their own technological ability in the use of digital material.

Table 1. Population (university teaching staff) and sample

University	Sample	Gender	Mean age	
		M	F	
University of Cadiz	112	64	48	43.30
University of Cordoba	126	65	61	44.10
University of Huelva	159	94	65	40.20
University of Sevilla	98	51	47	42.33
Total	495	274	221	

- To corroborate the indirect influence of measures to foment technology use in university teaching.

4. METHOD

The method consists of an ad-hoc questionnaire validated by experts which focuses on external and internal variables influencing professors in the use of teaching technologies. This questionnaire is applied to a random sample composed of 495 representative professors using LMS in four universities in the region of Andalusia during the academic year 2009-2010. Two statistical techniques are applied for two different objectives. On the one hand, through the Multiple Correspondence Analysis (MCA) we can identify the professors' frequency of use and teaching style of digital content in the LMS. This analysis offers an overview of the level of adoption of b-learning and the innovation associated to this pedagogical model. On the other hand, the previous factorial analysis would reduce the variables to factors so that we can obtain more explicative conclusions through the Structural Equation Modeling (SEM).

4.1. Sample Description

The study population is the teaching staff at the Universities of Cadiz, Cordoba, Huelva and Sevilla using LMS (Moodle or WebCT). A non-random proportional stratified sampling procedure was used, which Cohen and Manion (1990) called quota sampling.

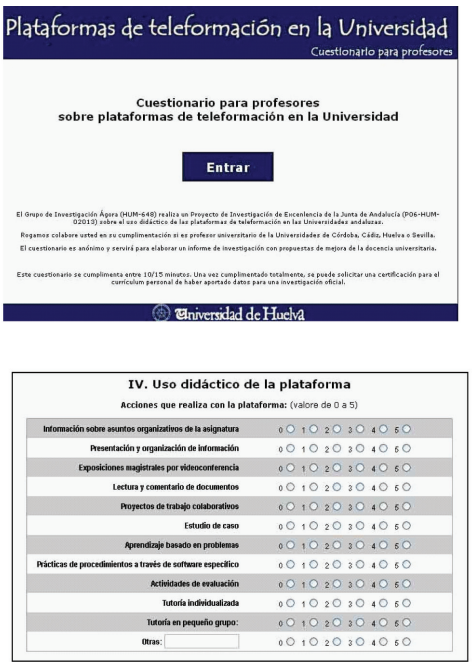
The initial sample size was 941 teachers using LMS, guaranteeing a confidence level of 95% and a sampling error of ±3%. The final sample was 495 teachers at the Universities of Cadiz, Cordoba, Huelva and Sevilla, a figure which deviated considerably from the initial expected sample size; but given the number and spread of faculty members taking part, it can be considered as highly representative of the teaching staff that uses virtual platforms at these four universities (Table 1).

4.2. Procedure, Instrument, and Variables

An *ad hoc* online questionnaire was designed, with a brief introduction to comply with established questionnaire norms. This questionnaire has been applied to 495 professors during the academic year 2009-2010. The participants have filled in the questionnaire voluntarily, either online or the in printed version (Figure 2). The questionnaire has been organized according to the pedagogical use of digital resources, teachers' perception of their own technological competence and the institutional support measures for the adoption of b-learning.

Specifically, the dimensions considered by the questionnaire are: teachers' perceived technological competence, the digital resources used and satisfaction with those resources, the didactic material used on the platforms, the functions for which the platform is used and the institutional measures to foment blended e-learning. Each dimension is analysed via the Likert-type scale with values ranging from 1

Figure 2. Some dimensions of the online questionnaire



and 6. Cronbach's Alpha tested 170 variables and a sample of 495 individuals, obtaining a reliability index of 0.941. However, as this article does not present the complete research, it is important to say that in total, 57 variables were used, according to the objectives presented above.

Cronbach's Alpha was also used to determine the reliability of the instruments, yielding the following results for each dimension:

- Variables relative to the didactic functions and digital resources used: Likert-type scale with values ranging from 1 (never) to 6 (very often). The Cronbach Alpha reliability index score was 0.91 for 23 elements.
- Variables relative to the institutional support measures: Likert-type scale with values ranging from 1 (never) to 6 (always). The Cronbach Alpha reliability index score was 0.843 for 12 elements.
- Variables relative to satisfaction: Likert-type scale with values ranging from 1 (never) to 6 (always). The Cronbach Alpha reliability index score was 0.854 for 17 elements.
- Variables relative to teachers' perceived competence: Likert-type scale with values ranging from 1 (not at all competent) to 6 (highly competent). The Cronbach Alpha reliability index score was 0.797 for 5 elements.

4.3. Multiple Correspondence Analysis

The multiple correspondence analysis (MCA) was made on a matrix of 496 observations and 48 active nominal variations with 258 associated modalities, 8 illustrative nominal variables with 38 response modalities and 2 continuous illustrative variables.

In general, the values in this type of analysis provide a highly pessimistic interpretation of the variability explained, as a result, as Benzécri (1979, p.. 377-378) proposes, more optimistic degrees of inertia can be calculated

Figure 3. Histogram of the first five factors

NUMBER	VALUE	PERCENTAGE	ACCUMLATED PERCENTAGE	
1	0.0556	51.86	51.86	**************************************
2	0.0297	27.70	79.56	****
3	0.0077	07.83	87.39	**********
4	0.0058	07.18	94.57	******
5	0.1072	05.43	100.00	*****
				****

from some transformed values. We use the formula proposed by this author to transform the values of the first five factors [$a_{i'}$ = (a_i – 1 / nº modalities – nº variables)^2], after which we discover the percentage of the variance explained by each factor (variance = $a_{i'}$ / Σ 5 first five values transformed x 100).

4.4. Structural Equation Model

Structural Equation Modeling combines factor analysis with multiple linear regressions. According to this technique each theory involves a set of correlations, and if the theory is valid then it must be possible to reproduce correlation patterns (suppositions) in empirical data. The aim of our investigation is to construct a model to corroborate the direct influence of teachers' perception of their technological competence on the use of e-learning resources, and the indirect influence of institutional measures to foment the adoption of blending e-learning. The Amos 5.0.1 program was used for the modeling.

5. RESULTS

The results now presented are organized according to the different analysis techniques used. On the one hand, the MCA, which identifies clusters of professors according to the frequency of use of digital resources in LMS, the perception of their own competence, their satisfaction and the institutional support measures. All this information would let to describe the level of adoption of b-learning in universities. On the other hand, the Structural Equation Modeling permits an approach to confirm the influence of teachers' perception about their competence and the institutional support they have, as well as the use and satisfaction of digital resources.

5.1. Multiple Correspondence Analysis

The histogram shows the first five factors obtained in the multiple correspondence factor analysis (Figure 3). Initially all five factors were retained, but on observing that the third, fourth and fifth factors contained redundant information only the first two factors were used, giving a total variance of 79.56%. The size of this value guarantees a minimal loss of information with the first two factors.

5.1.1. Factor Analysis

a) Factor 1. Extended use of the platform (Table 2).

This factor, which accounts for 51.86% of the total variance, is based on the variables relative to the functions for which the platform is used, the resources used on the platforms and the evaluation made of them.

On the positive side of the factor axis are the modalities that score highest which refer to functions such as tutorials, case studies, activity plans and work projects. All these can be defined as extended use of the platform. This side also features frequently used modalities such as links, Thesaurus and blogs. Other modalities that score high are chat rooms, the tools for submitting work, group work and self-assessment.

The negative side of the factor axis consists of response modalities with low scores that refer to the resources, their evaluation and the

Table 2. Description of the factor 1 axes

ID	V. TEST	LIBELLE MODALITE	LIBELLE	POIDE	Number
BLO1	-13.12	1	RR BLOGS RESOURCES	386.00	1
ESC1	-12.86	1	STUDY CASES	254.00	2
PRO1	-12.64	1	PROJECTS	210.00	3
RTE1	-12.44	1	RR THESSAURUS RESOURCES	352.00	4
SCH1	-12.25	1	SATISFACTION CHAT	364.00	5
SSE1	-12.15	1	SATISFACTION SELF-ASSESSMENT EVALUATION	293.00	6
RWI1	-12.06	1	RR WIKI RESOURCES	419.00	7
SBL1	-11.96	1	SATISFACTION BLOG	429.00	8
SCU1	-11.88	1	SATISFACTION QUESTIONNAIRE	233.00	9
RMU1	-11.84	1	RR MULTIMEDIA RESOURCES	254.00	10
RWI1	-11.75	1	SATISFACTION WIKIS	424.00	11
SWE1	-11.73	1	SATISFACTION WEB	407.00	12
ACT1	-11.72	1	ACTIVITIES	198.00	13
PRO1	-11.51	1	PROBLEM-BASED	205.00	14
RLI1	-11.47	1	RR LINKS RESOURCES	102.00	15
CENTRAL ZONE					
SCA5	7.61	5	SATISFACTION CALENDAR	89.00	244
RBL5	7.72	5	RR BLOGS RESOURCES	19.00	245
COM5	7.97	5	ADMINISTRATION COMPETENCE	37.00	246
RTE5	8.02	5	RR THESSAURUS	24.00	247
RLI5	8.04	5	RR LINKS RESOURCES	134.00	248
EFF5	8.12	5	EFFECTS	38.00	249
SMA5	8.26	5	SATISFACTION MAILS	168.00	250
PRO5	8.37	5	PROJECTS	44.00	251
SGR5	8.66	5	SATISFACTION GROUPS	3.00	252
SAU5	8.76	5	SATISFACTION SELF-ASSESSMENT AUTOEVALUATIONS	54.00	253
CES5	8.82	5	CASES STUDY	38.00	254
ACT5	8.92	5	ACTIVITIES	54.00	255
SSE5	9.17	5	SATISFACTIONS SUBMIT SEND PAPERS	152.00	256
TUT5	9.62	5	TUTORIAL	88.00	257
SFO5	9.84	5	SATISFACTIONS FORUMS	51.00	258

functions for which platforms are used. All the modalities represented are the forecasted minimal options relative to the resources and the most innovative functions. All those functions such as case study, work projects and problem-based activities score lowest on this side of the axis. The same can be said for resources like blogs, Thesaurus, wikis, multimedia and links, all of which increase the possibilities for learning on platforms and are associated to recent educational models.

b) Factor 2. Functions, resources and support measures (Table 3).

The second factor, accounting for a variance of 27.70%, represents those modalities related to functions, resources and the most frequent support measures.

On the negative side of the factor axis are the modalities with the highest scores which refer to those didactic functions that are widely used on the platform, including presentation of information, problem solving, case study, projects and practical work. On this side, the high scoring modalities that are particularly significant are the support measures, institutional backing, logistical support and incentives for developing material and the availability of infrastructure and resources to foment the use of these technological resources.

On the positive side of the factor axis are those modalities with medium to high scores that mainly correspond to the resources used. The resources represented in this section are more conventional and traditional, such as course work programs, digital documents, activity proposals, audiovisual media, links and multi-

Table 3. Description of the factor 2 axes

ID	V. TEST	LIBELLE MODALITYE	LIBELLE	POIDE	Number
PRO5	-9.66	5	PROBLEMS	45.00	1
PRE5	-9.14	5	PRESENTATION	240.00	2
REA5	-9.05	5	READ PAPERS	48.00	3
EST5	-8.79	5	STUDY CASES	38.00	4
TES5	-8.64	5	RR THESSAURUS RESOURCES	24.00	5
SSE5	-8.56	5	SATISFACTION SEARCH	64.00	6
INF5	-8.52	5	INFORMATION	206.00	7
ACT5	-8.41	5	ACTIVITIES	54.00	8
POL5	-8.29	5	POLITICS	100.00	9
SWE	-8.20	5	SATISFACTION WEB	7.00	10
LOG5	-8.09	5	LOGISTICAL SUPPORT	70.00	11
ACS5	-8.07	5	ACCESS RESOURCES	66.00	12
DIS5	-8.03	5	RESOURCES	53.00	13
PRO5	-8.03	5	PROJECTS	44.00	14
PRA5	-7.96	5	PRACTICAL WORKES	23.00	15
ZONA CENTRALE ZONE					
ACT3	5.81	3	ACTIVITIES	96.00	244
PRO3	5.82	3	PROJECTS	90.00	245
RMU4	5.88	4	RR MULTIMEDIA RESOURCES	61.00	246
RAU3	5.89	3	RR AUDIOVISUALS RESOURCES	66.00	247
SGL4	5.92	4	SATISFACTION GLOSSARIES	116.00	248
SSE4	5.97	4	SATISFACTION SUBMITSEND PAPERS	120.00	249
EFE3	5.99	3	EFECTS COMMUNICATION EFFECTS	101.00	250
RPR3	6.06	3	RR PROGRAMME RESOURCES	34.00	251
RLI4	6.25	4	RR LINKS RESOURCES	114.00	252
RAU4	6.48	4	RR AUDIOVISUALS RESOURCES	78.00	253
INF4	7.32	4	INFORMATION	151.00	254
RAC4	8.20	4	RR ACTIVITIES RESOURCES	102.00	255
PRE4	8.32	4	PRESENTATION	149.00	256
RDO4	8.57	4	RR DOCUMENTATION RESOURCES	92.00	257
RPR4	8.60	4	RR PROGRAMME RESOURCES	67.00	258

media resources. The nature of these resources reflects a didactic model of platform use that is informative and organizational. This is evident in the fact that the presentation and information functions are the most widely represented on this side of the axis.

5.1.2. Results of the Cluster Analysis

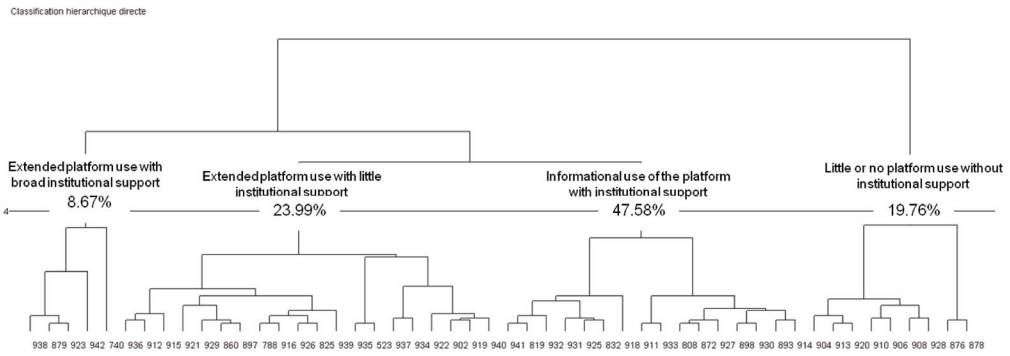
After establishing the two factors that synthesize the most important information of the interrelation of variables analyzed, subjects were grouped according to their affinity with respect to the variables studied. In the end, this classification into four groups or classes is what best serves as an explanation.

The dendogram shows the four classes divided along the axis and the percentage of each in the sample study (Figure 4).

a) Class 1. Extended platform use with broad institutional support.

This accounts for 8.67% of the sample (43 subjects). It generally consists of teaching staff that use platforms a lot, with a high degree of competence in managing resources like information search and who also have the backing of their university. This group also reports changes in learning processes and student participation. They use the platforms as a resource for distance teaching, and are normally

Figure 4. Dendogram with axis divisions with four classes



young scholarship holders with limited job experience. The functions for which they use the platform match extended usage models that go beyond the informative-assimilative teaching model. They use the platform to propose case studies, reading material, activities, problem-solving work and, of course, tutorials. They use resources such as Thesaurus and links to other information sources, multimedia material, etc. They also appreciate the tools for submitting work, chat rooms, the creation of work groups, among other resources.

These are teachers with a high degree of competence in managing platform resources and information search; they work in an environment that receives institutional support for the didactic exploitation of educational platforms in university teaching.

b) Class 2. Extended platform use with little institutional support.

This group accounts for 23.99% of the sample (119 subjects). These are teachers with a high degree of technological competence whose motivation for using platforms is informative-assimilative but also to generate activity via digital resources like blogs, links, audiovisuals, multimedia, etc. They do not normally count on official backing or infrastructure, neither are they offered incentives to develop didactic material using platforms as resources for distance learning.

The teachers in this class place a high value on digital course work, using material such as programming for course work, reading matter like technical articles, audiovisual resources and multimedia, as well as links to other information sources. They are highly competent in managing platform resources despite not receiving institutional backing for their work.

c) Class 3. Informational use of the platform with institutional support.

This class represents 47.58% of the sample (236 subjects) and consists of civil servant professors (TU/CU) with more than 13 years' professional experience, mainly in the Sciences, and who have logistical support and facilities to use platforms, although their level of technological competence is low. This group uses platforms in a limited way, as a resource for presenting information and course content.

Their didactic model is clearly to supply information and documentation, with the student assuming an assimilative role. This is evident in the functions for which they use the platform: to present information and inform the student on course content. The most highly rated resource is the glossaries, and the most widely used are the course program, digital documents, activity proposals and links to other documents or materials, defining this model as one based on information and assimilation of content.

The professors in this class, despite existing within a university context that supports and pushes the use of educational platforms and with logistical support and the provision of other facilities, have a low level of technological competence, which explains the limited use to which this resource is put.

d) Class 4. Little or no platform use without institutional support.

This class constitutes 19.76% of the sample (98 subjects). They make little or no use of educational platforms. These teachers receive no official backing and consequently their level of technological competence is scant or non-existent.

5.2. Structural Equation Model

5.2.1. Prior Factor Reduction

The results of these analyses (Figure 5), applying an orthogonal rotation with the quartimax method with the aim of determining the pertinence of the variables to a factor and thus achieving better discrimination better between factors, are the following in terms of each of the dimensions considered:

Didactic functions and materials used on the platform. Three factors are identified that account for 57.523% of the variance of the set of variables (Table 4):

- Factor 1. Extended platform use. This factor includes the variables that represent an extensive use of the platforms. Among the functions saturated by the factor are teacher presentations, projects for cooperative work, case or problem-based studies and individual or group tutoring. This factor includes the use of more innovative materials such as wikis, blogs, Thesaurus, binnacles and glossaries, which are all useful for generating content and consulting.
- Factor 2. The informative usefulness of the platform. This factor saturates variables that show a more limited and traditional usage of educational platforms; organization of information and its presentation. It also includes digital resources like course programs, documents, articles and links to other resources and activity proposals.
- Factor 3. The use of audiovisual and multimedia material. This factor saturates variables that refer to audiovisual, multimedia and interactive material.

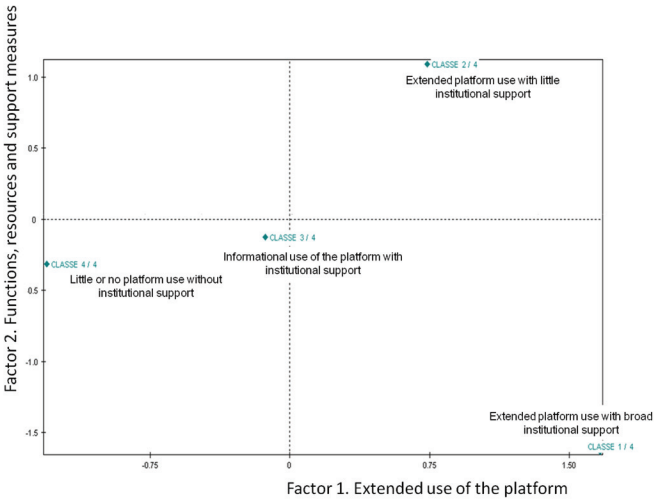
Institutional measures to support the use of platforms in university education. Two factors that saturate 57.573% of the variance in the set of variables (Table 5):

- Factor 4. Support measures. This factor saturates the variables that refer to measures that the university adopts to encourage the use of technological resources in teaching. The variables include: recognition of teaching effort, facilitating technology use, policies of ICT integration and development of materials, logistical and teaching support and the availability of infrastructure and resources.
- Factor 5. Institutional recognition. This factor saturates the following variables: economic incentives, academic recognition and reduction in teaching credits.

Satisfaction with the digital resources. Four factors saturate 58.382% of the variance (Table 6):

- Factor 6. Satisfaction with knowledge resources. This factor includes variables of teacher satisfaction with regards to the resources for presenting content and knowledge such as wikis, blogs, student web sites, chat rooms, etc. These resources allow the student to play a greater role as knowledge generators.
- Factor 7. Satisfaction with information-communication resources. This factor includes variables of satisfaction with digital resources put to conventional use

Figure 5. Factor plans of the classes



like forums, e-mails, calendars, work submission, etc.

- Factor 8. Satisfaction with document consultation resources. This includes variables that relate to satisfaction with resources for the assimilation of content such as glossaries, content modules, search tools and data bases.
- Factor 9. Satisfaction with self-assessment resources. Including variables that refer to teacher satisfaction with self-assessment resources such as questionnaires and self-assessments.

Teacher competence. The only factor extracted that explains the variance of 67.77% includes the following variables: competence in managing digital resources, competence in creating materials, competence in the didactic use of resources and in searching for information and resources (Table 7).

5.2.2. Confirming the Model

Prior to the confirmation test, a correlation analysis was performed in order to filter factors using the Spearman test for continuous numerical variables. The results enable the inclusion of factors with strong correlations in the model.

The close correlation between extracted factors and the confirmation of the regression models tested confirm a complex model that helps us to understand the uses to which educational platforms in the university context are being put. This model also confirms the direct influence of the teachers' perception of their ICT competence on the use of LMS. Teachers' perceived competence has the same, direct influence on two types of instructional model:

- The participative-generative model of knowledge, in which learning is based on the activity of the student and his leading role in the learning process.
- The informative-assimilative model, a traditional model in which learning is based on the presentation of information, resources and activity proposals for the assimilation of content.

Both models condition teacher satisfaction with regard to certain types of resources that are closer to one or other teaching model. In practice, there is no eclectic model, rather teachers opt

Table 4. Factorial analysis of educational functions, resources and materials. Matrix of rotated components.

	Components		
	F 1	F 2	F 3
Provide information about the subject		,805	
Present and organize information		,861	
Master classes	,616		
Collaborative work projects	,702		
Case study	,703		
Learn how to solve problems	,610		
Tutoring	,577		
Group tutoring	,709		
Program included		,842	
Documents, articles and reports included		,829	
Practices and activities included		,667	
Multimedia presentations included			,776
Audiovisual material included			,735
Interactive material included	,430		,665
Links to portals, e-libraries and databases included	,417	,436	
Blogs included	,750		
Thesaurus, glossaries included	,646		
Wikis included	,713		

Method of extraction: Analysis of main components.
Rotation method: Quartimax with Kaiser Normalization.
a Rotation converged in 4 iterations.

for one model or the other and, consequently, for one set of resources or others.

The indirect effect of institutional measures of support is also proved, via its influence on teachers' perception of competence.

The structural equation model was calculated to verify teachers' use of LMS and their influence on satisfaction with the digital resources used. The goodness of fit indexes indicate that the model fitted well with the data ($X^2/gl = 2.2$; $p>0.001$; CFI=0.99; IFI=0.99; NNFI=0.98; TLI=0.96; RMSEA=0.051; HOELTER=319).

The model explains the 15% variance in the use teachers made of the participative-generative models on the platforms, and also explains the 13% in variance in teacher's use of the informative-assimilative models.

The variance that occurred in the model of satisfaction with the resources used on the platforms is particularly wide, with knowledge at 44%, documentary consultation at 25% and information and communication at 32%.

The estimated model showed significant values ($p<0.001$) for all regression indexes, with the exception of the model that related satisfaction in terms of knowledge resources to satisfaction with information resources ($p<0.05$).

Firstly, the influence of institutional support on teacher competence in ICT use is relevant ($\beta = 0.23$, $p<0.001$). We can state that this series of support measures, which include stimulation plans, resources and materials, have a positive influence on teacher competence even though

Table 5. Factor analysis of institutional impulse measures. Matrix of rotated components.

	Components	
	F 4	F 5
Teachers' effort considered	,673	
Facilities offered	,790	
ICT integration policy	,826	
Material development	,756	
Economic incentives		,725
Logistic support	,677	
Devices and installation support	,537	,415
Time and place for training	,711	
Academic recognition	,487	,613
Reduction of teaching credits		,823

Method of extraction: Analysis of main components.
Rotation method: Quartimax Normalization with Kaiser.
a Rotation converged in 3 iterations.

Table 6. Factor analysis of satisfaction with digital resources. Matrix of rotated components.

	Components			
	F 6	F 7	F 8	F 9
Forums – assessment of use	,526	,572		
E-mail use – assessment of use		,711		
Chat – assessment of use	,686			
Calendar – assessment of use		,602		
Works submit – assessment of use		,694		
Questionnaires – assessment of use				,803
Self-evaluations – assessment of use				,732
Students¡ web – assessment of use	,657			
Wikis – assessment of use	,811			
Blogs – assessment of use	,839			
Work teams – assessment of use	,432		,449	
Qualifications – assessment of use		,538		
Glossary – assessment of use			,510	
Units / Content modules – assessment of use			,552	
Searching and consulting – assessment of use			,700	
Data bases – assessment of use			,693	

Method of extraction: Analysis of main components.
Rotation method: Quartimax Normalization with Kaiser.
Rotation converged in 5 iterations.

Table 7. Factor analysis of technological competence. Matrix of components.

	Component
	F 10
Competence in resource management	,831
Competence in material development	,795
Competence in didactical use of resources	,866
Competence in finding information and resources	,799

Method of extraction: Analysis of main factors.
a1 extracted component.

it only accounts for 5% of the variance in this factor. Nevertheless, its indirect influence on LMS use is more than possible.

The predictive force of the perception that teachers have of their competence regarding the types of use made of LMS is strong, whether as a utility for student participation and knowledge generation (β= 0.39, p<0.001) or as a resource for information and knowledge assimilation (β= 0.39, p<0.001).

The coefficient regression (β= -0.15, p<0.001) that indicates the negative influence of the participative-generative model on the informative-assimilative model reveals an inverse relation between the use of both models. In other words, the data confirm that the teaching staff opts for one of the two models when making didactic use of the platform.

It is with regard to satisfaction with the digital resources considered in the use of the platforms that the model reveals its most explicative values (Figure 6), with a 44% variance in satisfaction regarding digital resources for knowledge, a 33% variance for digital resources for information and communication between teacher and student, and a 25% variance in the satisfaction with respect to consultation resources. At the same time, the regression index values between these variables prove teachers' tendency to use e-learning in a traditional way, or oriented by constructivism and cooperation.

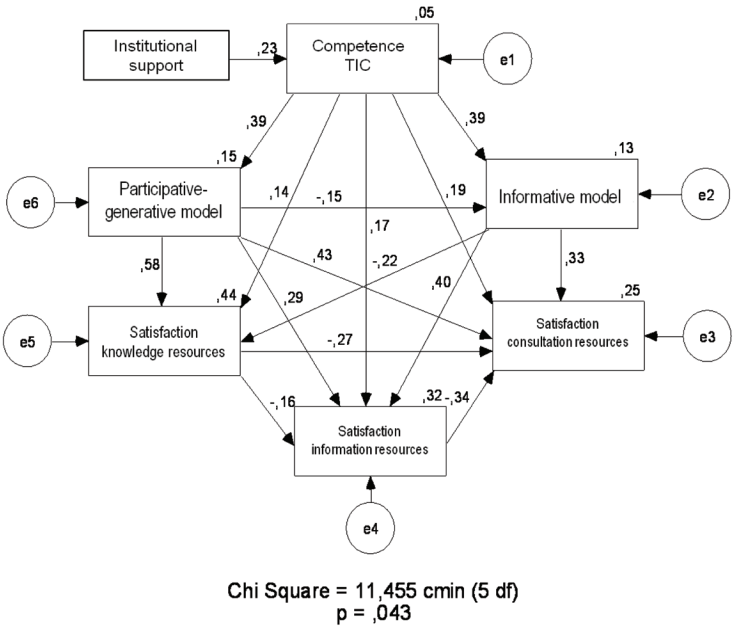
The high score in the regression coefficient for the generative-participative model regarding satisfaction with the knowledge resources (β = 0.58, p< 0.001) and the variance explained (0.44) indicates the considerable influence that this teaching model has on the use of and satisfaction with resources such as binnacles, wikis, Thesaurus, work groups, student webs, etc. But it also has high coefficients for satisfaction with the resources of information and communication (β = 0.29, p<0.001) and with consultation resources (β=0.43, p<0.001). This demonstrates the predictive capacity of the generative-participative model regarding the use of other resources, especially consultation, but also communication, leading us to conclude that besides the resources defined as knowledge, this model also includes the use of all the other resources indicated, although with less probability.

The regression coefficients of the informative-assimilative model with regard to satisfaction with information and communication resources (β = 0.40, p<0.001), with consultation resources (β = 0.33, p<0.001) and knowledge resources (β = 0.22, p<0.001), confirm that all these resource types are used habitually in this model, although an order of precedence can also be established in terms of the typology of resources that are closer to similar ones.

6. DISCUSSION

Firstly, the MCA has enabled us to check that the adoption of LMS in universities in Andalusia has a similar pattern to the Rogers model (1962/1995). While the majority of university teachers use b-learning, some 20% do not use platforms in their teaching, classified by Rogers as "laggards". Although transversal analysis

Figure 6. Explicative structural model



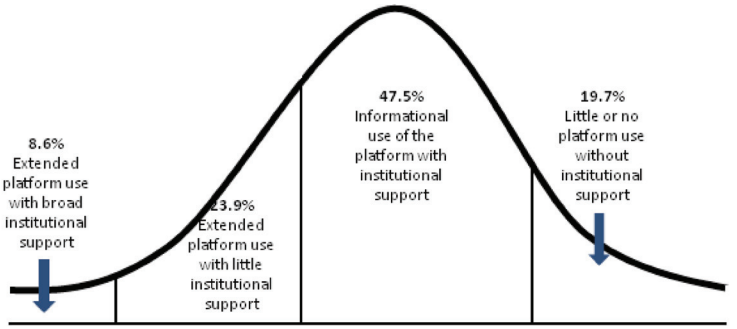
does not allow us to identify the time sequence of technology uptake with the groups identified, a minority group (4%) can be recognized as innovators who state that they make considerable use of platform resources. But that is not to say that they initiated the process of LMS adoption at universities in Andalusia.

The results are also similar to those of Zemsky and Massy (2004), who confirmed that only a small percentage of teachers (4%) made extensive, innovative use of LMS. With regard to the technology adoption cycles presented by these authors, technology integration in universities in Andalusia is passing through the second cycle. This means that 46% of teachers make very limited use of LMS, restricting themselves to platform use for the organization and diffusion of information. Also, 29% make more extensive use of the knowledge resources, such as multimedia. Only a small minority of the teaching staff can declare that technology uptake at their university is in the fourth cycle of development (Figure 7).

The results show the influence that perception of technological competence has on teachers' involvement (Jones, 2004; McCarney, 2004; Reynolds et al., 2003; Condi & Livingston, 2007), as well as external support measures (Owen, 2006; Fletcher, 2006). Four specific cycles can be identified in the development of innovation through blended e-learning in universities in Andalusia:

- Fourth cycle: a minority of users with institutional backing who make increased use of the resources offered by LMS, with a tendency to develop teaching models based not only on the assimilation of information but also on the use of new resources such as blogs, personnel webs or wikis that students deploy to create knowledge and content. They use a wide range of digital material. This is matched by high levels of technological competence with institutional support to encourage this type of proposals for teaching innovation with the specific provision of an infrastructure configured by technical support staff, resources and plans to stimulate innovation and teacher training.

Figure 7. Recreation of the innovation curve (Rogers, 1962/1995) with the study results



- Third cycle: users with no official backing whose use of LMS is more limited. They develop teaching proposals that are more focused on the didactic use of information, with the use of audiovisual resources, dossiers of digitalized documents, multimedia material (occasionally), links to other resources or online journals. They generally use LMS for the presentation of information and content. Yet they also make moderate use of advanced resources for knowledge generation such as blogs. They have a high level of competence although they do not receive backing or incentives from their universities for innovation.
- Second cycle: a majority of users, career civil servants, these professors have a low level of technological competence although they enjoy the support of their universities. These professors use LMS for the presentation and organization of information, enhancing the more traditional learning models. They frequently use conventional resources such as digital documents, present didactic activities, links to other resources and place great value on resources that aid the assimilation of information.
- First cycle: some 20% of university teachers state they are sporadic or occasional LMS users. These teachers have no technological competence and do not have the support of their university body.

Clearly, educational innovation by means of the adoption of technology at universities in Andalusia varies greatly, conditioned by the degree of support from the university body, with its direct effect on the teaching staff's ability to assimilate and make use of the potential of ICT and its practical use in education.

Two models of the educational use of LMS are identified: the generative model with its constructivist orientation, as used by a minority of teachers, and the traditional informative model used by the majority. Both can be considered pedagogical options in university teaching. However, the choice of one or other model does not exclude the use of materials available on the platforms, although it can be assumed that the pedagogical model influences the extent to which a specific type of material is used. So, far from contemplating incompatibility between digital resources that are closer to one model or the other, we need to focus on the idea developed by Duart and Sangra (2000) of the suitability of balanced LMS, with resources centred on the student, technology and the teacher, in which the teacher designs the course in accordance with his own pedagogical thinking (Ramsden, 2003; Robertson, 2004).

The analysis of the structural equation shows that the perception that teachers have of their own competence does not widely forecast an extended use of LMS beyond a traditional informative use. This corroborates the hypothesis that teachers' confidence in their technological

competence influences the frequency with which they use technology but it is insufficient to influence the innovative use they might make of these resources (McCarney, 2004; Reynolds et al., 2003; Condi & Livingston, 2007).

The dominance of the traditional informative model over the constructivist generative model could be due to the degree of compatibility with the socio-cultural values and beliefs of university teachers (Rogers, 1962/1995). Therefore, these values need to be considered as well as whether they respond to a traditional university model. If this is so, we need to create a process of reconceptualization of the university educational model. If this derives from the supposition that teachers' perceptions are the result of their interaction with people and situations and is not just limited to a static belief of the individual (Engelston, 1987; Lewin & Wadmany, 2008), then processes for teacher training based on research and action, among others, are fundamental for transformation at universities.

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