Motivational factors that influence the acceptance of Moodle using TAM

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ABSTRACT

Moodle and other virtual teaching platforms have bolstered the ability and motivation of universities to support distance learning.

The aim of our study is to improve understanding of the motivational factors behind student satisfaction, or dissatisfaction, with the Web-based learning platform, Moodle.

Our study extends the Technology Acceptance Model (TAM) to include technical support and perceived self-efficacy, with the expectation that they influence usage of Moodle. We surveyed 226 students of the Business Administration and Management (LADE) and Infant and Primary School Teaching degree courses of the University of Huelva.

The data showed that technical support has a direct effect on perceived ease of use and perceived usefulness. Moodle usage was also directly influenced by perceived ease of use and attitude. The results reveal the importance of perceived ease of use and perceived usefulness on attitude.

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1. Introduction

In these times of knowledge globalization, E-learning is one more product of the information society and the digital age.

E-learning is a new and important learning model, and is now a fundamental tool for universities and other educational centres to gain a competitive edge. They will be forced to design and offer better quality teaching given the easy access to training on the Internet (Longworth & Davies, 1996).

Perhaps a student is already thinking: why continue this course in business administration in my home town when there is a better offer elsewhere and I can study on the Internet?

The new learning model favoured by the European Space for Higher Education is based on a constructivist vision of learning in which knowledge flow in the lecture theatre and other spaces, such as the virtual, is multidirectional. Obviously new technology is a tool that may contribute to knowledge acquisition. E-learning allows the student to continue learning outside the lecture theatre, although a teacher-facilitator is still necessary for planning and preparation.

Conceptually, E-learning has many definitions: on-line training, on-line courses, virtual learning, telelearning, distance learning, virtual campus, etc. We will refer to it as the method of learning based on electronic media (Trombley & Lee, 2002).

Students who have access to an E-learning system can get course materials in different formats (text, image, sound, etc.), and can interact with their colleagues and lecturers individually and simultaneously via message boards, forums, chat rooms, videoconferencing, etc. This can be done wherever there is an Internet connection.

Students can learn at their own pace, and shape the learning process to suit their needs (Trombley & Lee, 2002; Zhang & Zhou, 2003).

The majority of educational centres are currently developing the non-attendance aspect of much of their course material by setting up virtual campuses. There are many different types of virtual environments on the market, but they all have a common methodology of usage and a similar appearance. They have tools for creating and managing content, and synchronous mechanisms – real time communication systems like chat rooms – and asynchronous ones, like e-mail and discussion forums. The most widely used virtual platforms are commercial or research and collaboration systems, which tend to be free.

The most widely used commercial systems are, among others: WebCT, FirstClass Collaborative Classroom and ECollege (Clark & Hermens, 2001; Hamberch, 2000; Smith, Murphy, & Teng, 2001).

Of the free research and collaboration Web-based learning systems, we have chosen to examine Moodle (http://www.moodle.org), with its management system of free courses for lecturers to create on-line learning communities. Created by Martín Dougiamas, a WebCT administrator, its design is based on collaborative learning, in which a teacher creates a student-focused environment that helps them to build up knowledge based

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on their own knowledge and skills, instead of simply posting and sending them information that the student is supposed to learn.

E-learning will help pedagogical systems to cross space and time. The success of E-learning systems will depend largely on their acceptance and usage by the students themselves.

Individual acceptance and usage of new technologies has been studied extensively over the past two decades, especially the Technology Acceptance Model (TAM), by Davis, Bagozzi, and Warshaw (1989), and its successor, TAM2 (Venkatesh & Davis, 2000), which has aroused particular interest. These models now provide a stable and secure way for predicting user acceptance of a wide range of new technologies.

This study employs a model based on the TAM extension (Davis et al., 1989) with the aim of:

(a) investigating the factors behind the acceptance of the Moodle platform by students at the Faculties of Business and Educational Sciences of the University of Huelva.
(b) determining current usage of Moodle at the Faculties of Business and Educational Sciences of the University of Huelva.

In doing so, we will explain and improve the new teaching model we tried out on the Moodle system, adapting it more precisely to the educational needs of our students.

We start with a review of the literature in which we examine various Technology Acceptance Models. We also analyse recent research into the acceptance of the various E-learning systems.

We then present the acceptance model and our hypotheses. Thirdly, we describe our data compilation method. Finally, we perform a statistical analysis of the data, present results and assess various hypotheses. The results are discussed and model limitations identified, along with future lines of investigation.

2. Literature review

Although many higher educational institutions currently use the Web for teaching and learning, little research has been done to identify the factors that influence students' acceptance of a Moodle-based learning system.

The TAM model was first introduced by Davis et al. (1989) to explain the acceptance and usage of information technologies. It was based on the "Theory of Reasoned Action" developed in Social Psychology by Fishbein and Ajzen (1975).

The Theory of Reasoned Action (TRA) is a general system designed to explain almost every type of human behaviour, and part of the importance of individual beliefs, in order to predict human conduct (Ajzen & Fishbein, 1980; Fishbein & Ajzen, 1975). TAM models centre exclusively on the analysis of information technology (Chau, 1996; Featherman & Pavlov, 2003; Mathieson, 1991; Taylor & Todd, 1995; Venkatesh, 2000) and, as opposed to TRA models, pre-establish those factors that condition user attitude towards innovation, behavioural intention and intensity of system usage. The two key factors in determining intention, which predict the development of an innovation and are present in all studies of TAM model development, are: perceived usefulness (PU) and perceived ease of use (PEOU) (Davis & Wiedenbeck, 2001; Davis et al., 1989).

Perceived usefulness is considered to be an extrinsic motivation for the user, and is defined as the degree to which a person believes that the use of a particular system can enhance work performance. Davis (1989), Lederer, Maupin, Sena, and Zhuang (2000) and Davis et al. (1989) insist on the influence that a belief such as usefulness has on user intention. An extensive body of theory on this, as well as empirical studies, allows us to affirm the link between both variables (Igbaria, 1993; Liaw & Huang, 2003; Triandis, 1977).

The other determining factor is ease of use, which is the degree to which the individual considers that the usage of a particular technology does not entail extra effort; the greater the perceived complication, the lower the degree. This has a positive influence on perceived usefulness (O'Cass and Fenech, 2003; Venkatesh, 2000).

However, this relationship between PU and PEOU variables has been questioned in other studies that find no empirical evidence to support it, although they verify their direct relationship to attitude and the user's final intention (Hu, Chau, Sheng, & Tam, 1999; Venkatesh, 1999, 2000).

Several investigations have shown the validity of this model through a wide range of Information Systems (Moon & Kim, 2001). The TAM model has an acceptable predictive validity when measuring the usage of new information and communication technologies, for example in electronic mail (Gefen & Straub, 1997), the Web (Agarwal & Karahanna, 2000; Agarwal & Prasad, 1998; Sánchez-Franco & Roldán, 2005), specific search engines (Morris & Dillon, 1997), websites (Lin & Lu, 2002; Van der Heijden, 2003), on-line sales (Chen, Gillenson, & Sherrell, 2002; O'Cass and Fenech, 2003), purchase intentions on the Web (Van der Heijden, Verhagen, & Creemers, 2003), etc.

Most TAM researchers have focused on its extrinsic perspective (Igbaria, Parasuraman, & Baroudi, 1996). Only recently have they taken account of the significance of non-cognitive aspects such as emotions, symbolism, desires, etc., in the understanding of attitudes towards usage of Information Systems and facets of human behaviour. Consequently, investigators call for the incorporation of intrinsic factors or other theories in studies that could enhance the TAM model (adapted from Hu et al., 1999; Legris, Ingham, & Collerette, 2003; Venkatesh & Davis, 2000).

There are few recent studies that explain the acceptance of Web-based learning systems. Lou, Luo, and Strong (2000) examined the critical mass effect as an external variable to explain acceptance of Groupware or collaborative software based on TAM. These authors acknowledged that the critical mass effect, perceived use and ease of use variables affected intention to use Groupware.

Selim (2003) investigated the student use and acceptance of course websites based on the variables of the perceived usefulness of the courses, perceived ease of use and usage. The results showed that there exists a significant relationship between usage and ease of use in determining usage of a website course.

Ngai, Poon, and Chan (2007) researched the factors that influence WebCT use in higher education institutions in Hong Kong, using the TAM model. They extended the model to include a new factor "technical support". The results revealed that technical support is an important direct factor in the feeling that the system is easy to use and is useful.

Van Raaij and Schepers (2008) studied the acceptance and usage of a virtual learning environment in China with the extended TAM2 model (Venkatesh & Davis, 2000), and the results indicated that perceived usefulness has a direct effect on the use of virtual learning environments (VLE). Perceived ease of use and subjective norms only had an indirect effect via perceived usefulness. It was also demonstrated that new variables related to personality traits, like being innovative and feelings of anxiety towards the computer, had a direct effect on perceived ease of use.

3. Research model and hypotheses

There has been growing empirical support over the years for TAM (Adams, Nelson, & Todd, 1992; Davis et al., 1989; Legris et al., 2003; Venkatesh & Davis, 2000), which has seen it become widely used for predicting acceptance of any new technology. We have used TAM for the same predictive validity it has shown in previous studies of

a similar context. Our research model is based on the study of the variables that affect the acceptance of the Moodle learning system using the TAM extension. We incorporate the technical support and computer self-efficacy variables but we discard intention to use, as Ngai et al. (2007) pointed out, when examining the validity and reliability of the variables, that lecturers' insistence on using a Web-based learning system had a great impact on the usage of that learning system. Even if a student's attitude towards Web-based learning systems were positive, they might have no intention of using one unless their lecturers deemed it necessary.

Our model consists of the following variables: technical support, perceived self-efficacy, perceived usefulness, perceived ease of use, attitude and system usage (see Fig. 1).

Several studies have already proved the existence of extrinsic and intrinsic factors that indirectly influence the acceptance of technologies, via perceived usefulness and perceived ease of use (Davis et al., 1989). In this study, we expect technical support and computer self-efficacy to be extrinsic and intrinsic factors respectively that affect acceptance of Moodle by University of Huelva students.

Ralph (1991) defines technical support as "people trained to help users in solving problems related to computer hardware and software", in the form of help desks, hot lines for complaints and suggestions, technical support on-line, by fax, telephone, etc.

Technical support is one of the most important factors in the acceptance of technology for teaching (Hofmann, 2002; Sumner & Hostetler, 1999) and in user satisfaction (Mirani & King, 1994).

Logically, a high degree of organizational support, including technical support, elicits more favourable attitudes that will lead to greater acceptance and the success of the personal computing systems (Igbaria, 1990).

Based on this, we propose the following hypotheses:

H1. Technical support has a positive effect on the computer self-efficacy towards using of Moodle.

H2. Technical support has a positive effect on the perceived ease of use of Moodle.

H3. Technical support has a positive effect on the perceived usefulness of Moodle.

Self-efficacy refers to the belief people have in their own ability to organize and execute actions required to handle future situations. The concept does not refer to the resources available but to the opinion one has on what can be done with them (Bandura, 1977). Put another way, self-efficacy is the confidence people have in their own ability to execute actions that need to be carried out.

Our study refers to self-efficacy with regard to computer systems, the confidence shown by users in their own ability to utilize these systems, which possibly influences perceived ease of use and acceptance of those computer systems (Gong, Xu, & Yu, 2004).

As a result, we propose the following hypotheses:

H4. Computer self-efficacy has a positive effect on the perceived ease of use of Moodle.

H5. Computer self-efficacy has a positive effect on the perceived usefulness of Moodle.

H6. Computer self-efficacy has a positive effect on attitudes towards using of Moodle.

As previously mentioned, perceived ease of use is defined as the degree to which a person believes that the use of a particular new technology will be effortless (Davis, 1989).

Our research defines ease of use of Moodle as the degree to which the user considers the usage of the system to be effortless. Davis (1989) showed that perceived ease of use directly affects perceived usefulness. Other TAM research empirically supports the positive relationship between perceived ease of use and perceived usefulness (Adams et al., 1992).

On the other hand, and as we explain in the literature review, Davis (1989) defines perceived usefulness as that belief people have that the use of some new technology would enhance their professional performance. The positive effect of this variable on the adoption of information technologies has been proved empirically on numerous occasions (Davis, 1989; Davis et al., 1989; Igbaria, Liveri, & Margahh, 1995; Lederer et al., 2000; Ong, YaLui, &
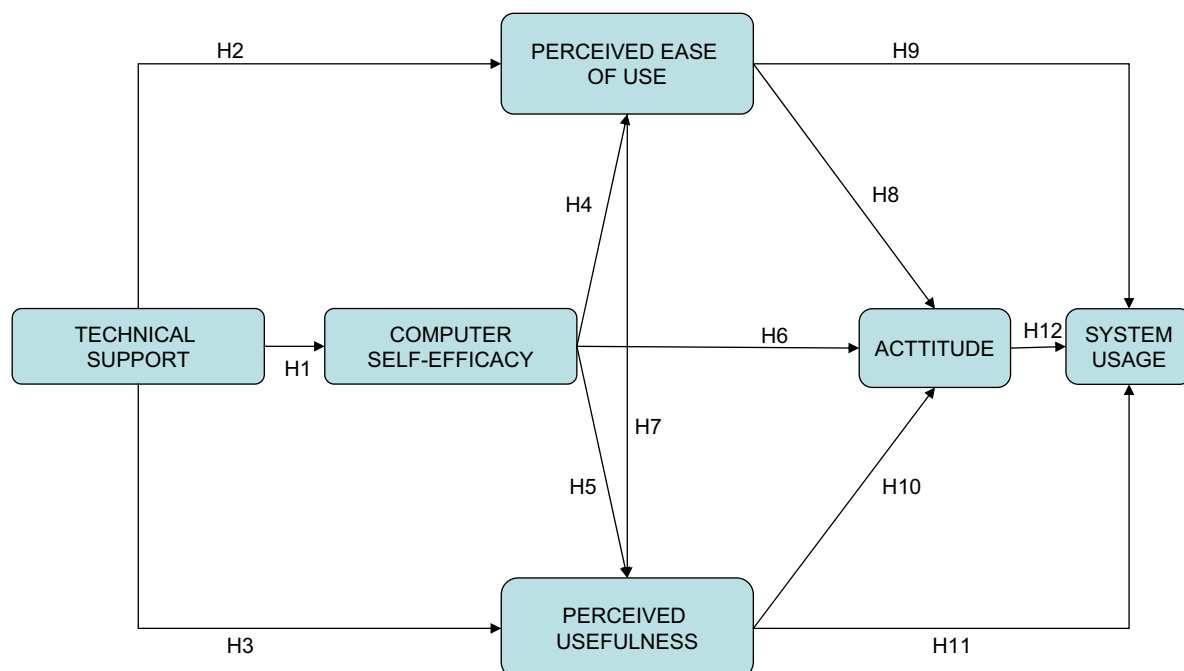

Fig. 1. Proposed model for the acceptance of the Moodle learning system.

Wang, 2004; Taylor & Tood, 1995; Venkatesh & Davis, 2000; Venkatesh, Morris, Davis, & Davis, 2003).

In our study, the perceived usefulness of Moodle is defined as the degree to which users believe that usage of the system would boost their learning capabilities (Davis, 1989). Improvement in results can be measured by the efficiency and efficacy of learning. TAM postulates that perceived usefulness and perceived ease of use have a direct effect on attitudes towards usage of new technology. Attitude is the degree to which the user is interested in specific systems, and it has a direct effect on intention to use those systems in the future (Bajaj & Nididumolu, 1998).

The usage of specific information systems is affected by perceived ease of use and perceived usefulness (Davis et al., 1989; Igbaria, Zinatelli, Cragg, & Cavaye, 1997; Selim, 2003).

So, we propose the following hypotheses:

H7. Perceived ease of use has a positive effect on the perceived usefulness of Moodle.

H8. Perceived ease of use has a positive effect on attitudes towards use of Moodle.

H9. Perceived ease of use has a positive effect on the use of Moodle.

H10. Perceived usefulness has a positive effect on attitudes towards use of Moodle.

H11. Perceived usefulness has a positive effect on the use of Moodle.

H12. Attitudes towards using Moodle have a positive effect on the use of Moodle.

4. Study method

4.1. Development of instruments

The research method used in our study is a questionnaire survey structured as follows: the first part consists of students' personal and academic data. The second part contains 28 items (see Appendix A) to assess the six variables of the model proposed, which are – technical support (TS), computer self-efficacy (CSE), perceived ease of use (PEOU), perceived usefulness (PU), attitude (A) and system usage (SU).

The items have been adapted from previous studies. Technical support was applied from a scale adapted by Igbaria (1990). Computer self-efficacy was developed using measurements taken from Compeau and Higgins (1995). Perceived ease of use and perceived usefulness are based on the Davis (1993) scale with modifications. Attitude is measured on a scale recommended by Ajzen and Fishbein (1980). These five variables were measured on a seven-point Likert scale ranging from 1 "strongly disagree" to 7 "strongly agree".

To measure Moodle acceptance, students were asked to rate frequency of usage on a scale of 1 "never" to 7 "a lot".

4.2. Sample and data collection

The sample was taken from students of the Business Management and Administration degree course (LADE), of the Faculty of Business Sciences, and from students of the Infant and Primary School Teaching degree course of the Faculty of Educational Sciences, both of the University of Huelva.

The questionnaire survey was completed in class after prior testing by two experts. After this pre-test, some questions were changed for greater clarification.

The questionnaire was completed by students on courses in April and May of academic year 2008/2009. Of the 266 questionnaires distributed, 226 were used for analysis. The overall response rate was 85%. We calculated sample error based on 1690 students enrolled in the LADE and teaching degree courses (see Table 1). The formula used to calculate sample error was $n = (Z^2 PQN)/[e^2(N-1) + Z^2 PQ]$; where n (sample): 226, N (total population size): 1690 enrolled students, $Z = 2$; $P = Q = 0.5$; e (sample error): 6.19%.

Based on a sample size of 226 valid questionnaires, with an unknown population variance, we reach a confidence level of 95%. Using a simple average of $Z = 2$, and with the least favourable hypothesis $P = Q = 0.5$ (P – the proportion of individuals with the characteristic and Q – the proportion of individuals without the characteristic; $1–P$), the maximum error is 6.19%.

5. Analysis and results

5.1. Demographics and descriptive statistics

The sample characteristics are presented in Table 2, which shows that 66.81% of those sampled were women, and 33.19% men.

We also observe that 54.42% of respondents were in their third year, and 28.32% were 21 years old. All 226 were official students, and there were no visiting students.

5.2. Results

The results of the empirical study were examined in three stages:

(a) Exploratory analyses to examine the validity of the variables proposed and to contrast the initial reliability of the scales.
(b) Confirmatory factorial analysis, to verify the dimensions obtained in the exploratory study and to allow set scales to be purged. It also facilitates the checking of the psychometric properties of factors that form part of the model.
(c) Causal analysis that contrasts the proposed structural relationships.

5.2.1. Data analysis

The sample of 226 students was split randomly into two subsamples. S1 contained 30% of the data, and S2 had 70%. The first exploratory analysis was carried out on sub-sample S1 using the SPSS program. Then Lisrel 8.80 and Amos 6 programs were used in the second confirmatory factorial analysis on sub-sample S2.

Table 1
Study specifications.

Population	
Sample units	LADE students
	Infant and primary education degree students
Sample elements	Students in the lecture theatre on a normal day of class
Location	Faculties of Business and Education, University of Huelva
Date	April and May 2009
Sampling	
Type	Random
Survey method	A questionnaire completed in class
Sample size	226 valid questionnaires
Sample error	±6.19%
Level of confidence	95% $Z = 2$ $P = Q = 0.5$

Table 2
Profile of the respondents.

	Frequency	Percentage
Gender		
Male	75	33.19
Female	151	66.81
Total	226	100.00
Academic year		
First	1	0.44
Second	25	11.06
Third	123	54.42
Fourth	77	34.07
Total	226	100.00
Occupation		
Student	226	100.00
Age		
19	6	2.65
20	44	19.47
21	64	28.32
22	44	19.47
23	28	12.39
24	20	8.85
25	9	3.98
26	7	3.10
29	2	0.88
32	1	0.44
37	1	0.44
Total	226	100.00
Course type		
Official	226	100.0
Visiting students	0	0
Total	226	100.00

5.2.2. Exploratory analysis

We made an exploratory analysis of the validity and reliability of the variables.

The validity of a variable is the degree to which a variable differs from the other set variables. Validity can be assessed by analysing the principle components with the Kaiser varimax rotation, as recommended in the literature (Kaiser, 1970, 1974; Hair, Anderson, Tatham, & Black, 1999).

The initial analysis of the principle components showed that we had to extract five components: technical support (TS), perceived ease of use (PEOU), perceived usefulness (PU), attitude (A) and system usage (SU). This was due to the computer self-efficacy variable loading onto perceived ease of use (PEOU), so we eliminated this variable from our model. Likewise, items TS_3, TS_4, TS_5 and TS_6 were also removed for loading onto a new component that did not coincide with the other items which explain the technical support (TS) variable. This was because the respondents were unaware of the possible existence, or not, of a fax number, e-mail, etc., to make technical enquiries about the Moodle system.

We made a second analysis of the principle components without the computer self-efficacy variable and items TS_3, TS_4, TS_5 and TS_6 from the technical support variable. We also introduced a new hypothesis (H13) that postulates the positive influence of technical support on attitude towards the use of Moodle.

In the second factorial analysis, the KMO (Kaiser–Meyer–Olkin) index was 0.834, suggesting the data was sufficiently interrelated and that a factorial analysis was feasible. Five components were obtained that explained the 76.23% variance in response to the survey, using the Kaiser–Guttman rule of eigenvalues above 0.95.

The results of the new analysis of principle components appear in Table 3. They show that the loading of each of the variables exceeds 0.4 (Nunnally, 1978), which proves that the items measured have sufficient validity. In our study, all factor loadings were equal or superior to 0.5.

The correlation matrix of the data set is presented in Table 4. Correlations higher than 0.3 were statistically significant at the 0.01 level. In our correlations matrix, the majority of correlations among items was significant at the 0.01 level, with values greater than or equal to 0.4.

We also checked that the correlations are stronger among items that measure the same variable than among items that measure different variables. As a result, the convergent and discriminant validity of our model is proved.

Table 3
Results of the analysis of principle components.

	Components				
	Factor 1 perceived usefulness	Factor 2 perceived ease of use	Factor 3 attitude	Factor 4 system usage	Factor 5 technical support
PU_1	0.65				
PU_2	0.67				
PU_3	0.76				
PU_4	0.84				
PU_5	0.83				
PU_6	0.69				
PEOU_1		0.80			
PEOU_2		0.78			
PEOU_3		0.85			
PEOU_4		0.80			
A_1			0.73		
A_2			0.50		
A_3			0.76		
A_4			0.66		
SU_1				0.82	
SU_2				0.93	
TS_1					0.79
TS_2					0.72
Cronbach α	0.91	0.90	0.86	0.83	0.70
Eigenvalue	8.18	1.80	1.60	1.17	0.95
Cumulative variance explained (%)	22.98	43.09	56.85	67.77	76.23

Extraction method: analysis of principle components. Rotation method: Varimax normalization with Kaiser

Table 4
Correlations matrix.

	TS_1	TS_2	PU_1	PU_2	PU_3	PU_4	PU_5	PU_6	PEOU_1	PEOU_2	PEOU_3	PEOU_4	A_1	A_2	A_3	A_4	SU_1	SU_2
TS_1	1																	
TS_2	.285*	1																
PU_1	0.127	-0.068	1															
PU_2	0.159	0.025	.486**	1														
PU_3	0.153	0.004	.598**	.643**	1													
PU_4	0.054	-0.096	.603**	.606**	.761**	1												
PU_5	0.129	-0.007	.610**	.608**	.526**	.706**	1											
PU_6	-0.012	-0.156	.699**	.489**	.656**	.627**	.669**	1										
PEOU_1	0.042	-0.11	.591**	.432**	.442**	.408**	.442**	.559**	1									
PEOU_2	0.019	0.024	.498**	.476**	.378**	.350**	.508**	.506**	.715**	1								
PEOU_3	0.207	-0.025	.402**	.394**	0.202	.289*	.371**	.330**	.675**	.662**	1							
PEOU_4	0.173	0.125	.458**	.473**	.328**	.345**	.364**	.447**	.703**	.713**	.665**	1						
A_1	.253**	.363**	.345**	.404**	.455**	.340**	.270*	.320**	.386**	.329**	.429**	.476**	1					
A_2	0.215	-0.065	.621**	.453**	.472**	.502**	.496**	.572**	.654**	.488**	.587**	.509**	.572**	1				
A_3	0.117	0.026	.528**	.450**	.614**	.513**	.427**	.607**	.448**	.516**	.341**	.456**	.607**	.648**	1			
A_4	0.078	0.016	.609**	.478**	.528**	.513**	.489**	.734**	.481**	.534**	.447**	.509**	.535**	.644**	.720**	1		
SU_1	-0.064	-0.162	.467**	.480**	.417**	.412**	.304*	.377**	.409**	.516**	.360**	.374**	0.191	.387**	.315*	.536**	1	
SU_2	0.055	-0.221	.281*	.306*	.301*	.267*	0.114	0.221	.271*	.351**	.335**	0.229	0.117	.266*	0.245	.406**	.752**	1

* Correlation significant at 0.05 level.
** Correlation significant at 0.01 level.

Finally, we made a preliminary analysis of the reliability of our model's measurement scale using Cronbach's alfa, the indicator most widely used for this type of analysis. This coefficient covers values of between 0 and 1. In our study, the Cronbach alfa for each of the five variables is greater than or equal to the 0.7 threshold, above which reliability is considered acceptable (Nunnally, 1978). Table 3 shows the Cronbach alfa coefficient ranging from 0.70 to 0.91, which indicates that the instrument can be regarded as reliable and internally coherent.

5.2.3. Confirmatory factorial analysis

After deleting the computer self-efficacy variable and the TS_3, TS_4, TS_5 and TS_6 items, the proposed structural model was revised and examined using structural equation models (SEM). SEMs originated as a tool to study measurement models, to analyse the relationship between a set of indicators or observed variables or between one or more latent variables and factors (Hoyle, 1995).

A confirmatory factorial analysis was made on the second sub-sample (S2) using Lisrel 8.80 and Amos 6 software. The estimation method was of maximum probability (Hu & Bentler, 1995).

To assess the model fit, we followed recent recommendations on the convenience of using multiple adjustment indicators (Hu & Bentler, 1995; Hu et al., 1999).

The goodness fit indexes we used were: Chi-squared, in which less than 3 is a good fit; GFI (Goodness of Fit Index) ranges from 0 (bad fit) to 1 (perfect fit); AGFI (Adjusted Goodness of Fit Index), with an acceptable value greater than or equal to 0.08; NFI (Normed Fit Index) recommends a value of 0.9 within a range of 0 and 1; CFI (Comparative Fit Index) fluctuates between 0 and 1, and RMSEA (Root Mean Squared Error of Approximation) fits well between 0.05 and 0.08.

As seen in Table 5, the goodness of fit of all the statistics falls within an acceptable range with the exception of GFI, which is close enough to the recommended value to be acceptable.

The results of the structural model are presented in Table 6 and Fig. 2. Table 6 shows the values of the R^2 coefficient of determination for each endogenous variable. It should be noted that the R^2 values for perceived usefulness, attitude and system usage, at 54%, 77% and 41%, respectively, are well supported.

Fig. 2 and Table 6 highlight the important structural relationship among the study variables. Hypotheses 2, 3 and 13 postulate that technical support has a positive influence on perceived ease of use (H2), perceived usefulness (H3) and attitude (H13). The findings show that technical support has a direct effect on perceived ease of use and perceived usefulness ($\beta = 0.43$ and 0.15, $p < 0.01$ and $p < 0.05$, respectively). Although the direct effect of technical support on attitude is insignificant ($\beta = 0.03$, $p > 0.05$), it is important to note that the indirect effect on attitude through perceived usefulness and perceived ease of use is significant ($\beta = 0.39$, $p < 0.01$). As a result, H2 and H3 are supported but H13 is rejected.

Hypotheses 7, 8 and 9 refer to the relationship between perceived ease of use and perceived usefulness (H7), attitude (H8) and system usage (H9). In line with other TAM studies (Davis, 1989, 1993), our model confirms that perceived ease of use has a direct effect on perceived usefulness ($\beta = 0.66$, $p < 0.01$), attitude ($\beta = 0.29$, $p < 0.01$) and Moodle usage ($\beta = 0.30$, $p < 0.01$). It also has a strong indirect effect on attitude through perceived usefulness ($\beta = 0.42$, $p < 0.01$). As a result, H7, H8 and H9 are supported.

Hypotheses 10 and 11 postulate the impact of perceived usefulness on attitude (H10) and Moodle usage. Perceived usefulness has a positive effect on attitude ($\beta = 0.63$, $p < 0.01$) and a weak effect on system usage ($\beta = 0.02$, $p > 0.05$). Thus, we accept H10 and reject H11.

Table 5
Statistical summary of model fit.

Model goodness of fit indexes	Recommended value	Results in this study
Chi-squared/degree of freedom	$\leqslant 3$	1.72
Goodness of Fit Index (GFI)	$\geqslant 0.90$	0.88
Adjusted Goodness of Fit Index (AGFI)	$\geqslant 0.80$	0.84
Comparative Fit Index (CFI)	$\geqslant 0.90$	0.99
Normalized Fit Index (NFI)	$\geqslant 0.90$	0.97
Root Mean Squared Error of Approximation (RMSEA)	$\leqslant 0.08$	0.06

Hypothesis H12 focuses on the influence of attitude on system usage. The results indicate that attitude positively and significantly affects system usage ($\beta = 0.37$, $p < 0.05$), so we accept H12.

Finally, hypotheses 1, 4, 5 and 6 are rejected since perceived the self-efficacy variable was deleted.

6. Conclusions

New information and communication technologies have developed considerably in recent years, and E-learning systems have become an important strategy for helping students to overcome problems such as geographical isolation from teaching centres and the need to constantly update and recycle knowledge that the information society imposes on us. As a result, the main aim of our study has been to investigate the factors that influence students to use the Moodle virtual teaching system.

Table 6
Effects of the variables on the acceptance of Moodle.

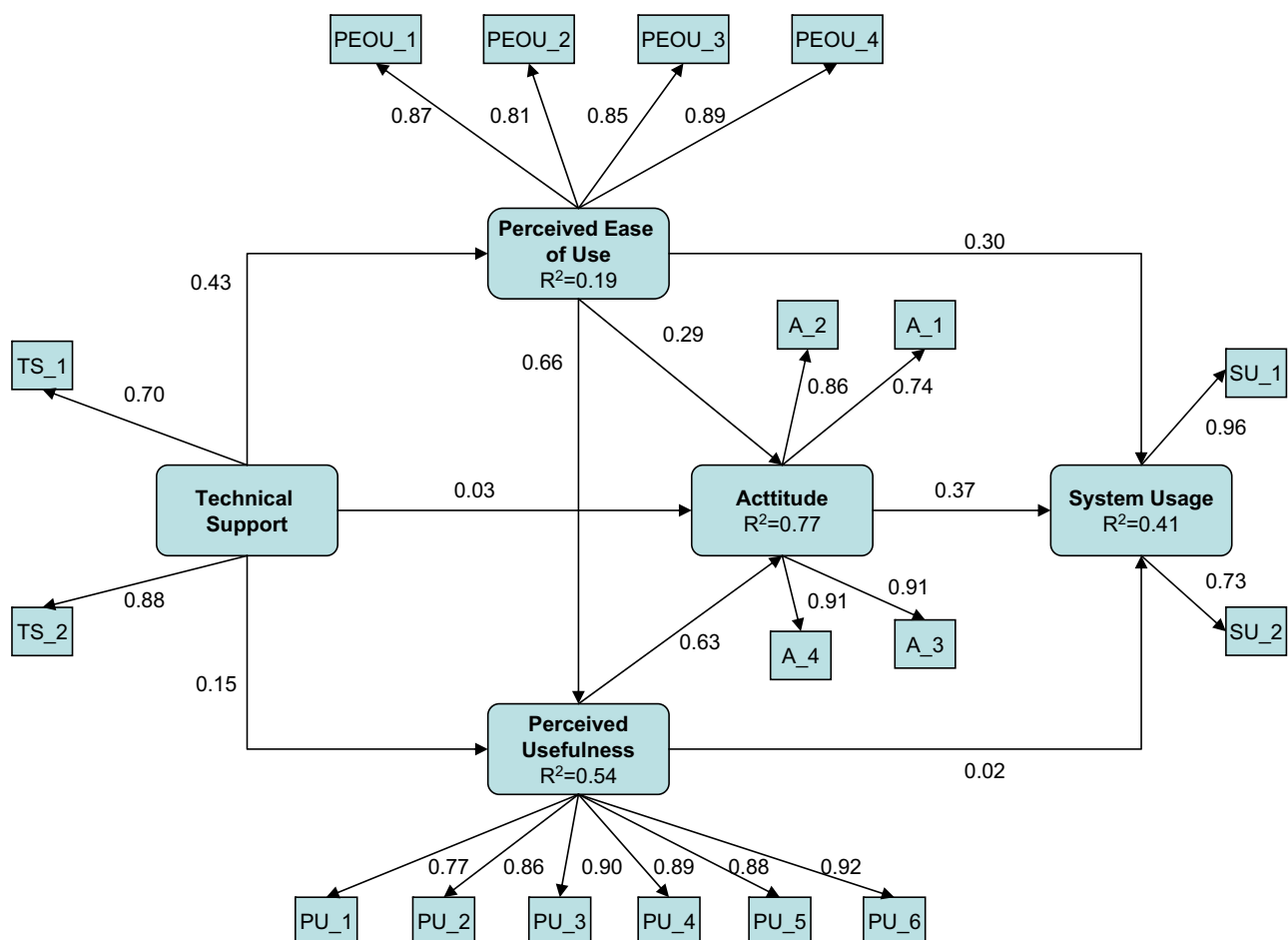|	Perceived ease of use		Perceived usefulness		Attitude		System usage	
	Direct effects	Indirect effects	Direct effects	Indirect effects	Direct effects	Indirect effects	Direct effects	Indirect effects
Technical support	0.43**		0.15*	0.28**	0.03	0.39**		0.29**
Perceived ease of use			0.66**		0.29**	0.42**	0.30**	0.27**
Perceived usefulness					0.63**		0.02	0.23*
Attitude							0.37*	
R^2	0.19		0.54		0.77		0.41	

* $p < 0.05$.
** $p < 0.01$.

Fig. 2. Result of the structural model.

By means of an extension of TAM, we have postulated a structural model to research the relationships among five variables: technical support, perceived usefulness, perceived ease of use, attitude and system usage. Most of the causal relationships among the variables are well supported, and the study reaffirms the convenience of applying TAM to measure acceptance in E-learning systems (Ngai et al., 2007).

The results show that the extrinsic variable, technical support, has a direct effect on perceived ease of use and, as in other studies (Ngai et al., 2007), on perceived usefulness. It also has a significant indirect effect on attitude, which underlines the importance of technical support both on a personal level and via the Web, as well as training users to use Moodle. Universities need to recruit personnel trained in the use of distance learning systems in order to support teaching staff and students, and boost the motivation to use the learning systems.

We also note that system usage is directly influenced by ease of use and attitude but very weakly by perceived usefulness. The weak influence of perceived usefulness on system usage could be due to the fact that students are urged to use the system by their lecturers, hence perceptions of use are not entirely real but influenced, and they do not have a strong direct relationship with system usage. We also see that perceived usefulness has a considerable indirect influence on system usage through attitude.

The findings also illustrate that perceived ease of use is a key element that links the exogenous variable (technical support) to perceived usefulness, attitude and system usage. This suggests that it is important to foster user self-confidence so they see that the system is easy to use. Technology advances rapidly and society needs time to adapt to changes brought on by the arrival of new systems. Adults more than young people fear the unknown and are prone to urban myths and prejudice against new technology that often has no basis in reality. If users have difficulty using a system, they might really believe that the system is too difficult to use and the benefits they will gain are not worth the effort.

So we urge system designers to incorporate more assistance options and support services in order that their users, students and teachers alike, can resolve problems and answer possible doubts about the system. We emphasise the role of the teacher in these technologies as constant providers of support for their students, resolving any doubts that arise on the platform.

Given the importance of the technical support variable in this study, and despite the University of Huelva's best efforts to strengthen the quality of technical support to teachers based on the virtual learning system, we believe more human resources and materials are necessary to provide the student with this same service.

In line with previous E-learning studies, we initially incorporated perceived self-efficacy in our model. Following the exploratory analysis, this intrinsic variable had to be rejected because it loaded onto the same component as perceived ease of use, in other words, they were similar variables.

This research has some limitations, in that students' varied experience and time spent using the system are not quantified. The determination coefficient of system usage ($R^2 = 0.41$) is very good, and implies that other variables can influence system usage to enhance that value.

Future research should explore other variables that might affect usage of the Moodle system, which could be teacher support for the students, peer support, as well as variables related to the system itself, such as accessibility, appearance, fashion, etc.

Appendix A. Questions used in the study

Technical support

TS_1	The system provides assistance when there is a technical problem
TS_2	A hotline is available at any time
TS_3	Enquiries by fax can be made when there is a technical problem
TS_4	E-mail enquiries can be made when there is a technical problem
TS_5	Web-based enquiries can be made when there is a technical problem
TS_6	The system offers good technical support

Perceived usefulness

PU_1	The Web-based system helps me to learn more efficiently
PU_2	The Web-based system improves my academic performance
PU_3	The Web-based system makes my learning more effective
PU_4	The Web-based system makes it easier to learn at university
PU_5	The Web-based system gives me more control over my learning
PU_6	Overall, the Web-based system is advantageous for my learning

Computer self-efficacy

CSE_1	I can access the contents of the Web-based system
CSE_2	I can freely navigate the contents of the Web-based system
CSE_3	I can use the Web-based system without needing to be told how it functions
CSE_4	I can solve problems that arise on the Web-based system
CSE_5	I can use the Web-based system if there are user manuals available
CSE_6	Overall, I am able to use the Web-based system

Perceived ease of use

PEOU_1	Learning to use the Web-based system is easy for me
PEOU_2	It is easy to get materials from the Web-based system
PEOU_3	The process of using the Web-based system is clear and understandable
PEOU_4	Overall, I believe that the Web-based system is easy to use

Attitude

A_1	Learning on the Web-based system is fun
A_2	Using the Web-based system is a good idea
A_3	The Web-based system is an attractive way to learn
A_4	Overall, I like using the Web-based system

System usage

SU_1	I use the Web-based system on a scale of 1- never to 7- a lot
SU_2	The number of hours I spend on the Web-based system, on a scale of 1-never to 7- a lot of hours)

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