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PSYCHOMETRIC ANALYSIS OF A PERCEPTION SCALE ON THE USEFULNESS OF MOODLE IN THE UNIVERSITY

[Análisis psicométrico de una escala de percepción sobre la utilidad de Moodle en la Universidad]

by/por

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Article record
About authors
HTML format

Ficha del artículo
Sobre los autores
Formato HTML

Abstract

Because of the acquired relevance of learning management systems in higher education, and the spread of the use of the *Moodle* platform in many academic institutions, a scale of perceived usefulness of the*Moodle* in this context is designed, and the psychometric validity of the scale has been tested. The aim is to provide a reliable and valid instrument to measure the students' perception about the usefulness of*Moodle*. The study obtained a sample of 754 subjects from the population of university students in fields of Educational Sciences. The results show that the scale evaluates the utility of the platform adequately in five dimensions: content, activities, assessment, interaction and learning. Finally, a discussion is developed about the usefulness of the scale to evaluate the usefulness of *Moodle* and to implement processes to improve its use in higher education institutions.

Keywords

Information and communication technologies, computer application, evaluation, factor analysis

Resumen

Dada la importancia que los entornos virtuales de aprendizaje (*learning management systems*) han adquirido en la educación superior, y la generalización en el empleo de la plataforma *Moodle* en muchas instituciones universitarias, se diseña y se validan las cualidades psicométricas de una escala de utilidad percibida sobre el uso de *Moodle*. Se pretende aportar un instrumento válido y fiable que permita comprobar cuál es la percepción de los estudiantes sobre la utilidad de *Moodle*. De la población de estudiantes universitarios del ámbito de las Ciencias de la Educación, se obtiene una muestra de 754 sujetos. Los resultados manifiestan que la escala evalúa, adecuadamente, la utilidad de la plataforma en cinco dimensiones: contenidos, actividades, evaluación, interacción y aprendizaje. Finalmente, se discute sobre la utilidad de la escala para evaluar la utilidad de *Moodle* y para la implementación de procesos de mejora de su empleo en las instituciones de Educación Superior.

Descriptores

Tecnología de la información y la comunicación, aplicación informática, evaluación, análisis factorial.

Learning Management Systems (*LMS*) have acquired a significant relevance as support tools for learning (Britain and Liber, 1999; Melton, 2006; Ellis, 2009) in Higher Education, due to the fact that they allow us to manage contents, to establish synchronous and an asynchronous communication and to manage student assessment (Ross, 2008). However, these organisational changes entail a modification of the tutoring processes and types of activities, while they enable a constant and continuous monitoring of the students' evolution

(Antonenko, Toy and Niederhauser, 2004). Their main interest lies in the space that Information and Communication Technologies (ICT) take up in all sectors of the global society (Castells, 1999; Cohen and McCuaig, 2008). This fact opens up new fields of ICT-related research, such as the one explored in this study.

We can consider an LMS as "*a software system that combines a number of different tools that are used to systematically deliver content online and facilitate the learning experience around that content*" (Weller, 2007, p. 5). These environments have evolved in the past few years and they have been used as a complement in diverse learning formats and contents, from a face-to-face context to an exclusively virtual one (e-learning), including mixed or b-learning contexts (DeNeui and Dodge, 2006; Conrey and Smith, 2007; Vaughan, 2007).

Their didactic contribution lies in the combination of elements that are specific to traditional teaching (information presentation, accessibility to materials, evaluation of student work) (Yueh and Hsu, 2008), and a series of additional elements that provide multiple communication pathways (including learning-centred social media) (Ellison, Steinfield and Lampe, 2007). Thus, this supports the adjustment of "traditional tools" to the new teaching-learning scenarios conditioned by the potential provided by the use of *LMS* (Pérez and Garcias, 2007).

LMS entail innovative elements that have different characteristics from face-to-face education and allow students to take a more active role (Silva Quiroz, 2011). Their integration in the different educational stages favours both the virtual learning and the student-teacher interaction. Consequently, the student's role is redefined as an individual who generates and transmits knowledge on the net. To this end, the student needs a series of skills aimed at self-regulating the leaning process and favouring the construction of knowledge through information searching, selection, transformation and dissemination (Barberá and Badía, 2004).

To attend to the characteristics of LMS and the need to promote an active role for the students, different free-access or commercial-access platforms have been designed and implemented (Martín-Blas and Serrano Fernández, 2008): *Atutor*, *Claroline*, *ILIAS*, *Chamilo*, *Moodle*, *LRN*, *Teleduc*, *FLE3*, *Ganesha*, etc. The institutions' choice is based on criteria such as the users' needs, the cost and the potential number of users (Martín-Blas and Serrano Fernández, 2008).

In the educational field, many universities have decided in favour of the *Moodle* platform. It is an open resource based upon pedagogycal principles (Cole y Foster, 2007; Goyal y Puhorit, 2010), which integrates diverse multimedia resources. For these very reasons, *Moodle* has become one of the most used LMS in Higher Education (Aydin and Tirkes, 2010; Saito and Ulbricht, 2012; Williams van Rooij, 2012).

Moodle is presented as a platform that provides the necessary tools for virtual education (Aydin and Tirkes, 2010; Saito and Ulbricht, 2012; Williams Van Rooij, 2012). In addition, it promotes new learning, easing the access to the material in an organised way (Peat and Franklin, 2002).

Thus, *Moodle* facilitates the development of the teaching-learning processes in *e-learning*, *b-learning* and face-to-face education through elements such as interaction (Swan, Shea, Fredericksen, Pickett, Pelz and Maher, 2002), usability (Kirner and Saraiva, 2007) and social presence (Richardson and Swan, 2003).

In this sense, it becomes clear that *LMS* improve learning outcomes (Martín-Blas and Serrano-Fernández, 2009; Núñez et al., 2011; Escobar-Rodríguez and Monge-Lozano, 2012), and that teachers who use virtual resources increase student attention and participation, enabling a more meaningful learning process (Soyibo and Hudson, 2000). Other authors such

as Steyaert (2005) prove that both *LMS* and the use of the internet, allow teachers to organise the contents by topics and to manage the organisation of the subject in a more efficient way, enabling a simpler visualisation of the syllabus (Peat and Franklin, 2002).

Therefore, the aim of LMS in general, and *Moodle* in particular, entails interaction with the information and joint work between teachers and students. However, reality seems to be far from this aim, and these environments are often used as mere document repositories.

In this context, the interest of studying the students' perception of the virtual platform's usefulness in Higher Education processes becomes apparent. With the aim of analysing and trying to collaborate in the improvement of the implementation of LMS, we have designed a scale for its real use in university contexts.

It is a fact that the usefulness perceived by the user is extremely important for the success of a technological tool such as LMS (Davis, 1993; Friedrich and Hron, 2010; Sørebø, Halvari, Gulli and Kristiansen, 2009). Several studies based on the Technology Acceptance Model (Davis, Bagozzi and Warshaw, 1989), developed from the Theory of Reasoned Action (Ajzen and Fishbein, 1980; Rus, Pina, Sánchez and Martínez, 2011), which explains the current use of technologies based on the attitudes of the user towards the very use of the technologies, the usefulness and the perceived ease of use, show that there is a positive relationship between the use of a given technology and these three variables. Thus, people's beliefs about an object will influence their attitude towards it. Therefore, the level and frequency of use of an LMS will be partly affected by the individual attitudes towards it. If we wish the LMS to be integrated in the teaching methods we need to promote adequate attitudes towards these tools.

Based on the scarcity of studies in this field (that provide valid and reliable measuring instruments) that help to design and evaluate empirical models based on the Technology Acceptance Model, it seems useful to design a scale of the student's perception of the usefulness of *Moodle* within the learning process. Therefore, the ultimate aim of this study is to create a tool that provides valuable information on the integration of *Moodle* in the university context and that allows for improvements in the teaching-learning environments that integrate LMS

Method

Participants

From the total population of university students enrolled in Educational Sciences degrees in the academic year 2011-12 we established a non-probability accidental sample (Arnal, Rincón and Latorre, 1992) comprising 754 subjects. Thus, considering an infinite population, and supposing maximum variability (p=q=.5) and a k-sigma=2, the error obtained for the sample is 3.64%.

Variables and instruments

The instrument consists of a scale designed to evaluate the students' perception of the usefulness of *Moodle* in the university teaching processes. We chose a survey study based on a quantitative instrument.

After the content validation process (with judges), we obtained an instrument composed by 40 items (see table 1). It is a Likert-type scale (Morales, Urosa and Blanco, 2003), with four response options (0=not at all, 1=not much, 2=quite a lot, 3=a lot/very much). The items are distributed in five theoretical dimensions (Moore and Iida, 2010; Palmer and Holt, 2010; Al-Busaidi and Al-Shihi, 2012):

- Contents (9 ítems): Level of suitability of the transference of contents to a virtual platform.
- Activities (11 ítems): Student perception on the real usefulness of *Moodle* as a work environment.
- Assessment (8 ítems): Assessment strategies used in the platform.
- Interaction (4 ítems): Level of relationship between students and teachers within the platform.

- Learning (8 ítems): Student opinion on the degree to which the platform facilitates learning.

Table 1: Questionnaire items about student perception on the usefulness of Moodle

	Wording
Contents_01	There is a logic organisation of the teaching units
Contents _02	The contents are appropriate to the syllabus
Contents _03	The contents are updated
Contents _04	The resources uploaded by the teacher are interesting
Contents _05	*Studium* is an efficient tool to get relevant information related to the subject
Contents _06	I like that the teacher provides the class with presentations through *Studium*
Contents _07	The links to web sites selected by the teacher allow us to extend the topic of study and understand it better
Contents _08	The videos or the images selected allow us to learn in a more intuitive and dynamic way
Contents _09	I am interested in checking all the resources listed in *Studium*
Activities_01	Critical thinking
Activities _02	Drawing up creative and personal syntheses
Activities _03	Applying knowledge to real-life situations
Activities _04	Problem solving
Activities _05	Understanding basic concepts and ideas within the discipline
Activities _06	Analysis and reflection on the contents
Activities _07	Memorizing and reproducing contents
Activities _08	Evaluating and giving personal value judgements about the covered topics
Activities _09	Researching and/or consulting other sources and materials
Activities _10	Cooperative work among the students
Activities _11	Organising the study and presenting assignments on time
Assessment_01	The teacher proposes self-assessment activities in the platform
Assessment_02	The teacher lays out the exams in the platform
Assessment_03	There is a clear definition of the assessment criteria for the activities proposed by the teacher
Assessment_04	The teacher assesses the assignments in the platform
Assessment_05	The teacher offers continuous feedback to the students in the platform
Assessment_06	The teacher assesses participation in the platform
Assessment_07	All the activities proposed in the platform have an influence on the final mark of the subject
Assessment_08	We have access to grades in the platform
Interaction _01	*Studium* allows for a more fluid communication with the teacher
Interaction _02	It promotes longer and more continuous tutoring sessions with the teacher (they are not limited to a fixed timetable)
Interaction _03	It promotes communication among students
Interaction _04	It is the tool that I most frequently use to communicate and work with other classmates
Learning_01	It complements face-to-face learning
Learning _02	It increases my involvement with content learning
Learning _03	It constitutes an environment that favours the knowledge building process
Learning _04	It facilitates learning
Learning _05	It is important for my future professional practice because it allows for continuous learning
Learning _06	It enables cooperative learning by allowing the students to share information and opinions with their classmates
Learning _07	It makes it possible to attend to the diverse interests of the students
Learning _08	It is motivating to receive feedback from the teacher about the learning process (through the correction of tasks and exercises, interaction in the forums...)

Content validity is guaranteed through expert judges. The first draft, composed of 32 items, was assessed based on clarity and relevance criteria by eight experts in educational technology, three experts in research methodology and four university students. Based on these assessments we drew up the survey that was administered to the sample.

Each expert judge had to indicate whether each of the 32 items assigned to the theoretical dimensions was adequate. In the case an item was deemed inadequate, the judge specified some recommended modifications. Given that we have a qualitative and multi-judge measurement, we decided to calculate the concordance index and the Kappa index (Cohen, 1960) to check the level of interjudge agreement, considering each questionnaire item as an observed subject, in particular based on the calculation of the *free-marginal multirather Kappa* (Brennan and Perdiger, 1981). This index is recommended when the judges are unaware *a priori* of the number of cases they must assign to each category in the different observations, which is the case here (Brennan and Prediger, 1981). Thus, we obtained a concordance index of 83.75% and a Kappa index of .67, from which we can consider the existence of a good level of interjudge agreement (Landis and Koch, 1977).

Procedure

The first version of the questionnaire was designed in November 2011. After the judges' assessment, the instrument went from 32 items to 40.

The data collection was carried out between January and June 2012 through an on-line survey procedure. The resource that integrated the questionnaire guaranteed anonymity, which avoids social desirability bias.

We tried to reduce the measurement errors which stemmed from the survey respondents by standardizing the conditions for administering the survey. Each survey taker was given precise instructions so that they would pass on systematic information to the participants.

Given the low partial non-response index, which is not over 1.5% in any item (the highest frequency amounts to 10 lost values), considering in consequence that the effect of imputation is going to be minimum, we applied classical imputation techniques. On the other hand, taking into account the multivariate techniques used below, to avoid overestimation of the correlation coefficients among the variables, we decided to substitute the lost values with the unconditional mean imputation (Medina and Galván, 2007).

Data analysis

Even though, given the nature of the scales used in this study, it might be preferable to use alternative methods other than those based on Person's correlation matrix, (López-González, Pérez-Carbonell and Ramos, 2011; López-González, 2012) or the use of the polychoric correlation matrix (Elosua Oliden and Zumbo, 2008), the vast scientific evidence developed in the '70s and '80s of the 20th century (Hofacker, 1984; Labovitz, 1967, 1970; Morales Vallejo, 2006) suggests that the use of these methods entails small biases (Nunnally, 1978).

In this study, given that "any answer codification, consistent with the conceptual order, does not distort the statistical conclusions to an acceptable degree" (Morales Vallejo, 2006, p. 39), we consider the Likert-type scale used as an interval scale, and we used Pearson's correlation for the calculation of the matrices. However, we conducted a previous analysis to confirm this, which consisted in comparing Pearson's correlation matrix and the polychoric correlation matrix obtained, confirming that the differences among the coefficients, always in favour of the polychoric correlation matrix, do not exceed in any case a 0.2 value, and in 87% of the cases they don't reach a 0.1 value.

We started by studying the inter-item correlation between the groups of items within each dimensions. When we obtained excessively low or high correlation indexes we assessed their elimination by studying their theoretical importance and/or their co-linearity with other items of the factor.

We checked the previous assumptions of univariate and multivariate normality, homoscedasticity and non multi co-linearity, with the aim of selecting the most suitable estimation method. Once checked, we studied the dimensional characteristics of each theoretical factor and the possible reduction of dimensions of their item groups through a Principal Components Analysis (Martorell, González, Ordóñez and Gómez, 2011).

After that, we measured the reliability through Cronbach's alpha, both for the whole of the scale and the groups of items that make up each principal component, and we also measured the reliability of the factors through the Composite Reliability Index (CRI). Finally, we studied both the convergent and the discriminant validity through the calculation of the Average Variance Extracted (AVE).

Once the reliability and validity of the dimensions that make up the scale had been proven, we confirmed the model's goodness-of-fit through a confirmatory factor analysis (CFA). We studied the normed absolute fit indexes, such as Root Mean Square Error of Approximation (RMSEA), the Root Mean Square Residual (RMR) or the Goodness of Fit Index (GFI), and also the incremental fit indexes, including the Adjusted Goodness of Fit Index (AGFI), the Normed Fit Index (NFI) or the Relative Fit Index (RFI).

The results of this study have been obtained by using the statistical programme *IBM SPSS* v.21, together with its extension *AMOS*, *Excel* y *Epidat 3.1*.

Results

Item analysis

The study of item-element correlations, considering as low correlations those below or close to .4 (Morales Vallejo, 2006), focuses its attention only on two items of the theoretical dimension contents (see table 2).

Table 2: Total-element statistics for each theoretical dimension

	Contents	Activities	Assessment	Interaction	Learning
Item 01	.525	.602	.495	.626	.577
Item 02	.604	.626	.491	.672	.693
Item 03	.526	.586	.540	.714	.688
Item 04	.597	.626	.613	.522	.676
Item 05	.550	.593	.516	-	.733
Item 06	**.388**	.633	.587	-	.674
Item 07	.564	.477	.616	-	.664
Item 08	.553	.572	.568	-	.549
Item 09	**.406**	.511	-	-	-
Item 10	-	.508	-	-	-
Item 11	-	.483	-	-	-
Cronbach's α	**.818**	**.864**	**.827**	**.809**	**.883**

Firstly, item 06 is considered of theoretical relevance because it belongs to the factor that addresses the resources related to class presentations, so we did not consider discarding it. Item 09, apart from being vague and excessively generic in its definition, addressing generally the interest of revising any kind of resource, slightly overlaps with item 04. In addition, the perspective provided by item 04 is closer to what we desire to convey with the item, so we decided to remove item 09 from the definitive scale.

Regarding the rest of theoretical dimensions, we do not observe indexes below .4 or above .8. On the other hand, by analysing the inter-item correlations for each dimension, we obtained acceptable correlation items for the most part, and in any case above .75.

Previous assumptions

After checking the co-linearity multi co-linearity assumption, we obtained Variance Inflation Factor values below 2.5, and condition indexes below 25 points for all items with regard to their theoretical dimension. On the other hand, the value of the correlation coefficient between the items of different dimensions does not exceed ~~a~~ .75 in any case.

Regarding normality and homoscedasticity, being CFA a multivariate technique, we must check both the univariate and the multivariate normality. The Kolmogorov-Smirnov test locates, in every case, the contrast statistic in the reject area of H_0 (α=.05). Table 3 shows how all null hypotheses are rejected with a p-

value below .001. On the other hand, Mardia's Coefficient (Mardia, 1970) results in a standardized score of 67.669 points, meaning that the joint distribution of the items is very far from the normal multivariate distribution. Thus, the normality of the data is not confirmed, and we will select an estimation method that does not imply this previous assumption.

Table 3: Tests for the verification of normality and homoscedasticity

	Asymmetry	Critical Ratio	Kurtosis	Critical Ratio	Z (k-s)	p.
Contents_01	-0.410	-4.594	1.141	6.393	9.376	<.001
Contents_02	0.128	1.431	0.801	4.492	10.995	<.001
Contents_03	-0.358	-4.010	0.527	2.952	9.106	<.001
Contents_04	-0.172	-1.925	0.657	3.680	9.941	<.001
Contents_05	-0.456	-5.115	0.212	1.191	8.446	<.001
Contents_06	-1.678	-18.811	3.187	17.863	12.162	<.001
Contents_07	-0.555	-6.216	0.881	4.94	8.454	<.001
Contents_08	-0.538	-6.027	0.521	2.923	8.201	<.001
Activities_01	-0.381	-4.267	1.753	9.828	10.119	<.001
Activities_02	-0.400	-4.485	0.762	4.270	9.160	<.001
Activities_03	-0.259	-2.908	0.486	2.726	8.903	<.001
Activities_04	-0.301	-3.371	1.281	7.178	9.741	<.001
Activities_05	-0.305	-3.415	0.942	5.280	9.318	<.001
Activities_06	-0.178	-1.993	0.174	0.977	8.900	<.001
Activities_07	-0.308	-3.453	0.891	4.992	9.505	<.001
Activities_08	-0.367	-4.112	0.550	3.082	8.635	<.001
Activities_09	-0.604	-6.776	0.173	0.968	7.666	<.001
Activities_10	-0.851	-9.541	0.945	5.296	8.203	<.001
Activities_11	0.167	1.874	-1.182	-6.626	4.794	<.001
Assessment_01	0.450	5.046	-1.062	-5.955	6.710	<.001
Assessment _02	-0.555	-6.226	-0.093	-0.523	7.656	<.001
Assessment _03	-0.582	-6.521	-0.801	-4.492	6.271	<.001
Assessment _04	-0.037	-0.420	-0.922	-5.168	5.705	<.001
Assessment _05	-0.129	-1.443	-0.926	-5.191	6.018	<.001
Assessment _06	-0.863	-9.671	0.052	0.292	6.818	<.001
Assessment _07	-0.665	-7.455	-0.678	-3.798	6.228	<.001
Assessment _08	-0.596	-6.683	0.498	2.790	7.735	<.001
Interaction_01	-0.623	-6.985	0.381	2.134	7.910	<.001
Interaction _02	-0.379	-4.248	-0.289	-1.622	7.195	<.001
Interaction _03	0.287	3.213	-0.664	-3.719	6.353	<.001
Interaction _04	-0.487	-5.455	0.596	3.338	8.072	<.001
Learning_01	-0.335	-3.757	0.952	5.338	9.089	<.001
Learning_02	-0.412	-4.620	1.131	6.338	9.045	<.001
Learning_03	-0.395	-4.423	0.666	3.736	8.702	<.001
Learning_04	-0.308	-3.450	-0.065	-0.364	7.942	<.001
Learning_05	-0.482	-5.405	0.091	0.508	7.746	<.001
Learning_06	-0.489	-5.480	0.463	2.595	8.412	<.001
Learning_07	-0.860	-9.637	0.717	4.018	8.202	<.001
Learning_08	-0.410	-4.594	1.141	6.393	9.376	<.001
	Mardia's coefficient		278.72	67.66		

Principal Components Analysis

Since principal component analysis does not demand the assumptions of normality and homoscedasticity (García Jiménez, Gil Flores, and Rodríguez Gómez 2000), we proceeded with its direct application on all items, forcing the extraction of 5 factors.

With the model, a 50.9% of the total variance is explained, from which the first factor (in the initial solution, without rotating) explains a 30.3%. On the other hand, the sedimentation graph does not show evidences of the scale's unidimensionality. Regarding the rotated solution, the configuration matrix (oblimin method) suggests that the theoretical assumptions on the dimensionality of the questionnaire can be correct, as shown in table 4.

Tabla 4: Configuration matrix in the complete scale

	Activities	Assessment	Interaction	Contents	Learning
Contents_01				-.498	
Contents_02				-.602	
Contents_03				-.577	
Contents_04				-.667	
Contents_05				-.488	
Contents_06				-.614	
Contents_07				-.574	
Contents_08				-.531	
Activities_01	.629				
Activities_02	.690				
Activities_03	.688				
Activities_04	.696				
Activities_05	.640				
Activities_06	.673				
Activities_07	.570				
Activities_08	.592				
Activities_09					
Activities_10					
Activities_11					
Assessment_01		.656			
Assessment_02		.672			
Assessment_03		.623			
Assessment_04		.708			
Assessment_05		.571			
Assessment_06		.697			
Assessment_07		.732			
Assessment_08		.665			
Interaction_01			-.588		
Interaction_02			-.686		
Interaction_03			-.802		
Interaction_04			-.680		
Learning_01					
Learning_02			-.410		-.513
Learning_03			-.450		-.522
Learning_04			-.426		-.476
Learning_05			-.537		
Learning_06			-.749		
Learning_07			-.674		
Learning_08			-.453		

Extraction method: Principal components analysis.
Rotation method: Oblimin normalization with Kaiser.

The three last items of the dimension *activities* have a saturation below .4 on the dimension itself. Despite this, we decided to keep them because we deemed them to be theoretically important. The same goes for the first item of the dimension *learning*.

Likewise, we found that the dimensions *learning* and *interaction* contain shared information, saturating a good part of their items in the fourth dimension. After the content analysis if the items involved, we verified this similarity, taking into account that learning is, ultimately, a shared and social process (Vigostky, 1995).

If we apply the principal component analysis dimension after dimension, we obtain unidimensional structures except for the dimension *contents*, where there are 2 principal components that explain 58.31% of the variance. By analysing the items of this dimension, we observe how the first five are related to general aspects of the platform's content, and the other 3 refer to specific resources. In other cases, we obtained an explained variance of 43.4% (*activities*), 45.8% (*assessment*), 64.7% (*interaction*) and 56.1% (*learning*).

Table 5 shows the correlation between the factors obtained in the exploratory factor analysis. The value of the coefficients indicates that the factors have shared information, which makes the rotation method the most suitable for this case.

Table 5. Matrix of correlations between dimensions

	Activities	Assessment	Interaction	Contents	Learning
Activities	1.000	.231	-.394	-.433	-.166
Assessment		1.000	-.355	-.259	-.172
Interaction			1.000	.331	.140
Contents				1.000	.187
Learning					1.000

Confirmatory Factors Analysis

Given the evidences of the non-compliance with the normality assumption, and that the measurement scale for all the items is identical, we chose to use the estimation method of unweighted least squares (Bollen, 1989; Byrne, 2001; Kline, 2005). Choosing this method over other non-parametric ones responds to its analogue properties of OLS estimation (Lévy Mangin, 2006) and to its good behaviour towards the existence of low factorial loads (Ximénez and García, 2005), which is evidenced in the study.

The implemented theoretical model is shown in figure 1. There are five first order factors, and a second order one, with the exception of the first order factor *contents* which, as explained before, is divided in two subdimensions.

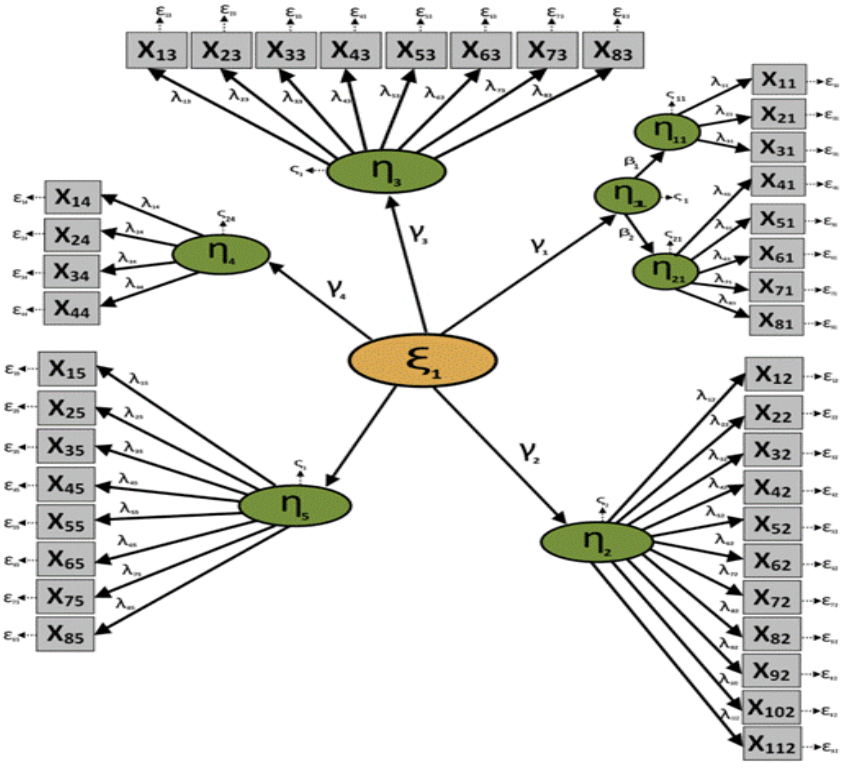

Figure 1. Theoretical model of the two level CFA

The parameters of the model, which estimation is presented in table 6, have factorial loads with scores on each factor exceeding .4 in every case, and in average they are above .6. Therefore we can conclude that every item properly contributes to its dimension. The square multiple correlations are generally low, which indicates there is a good part of the variance that is not explained by the factors. However, the CRI and Cronbach's alpha obtained seem to indicate that the instrument has an acceptable reliability level, both at global and factor level (Lévy Mangin, 2006). On the other hand, the AVE values are below .5 in most of the factors, and therefore the validity (both convergent and discriminant) is not compromised (Kline, 2005). However, given the scarcity of scales that collect information on the different dimensions involved in the educational use of *Moodle*, this instrument represents a starting point in this research field. This way, the questions introduced in the questionnaire have a great amount of noise (non-explained variance), valuable information contained by these variables, although it is placed in acceptable percentages, it is lower than desirable.

Table 6: Questionnaire reliability and validity indexes

	Standard weight L_{ij}	R^2	CRI	AVE	α Cronbach
Contents_01	.660	.394	.80	.44	.82
Contents_02	.694	.257			
Contents_03	.588	.273			
Contents_04	.659	.341			
Contents_05	.701	.381			
Contents_06	.404	.244	.69	.44	.79
Contents_07	.756	.392			
Contents_08	.766	.353			
Activities_01	.598	.316	.86	.36	.87
Activities_02	.613	.406			
Activities_03	.632	.285			
Activities_04	.640	.536			
Activities_05	.594	.609			
Activities_06	.626	.573			
Activities_07	.494	.491			
Activities_08	.617	.434			
Activities_09	.584	.345			
Activities_10	.637	.481			
Activities_11	.562	.436			
Assessment_01	.522	.409	.80	.38	.83
Assessment _02	.506	.399			
Assessment _03	.628	.376			
Assessment _04	.667	.357			
Assessment _05	.625	.406			
Assessment _06	.643	.491			
Assessment _07	.682	.480			
Assessment _08	.624	.484			
Interaction_01	.757	.561	.88	.50	.82
Interaction _02	.780	.543			
Interaction _03	.732	.518			
Interaction _04	.534	.417			
Learning_01	.637	.163	.89	.49	.89
Learning_02	.701	.572			
Learning_03	.693	.587			
Learning_04	.696	.390			
Learning_05	.749	.465			
Learning_06	.737	.414			
Learning_07	.719	.391			
Learning_08	.646	.444			

Regarding the model's goodness of fit, we obtain indexes that show good fit (Bollen, 1989; Byrne, 2001; Kline, 2005; Lévy Mangin, 2006) both global (GFI=.985; RMSEA=0.47; RMR=.022) and incremental (AGFI=.981; NFI=.977; RFI= .976), by being below .05 in RMSEA and RMR and above .95 in the rest of the cases. As for the global fit, the results indicate that the model makes a satisfactory prediction of the data covariance matrix. The results regarding incremental fit suggest that the proposed model is adequate in comparison with the null model, and therefore the proposed relations have substantial weights

Discussion

Moodle is one of the more complete and adequate platforms for its implementation in Higher Education (Aydin and Tirkes, 2010; Saito and Ulbricht, 2012; Williams van Rooij, 2012). This fact is evidenced because *Moodle* provides three essential resources: the possibility of supplying contents and activities online, interactive assessment (Ross, 2008) and the flexible interaction and communication between the teacher and the students- (Ellison et al., 2007). In this sense, both the use of *Moodle* and on-line materials and resources enhance and/or improve the learning outcomes (Martín-Blas and Serrano-Fernández, 2009; Núñez et al, 2011; Escobar-Rodríguez and Monge-Lozano, 2012).

The success of an LMS depends on many factors (Davis et al., 1989), among which is the user's perceived usefulness of the LMS itself. In the scientific literature, we can locate a large number of studies which determine the keys of the success of an LMS. While these studies often contain student perception scales on the usefulness of the LMS, in many cases these scales don't have the psychometric properties that would be necessary in order to ensure the reliability and validity of the collected information (Lin, 2008; Weaver, Spratt and Nair, 2008; Klobas and McGill, 2010; Al-Busaidi and Al-Shihi, 2012).

In many cases, the researchers only include *ad hoc* designed scales without an associated psychometric study (Ozkan and Koseler, 2009; Naveh, Tubin and Pliskin, 2010; Palmer and Holt, 2010; Rubin, Fernades and Avgerinou, 2013), or with a very simple and superficial study. In other cases, the sizes of the samples obtained in order to implement the psychometric study are small (Lin, 2008; Ozkan and Koseler, 2009; Al-Busaidi and Al-Shihi, 2012) and largely limit its results. On the other hand, the dimensions included in these scales are vague and highly varied, depending on the interest of the specific research.

This way, the present study overcomes many of these obstacles, because based on the set objectives, we designed a scale with content validity criteria, to subsequently validate the psychometric properties through the application of statistical techniques from a representative sample.

Given the importance of the perceived usefulness as predictor variable of the success in the implementation of a technological tool such as the LMS (Davis, 1993; Sørebø et al., 2009; Friedrich and Hron, 2010), the described scale constitutes an instrument that is valid and reliable on a psychometric level, which allows the organisations and teachers to reflect on the weaknesses of *Moodle* as a complement of face-to-face education.

On the other hand, due to the amount and robustness of the empirical studies that verify the predictive value of the perception studies in the sphere of the Social Sciences (Eastman and Marzillier, 1984; Bandura and Locke, 2003; Rottinghaus, Larson, and Borgen, 2003; Valentine, Dubois and Cooper, 2004) in the field of the Higher Education (De Barros, 2012), the scale can be used as a measure of the quality and efficacy of the use of the institutional LMS in its every dimension, and it can be useful in the diagnostic and evaluation of the current state of the use of the platform.

While the results obtained suggest that the scale adequately measures the users' perceived usefulness of the LMS *Moodle* in the dimensions identified as key for all LMS (Moore and Iida, 2010; Palmer and Holt, 2010; Al-Busaidi and Al-Shihi, 2012), which are the contents, activities, assessment, interaction and learning, we obtain variance indexes below the desirable ones in some cases. Given the inexistence of global scales with adequate psychometric properties, and this scale being a perception one, it is only logical to obtain these values. Using Pearson's correlation matrix to carry out the analysis includes a certain bias relative to the metric of the variables (Elosua Oliden and Zumbo, 2008; Morales Vallejo, 2006),and it contributes to the obtainment of these low indexes, because in this case the value of the coefficients is underestimated in relation to the polychoric correlation matrix. Taking into consideration the underestimation of the real value of the correlation between the pairs of variables obtained here, an improvement of the goodness of fit indexes and the explained variance is to be expected with the application of more adequate techniques for Likert-type response scales when facing future research (López-González, Pérez-Carbonell and Ramos, 2011; López-González, 2012). Despite the importance of the weaknesses present in this research, this scale entails a starting point in future investigations for the development of scales adapted to sub-populations of university students from diverse areas of knowledge, whose dimensions will explain a bigger percentage of the variance. In this sense, it is worth remembering that the present study is restricted to the population of students from the area of Social Sciences, in particular from Educational Sciences, and that despite the large size of the sample, the non-probabilistic sampling method can be a source of important biases.

On the other hand, it is worth mentioning another weakness related to the context of this study, which focuses on the use of *Moodle* as a complement to face-to-face education. In this way, the subjects involved in this study have been users of *Moodle* in face-to-face contexts, and because of that we are unable to know how the scale would behave when adapted to b-learning or e-learning contexts. There is room for the possibility of adapting the scale in future studies in order to observe its behaviour in these other educational contexts.

In conclusion, based on the evidences gathered and shown in the present research, we can conclude that this study constitutes a solid base for the development of coming investigations related with the analysis of the use of *Moodle* as an LMS in different educational institutions.

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Abstract / Resumen	*Because of the acquired relevance of learning management systems in higher education, and the spread of the use of the Moodle platform in many academic institutions, a scale of perceived usefulness of the Moodle in this context is designed, and the psychometric validity of the scale has been tested. The aim is to provide a reliable and valid instrument to measure the students' perception about the usefulness of Moodle. The study obtained a sample of 754 subjects from the population of university students in fields of Educational Sciences. The results show that the scale evaluates the utility of the platform adequately in five dimensions: content, activities, assessment, interaction and learning. Finally, a discussion is developed about the usefulness of the scale to evaluate the usefulness of Moodle and to implement processes to improve its use in higher education institutions.* Dada la importancia que los entornos virtuales de aprendizaje (*learning management systems*) han adquirido en la educación superior, y la generalización en el empleo de la plataforma *Moodle* en muchas instituciones universitarias, se diseña y se validan las cualidades psicométricas de una escala de utilidad percibida sobre el uso de *Moodle*. Se pretende aportar un instrumento válido y fiable que permita comprobar cuál es la percepción de los estudiantes sobre la utilidad de *Moodle*. De la población de estudiantes universitarios del ámbito de las Ciencias de la Educación, se obtiene una muestra de 754 sujetos. Los resultados manifiestan que la escala evalúa, adecuadamente, la utilidad de la plataforma en cinco dimensiones: contenidos, actividades, evaluación, interacción y aprendizaje. Finalmente, se discute sobre la utilidad de la escala para evaluar la utilidad de *Moodle* y para la implementación de procesos de mejora de su empleo en las instituciones de Educación Superior.
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