Analysis of Good Teaching Practices With Mobile Devices at the University: Design and Validation of the APMU Scale

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***Abstract*— The purpose of this paper was to validate the scale of Analysis of M-learning Practices in the University (APMU), designed to evaluate good teaching practices with mobile devices in the university environment. Different strategies were used such as expert judgement, exploratory factor analysis, confirmatory factor analysis and reliability analysis from a sample of 1125 university professors. The scale was composed of 16 items configured in five factors: mobile devices, digital competence, knowledge construction, cooperative work and education. Finally, the scale presented good psychometric properties, gathering a unique and reliable instrument to evaluate good teaching practices with mobile devices at the University.**

***Index Terms*— Mobile learning, mobile devices, higher education, good teaching practices, evaluation.**

I. Introduction

FOR a few years now, the educational use of mobile devices has been standardized in classrooms [1]. This has happened because of the portability and high performance of these mobile devices [2].

Its use applied to teaching is called mobile learning (m-learning from here on), referring to the mediation of mobile devices in the teaching and learning process [3]. Such is its relevance today that reports at the international level such as the Horizon Report place it as a trend to be implemented in the short term in higher education, in one year or less [4].

In turn, the applicability of these devices at the university stage brings certain benefits to student learning: improved academic performance [5], increased motivation [6], development of digital skills [7], [8], and promotes self-regulation of learning [9]. However, there are also concerns about the misuse of mobile devices in the classroom, especially when students use them for leisure purposes while the teacher is explaining the lesson. Therefore, it is important to integrate mobile devices into the dynamics of the classroom, allocating a specific time for their use in order to take advantage of their potential and reduce their misuse.

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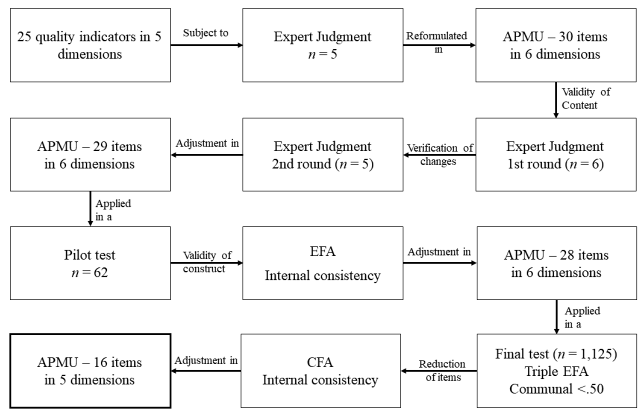

Fig. 1. Diagram of the process followed in the design and validation of the instrument. Note: EFA = Exploratory Factor Analysis; CFA = Confirmation Factor Analysis.

However, university professors may encounter certain difficulties in introducing mobile devices into the classroom for the first time. These difficulties are related to the lack of teacher training [10] and the absence of reference models [11]. Therefore, the need arises for good teaching practices of m-learning that serve as a reference for those teachers who want to start m-learning with certain guarantees of success. This is key to being able to distinguish between the pedagogically based application of mobile devices in the classroom and with benefits for students, from simply introducing them.

Based on these considerations, the aim of this work was to validate the scale of Analysis of M-learning Practices in the University (APMU), designed to evaluate good teaching practices of m-learning in the university environment.

II. Method

The design of the scale followed a rigorous process divided into different phases, which are fundamental for the creation of ad hoc instruments [12]–[15]: (i) review of the literature; (ii) establishment of the dimensions of the questionnaire; (iii) item formulation; (iv) content validity through expert judgement; (v) construct validity and; (vi) reliability analysis (Fig. 1).

In order to establish the validity of the instrument, a content and construction validity was carried out. Although the three most common types of validity are content, criterion and construct validity [16], [17], criterion validity could not be performed, since there are no instruments at present time of validation that measure something similar to our object of study and, therefore, serve as criteria for comparison.

A. Participants

A cross-sectional study design was adopted with a non-probabilistic and purposive sample. The sample was made up of 1125 university professors who teach in the Faculties of Education of Spanish public and private universities. Specifically, the sample included 691 women (61.42%) and 434 men (38.58%), aged between 20 and 77 years ($M = 44.66$; $SD = 10.36$) and with teaching experience between 1 and 47 years ($M = 14.71$; $SD = 10.98$). The areas of knowledge to which the teachers belonged were Didactics of Body Language ($n = 66$); Didactics of Musical Expression ($n = 42$); Didactics of Visual Expression ($n = 41$); Didactics of Language and Literature ($n = 110$); Didactics of Experimental Science ($n = 86$); Didactics of Social Science ($n = 72$); Didactics of Mathematics ($n = 59$); Didactics and School Organisation ($n = 241$); Physical Education and Sport ($n = 78$); Research and Diagnostic Methods in Education ($n = 81$); Educational and Developmental Psychology ($n = 153$); Theory and History of Education ($n = 96$).

B. Instrument

The instrument approach started with a review of the literature on m-learning instruments. This led to the detection of different instruments that were mainly used to measure perceptions and/or attitudes about mobile devices, in the work of Seifert, Hervas-Gómez and Toledo-Morales [18] all of them are collected [19]–[27].

Since none of the instruments on m-learning was related to the analysis of good teaching practices for m-learning, the instruments used in the doctoral theses defended in Spain on m-learning were reviewed [28]. From this review it was concluded that each thesis built its own instrument, which also did not relate to the objective of the scale. Therefore, the decision was made to build their own instrument.

Taking into consideration the quality indicators to evaluate good teaching practices of m-learning [29], the dimensions and items were established. The definition provided by these authors on the consideration of good teaching practices of m-learning is linked to learning that is established through the mediation of mobile devices for the development of digital competence, involving the construction of knowledge, self-regulation of learning and cooperative work. Based on this, the following dimensions were established:

Dimension 1 Mobile Devices [30], [31]: refers to those aspects prior to the use of mobile devices (smartphones, tablets or laptops) to carry out the teaching-learning process.

Dimension 2 Digital Competence [32]–[34]: the availability of skills to be able to discriminate on the quality of information available on the network, communicate over digital networks, create digital content and effectively solve problems with the use of technology, while making responsible and safe use of the network.

TABLE I
ITEM DISTRIBUTION BY DIMENSION

Dimension	Items	Total
Mobile devices	1-5	5
Digital competence	6-12	7
Knowledge construction	13-16	4
Self-regulating learning	17-20	4
Cooperative work	21-25	5
Proper use of technology	26-30	5

Dimension 3 Knowledge Construction [35]–[40]: creation of new knowledge by the student in a comprehensive way from existing information, previous knowledge, experience and interaction with the environment.

Dimension 4 Self-regulating Learning [41]–[44]: process in which the student forms an active part of his learning through reflection and awareness of how he learns, since it is he himself who establishes the guidelines for learning, times for it, strategies and motivation. In such a way that he adapts the learning to his needs and acts on them.

Dimension 5 Cooperative Work [45]–[49]: a way of acting autonomously and jointly among the members of a group in order to carry out a collective task and learn from each other. Unlike collaborative work where ideas are discussed and a single line of argument is generated, cooperative work is the sum of ideas of the group members.

Although these were a priori the five dimensions set out in the quality indicators on good teaching practices of m-learning, it was considered to add a sixth dimension related to education in the proper use of technology, since it is an essential component that must include good ICT teaching practice.

Dimension 6 Proper use of technology [50]–[52]: establishment of guidelines and transmission of information by teachers to raise student awareness of the proper use of mobile devices, in order to avoid risky behavior on the Internet and addiction to mobile devices.

After establishing the six dimensions, the quality indicators that were part of them were reformulated in the first five dimensions [29]. In contrast, new items were created for dimension 6. The distribution of items by dimension is shown in Table I.

In addition, the instrument was initially composed of 30 items. The response mode was categorized on a four-level Likert scale based on frequency (1 = Never, 2 = Ever, 3 = Frequently, 4 = Always).

C. Data Collection and Analysis Procedure

The questionnaire was developed in digital format using the Google Forms tool in order to reach as many participants as possible. It was distributed by e-mail to all university teachers in public and private universities with face-to-face teaching in Spain, belonging to departments attached to the Faculties of Education and linked to educational knowledge areas ($N = 9655$). The questionnaire was administered on 17 May 2019.

On the other hand, data processing was carried out with different statistical programs depending on the type of information and analysis sought, specifically the data was processed with SPSS software and AMOS software, both in its version 24.0. To carry out the validation of the instrument, the construct validity was performed through exploratory factorial analysis (EFA) and confirmatory factorial analysis (CFA). The internal consistency analysis was performed using Cronbach's Alpha coefficient.

III. Results

A. Content Validity

Content validity refers to the degree of similarity of each element with the theoretical construct [53]. The most commonly used technique for its determination is expert judgement, which "basically consists of asking a number of people for judgement on an object, an instrument, a teaching material, or their opinion on a particular aspect" [54]. In this case, the question was asked about the suitability of each item regarding the objective of the study, in terms of the assessment criteria of clarity, consistency and relevance [55].

- Criterion 1. Clarity: The item is easily understood, i.e. its syntax and semantics are adequate.
- Criterion 2. Consistency: The item has a logical relationship to the dimension or indicator it is measuring.
- Criterion 3. Relevance: The item is essential or important, i.e. it must be included.

The strategy proposed for expert judgement had two rounds. In the first round, each item was included and had to be judged in relation to its clarity, coherence and relevance through a four-level Likert scale, where 1 corresponded to "Does not meet the criterion"; 2 to "Low level"; 3 to "Moderate level"; and 4 to "High level". Instead, the second round was conducted to check whether the experts agreed with the changes made in the previous round. Therefore, it was asked exclusively about their agreement with each modification in a dichotomous way (marking with an X if affirmative). It should be noted that a specific section for comments/suggestions was added in both rounds.

In consideration, the protocol for expert judgment was established (Table II). The experts were selected based on their experience in instrument validation and subject matter. Finally, six experts participated in the first round and five in the second, an optimal number for the execution of an expert judgment, where the task of the expert is to eliminate irrelevant aspects, incorporate new elements and modify items that require it [56].

Once the action protocol and the basis for the expert judgement had been established, the experts were invited to participate by means of a formal letter sent by e-mail, together with the assessment template. The first round took place from 19 February 2019 until 21 March 2019 when the last response was collected. For the second round the contact mode was identical and lasted from 22 March 2019 to 1 April 2019.

1) Expert Judgement (First Round): The responses of each expert were compiled in Table III, which grouped the mean, standard deviation and agreement index. The agreement index was calculated on the basis of the frequency, expressed as the percentage of agreement of each expert with regard to the clarity, coherence and relevance of each of the items.

Concerning the comments on each of the items by the experts, all of them were addressed with the aim of modifying and improving the instrument on the basis of the suggestions made. These changes were added for later submission in the

TABLE II
Expert Judgement Protocol

Validation objectives	· Validate the dimensions of the instrument. · Confirm the suitability of each item according to its size and within the overall set.
Experts	· Expert 1. Male, Senior Lecturer, with 14 years of experience in Higher Education and belonging to the area of Didactics and School Organization. · Expert 2. Female, Senior Lecturer, with 14 years of experience in Higher Education and belonging to the area of Didactics and School Organization. · Expert 3. Female, Interim Substitute Professor, with three years of experience in Higher Education and belonging to the area of Didactics and School Organization. · Expert 4. Male, Lecturer, with nine years of experience in Higher Education and belonging to the area of Theory and History of Education. · Expert 5. Male, Senior Lecturer, with 15 years of experience in Higher Education and belonging to the area of Evolutionary and Educational Psychology. · Expert 6. Male, Senior Lecturer, with 15 years of experience in Higher Education and belonging to the area of Didactics and School Organization.
Validation mode	Individual method by which the information of each expert has been obtained without any contact between them.

TABLE III
Mean, Standard Deviation and Agreement Index Based on Frequency

Item reference (dimension/no.)	Clarity	Coherence	Relevance
		M/SD (%)	
DM1	3.6/.47 (66.6)	3.5/1.1 (83.3)	3.5/1.1 (83.3)
DM2	4/0 (100)	3.5/1.1 (83.3)	3.5/1.1 (83.3)
DM3	3.3/.74 (50)	3.5/1.1 (83.3)	3.16/1.06 (50)
DM4	2.6/.94 (50)	3/1 (50)	3.16/1.06 (50)
DM5	3.16/1.06 (50)	3.3/1.10 (66.6)	3.3/1.10 (66.6)
CD6	3/.8 (33.3)	3.5/1.1 (83.3)	3.5/1.1 (83.3)
CD7	4/0 (100)	3.8/.37 (83.3)	3.8/.37 (83.3)
CD8	3.3/1.10 (66.6)	3.8/.37 (83.3)	3.6/.47 (66.6)
CD9	3.6/.74 (83.3)	3.6/.47 (66.6)	3.6/.47 (66.6)
CD10	3.16/1.21 (66.6)	3.5/.76 (66.6)	3.5/.76 (66.6)
CD11	3.3/.74 (50)	3.5/.76 (66.6)	3.5/.76 (66.6)
CD12	3.16/.89 (50)	3.16/.89 (50)	3/1.15 (50)
CC13	3.16/1.21 (66.6)	3.5/1.1 (83.3)	3.5/1.1 (83.3)
CC14	3.3/1.10 (66.6)	3.8/.37 (83.3)	3.5/.76 (66.6)
CC15	3.8/.37 (83.3)	3.5/.76 (66.6)	3.6/.74 (83.3)
CC16	3.8/.37 (83.3)	3.6/.74 (83.3)	3.6/.74 (83.3)
AA17	3.5/.76 (66.6)	3.3/1.10 (66.6)	3.5/.76 (66.6)
AA18	3.3/1.10 (66.6)	3.5/1.1 (83.3)	3.3/1.10 (66.6)
AA19	3.16/1.21 (66.6)	3.16/1.21 (66.6)	3.16/1.21 (66.6)
AA20	3.16/1.21 (66.6)	3.3/1.10 (66.6)	3/1.15 (50)
TC21	3/1.15 (50)	3.16/1.21 (66.6)	3.16/1.21 (66.6)
TC22	3.16/1.06 (50)	3.5/1.1 (83.3)	3.3/1.10 (66.6)
TC23	3.3/1.10 (66.6)	3.16/1.21 (66.6)	3.16/1.21 (66.6)
TC24	3.16/1.06 (50)	3.5/1.1 (83.3)	3.5/1.1 (83.3)
TC25	3.16/1.21 (66.6)	3.16/1.21 (66.6)	3/1.15 (50)
EDU26	3.8/.37 (83.3)	3.5/1.1 (83.3)	3.5/1.1 (83.3)
EDU27	3.6/.74 (83.3)	3.3/1.10 (66.6)	3.5/1.1 (83.3)
EDU28	3.16/.89 (50)	3.3/1.10 (66.6)	3.3/1.10 (66.6)
EDU29	3.5/1.1 (83.3)	3.3/1.10 (66.6)	3.5/1.1 (83.3)
EDU30	3.3/1.10 (66.6)	3.5/1.1 (83.3)	3.5/1.1 (83.3)

Note. DM = Mobile devices; CD = Digital competence; CC = Knowledge construction; AA = Self-regulating learning; TC = Cooperative work; EDU = Proper use of technology.

TABLE IV
EXPERT AGREEMENT RATE BASED ON FREQUENCY IN THE SECOND ROUND

ITEM REFERENCE (DIMENSION/NO.)	EXPERT AGREEMENT					%
	EX1	EX2	EX3	EX4	EX5	
DM1	X	X	X	X	X	100
DM2	X	X	X	X	X	100
DM3	X	X	X	X	X	100
DM4	X		X	X	X	80
DM5	X	X	X	X	X	100
CD6	X	X	X	X	X	100
CD7	X		X	X	X	80
CD8		X	X	X	X	80
CD9	X	X	X	X	X	100
CD10	X	X	X	X	X	100
CD11		X	X	X	X	80
CC12		X	X	X	X	80
CC13	X	X	X	X	X	100
CC14		X	X	X	X	80
CC15	X	X	X		X	80
CC16	X	X	X	X	X	100
AA17	X	X	X	X	X	100
AA18	X	X	X	X	X	100
AA19	X	X	X	X	X	100
AA20	X		X		X	60
AA21		X	X	X	X	80
TC22	X		X	X	X	80
TC23	X	X	X	X	X	100
TC24	X		X	X	X	80
TC25	X	X	X	X	X	100
TC26	X	X	X	X	X	100
EDU27	X		X	X	X	80
EDU28	X		X	X	X	80
EDU29	X		X	X	X	80
EDU30	X		X	X	X	80

Note. DM = Mobile devices; CD = Digital competence; CC = Knowledge construction; AA = Self-regulating learning; TC = Cooperative work; EDU = Proper use of technology.

second round. On the recommendation of the experts, item CD12 became CC12, entailing a change of dimension. Item AA21 was formulated, increasing the self-regulation dimension of learning by five items. Moreover, one of the items from the education in good use dimension was eliminated.

2) Expert Judgement (Second Round): With the result of the first round, the modifications made were again submitted to expert opinion. Likewise, the concordance index was calculated based on the frequency according to each modified item (Table IV). In this second round, all suggestions for improvement of those items requiring expert review were addressed. Finally, the decision was taken to eliminate those items with a percentage of agreement of less than 80%, in this case only item 20.

Finally, the result of the expert judgment, conducted in two rounds, was the restructuring and refinement of some items and the elimination of item AA20. Thus, the scale went from 30 to 29 items where: the DM dimension was composed of five items; the CD dimension was compiled into six items; the CC dimension was expanded to five items; the AA dimension was reduced to four items as initially composed; the TC dimension remained the same, with five items; and; the items from the EDU dimension were grouped into four items.

B. Constructional Validity

Once the content validity was performed, the next step was to calculate the construct validity. Construct validity is used to check the extent to which items measure construct validity correctly [57]. The main statistical tests for its calculation are EFA and CFA [58].

EFA provides information on the distribution of items by variable and their suitability, so that it can be used to explore the set of variables that define the items and their internal structure [59]. CFA is used to confirm the suitability of the items in a given variable [60]. This is a complementary step to EFA that indicates whether the distribution of items is relevant to the dimension of which they are part.

1) Pilot Test: A pilot test was carried out to adjust the scale before final application. A total of 62 university professors participated in this pilot test. In terms of the demographic characteristics of the sample, 58.3% were male and 41.7% female, with ages ranging from 23 to 67 ($M = 42.8$; $SD = 11.8$).

The data obtained in the EFA showed an optimal factorial load in almost all items, with commonalities above .50 [61]. The only item below was DM2 (.490). In turn, the calculation of the Kaiser-Meyer-Olkin measure for sampling adequacy collected an adequate value (KMO = .694) and Bartlett's sphericity test showed the significance of the data ($\chi^2 =$ 956,704; $df = 406$; p-value = .000). On the other hand, the overall reliability of the questionnaire was optimal ($\alpha = .901$), since it was close to 1 [62].

Finally, taking into account the data obtained in the EFA and the reliability test, it was decided to eliminate the item DM2. After eliminating this item, the overall reliability increased (α =.904) and the sampling adequacy measure improved (KMO =.703). Thus, the scale went from 29 to 28 items for the final application.

2) Final Test: The pilot test made it possible to adjust the scale for final application to the total sample of university teachers ($n = 1125$). Thus, the final values of the EFA, CFA and internal consistency of the instrument were calculated.

Before the EFA, the Kaiser-Meyer-Olkin measurement was recalculated for sampling adequacy (KMO = .908) and the Bartlett sphericity test ($\chi^2 = 11040.687$; $df = 378$; p-value = .000). The values obtained confirmed the relevance of the EFA. Thus, the analysis of the commonalities showed that most of the items were adequately explained by the factorial structure, except for DM3, CD5, CD10, CC12, CC13, AA16, AA18, TC20 and TC22 (Table V). These nine items were eliminated for lack of sufficient explanation [63]. Therefore, the scale is now set at 19 items.

After the elimination of the nine items, a second EFA was performed to confirm the suitability of the items. In this second analysis, items CD6 (.397), CD9 (.484) and AA19 (.471) were below .50. Therefore, it was decided to eliminate these items for the final interpretation of the analysis.

Once the items with communalities below .50 were eliminated, a third EFA confirmed that the remaining 16 items were at appropriate values. Although the value obtained in the KMO test was somewhat lower than the first analysis, the measurement was at adequate values (KMO = .844), as was the Bartlett's sphericity test ($\chi^2 = 6194.333$; $df = 120$; p-value =.000).

In turn, the grouping of items by dimensions set five factors that explained 66.846% of the variance (Table VI). This was

TABLE V

ITEMS WITH COMMUNALITIES LESS THAN .50

Item	Initial	Extraction
DM3	1,000	.498
CD5	1,000	.466
CD10	1,000	.351
CC12	1,000	.482
CC13	1,000	.486
AA16	1,000	.362
AA18	1,000	.413
TC20	1,000	.415
TC22	1,000	.433

Note. Extraction method: principal component analysis; DM = Mobile devices; CD = Digital competence; CC = Knowledge construction; AA = Self-regulating learning; TC = Cooperative work.

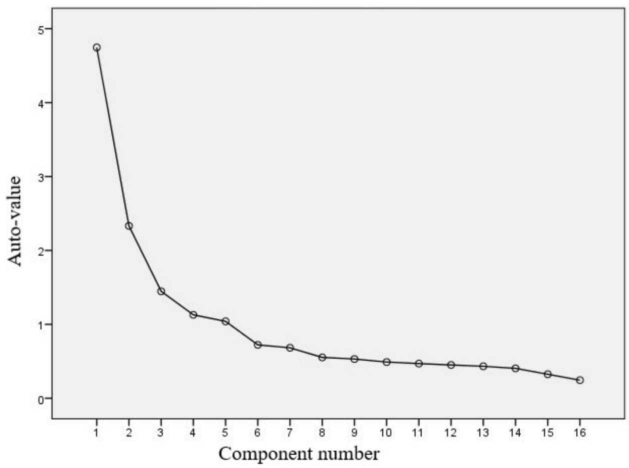

Fig. 2. Sedimentation graph.

TABLE VI

VARIANCE EXPLAINED WITH EFA

Comp.	Auto-values			Sums of saturations squared from extraction			Sums of the saturations squared of the rotation		
	Total	% variance	% accumulated	Total	% variance	% accumulated	Total	% variance	% accumulated
1	4.746	29.66	29.66	4.746	29.66	29.665	2.75	17.22	17.221
2	2.332	14.57	44.24	2.332	14.57	44.243	2.35	14.73	31.958
3	1.447	9.042	53.28	1.447	9.042	53.285	2.20	13.77	45.734
4	1.129	7.055	60.34	1.129	7.055	60.340	1.81	11.35	57.084
5	1.041	6.506	66.84	1.041	6.506	66.846	1.56	9.762	66.846

confirmed in the sedimentation graph, where the change in the slope of the curve is shown by the fifth factor (Fig. 2).

The factorial model was made up of appropriate construction indicators, since no item with factorial loads lower .30 [64], [65] was collected (Table VII). Regarding the distribution of items by factor, the first factor explained 17.22% of the variance and included four items, those that referred to the "proper use of technology" dimension. The second factor explained 14.73% and comprised the three items relating to the "cooperative work" dimension. The third factor explained 13.77% and included four items, grouping the initial dimensions "knowledge construction" and "self-regulating learning". Therefore, it was decided to merge both dimensions in "knowledge construction". The fourth factor explained 11.35% and grouped the three items corresponding to the dimension "mobile devices". Finally, the fifth factor explained 9.762% and included the two items referring to the "digital competence" dimension.

TABLE VII

ROTATED COMPONENT MATRIX

	Component				
	1	2	3	4	5
DM1				.829	
DM4				.807	
DM5				.550	
CD7					.776
CD8					.839
CC11			.638		
CC14			.761		
CC15			.687		
AA17			.654		
TC21		.791			
TC23		.843			
TC24		.834			
EDU25	.756				
EDU26	.831				
EDU27	.865				
EDU28	.798				

Note. Method of extraction: principal component analysis Rotation method: Equamax with Kaiser standardisation. DM = Mobile devices; CD = Digital competence; CC = Knowledge construction; AA = Self-regulating learning; TC = Cooperative work; EDU = Proper use of technology.

For the CFA, goodness-of-fit indices were collected that were appropriate for the model established in the validation of the instrument. Thus, the Root Mean Squared Error of Approximation (RMESEA = .058) indicated the anticipated fit with the total population value; the Root Mean square Residual (RMR = .038) measured the variances and covariances of the sample and whether these differed from the estimates obtained; the Parsimony Goodness-of-Fit Index (PGFI = . 657) considered the degrees of freedom available for testing the model; the Tucker-Lewis Index (TLI = .924) is corrected for model complexity; and the Comparative Fit Index (CFI = .941) indicated the percentage of covariance representativeness that could be reproduced by the model [66], [67].

On the other hand, correlations between dimensions were positive with correlation values (R) ranging from .187 to .650 (Table VIII). In addition, all correlations were statistically significant, since values in the critical ratio above 1.96 were obtained [68].

Specifically, the graphic expression of the CFA was composed of the five dimensions of the scale: mobile devices (DM), digital competence (CD), knowledge construction (CC), cooperative work (TC) and proper use of technology. (EDU) (Fig. 3).

The factor weights of each of the dimensions showed the suitability of each item regarding the dimension of which they form part. Likewise, the DM dimension was composed of DM1, DM3 and DM4, with factor weights ranging from .55 to .71. In CD, composed of two items (CD7 and CD8), the factor weights were .71 and.61 respectively. CC collected four items (CC11, CC14, CC15 and AA17) with

TABLE VIII
COVARIANCES AND CORRELATIONS OF CFA

Relation	Covariance	SE	CR	p-value	R
DM <---> CD	.095	.012	7.754	***	.448
TC <--> EDU	.120	.019	6.281	***	.227
CC <--> EDU	.142	.019	7.597	***	.303
DM <--> CC	.137	.013	10.526	***	.650
CD <--> TC	.136	.016	8.580	***	.433
DM <--> EDU	.067	.014	4.686	***	.187
TC <--> CC	.178	.015	11.541	***	.570
CD <--> EDU	.163	.022	7.548	***	.345
CD <---> CC	.162	.017	9.618	***	.579
DM <--> TC	.103	.012	8.966	***	.435

Note. SE = Standard Error; CR = Critical Ratio; *** = *p*-value < .001; DM = Mobile devices; CD = Digital competence; CC = Knowledge construction; AA = Self-regulating learning; TC = Cooperative work; EDU = Proper use of

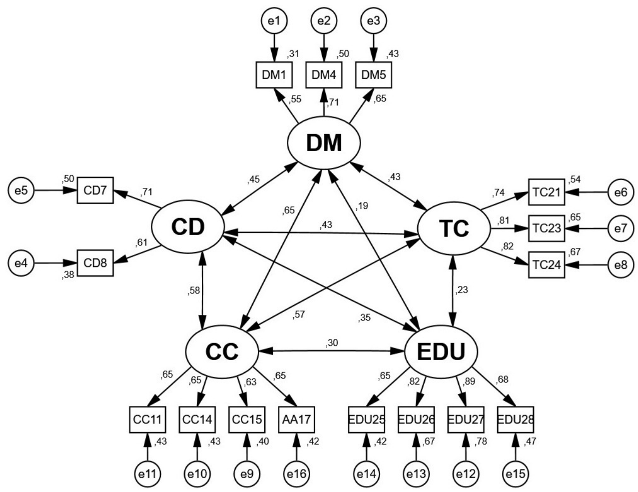

Fig. 3. Confirmatory Factor Analysis estimates. Note: $\chi^2 = 455{,}370$; $df = 94$; p-value $=.000$.

factor weights between .63 and .65. TC was defined by three items (TC21, TC23 and TC24) with factorial weights between .74 and .82. EDU was defined by four items (EDU25, EDU26, EDU27 and EDU28), with factorial weights between .65 and .89.

C. Reliability Analysis

Reliability indicates the internal consistency of the instrument itself [12]. In other words, the instrument will be reliable if what it measures is measured correctly. To obtain the reliability of an instrument, different statistical tests are used such as the Guttman two-half test, test-retest method or the well-known Cronbach's Alpha, which is the most used for calculating the reliability of instruments [69]. It was also decided to calculate the reliability of the scale based on Cronbach's Alpha coefficient (α).

The overall reliability of the instrument was high (α =.834), as was the value obtained in the pilot test. For each of the dimensions the reliability was: mobile devices (α =.665); digital competence ($\alpha = .605$); knowledge building ($\alpha = .742$); cooperative work (α =.830); and proper use of technology (α =.843). If any item was removed, reliability would decrease, unless item DM1 was removed, which would remain the same (Table IX).

TABLE IX
RELIABILITY BY DIMENSION AND AFTER ELIMINATION OF EACH ITEM

Dimension	Item	Mean	SD	α if the item is deleted	α of the dimension
Mobile devices	DM1	3.42	.723	.834	.665
	DM4	3.20	.792	.828	
	DM5	2.95	.914	.822	
Digital competence	CD7	2.90	.865	.826	.605
	CD8	3.17	.862	.828	
Knowledge construction	CC11	2.77	.718	.824	.742
	CC14	2.89	.872	.823	
	CC15	3.15	.832	.824	
	AA17	2.76	.787	.823	
Cooperative work	TC21	2.93	.804	.824	.830
	TC23	3.07	.769	.824	
	TC24	2.89	.791	.822	
Proper use of technology	EDU25	2.72	1.090	.824	.843
	EDU26	1.80	1.005	.824	
	EDU27	1.88	1.003	.821	
	EDU28	2.58	1.189	.830	

Note. SD = Standard Deviation; α = Cronbach's Alpha.

TABLE X
APMU SCALE ITEMS

Dimension 1. Mobile devices
1. Do students have a mobile device to work in the classroom (smartphone or tablet)?
2. Do students use mobile devices in the classroom during subject time, i.e. do they use them in the tasks that require their use?
3. Do you make a didactic use of the mobile device in the activities you develop in the classroom, that is, do you take into account the functionalities of the mobile device in the teaching and learning process?
Dimension 2. Digital competence
4. Do the activities planned with mobile devices allow students to produce digital content?
5. Do the activities planned with mobile devices allow students to share information socially?
Dimension 3. Knowledge construction
6. In the activities that you implement through mobile devices, do you consider that there is a greater understanding of the content by students?
7. Do the activities you implement through mobile devices allow you to track the student's learning process?
8. Does it provide feedback to students in the different activities that take place with mobile devices?
9. Do the activities, tasks or projects developed through the mobile device encourage the student to reflect on his/her own learning?
Dimension 4. Cooperative work
10. Do the activities developed through mobile devices encourage cooperative work?
11. Do the activities planned with mobile devices encourage interaction between students?
12. Do the activities proposed with mobile devices allow for group decision-making?
Dimension 5. Proper use of technology
13. When doing any activity that requires the use of the mobile device, do you warn students about the risks of improper use?
14. Do you teach students to use available filters so that mobile devices do not display adult content?
15. When you apply a methodology based on mobile learning, do you establish prevention guidelines to avoid addictive behaviours to mobile devices?
16. Does it inform students about the health consequences for children of inappropriate use of a mobile device at an early age?

IV. DISCUSSION AND CONCLUSION

The design and validation of the scale of Analysis of M-learning Practices in the University (APMU), started from the need to create an instrument to evaluate the good teaching practices of m-learning, since the different m-learning instruments did not measure this construct [18]–[27]. To this end, a rigorous validation process was followed, where the scale was changed from 30 items initially to 16 items grouped in five dimensions.

Thus, the multiple EFA were used to adjust the items [63], and their grouping into five factors, coinciding with the dimensions previously established. Although six dimensions were initially established, the rotated component matrix indicated the adjustment in five factors, so it was decided to unify two dimensions, passing the single item of self-regulation of learning to form part of the knowledge construction dimension due to their similarities. The CFA confirmed the adequacy of the items in each factor, where factor loads above .30 were obtained [64], [65].

As a product, a valid and reliable scale is established to evaluate good teaching practices of m-learning in the university environment. So it is considered a useful tool to detect good teaching practices with mobile devices through the response to 16 items, with a response mode based on a four-level Likert scale according to frequency (1 = Never, 2 = Ever, 3 = Frequently, 4 = Always). Therefore, the minimum score that can be obtained on the scale is 16 and the maximum 64 points, with the cut-off at $\geq$ being 48 points to estimate that teachers are applying good teaching practices of m-learning in their classrooms. This would be the equivalent of responding "frequently" to all the items, thus ensuring that all the factors are present in the m-learning experiences.

Appendix

See Table X.

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