Behavioral Intention of Use of Mobile Technologies Among Pre-Service Teachers

Implementation of a technology adoption model based on TAM with the constructs of Compatibility and Resistance to Change

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***Abstract*— The knowledge of the process of accepting ICTs in formal education contexts entails an essential tool to achieve a successful incorporation of technologies in schools. This paper presents the results of a descriptive study on the behavioral intention of use of mobile learning among the students of the Primary Education Teacher Bachelor's Degree. The population is composed of students from said degree from the University of Salamanca, who have completed a questionnaire based on the TAM model, expanded with the constructs of compatibility and resistance to change. 678 individuals participated in this study. Results show a moderately favourable disposition towards the future use of this methodology. Significant differences were found according to gender, especially in the constructs of compatibility and resistance to change.**

Keywords—TAM; mobile learning; technology acceptance; university students; teachers

I. INTRODUCTION

The process of including ICTs in schools is a complex phenomenon, composed of numerous factors that contribute to the success or failure of the initiatives [1, 2].

One of the essential elements of this process is the cooperation of the teachers [3]. Therefore, to be aware of the teachers' attitude towards a given technology, as well as of the factors contributing to define this attitude, can be a very useful tool to predict either the success or the failure of the implementation of a new information system, and to detect and rectify possible mistakes [4-8].

After their explosion of popularity over the past few years [9-11], mobile technologies are in the initial stages of their integration in formal education contexts, promoting the flexibility and individualisation of the teaching-learning process [12-14].

Technology adoption models constitute an efficient alternative for the study of the teachers' acceptance of these devices.

The most popular among these models is the TAM (Technology Acceptance Model). Formulated by Davis [15], this model comes from the principles of TRA (Theory of Reasoned Action) [16] and the TPB (Theory of Planned Behavior) [17], two theories that originate in the field of cognitive psychology, and which analyse the process that leads an individual to engage in a given behavior.

The TAM is designed to explain the technology acceptance process and it is based on two basic concepts: perceived usefulness (PU), understood as the degree to which an individual perceives that the use of a tool can enhance their efficacy in the performance of a task, and perceived ease of use (PEU), which refers to the individual's perception of the amount of effort necessary to use a technology.

These two constructs influence the individual's attitude towards the use of technologies (A), which in its turn influences their behavioral intention of use (BI), which determines the actual use (AU) of an information system (Figure 1).

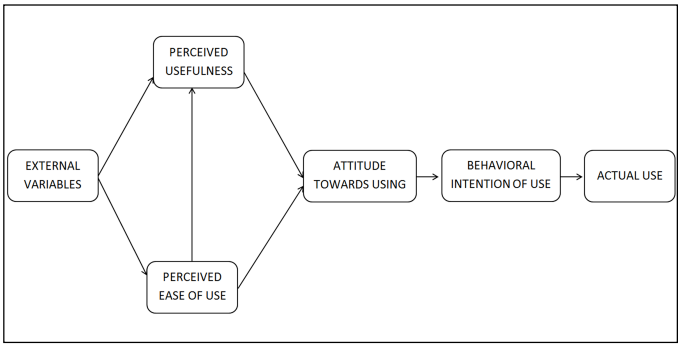

Fig. 1. TAM model diagram (*Davis, 1989*) [15].

The main advantages of this theory are its simplicity, adaptability and theoretical soundness, all of which have lead the it to be the most employed acceptance model at present [18]. The model is implemented in numerous fields, and it is frequently extended by adding constructs from other theories.

Within the field of education, we can find examples of its use, both with students' [19, 20], and teachers' attitudes [21,

22]. Our research falls within studies that apply the model with teachers during their initial university training period [24-25].

This paper aims to present the results of a descriptive study on the acceptance of mobile technologies among students from the Primary Education Teacher Bachelor's Degree. The communication is organised in three sections. The first one is dedicated to describing the methodology. It details the composition of the model and its variables, as well as the sample and the instrument prepared for the data gathering. After that, we present the results obtained, including a hypothesis testing. Lastly, we end with some brief conclusions.

II. METHODOLOGY

Our proposal poses a research problem related to the factors that lead teachers to use mobile technologies. To this end, we propose the following hypothesis: the integration of these technologies depends on the teachers' acceptance.

The aim of the research it to know the level of acceptance of mobile technologies among pre-service teachers, defined as the intention of using these devices in their future teaching practice.

This section explores the research methodology used. To this end, we start by describing the model, defining the constructs added to the model and the relational hypotheses formulated. After this, we present the variables and the population and sample of the study. Lastly, we detail the instrument used to collect the data.

A. Research model

The present research model is composed of three constructs from the TAM model, to which we decided to add two intrinsic factors highly related to one another, to study their role in the technology acceptance process.

1) TAM model constructs

The starting point for the development of our theoretical approach is Davis' TAM model, from which we have included the following constructs: perceived ease of use, perceived usefulness and behavioral intention of use. For this study, we have eliminated the attitude towards use, a construct which is frequently removed due to its low degree of explanation of behavioral intention of use [26].

The construct of actual use has also been removed, because this study deals with the future use of the devices. This also has its precedents in studies conducted with the same populaton [24, 27, 28].

For the constructs from the TAM model, the following hypotheses are proposed:

- **H1**: Perceived usefulness is positively related to the behavioral intention of use of mobile technologies of the pre-service primary teachers in their future teaching practice.
- **H2**: Perceived ease of use is positively related to the behavioral intention of use of mobile technologies of the pre-service primary teachers in their future teaching practice.
- **H3**: Perceived ease of use is positively related to the perceived usefulness of the pre-service primary teachers in their future teaching practice.

2) Perceived compatibility

Perceived compatibility is a construct from the innovation diffusion theory (IDT) [29], which is used to analyse the extent to which an innovation is consistent with the potential adopter's existing values, previous experiences and needs. The compatibility helps us to know the degree of suitability of a given IS for the person's values and habits. This factor has been previously incorporated in TAM-based models with positive results with university and non-university students [30-32].

Thus, compatibility would influence both perceived usefulness and the behavioral intention of use, posing the following hypotheses:

- **H4:** Perceived compatibility is positively related to the perceived usefulness of the students from the pre-service primary teachers in their future teaching practice.
- **H5:** Perceived compatibility is positively related to the behavioral intention of use of mobile technologies of the students from the pre-service primary teachers in their future teaching practice.

3) Resistance to change

Resistance to change can be defined as the difficulty to break with routines and the emotional stress generated when facing the expectation of changes. Although it is not included in any of the main theories, it has been explored in acceptance studies based on TAM, thus supporting its relationship with the behavioral intention of use [33].

This definition of resistance to change locates the construct close to perceived compatibility, more specifically to the constructs of compatibility with preferred work style and compatibility with existing work practices, proposed by Karahanna, Agarwal and Angst [34].

As it is a relatively unexplored construct, which we consider might have a significant influence in the acceptance of mobile technologies on the part of primary education teachers, we propose the study of its relationships with the three constructs from the TAM model. Moreover, taking into account the close relationship between this construct and perceived compatibility, we also propose as a hypothesis the positive relationship among them (Figure 2). Therefore, the hypotheses posed for this construct are as follows:

- **H6:** Resistance to change is positively related to the behavioral intention of use of mobile technologies of the pre-service primary teachers in their future teaching practice.
- **H7:** Resistance to change is positively related to the perceived usefulness of the pre-service primary teachers in their future teaching practice.

- **H8:** Resistance to change is positively related to the perceived ease of use of the pre-service primary teachers in their future teaching practice.
- **H9:** Resistance to change is positively related to perceived compatibility.

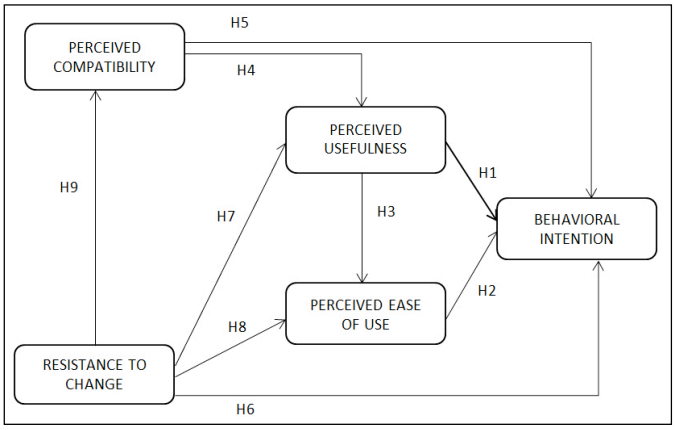

Fig. 2. Extended TAM model diagram.

B. *Variables*

For this research we selected the following variables:

- **Exogenous:** Perceived usefulness, perceived ease of use, compatibility and resistance to change.
- **Endogenous:** Behavioral intention of use.
- **Other explaining variables:** Age, gender and year.

C. *Population and sample*

The population of this study is composed of the students enrolled in the Grado de Maestro de Educación Primaria of the university of Salamanca in its branches of Salamanca (N=480), Zamora (N=320) and Ávila (N=234).

There was a total of 678 students participating: 48.2% (327) from the Faculty of Education of Salamanca, 26.1% (177) from Avila's School of Education and Tourism and 25.7% (174) From Zamora's University School for Teacher Training.

As for the gender distribution, 65.2 % of participants are female, while 34.8% are male. 51.3% of the surveyed are aged between 19 and 21, with the average age being 21.09.

Lastly, the distribution according to the year the students are enrolled in is 29.8% 1st year students, 27.9% 2nd year students, 19.5% 3rd year students and 22.9% 4th year students.

D. *Instrument*

To carry out the data collecting process we prepared a two-part instrument following Davis' proposal. The first section is destined to gather the students' identification data (age, gender and year). The second one is composed of sixteen items formulated with a seven-point Likert-type scale (0-6) which represent the rest of the variables of the study.

The items for the perceived usefulness and perceived ease of use were adapted from Davis' proposal [15]:

- **Perceived usefulness (PU):** *The use of mobile technologies can enhance my teaching performance* (PU_01); *the use of mobile technologies can make me more effective at my teaching practice* (PU_02); *the use of mobile devices can make teaching tasks easier* (PU_03); *generally I consider that mobile devices can be useful in education* (PU_04).
- **Perceived ease of use (PEU):** *Learning to use mobile devices in the classroom would be easy for me* (PEU_01); *I find it easy to interact with mobile devices* (PEU_02); *I believe that interacting with mobile devices is flexible* (PEU_03); *generally I consider that mobile devices are easy to use* (PEU_04).

For the behavioral intention of use, we have adapted those proposed by Venkatesh and Vala [35]:

- **Behavioral intention of use (BI):** *I intend to use mobile technologies in my future teaching practice* (BI_01); *I predict that I will use mobile technologies in my future teaching practice* (BI_02).

For the construct of perceived compatibility we have adapted the items proposed by Moore and Benbasat [36]:

- **Perceived compatibility (PC):** *Using mobile technologies to teach would be compatible with my teaching style* (PC_01); *Using mobile technologies to teach would be coherent with my way of thinking* (PC_02); *Using mobile technologies to teach would fit with my lifestyle* (PC_03).

Lastly, the items for the construct of resistance to change were adapted from the proposals of Bhattacherjee and Hikmet [37] and Guo *et al*. [38], who formulated the items in an inverse way.

- **Resistance to change (RC):** *I wouldn't want mobile technologies to change the way the teaching practice is carried out* (RC_01); *I don't want mobile technologies to change student-teacher interactions* (RC_02) *Assuming the changes in the teaching methodology introduced by mobile technologies would be easy for me* (RC_03).

To assess the internal consistency of the instrument we employed Cronbach's α coefficient, which indicated a high internal consistency (α=0.862).

III. RESULTS

Aiming to conduct and assessment of the behavioral intention of using mobile technologies in the future teaching practice of the students from the Primary Education Teacher Bachelor's Degree, below we present the results obtained from the descriptive analysis performed, organised by constructs (Table I). The items pertaining to the mobile device anxiety were recoded on account of their negative formulation.

TABLE I. DESCRIPTIVE OF THE EXTENDED TAM MODEL ITEMS .

	Average	St. Dev.	% Valid							N
			0	*1*	*2*	*3*	*4*	*5*	*6*	
PEU_04	4,55	1,222	,6	1,9	4,3	9,2	25,7	35,7	22,6	676
PEU_01	4,49	1,282	,6	2,8	3,2	13,9	22,9	33,3	23,3	678
PEU_02	4,45	1,213	1,2	1,2	3,6	12,0	27,8	35,2	18,9	665
PU_04	4,32	1,285	1,3	3,3	4,3	11,7	25,3	40,4	13,6	668

PU_01	4,20	1,328	1,2	2,8	7,2	14,0	28,5	30,7	15,6	678
RC_03	4,18	1,314	1,0	3,9	6,0	13,5	30,4	31,4	13,8	672
BI_01	4,15	1,450	2,1	3,9	6,1	17,8	23,9	27,7	18,7	675
PU_03	4,10	1,301	1,2	3,0	7,2	17,0	27,5	32,9	11,3	666
PC_01	4,08	1,357	1,9	3,8	4,9	19,7	24,0	34,3	11,4	676
PU_02	4,08	1,272	1,6	2,8	5,2	18,4	30,0	32,1	9,7	669
PEU_03	4,06	1,221	,6	2,8	3,2	13,9	22,9	33,3	23,3	659
BI_02	4,03	1,418	2,1	4,7	6,3	18,1	25,2	31,0	12,7	664
PC_03	3,91	1,392	1,6	5,1	7,9	20,5	26,6	27,7	10,6	669
PC_02	3,87	1,397	2,5	4,5	7,6	21,3	25,2	30,4	2,5	670
RC_01	2,40	1,698	15,9	17,7	18,8	23,8	10,0	8,6	15,9	671
RC_02	2,01	1,736	24,1	21,4	18,0	18,1	7,5	5,7	5,2	668

[a] Dimensions organised according to mean value.

The results obtained show the students' positive attitude towards the incusion of mobile devices during the future exercise of their job, given that the scores are above 4 (in a scale of 0 to 6) in 12 out of the 16 items. Out of the remaining 4 items, 2 of them (PC_02 and PC_03), which belong to the construct of perceived compatibility, obtained scores above 3. The other 2 items, RC_01 and RC_02, obtained scores below the midpoint of the scale. This suggests that the factors of resistance to change and perceived compatibility are open to intervention.

Once the general descriptives are analysed, we need to verify if there are any significant differences according to the year and gender of students.

The year of the students will be the first variable to be analysed, focusing on the first and fourth years, because they are the groups that can show the greatest differences.

To this end we studied the variables differentiating by year (Table II). At first sight there are no major differences, although we can appreciate some discrepancies, so we decided to conduct a hypothesis testing to determine wether they are significant differences.

TABLE II. DESCRIPTIVE OF THE EXTENDED TAM MODEL ACCORDING TO THE VARIABLE YEAR.

	Year					
	First			***Fourth***		
	Average	***St. Dev..***	***N***	***Average***	***St. Dev..***	***N***
BI_01	4,15	1,399	200	4,19	1,539	154
BI_02	4,05	1,431	198	3,92	1,566	154
PC_01	4,09	1,402	202	3,99	1,493	154
PC_02	3,92	1,344	199	3,83	1,491	152
PC_03	4,01	1,391	201	3,75	1,553	151
PEU_01	4,53	1,316	202	4,38	1,364	155
PEU_02	4,46	1,246	199	4,37	1,292	153
PEU_03	4,11	1,120	195	4,01	1,386	152
PEU_04	4,60	1,231	202	4,41	1,293	155
PU_01	4,01	1,369	202	4,28	1,417	155
PU_02	4,04	1,235	200	4,11	1,346	154
PU_03	4,05	1,324	201	4,13	1,289	151
PU_04	4,27	1,365	199	4,28	1,331	154
RC_01	2,48	1,588	200	2,39	1,726	155
RC_02	2,04	1,586	200	1,99	1,806	154
RC_03	4,24	1,296	200	4,05	1,536	153

[a] Dimensions organised alphabetically

We applied the normality tests of Kolmogorov-Smirnov and Shapiro Wilk (Table III) with the aim of selecting the most suitable method for the hypothesis testing. The results suggested the rejection of the normality hypothesis (n.s. 0.05), therefore non-parametric statistics should be used.

TABLE III. KOLMOGOROV-SMIRNOV AND SHAPIRO-WILK NORMALITY TESTS

	Kolmogorov-Smirnov			**Shapiro-Wilk**		
	Statistic	***Df.***	***Sig.***	***Statistic***	***Df.***	***Sig.***
BI_01	,190	580	,000	,900	580	,000
BI_02	,196	580	,000	,904	580	,000
PC_01	,213	580	,000	,893	580	,000
PC_02	,180	580	,000	,913	580	,000
PC_03	,173	580	,000	,920	580	,000
PEU_01	,226	580	,000	,876	580	,000
PEU_02	,211	580	,000	,883	580	,000
PEU_03	,207	580	,000	,892	580	,000
PEU_04	,224	580	,000	,873	580	,000
PU_01	,195	580	,000	,897	580	,000
PU_02	,201	580	,000	,897	580	,000
PU_03	,200	580	,000	,905	580	,000
PU_04	,241	580	,000	,864	580	,000
RC_01	,130	580	,000	,930	580	,000
RC_02	,182	580	,000	,896	580	,000
RC_03	,208	580	,000	,892	580	,000

[a] Liliefors significance correction.

The selected statistic for the hypothesis testing is the Mann-Whitney's U test (Table IV). The results indicate that there are no significant differences according to the year of the students (n.s. 0.05).

TABLE IV. MANN-WHITNEY'S U TEST RESULTS FOR THE VARIABLE YEAR.

	Mann-Whitney's U	**Wilcoxon's W**	**Z**	**Asymptot. sig. (bilateral)**
BI_01	14807,000	34907,000	-,637	,524
BI_02	14753,000	26688,000	-,535	,593
PC_01	15125,000	27060,000	-,460	,646
PC_02	14883,000	26511,000	-,263	,792
PC_03	14084,500	25560,500	-1,184	,236
PEU_01	14717,500	26807,500	-1,000	,318
PEU_02	14768,000	26549,000	-,498	,618
PEU_03	14713,000	26341,000	-,120	,905
PEU_04	14315,500	26405,500	-1,437	,151
PU_01	13915,000	34418,000	-1,849	,064
PU_02	14614,000	34714,000	-,852	,394
PU_03	14587,000	34888,000	-,643	,520
PU_04	15279,500	35179,500	-,048	,962
RC_01	14820,000	26910,000	-,722	,471
RC_02	14753,500	26688,500	-,690	,490
RC_03	14623,000	26404,000	-,734	,463

The second factor we wish to consider is the gender of the students. To this end, we followed the same procedure to verify if there are significant differences between the means (n.s. 0.05): first we carried out a descriptive study which differentiated according to gender (Table V) an then, given the numerous differences between means observed, we calculated the Mann-Whitney's U index (Table VI).

TABLE V. DESCRIPTIVE OF THE EXTENDED TAM MODEL ACCORDING TO THE VARIABLE GENDER.

	Gender of students					
	Female			***Male***		
	Average	***St. Dev..***	***N***	***Average***	***St. Dev..***	***N***
BI_01	4,10	1,486	438	4,28	1,361	234
BI_02	3,98	1,411	433	4,14	1,427	228

PC_01	4,01	1,357	440	4,23	1,351	233
PC_02	3,78	1,389	432	4,06	1,378	235
PC_03	3,83	1,371	435	4,07	1,417	231
PEU_01	4,39	1,337	440	4,69	1,148	235
PEU_02	4,40	1,247	434	4,59	1,101	228
PEU_03	4,00	1,246	428	4,19	1,155	228
PEU_04	4,52	1,241	440	4,62	1,180	233
PU_01	4,15	1,354	440	4,34	1,258	235
PU_02	3,98	1,259	432	4,28	1,252	234
PU_03	4,03	1,325	431	4,26	1,242	232
PU_04	4,26	1,307	432	4,44	1,235	234
RC_01	2,28	1,662	437	2,63	1,749	231
RC_02	1,92	1,705	437	2,19	1,788	228
RC_03	4,16	1,330	437	4,23	1,286	233

TABLE VI. MANN-WHITNEY'S U TEST RESULTS FOR THE VARIABLE GENDER.

	Mann-Whitney's U	**Wilcoxon's W**	**Z**	**Asymptot. sig. (bilateral)**
BI_01	48154,000	144295,000	-1,322	,186
BI_02	45640,000	139601,000	-1,640	,101
PC_01	46294,000	143314,000	-2,139	,032
PC_02	45008,500	138536,500	-2,490	,013
PC_03	44686,500	139516,500	-2,413	,016
PEU_01	45605,000	142625,000	-2,611	,009
PEU_02	45713,500	140108,500	-1,672	,094
PEU_03	44369,000	136175,000	-1,990	,047
PEU_04	49210,500	146230,500	-,888	,375
PU_01	47886,000	144906,000	-1,630	,103
PU_02	43153,500	136681,500	-3,230	,001
PU_03	45251,000	138347,000	-2,084	,037
PU_04	46285,500	139813,500	-1,880	,060
RC_01	45006,500	140709,500	-2,342	,019
RC_02	45331,500	141034,500	-1,944	,052
RC_03	49378,500	145081,500	-,664	,507

As we can observe in the table, we have found significant differences in 9 out of the 16 proposed items. The difference is especially relevant in the case of perceived compatibility, because all three items that compose the construct yield significant differences. Regarding resistance to change, there are differences in two out of its three items: RC_02 and RC_03. The rest of the items that show significant differences are: PEU_01, PEU_03, PU_02 and PU_03.

In each case, men obtain higher scores than women, which leads us to think that men have a better disposition towards the use of these technologies in their teaching practice.

IV. CONCLUSIONS

The results of this research carried out with the students from the Primary Education Teacher Bachelor's Degree from the University of Salamanca show a behavioral intention of use moderately prone to the use of mobile technologies in their future teaching practice, with results above three in all items except for RC_01 and RC_02. These results suggest that the factors of perceived compatibility and resistance to change are open to improvements through planned educational interventions.

The mean scores obtained agree with those obtained in other studies on the level of technology acceptance of pre-service teachers [39, 40].

The hypothesis testing has not shown significant differences between the means according to the year the students are enrolled in, for the groups of the first and the fourth year. This can suggest a lack of training in the use of these tools or a lack of student participation in mobile learning experiences [41].

The results obtained therefore suggest the need to include specific mobile learning programmes in regards to the progressive improvement of the students' acceptance of these devices as their educational process advances.

Lastly, the statistically significant differences found according to gender in over half of the instrument's items are striking, especially so in the case of perceived compatibility and resistance to change. The in-depth study of the influence of this factor in the abovementioned constructs constitutes an interesting research field for future studies.

The study of the influence of gender in the technology adoption process constitutes a field of interest within which we can find other examples of research that have found differences between men and women [42], although not all of them find such differences [43], which makes it necessary to keep researching on the subject.

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