ANEXO D: MLEARNING AND PRE-SERVICE TEACHERS: AN ASSESSMENT OF THE BEHAVIORAL INTENTION USING AN EXPANDED TAM MODEL

Sánchez-Prieto, J. C., Olmos-Migueláñez, S., y García-Peñalvo, F. J. (2017). MLearning and pre-service teachers: An assessment of the behavioral intention using an expanded TAM model. Computers in Human Behavior, 72, 644-654. doi:http://doi.org/10.1016/j.chb.2016.09.061

MLearning and pre-service teachers: An assessment of the behavioral intention using an expanded TAM model

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ABSTRACT

This paper presents the results of a study conducted in the University of Xxxxxxxxx, on the behavioral intention of using mobile devices within the future teaching practice of pre-service primary education teachers. To this end we elaborated a technology adoption model based on the Technology Acceptance Model (TAM), to which we incorporated the constructs of self-efficacy and mobile anxiety. The study consisted of 678 participants from the Primary Education Teacher Bachelor's Degree at said university.

The model was examined with the PLS-SEM technique. The analysis supported all the relational hypotheses proposed, and suggested that the stronger relationships were those established between perceived usefulness and behavioral intention, perceived ease of use and perceived usefulness, and self-efficacy and perceived ease of use.

The multi-group analysis barely yielded any significant differences at a structural level controlling for gender and course year. However, we did find some significant differences between mean scores at an indicator level. The PLS-POS analysis of unobserved heterogeneity identified two groups with significant differences in their path coefficients.

Keywords

mLearning Adoption; Technology Acceptance Model; Self-Efficacy; Mobile Anxiety; Pre-service teachers.

1. INTRODUCTION

The research on the incorporation of technology to the teaching methods in formal education has experienced an evolution process that has increased the number of research topics and disciplines interested in this matter. At first, research had a technological point of view, and it was focused on studying the advantages of using ICTs in the classroom (Petrova & Li, 2009).

Without abandoning this line of research, the gradual recognition on part of the society of the integration of new technologies as one of the key factors for the improvement of the teaching-learning process (Pelgrum, 2001) has

caused a rise in the number of studies centered on characteristics other than the functional features of the information system (IS).

One of the topics of study that is attracting the most attention is the analysis of the factors that influence the success or failure of initiatives dealing with the integration of a new information system (Murray & Olcese, 2011; Orr, 2010; Wang, Wiesemes, & Gibbons, 2012). Within these factors, teacher acceptance has proven to be an essential element in the educational innovation process (Chen, Looi, & Chen, 2009).

However, engaging teachers in this process is a complex task (Dündar & Akçayır, 2014). Among the factors that condition their attitude we find elements such as the extra work that preparing new materials or activities for new ISs entails for teachers, the need to invest time to undertake the necessary training, or the anxiety produced by not feeling able to handle new devices.

One of the most recurrent tools for the study of these factors is the elaboration and application of technology adoption models. The pioneer of these models is the IDT (Innovation Diffusion Theory) (Rogers, 1962), a theory that explains the stages of the technology innovation process. After this theory, the development of other acceptance models has constituted a research field with a growing number of investigations, due to the increasing importance of ICTs in all human activities.

Among all these models, the most extended one is the TAM (Technology Acceptance Model) (Davis, 1989). The proposal, based on the assumptions of the TRA (Theory of Reasoned Action) (Fishbein & Ajzen, 1975), characterizes a system's acceptance process through 5 constructs:

- **Perceived usefulness (PU):** PU is "*defined as the prospective user's subjective probability that using a specific application system will increase his or her job performance within an organizational context*" (Davis, Bagozzi & Barsaw, 1989, p.985)
- **Perceived ease of use (PEU):** It "*refers to the degree to which the prospective user expects the target system to be free of effort*" (Davis, Bagozzi & Barsaw, 1989, p.985).
- **Attitude towards use (A):** Based on the definition proposed on the TRA, it designates "*an individual's positive or negative feelings (evaluative affect) about performing the target behavior*" (Davis, Bagozzi & Barsaw, 1989, p.984).
- **Behavioral intention (BI):** Another concept built from the TRA, it is conceived as *"a measure of the strength of one's intention to perform a specified behavior",* in this case the use of an IS (Davis, Bagozzi & Barsaw, 1989, p.984).
- **Actual use (AU):** The level of actual use of the IS.

From these constructs, Davis proposes a series of relational hypotheses, shown in Figure 1.

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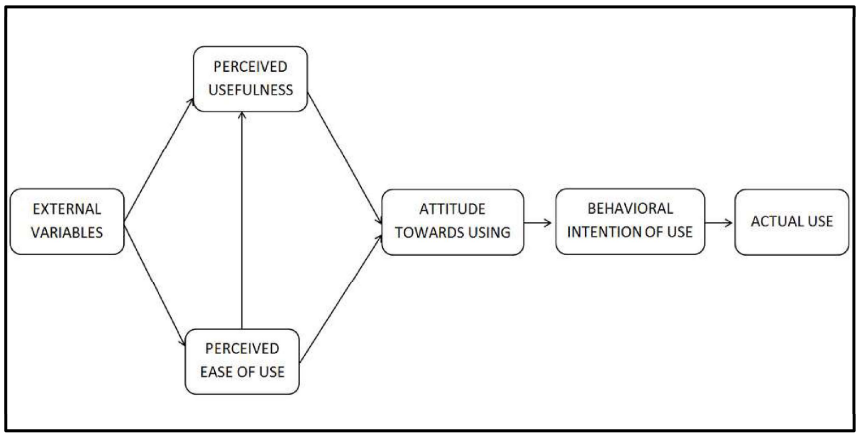

Figure 1. TAM (Davis, Bagozzi & Barsaw, 1989)

Since its inception, TAM has been established as the most frequently used model for the study of technology adoption (Teo, Lee, & Chai, 2008). Authors highlight parsimony as the model's main advantage, with which we can explain a significant percentage of the variance (King & He, 2006).

This model has been subject to modifications by researchers, both to adapt it to different contexts and to increase the percentage of variance it can explain by adding new constructs from other theories (Hernández García, 2012). Aiming to integrate the findings of these extended models, two new versions of the TAM were created: TAM 2 (Venkatesh & Davis, 2000), which introduces constructs such as subjective norm and image, and TAM 3 (Venkatesh & Bala, 2008), which extends the TAM 2 with factors such as perceived enjoyment and perception of external control.

In the field of education, the number of studies that use TAM to investigate technology adoption processes is on the rise. We can find significant examples of its use in research both with teachers and students at all educational levels, especially in the field of elearning and higher education (Sánchez-Prieto, Olmos-Migueláñez & García-Peñalvo, 2016a).

Our research focuses on the study of the acceptance of mobile technologies among primary education pre-service teachers. The inclusion of mobile devices in the formal field of education has been one of the most prominent technological innovation processes in the past few years (Fulantelli, Taibi, & Arrigo, 2015), with a growing number of studies focused on the educational applications of these devices (Sánchez Prieto, Olmos Migueláñez & García-Peñalvo, 2014). Given this rising importance, the number of studies on their acceptance among teachers and students, both within the educational context (Joo, Lee, & Ham, 2014; Kim, Chun, & Lee, 2014; Yamakawa, Delgado, Díaz, Garayar, & Laguna, 2013), and outside of it (Kuo, Liu, & Ma, 2013; Riad Jaradat, 2013) has also grown.

However, despite this interest, most of the research on the acceptance of mobile technologies is focused on the students (Kim, Kim, & Han, 2013; Park, Nam, & Cha, 2012; Yamakawa et al., 2013), paying little attention to teachers.

Our initiative goes along the lines of other studies on the employment of technology acceptance models with pre-service teachers (Acarli & Sağlam, 2015; Camilleri & Montebello, 2011; Teo, 2010; Valtonen et al., 2015), aiming to analyze the future teachers' intention to use these devices when they take up their job, and to gain a better understanding of the factors that contribute to the acceptance of mobile learning within this collective.

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To this end we have developed a TAM-based model expanded with two constructs: mobile anxiety and self-efficacy. With this porpose we have conducted a study on the intention to use mobile technologies in the future teaching practice of students from the Primary Education Teacher Bachelor's Degree at the University of Xxxxxxxxx.

The structure of the reminder of this paper is divided in three sections. The first one will include a literature review and describe the methodology employed in the study. After that, we will present the results obtained from the analysis of the measurement and structural models, including the descriptive statistics, the hypothesis testing related to demographic factors and the study of unobserved heterogeneity. Lastly, we will finish the paper providing the discussion drawn from the results.

2. LITERATURE REVIEW AND METHODOLOGY

Our research is focused on a topic related to the level of acceptance of mobile technologies among pre-service primary education teachers, in order to try to assess their future intention to these devices technologies and to gain a better understanding of the factors that affect such disposition.

Below we will explain the methodology employed in our research. We will begin by presenting the theoretical model we designed, focusing on the definition of the constructs and the basis for the formulation of relational hypotheses. After this, we will describe the characteristics of the population and sample and, lastly, the operationalization of the variables.

2.1. Study variables and research hypotheses

Our proposal is composed of three factors from the original TAM, to which we have added two factors, self-efficacy and mobile anxiety, in order to study their role in the technology acceptance process of the pre-service teachers.

2.1.1. Constructs from the TAM model

To draw up the model used in this study, we started with TAM. From this model we kept the following constructs: perceived ease of use, perceived usefulness and behavioral intention. However, we decided to eliminate the construct of attitude towards use due to its limited moderating effect (Hu, Clark, & Ma, 2003) and also aiming to simplify the model and reduce the number of items on the instrument. The removal of the construct attitude towards use is supported by other popular technology adoption models such as TAM 3 (Venkatesh & Bala, 2008) or UTAUT (Venkatesh et al., 2003), as well as by studies that apply TAM-based models in an educational context (Tan, Ooi, Leong & Lin, 2014; Park, 2009).

Also, since it is a study on the behavioral intention of use in future teaching practice, we are not able to measure actual use. This decision has its precedents in other studies based on the TAM model in contexts when the availability of the technologies is not ensured (Abbad, Morris, & de Nahlik, 2009; Chen, Lin, Yeh, & Lou, 2013; Roca & Gagné, 2008; Saadé & Bahli, 2005; Teo & Noyes, 2011; Wu & Liu, 2013; Bourgonjon et al., 2013).

Moreover, we need to take into consideration that, within the educational context, the dependence on self-reports to register actual use makes the answers of the teachers unreliable, because they can opt to give the answer that they consider to be desirable in their organizational context (Teo, 2011). Finally, there are also studies conducted in the education field whose results question the relationship between behavioral intention and actual use (Nistor, 2014).

Therefore, our proposal identifies the acceptance of mobile technologies with the behavioral intention to use them in the future teaching practice.

Regarding relational hypotheses, we propose and adapt the three hypotheses suggested by Davis & Venkatesh (1996):

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H1: Perceived usefulness positively predicts pre-service primary teachers' behavioral intention to use mobile technologies in their future teaching practice.

H2: Perceived ease of use positively predicts pre-service primary teachers' behavioral intention to use mobile technologies in their future teaching practice.

H3: Perceived ease of use positively predicts pre-service primary teachers' perceived usefulness of mobile technologies in their future teaching practice.

The hypothesis 3 proposed in the model is excluded from studies on technologies that are in an advanced stage of adoption. However, in the context of our research we chose to keep it, because the research target is to predict the intention to use these technologies in the future teaching practice, and we consider that, for pre-service teachers, the didactic use of mobile devices is in an initial adoption stage.

These hypotheses have been tested in a considerable number of studies on technology acceptance in the field of formal education. Table 1 presents as an example a series of studies conducted within the field of education that explore hypotheses similar to the ones we propose. These studies have been selected after a literature review.

Authors	Proposed relationships	Collective	Supported	Not supported
Tan, Ooi, Leong & Lin (2014)	PU→BI PEU→BI PEU→PU	University students	• • •	
Escobar-Rodriguez & Monge-Lozano (2012)	PU→BI PEU→BI PEU→PU	University students	• •	•
Arenas-Gaitán, Ramírez-Correa & Rondán-Cataluña (2011)	PU→BI PEU→BI PEU→PU	University students	• • •	
Lee, Yoon & Lee (2009)	PU→BI PEU→BI PEU→PU	University students	• • •	
Park (2009)	PU→BI PEU→BI PEU→PU	University students	 •	• •

Table 1. Relationships among the constructs from the TAM analyzed in previous studies

2.1.2. Mobile anxiety

Anxiety towards technology belongs to the internal control factors, understood as factors related to the user's internal control ability (Hernández García, 2012).

This factor refers to the negative feelings that can arise in the individual when they have to deal with handling technology to perform a task.

To elaborate the mobile anxiety construct we have started from the concept of computer anxiety (Venkatesh & Bala, 2008). This construct could be defined in this study as the feeling of apprehension, anxiety or fear towards the use of mobile technologies in the teaching practice.

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Although it is less frequently used than other constructs such as enjoyment or compatibility, anxiety is a concept that has been previously analyzed in technology acceptance studies in the field of education, mainly focused on its relationship with self-efficacy and ease of use (Table 2).

Authors	Proposed relationships	Collective	Supported	Not supported
Alenezi, Karim, & Veloo (2010)	MA→BI	University students	•	
Chen, Lin, Yeh & Lou (2013)	MA→SE	University students	•	
Agudo-Peregrina, Hernández-García & Pascual-Miguel (2014)	MA→SE	University students and Lifelong learning students	•	
Chatzoglou, Sarigiannidis, Vraimaki & Diamantidis (2009)	MA→PEU MA→PU SE→MA	Lifelong learning students	• •	•
Chen & Tseng (2012)	MA→PU MA→PEU	High school teachers	•	•

Table 2. Relationships between mobile anxiety and other constructs analyzed in previous studies.

Starting from the abovementioned antecedents, as well as the proposals of TAM3, our research proposes the following hypothesis for this construct:

> **H4**: Mobile anxiety negatively predicts pre-service primary teachers' perceived ease of use of mobile technologies in their future teaching practice.

2.1.3. Self-efficacy

Self-efficacy is a concept from Bandura's social cognitive theory (Bandura, 1978). It refers to the individual's belief in their own abilities to organize and execute the actions necessary to manage certain situations.

With this definition as a starting point, self-efficacy has been adapted in order to be incorporated to technology adoption models, defined as the assessment of one's own ability to use an information system (Compeau & Higgins, 1995; Yuen & Ma, 2008).

The perception of self-efficacy among teachers constitutes the focus of several studies, related or not to new technologies. This concept is defined as the teachers' belief in their own skills to produce an improvement in their students' learning (van Dinther, Dochy, Segers, & Braeken, 2013).

Starting from these definitions, our study understands self-efficacy as the belief the teachers have in their ability to integrate the use of mobile technologies in their future professional practice to enhance their students' learning process.

The effect that this construct has on the IS acceptance process within the field of education has been explored with good results both with teachers and students, dealing with technologies ranging from elearning to the use of computers (Nam, Bahn, & Lee, 2013; Tarhini, Hone, & Liu, 2014; Wong, Teo, & Russo, 2012). These studies analyze its relationship with other TAM model constructs such as perceived usefulness or perceived ease of use, as well as with factors from other theories, especially with anxiety (Table 3).

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Authors	Proposed relationships	Collective	Supported	Not supported
Agudo-Peregrina, Hernández-García & Pascual-Miguel (2014)	SE→PEU	University students and Lifelong learning students		•
Lee, Hsieh & Chen (2013)	SE→PU SE→PEU	Lifelong learning students	 •	•
Park (2009)	SE→PU SE→PEU SE→MA[1] SE→BI	University students	• • •	 •
Abbad, Morris & Nahlik (2009)	SE→PEU	University students	•	
Wong, Teo & Russo (2012)	SE→PU SE→PEU SE→MA[1]	Pre-service teachers	• • •	
Chatzoglou, Sarigiannidis, Vraimaki & Diamantidis (2009)	SE→PU SE→PEU MA[1]→SE	Lifelong learning students	 • •	•
Chen & Tseng (2012)	SE→PU SE→PEU	High school teachers	• •	
Hu, Clark & Ma (2003)	SE→PEU SE→BI	School teachers	• •	

[1] The study has been conducted using the construct Computer Anxiety.

Table 3. Relationships between self-efficacy and other constructs analyzed in previous studies.

Our proposal follows the TAM3 model, which places self-efficacy as an antecedent to ease of use and anxiety, and it poses the following hypotheses:

H5: Perceived self-efficacy positively predicts pre-service primary teachers' perceived ease of use of mobile technologies in their future teaching practice.

H6: Perceived self-efficacy negatively predicts pre-service primary teachers' mobile anxiety.

2.2. Research Model

Based on the proposed hypotheses (Figure 2), we formulate the following research variables. We propose perceived usefulness and perceived ease of use as antecedents of behavioural intention, self-efficacy and mobile anxiety as antecedents of perceived ease of use, and perceived ease of use as antecedent of perceived usefulness. The pre-service teachers' behavioral intention to use mobile technologies in their future teaching practice would be the main target, and lastly, we propose three moderating variables: age, course year and gender based on the moderating variables proposed in the UTAUT (Venkatesh et al., 2003).

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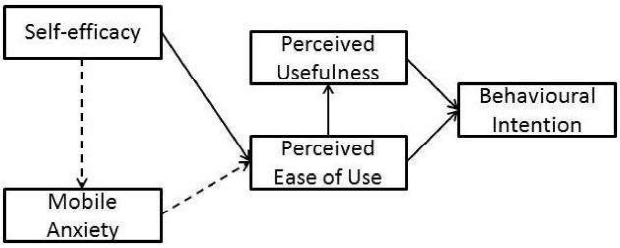

Figure 2 Extended TAM model

2.3. Population and Sample

The population of the study consists of students enrolled in the Primary Education Teacher Bachelor's Degree in the University of Xxxxxxxxx, in its branches of Xxxxxxxxx (N=480), Yyyyyy (N=320) and Zzzzz (N=234).

The study's sample is composed of 678 students from the aforementioned degree: 327 (48.2%) from the Faculty of Education of Xxxxxxxxx, 177 (26.1%) from the School of Education and Tourism of Zzzzz, and 174 (25.7%) from the University School of Teacher Training of Yyyyyy.

65.2% of the interviewed are women and 34.8% are men. Looking at the age variable, the average age of the participants is 21.09 years, most of them (51.3%) being between 19 and 21 years old. The scores have a standard deviation of 2.827.

Lastly, according to the course year variable, 29.8% of students are first-year students, 27.9% are second-year, 19.5% are third-year and 22.9% are fourth-year.

2.4. Measurement Instrument

The instrument used in this study is an adaptation of a former proposal for the assessment of the intention to use mobile technologies in the teaching practice of primary education teachers (Sánchez-Prieto, Olmos-Migueláñez & García-Peñalvo, 2016b). The instrument created in that research was subjected to a content validation process performed by a committee of experts, which ensured the validity of the model at a global level, and also the validity of the constructs and indicators. This research intends to contribute to the validation process of said scale.

The instrument is divided in two sections: the first one gathers the students' identification data (gender, age, branch and course year), and the second is composed of sixteen items formulated with a Likert-type scale of seven intervals (0-6) to measure the rest of the variables; we decided to start our scale from 0 in order to better reflect the notion of total disagreement, as suggested during the content validation process of the scale.

The items related to perceived usefulness and perceived ease of use were derived from Davis (1989):

- **Perceived usefulness (PU):** *The use of mobile technologies improves the teaching practice* (PU_01); *the use of mobile technologies makes the teaching practice more effective* (PU_02); *the use of mobile devices makes it easier to carry out teaching tasks* (PU_03); *in general, I consider that mobile devices are useful in education* (PU_04).
- **Perceived ease of use (PEU):** *Learning how 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 find it flexible to interact with mobile devices* (PEU_03); *in general, I consider mobile devices to be easy to use* (PEU_04).

For the constructs behavioral intention, self-efficacy and mobile anxiety we proposed the following items, constructed taking into consideration the contributions of Venkatesh & Bala (2008), Holden and Rada (2011), van Dinther, Dochy, Segers and Braeken (2013) and Hernández García (2012):

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- **Behavioral intention (BI):** *I intend to use mobile technologies in my future teaching practice* (BI_01); *I predict that I would use mobile technologies in my future teaching practice* (BI_02).
- **Self-efficacy (SE):** *I know I can use mobile technologies even if I have not used them in an educational setting* (SE_01); *I am able to design educational activities that make use of mobile devices* (SE_02); *I can use mobile devices in the classroom even if there is nobody to help me* (SE_03).
- **Mobile anxiety (MA):** *I doubt about using mobile technologies in the classroom because I fear I could make mistakes I cannot correct* (MA_01); i*n general, I get stressed by the use of mobile technologies in the classroom* (MA_02); *I feel wariness about the use of mobile devices* (MA_03).

3. RESULTS

3.1. Descriptive analysis

Aiming to facilitate the evaluation of the attitude of the Primary Education Teacher Bachelor's Degree students towards the use of mobile technologies in their future teaching practice, below we present the descriptive analysis we carried out, organized by constructs, in table 4. The items corresponding to anxiety were re-coded on account of being a negative construct.

	AVG	STD	Med	N	Asymp. Sig. Gender[1]	Asymp. Sig. Course year[2]
BI_01	4.15	1.450	4	675	.186	.100
BI_02	4.03	1.418	4	664	.101	.621
MA_01	4.04	1.629	4	667	.289	.509
MA_02	3.91	1.645	4	670	**.028**	.258
MA_03	3.97	1.654	4	668	.737	.542
PEU_01	4.49	1.282	5	678	**.009**	.337
PEU_02	4.45	1.213	5	665	.094	.473
PEU_03	4.06	1.221	4	659	**.047**	.463
PEU_04	4.55	1.222	5	676	.375	.413
PU_01	4.20	1.328	4	678	.103	**.026**
PU_02	4.08	1.272	4	669	**.001**	**.043**
PU_03	4.10	1.300	4	667	**.043**	.115
PU_04	4.32	1.290	5	668	.063	.296
SE_01	4.43	1.212	5	662	.686	.571
SE_02	4.28	1.297	5	674	.955	.201
SE_03	4.39	1.422	5	664	.853	**.002**

[1]Asymptotic significance results of Mann-Whitney's U.

[2] Asymptotic significance results of Kruskal Wallis Test.

Table 4. Descriptive statistics of the items of the extended TAM model and indicator level hypothesis contrast

As we can see in table 4, the scores obtained show the students' inclination towards the use of mobile technologies in their future teaching practice, with scores above 4, out of a maximum of 6, in most of the items; the median scores are between 4 and 5 in all of the indicators.

Two of the three items related to the construct of mobile anxiety have obtained values under 4, which makes it a possible field for improvement through education and training initiatives.

With the aim of selecting the most suitable analysis technique, we carried out the normality tests of Kolmogorov-Smirnov and Shapiro-Wilk to assess the normality of the sample. The result of these analyses entailed the rejection of the normality hypothesis (s.l. .05).

After this, we also calculated the kurtosis and skewness coefficients in order to know the extent to which the factors concentrate around the central zone of the distribution. According to the obtained results, there are no extreme values that prevent us from conducting the intended PLS analysis.

Finally, aiming to know whether there are differences at an indicator level according to student gender and course year, we applied non-parametric statistics to verify if there are significant differences in the mean scores obtained by the students grouped according to these variables.

Table 4 also shows the results of asymptotic significance of the Kruskal-Wallis test for the variable course year and Mann-Whitney's U for the variable gender. We have found statistically significant differences in 5 of the 16 items of the instrument for the variable gender (s.l. .05). In all of them, men obtain slightly higher scores than women, except in the item MA_03, which can lead us to suppose that males show a slightly better disposition towards the use of mobile technologies in their future teaching practice. We also found statistically significant differences in 3 items for the variable course year (s.l. .05).

3.2. Model Assessment

In order to carry out the assessment of the model we used the PLS-SEM technique, more appropriate given the exploratory and predictive focus of our research and the lack of normality of the sample distribution. The process was conducted with the program SmartPLS in its version 3.2.

We began by analyzing the reliability of the items through a standardized loadings analysis, which we can see in table 5. Although items PU_03, SE_01, MA_01 and PEU_04 had to be removed during the process, the rest of the item scored above .7, which is considered the suggested threshold to ensure reliability (Nunnally, 1978).

	Loading
BI_01	.926
BI_02	.923
MA_02	.845
MA_03	.792
PEU_01	.775
PEU_02	.729
PEU_04	.765
PU_01	.802
PU_02	.837
PU_04	.845
SE_02	.815
SE_03	.845

Table 5. Results of item reliability

In addition to item reliability, we also analyzed the convergent and discriminant validity of the model. To verify the convergent validity of the constructs we employed the composite reliability index (CRI) and the average variance

extracted (AVE). Table 6 shows that all scores exceed .6 for the CRI and .5 in the case of the AVE, which are considered to be the minimum threshold.

	CRI	AVE
BI	.922	.855
MA	.803	.671
PEU	.859	.671
PU	.868	.686
SE	.816	.689

Table 6. Results of convergent validity analysis

Lastly, we carried out a discriminant validity analysis by using the Fornell-Larcker criterion (Fornell & Larcker, 1981). According to this, there is discriminant validity when the variance among the constructs of a model is lower than the variance that each construct shares with its items (Fornell, Tellis, & Zinkhan, 1982).

In order to calculate this validity, we have to calculate the average variance extracted index. For this test, we compare the square root of the AVE with the correlation among each one of the constructs. We consider that there is discriminant validity when the square root of the AVE is higher than the correlation index. As we observe in table 7, all constructs comply with the Fornell-Larcker criterion.

Factor	BI	MA	PEU	PU	SE
BI	**(.925)**				
MA	.371	**(.819)**			
PEU	.340	.380	**(.819)**		
PU	.716	.388	.361	**(.828)**	
SE	.477	.342	.537	.416	**(.830)**

Table 7. Results of Fornell-Larcker

Additionally, we checked the discriminant validity through HTMT. The HTMT method is a new technique to assess discriminant validity developed by Henseler, Ringle & Sarstedt (2015).

There are two ways to analyze discriminant validity with HTMT. On the one hand, there is the calculation of the HTMT ratio through the application of the PLS algorithm on the data from the original sample. On the other hand, there is the HTMT inference, which is carried out through an analysis of the confidence intervals obtained by the HTMT after a bootstrapping process.

In order to be able to ensure discriminant validity, the indexes obtained by the HTMT ratio have to be below .85 applying a more restrictive criterion (Clark & Watson, 1995; Kline, 2005) or .90 if applying a more permissive criterion proposed by other authors (Gold, Malhotra, & Segars, 2001; Teo, Srivastava, & Jiang, 2008). To confirm the existence of discriminant validity with HTMT inference, the confidence intervals obtained should not include the value 1.

As we can see in table 8, for a s.l. of .05 we have obtained scores under .90 in all the relationships, and only the relationship BI-PU has scores above .85. On the other hand, the HTMT inference does not show the value 1 in the confidence intervals of any of the relationships. Thus, the results allow us to state that there is discriminant validity, both through the use of $HTMT_{90}$ and HTMT inference.

	HTMT ratio					HTMT inference (5% - 95%)				
	BI	MA	PEU	PU	SE	BI	MA	PEU	PU	SE
BI										

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MA	.561					.468 - .655				
PEU	.391	.592				.315 - .467	.498 - .691			
PU	.895	.615	.434			.849 - .939	.522 - .708	.342 - .525		
SE	.706	.643	.798	.638		.610 - .809	.536 - .762	.718 - .884	.527 - .753	

Table 8. Results of the HTMT

3.2. Structural Model Assessment

Once the reliability and validity of the measurement model have been established, we performed an analysis of the structural model to examine both the percentage of variance predicted by our model and the size of the direct and indirect effects of the latent variables (Figure 3).

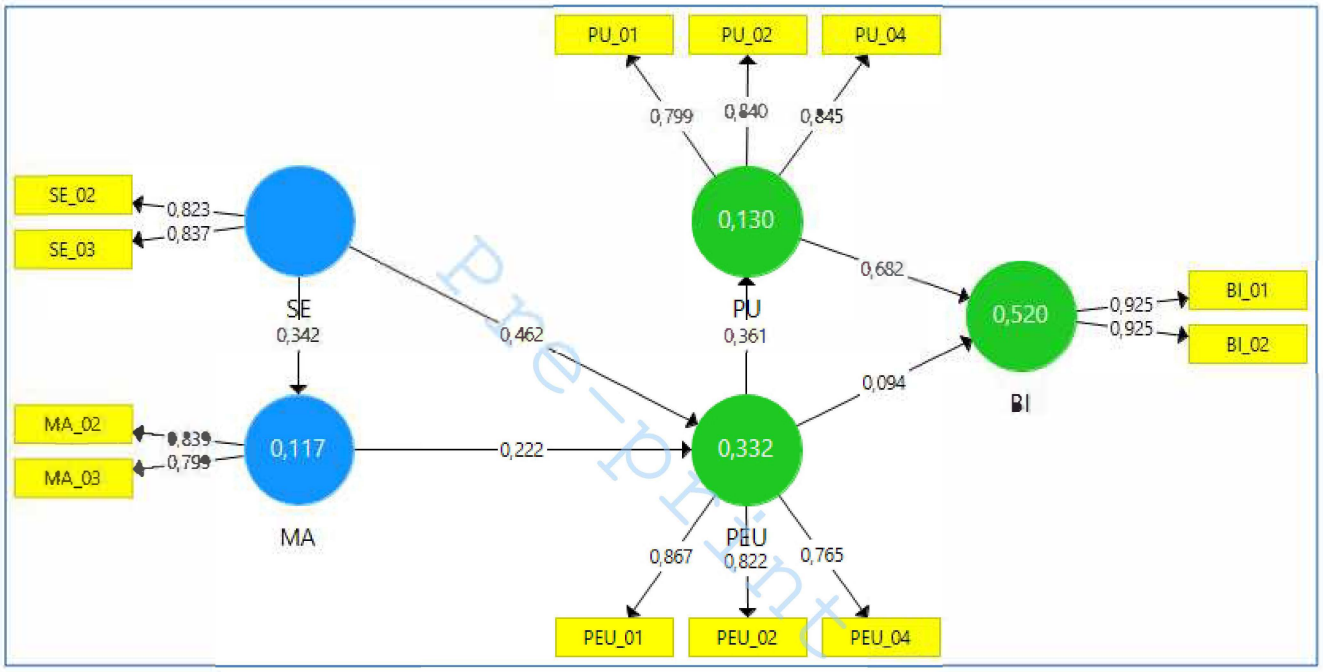

Figure 3. Path coefficients of the structural model analysis

As we can see in the above figure, the proposed model manages to explain over a fifty percent of the variance of the participants' behavioral intention. Additionally, it explains more than a thirty percent of perceived ease of use through the influence of variables MA and SE. Perceived ease of use explains thirteen percent of PU's variance. Lastly, self-efficacy explains roughly ten percent of the variance of mobile anxiety.

To confirm the predictive relevance of the model we applied the Stone-Geisser test, obtaining a Q^2 above 0 in all the constructs, therefore establishing the predictive capability of the model.

Secondly, we examined the size of the proposed relationships among the latent variables. Figure 3 reflects the path coefficient value of each relational hypothesis. The stronger relationships are the one proposed between perceived usefulness and behavioral intention (hypothesis 1), and between self-efficacy and perceived ease of use (hypothesis 5). On the other hand, the weakest relationships occur between perceived ease of use and behavioral intention, and between mobile anxiety and perceived ease of use, corresponding to hypotheses 2 and 4 respectively.

Aiming to verify whether the proposed relational hypotheses are significant, as well as the size of the effect of the latent variables, we calculated the T values of the path coefficients and the f^2 statistic (table 9).

Path	Path coeff.	T values	f^2	Results

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PU→BI	.682*	26.039	.844	**Supported**
PEU→BI	.094**	3.028	.016***	**Supported**
PEU→PU	.361*	8.745	.150	**Supported**
SE→PEU	.462*	12.961	.282	**Supported**
SE→MA	.342*	9.206	.132	**Supported**
MA→PEU	.222*	6.239	.065****	**Supported**

*p<.001 **p<.01, one tailed t-student ***marginal ****small effect

Table 9. Results of Student's t and f^2

From the results we can conclude that the PLS analysis supports all relational hypotheses among the constructs proposed in the model, with a significance level of .001, except for H2, which is supported at a significance level of .01.

Regarding Cohen's size effect (Cohen, 1988), it establishes that the relationships with a value below .02 do not have a sufficient effect and must be eliminated from the nested model. In our research, H2 has an f^2 of .016, which leads us to question its inclusion in the model due to not being able to ensure that it would have a sufficient effect size.

According to the values established by Cohen, the effects of hypotheses 4 and 6 are considered small on account of their values being under .15, hypotheses 3 and 5 have a medium effect size with values under .35, and finally, hypothesis 1 presents a large effect size.

Lastly, as a complement for the analysis of direct effects, we conducted an analysis of the constructs' indirect effects (table 10), and we found significant effects, among which we can highlight the effect of PEU on BI through PU, and the effect of SE on PU and BI through PEU.

Relation	**Eff. Coeff.**	**T values**	**p-values**
MA →BI	.076	4.816	**Supported***
MA → PU	.080	4.665	**Supported***
PEU → BI	.246	8.163	**Supported***
SE → BI	.183	7.174	**Supported***
SE → PEU	.076	4.995	**Supported***
SE → PU	.194	7.071	**Supported***

*p<.001

Table 10. Results of the indirect effects analysis

3.2. Multi-group Analysis

Once the global model has been analyzed and we have verified whether there are differences at an indicator level regarding moderating variables, we checked whether these differences also occur at a structural level. To this purpose, we conduct a multi-group analysis (MGA).

As a previous step, we explore the measurement invariance between the different groups. To this end, we followed the three steps that comprise the MICOM (Measurement of Invariance of Composite Models) (Henseler, Ringle, & Sarstedt, 2016). The first step consists in verifying the configural invariance of the model, which occurs when there are the same indicators and latent variables in the groups, they have the same reflective or formative nature, and the data gathering and treatment processes follow the same procedures.

Once the requisites of the configural invariance have been confirmed, we explore the compositional invariance, which is established when the composites have similar scores in the different data groups. The third and last step of

the MICOM consists in observing the scalar invariance among the groups. In order to carry out steps 2 and 3, we executed a non-parametric test with 5000 permutations.

The MICOM analysis of the variable gender did not find any significant differences in the compositional scores between the two groups. However, step 3 yielded significant differences in the measurements of variables PU, PEU and BI.

For the analysis controlling for course year we decided to group the scores in two categories: Initial phase students, comprised of first and second-year students, and final phase students, which encompasses third and fourth-year students.

The MICOM analysis did not find significant differences between the groups in the second step, but the third step revealed significant differences between the measurements of the constructs SE and PU.

Therefore, the MICOM results show a partial measurement invariance, both in the groups established according to the variables gender and the groups resulting from the variable course year. The partial measurement invariance is enough to apply MGA, aiming to compare the path coefficients of the groups (Henseler et al., 2016).

We began by conducting the MGA for the variable gender. The results of the analysis confirmed both the reliability and the convergent validity. Regarding discriminant validity, although the application of the Fornell-Larcker criterion did not find validity problems, it was necessary to eliminate the item PU_02 in order to ensure discriminant validity under $HTMT_{90}$. The results of the MGA between these two groups do not point out any significant differences between the path coefficients in any of the proposed research hypotheses.

As for the MGA for the variable course year, the analysis of the structural model with the two subsamples confirms the reliability and the convergent and discriminant validity, both through Fornell-Larcker and HTMT criteria. Just like with gender, the MGA shows no significant differences between the path coefficients according to this variable.

3.3. PLS-POS

In light of the results, and aiming to delve into the potential unobserved heterogeneity of the sample, we conducted a PLS-POS analysis.

PLS-POS is a non-parametric sample segmentation technique through the analysis of the heterogeneity of scores. Unlike the MGA, which segments according to a classification variable known by the researcher, PLS-POS applies an algorithm for the grouping of the subjects based on the R^2 of the latent variables, aiming to generate groups based on differences that are not directly observable (Garson, 2016).

After conducting several tests dividing the sample in 2, 3 and 4 segments, we opted for stablishing a 2-segment PLS-POS analysis due to minimum sample size requirements and to ensure reliability and validity.

In order to distribute our sample in two segments we applied the PLS-POS a total of 10 times with 1000 iterations and a search depth of 678, which is equivalent to the size of the sample. As an optimization criterion we chose R^2 of the objective variable, in this case BI. After analyzing the stability of the results obtained in the 10 operations, we selected the most representative one to carry out the analysis of the resulting segments.

This way, the application of PLS-POS lead to the conformation of two groups of 432 (63.72%) and 246 (36.28%) subjects respectively. Once the segments were obtained, and we checked that their size was above 11% of the sample, we conducted the invariance test and the MGA to verify whether there are significant differences between them.

During the calculation of the MICOM we came across invariance issues in step 2, which lead to the elimination of mobile anxiety. Once this latent variable was removed, the invariance of the compositional model was confirmed. However, step three revealed significant differences, both in the variance of the constructs and the measurements, meaning that the invariance of the model is partial.

The analysis of the model confirms its reliability and validity in the two subsamples, although it finds some discriminant validity problems during the application of the HTMT in the segment 2. These problems are not found when applying Fornell-Larcker or cross loading as criteria for discriminant validity.

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The results of the analysis of the structural model with two subsamples (Figure 4) show two notably different results.

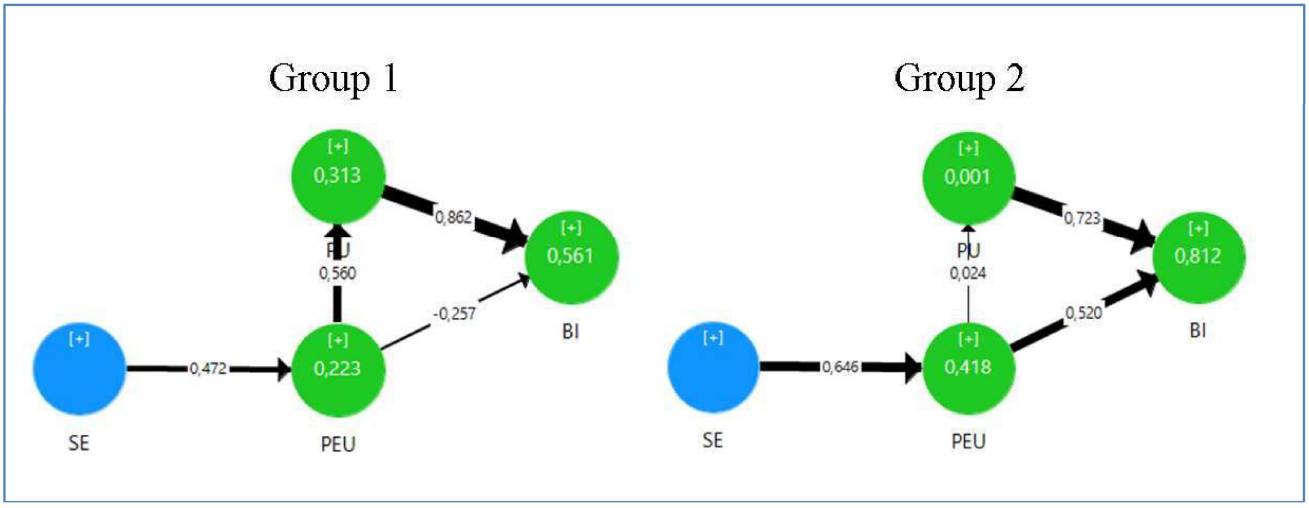

Figure 4. Results of the structural model analysis of the two groups

On the one hand, group 1 reflects a group of students for whom the main predictor of BI is PU and PEU has a weak negative direct effect on BI and a strong positive indirect effect through PU (.482). The hypothesis testing shows all proposed relationships are significant with an s.l. of .001. However, the negative nature of the relationship PEU → BI leads us to conclude that the hypothesis is not supported. The model manages to explain 56.1% of the variance, which surpasses the analysis with the full sample.

Group 2 presents a model where the relationships SE→PEU and PEU→BI are much stronger, and the relationship PEU→PU, much weaker. The hypothesis testing confirms all proposed hypotheses with an s.l. of .001 except for PEU→PU, which has a t statistic of .070 and a p-value of .472, and therefore it is not supported. The model manages to explain 81.2% of the variance of BI, a much larger value than the result of the complete model.

The MGA analysis conducted to verify whether the differences we found were significant indeed yields significant differences for all path coefficients (table 11).

Path	MGA p-value
PEU→ BI	1
PEU→PU	.000
PU→BI	.002
SE→PEU	.998

Table 11. Results of the MGA

Lastly, we analyzed the socio-demographic characteristics of the subsamples to check for significant differences that might be able to explain the formation of the two groups. To this end we apply Mann-Whitney's U for the variables gender and course year, grouped in initial and final phase, and we concluded that there are no relevant differences according to these variables. Additionally, we also verified the relevance of the differences according to the variable course year without grouping it by employing the Kruskal-Wallis test, with the same results.

4. DISCUSSION

The results of this research with students from the Primary Education Teacher Bachelor's Degree of the University of Xxxxxxxxx shed light on their intention to use mobile technologies in their future teaching practice, and return scores above the medium level in all items, and slightly above the scores obtained in other studies on the attitudes

of pre-service teachers towards new technologies (Teo, Lee, Chai, & Wong, 2009; Teo & Noyes, 2011, Acarli & Sağlam, 2015), which could facilitate the integration of these devices in formal education processes.

At an indicator level we have found some statistical differences according to the variable gender for a significance level of .05. These differences can be observed in five out of the sixteen items, belonging to the constructs of mobile anxiety, perceived usefulness and perceived ease of use. In all cases male students presented slightly higher scores than their female counterparts, these scores follow the lines of other studies on technology acceptance, who have also found significant differences between both genders (Padilla-Meléndez, del Aguila-Obra, & Garrido-Moreno, 2013), although there are other studies that have not found these differences (Ramírez-Correa, Rondán-Cataluña, & Arenas-Gaitán, 2010), which would make it interesting to carry on with the study of the variable gender in the future.

On the other hand, the variable course year barely presented any significant differences, which can be due to the students not having received a proper training in the use of these devices in their future teaching practice, or them having had few experiences as students in mLearning activities (Lei, 2009). The impact of the training and the implications of the concept of the teaching-learning process in the behavioral intention to use mobile devices in their future teaching practice open an interesting research field for future investigations (Valtonen et al., 2015).

The PLS analysis of the structural model confirmed all the proposed hypotheses, differing from other consulted proposals which questioned the relationships PU→BI, PEU→BI, PEU→PU, SE→PEU and SE→ MA (Park, 2009; Agudo-Peregrina, Hernández-García & Pascual-Miguel, 2014; Escobar-Rodriguez & Monge-Lozano, 2012); this may have its root on the technology under analysis or the study approach, given that ours is centered on student attitudes towards its use once they have assumed their teaching role, while other initiatives research the participants' adoption in their role as students.

In the case of the relationship PEU→PU, the results that support it may be explained by the stage of adoption of mobile technologies among the students. However, the low R^2 value of PU (.13) predicted through this relationship might indicate that the students perceive mobile devices as a familiar tool in their daily lives, but that they have trouble picturing their use as a didactic tool. This possible explanation is reinforced by the few differences found according to the course year at an indicator level, which leads us to venture that the students have had little contact with mobile technologies as a didactic tool, or that this contact has not been significant. We will expand on this topic later in the discussion of the PLS-POS analysis.

The path coefficients highlight the importance of perceived usefulness as a predictor of behavioral intention, and the effect of perceived ease of use on perceived usefulness.

The results show that in order to foster mobile technology acceptance on the part of future teachers it is important to design educational actions that stress the usefulness of these technologies within the teaching practice, and reducing the anxiety they might produce. Bearing these two points in mind, we suggest that training actions should be centered in the diverse functionalities and didactic uses of these devices in real working contexts through practical activities.

Unlike the indicator level analysis, the MGA conducted with the variables gender and age does not point out significant differences of these factors within the structural model, which again demands to carry on with the study of the effect of these variables to reach a definitive conclusion on their influence.

The study on the unobserved heterogeneity offers some interesting results, having established two notably different groups which cannot be explained by any of the socio-demographic variables proposed. The main change is the role played by perceived ease of use in the model, which goes from having an indirect effect on behavioral intention

through perceived usefulness that compensates the strange weak negative direct effect in the first group to having a direct effect on in in the second one. Given that the relationship PU→PEU is stronger in early adoption stages, this could be the cause that explains the making of the groups. However, it is necessary to propose new studies geared towards the identification of the source of this heterogeneity.

This study presents certain limitations, the first of which is related to the included constructs. Our research has been focused on the study of the role of self-efficacy and mobile anxiety, leaving out other constructs that might enrich the analysis, such as subjective norm, perceived enjoyment or facilitating conditions.

On the other hand, the discriminant validity analysis did not manage to pass the most restrictive $HTMT_{85}$ criterion, which indicates the possibility of certain discriminant validity problems between PU and BI. These problems seem to be even worse in the analysis of group 2 in PLS-POS, which only complies with the requirements of the cross-loadings and Fornell-Larcker criteria. In light of these results, it might be beneficial to reformulate the conceptualization of PU to avoid these problems.

However, the proposal presented in the study offers an expanded TAM model which is functional for the analysis of behavioral intention through the factors perceived usefulness, perceived ease of use, mobile anxiety and self-efficacy.

Also for future studies, it would be interesting to apply the model with teachers that have already joined teaching practice to verify whether these patterns are reproduced. Finally, bearing in mind that all the relationships between the construct have been supported, it would be interesting to expand the model with other relationships with SE that were discarded for this study, but which have been supported in some previous experiences (Park, 2009; Wong, Teo & Russo, 2012; Chen & Tseng, 2012)

The model developed for this research constitutes an effective tool to analyze mobile technology acceptance, whose items are specifically focused on the intention to use mobile devices in the future teaching practice, differing from other studies conducted to date (Teo 2010 & Teo 2012).

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