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# Design of a Technology adoption model to assess the acceptance of mobile technologies among Primary Education teachers

PhD Thesis

Doctoral student

**D. José Carlos Sánchez Prieto**

Supervisors

**Dra. Dña. Susana Olmos Migueláñez**

**Dr. D. Francisco José García Peñalvo**

**Dra. Dña. María José Rodríguez Conde**

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# EXTENDED ABSTRACT

Mobile devices constitute one of the technologies that have experienced a greater popularity explosion in the past few years, having been consolidated as one of the most used technologies in day-to-day activities for people from all social backgrounds.

This fast expansion has prompted the interest of a growing number of fields in the potential advantages derived from the use of these devices. The field of education is no exception, and it has coined the term mobile learning (or *mLearning*) to group all initiatives seeking to take advantage of these technologies.

Although the first mobile learning experiences were primarily developed in the informal and non-formal education fields, we have seen a growing number of initiatives implemented in formal education contexts. This phenomenon has been promoted in the last decade by the appearance and fast development of two devices, smartphones and tablets, which have fostered its inherent advantages and helped it overcome its main shortcomings.

The most notable advantages of the use of mobile devices in formal education processes are the adaptation of contents to the educational needs of students, the ability to integrate multimedia resources, the ability to facilitate communication and interaction between all the educational agents, and the increased flexibility of the teaching-learning process, allowing us to break the barriers of the classroom for learning to happen anytime and anywhere.

Consequently, today the integration of mobile technologies in the teaching methodologies of formal learning contexts constitutes a topic of growing concern, as is evidenced by the implementation of different initiatives by public administrations.

However, this interest does not seem to be producing any results, and the policies developed by administration do not always bring about the desired methodological change.

One of the key agents for the success of these initiatives are teachers, given that they have the last word over which methodologies they will employ in the

classroom. Therefore, knowing the factors that condition their decision to use methodologies involving mobile technologies is essential for designing successful technology integration initiatives.

However, the study of mobile technology acceptance on the part of teachers is still in an initial stage of exploration, and there are few studies focused on the topic.

This thesis intends to contribute to the body of knowledge of this particular subject through the development of a technology adoption model based on the Technology Adoption Model by Davis (1989), which has been expanded with factors from other theories, and specifically designed to analyse the factors that condition the intention of primary education teachers to use mobile technologies.

Consequently, this proposal intends to contribute to the resolution of a research problem related to the teachers' acceptance of mobile devices as a tool in formal education processes.

Thus, the following general aim is proposed for this thesis:

- To develop a technology adoption model that allows us to analyse the factors that determine the use of mobile technologies by Primary Education teachers.

With this general aim in mind, the following specific aims are proposed:

- To analyse the different technology adoption models and the characteristics determining the process of accepting an information system.
- To establish the determining factors in the adoption of mobile technologies by teachers.

In order to develop this model and achieve the objectives, a series of studies were carried out in a sequential manner.

Firstly, a systematic literature review was carried out together with a mapping study to determine the current state of research in this field, to establish the most adequate practices and to identify areas subject to study.

The results of these two studies confirm the usefulness of employing TAM-based models for the analysis of technology acceptance among teachers, and they also confirm the need to delve into the study of the factors that condition the adoption of technologies on the part of in-service Primary Education teachers, given the scarcity of studies on the subject.

In this line, there is also the need to develop technology adoption models designed for emergent technologies that are currently being implemented in the classrooms.

The most frequently used constructs were also detected. Some noteworthy ones are self-efficacy, facilitating conditions and subjective norm. The convenience of incorporating new constructs from other theories in order to improve the effectiveness of the models also became evident. This information, together with the lack of agreement on the exclusion or inclusion of the construct of attitude towards use, was especially relevant when designing the MAM-PET.

Lastly, the mapping study also provided some useful information to identify the journals with potential to disseminate the results of this research and the most relevant authors writing about the subject, which was a point of reference when organising the research stay carried out for this thesis.

Based on the results obtained, during the second phase, a first draft of the *mobile adoption model for primary education teachers* (MAM-PET) was proposed and subjected to a content validation process by a group of experts. As a result of this phase, a complete theoretical model was obtained, specifically designed to study the Technology adoption process in Primary Education teachers.

The model is composed of nine constructs: subjective norm (SN), resistance to change (RC), mobile anxiety (MA), self-efficacy (SE), perceived enjoyment (PE), facilitating conditions (FC), perceived usefulness (PU), perceived ease of

use (PEU) and behavioural intention (BI). Additionally, thirteen relational hypotheses were proposed (figure 1).

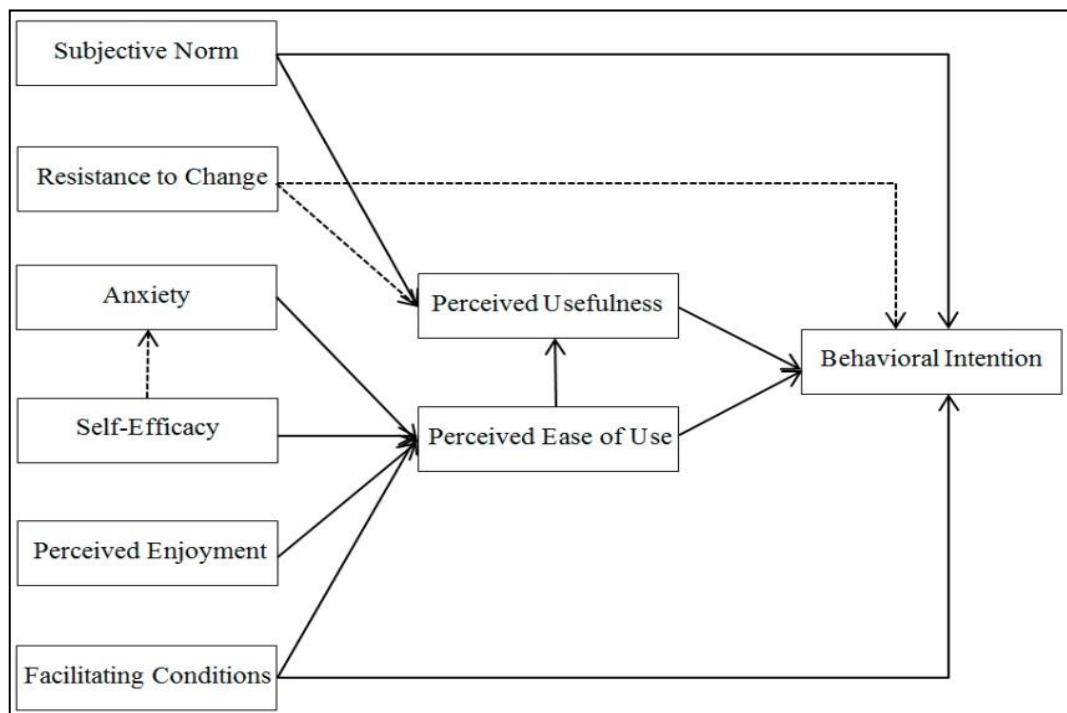


Figure 1. Diagram of the MAM-PET model. Source: Sánchez-Prieto, Olmos-Migueláñez and García-Peñalvo (2016a).

The model combines constructs that are frequently used in the literature, such as facilitating conditions, self-efficacy or subjective norm, and other less-present factors such as anxiety or resistance to change.

This proposal constitutes a first draft of the model, which will serve as a starting point both for the intermediate studies described below and for the elaboration of the MAM-PET2. The assessment performed by the judges during the content validation of the model was especially useful for the improvement of the MAM-PET and for the development of further research.

After the validation, and following the judges' suggestions, three intermediate (or pre-pilot) studies were carried out with the model to detect any possible improvements to be made.

These studies were conducted with pre-service teachers in their university education period, given the difficulty of accessing the study population and the

similarity between both groups, which has been proven in previous studies on the matter.

Additionally, although these studies were proposed because of the suggestion of the judges and their aim was to check for possible errors in the design of both the model and the instrument, they were also proposed as independent studies. Therefore, they are studies in their own right which provide relevant information on the intention to use mobile technologies in the future teaching practice of pre-service teachers, with implications for the development of research in the field of technology adoption as well as the training of future teachers.

In order to analyse the validity of the models and relational hypotheses of these three studies, structural equation modelling (SEM) was used. Covariance-based SEM (CB-SEM) or partial least squares SEM (PLS-SEM) were used depending of the characteristics of each study.

The conduction of these studies was useful for gaining a deeper knowledge of the technology adoption process of pre-service teachers, as well as for detecting the aspects of the model that could benefit from an improvement.

The results obtained from the analysis of the model employed in the third study confirmed the appropriateness of the modifications done to the instrument based on the limitations encountered in the first two studies, and they provided relevant information for the elaboration of the MAM-PET2.

Secondly, aiming to acquire experience with the research methodology and data analysis using technology acceptance models, a research stay was made in the University of Macau under the supervision of Professor Timothy Teo, during which two studies reflecting the interests of both research groups were conducted. These studies were focused on the influence of teaching beliefs and cultural values in the technology acceptance of university professors.

Just like in the three previous studies, the models were analysed through the use of structural equation modelling.

The results of these two studies provide evidences on the influence of cultural values on the technology adoption process of teachers in China and Spain.

However, given the low degree of explanation of the variance obtained in both models, it was deemed necessary to continue with the study of the influence of culture on technology acceptance in future research, although the studies seem to indicate a moderating effect of the cultural values on the relationships between the other constructs.

Therefore, regarding the development of the MAM-PET, the studies suggested the convenience of including cultural variables in the model in order to contribute to this line of research.

After the conclusion of these five empirical studies, a synthesis and critical revision of the model was carried out, and modifications were made both in the constructs and hypotheses included in the MAM-PET and in the configuration of the instrument proposed for the collection of data.

The result of this process is the MAM-PET2, a more mature model composed of nine constructs: subjective norm, perceived compatibility (PC), perceived enjoyment, self-efficacy, mobile anxiety, facilitating conditions, perceived usefulness, perceived ease of use and behavioural intention (figure 2).

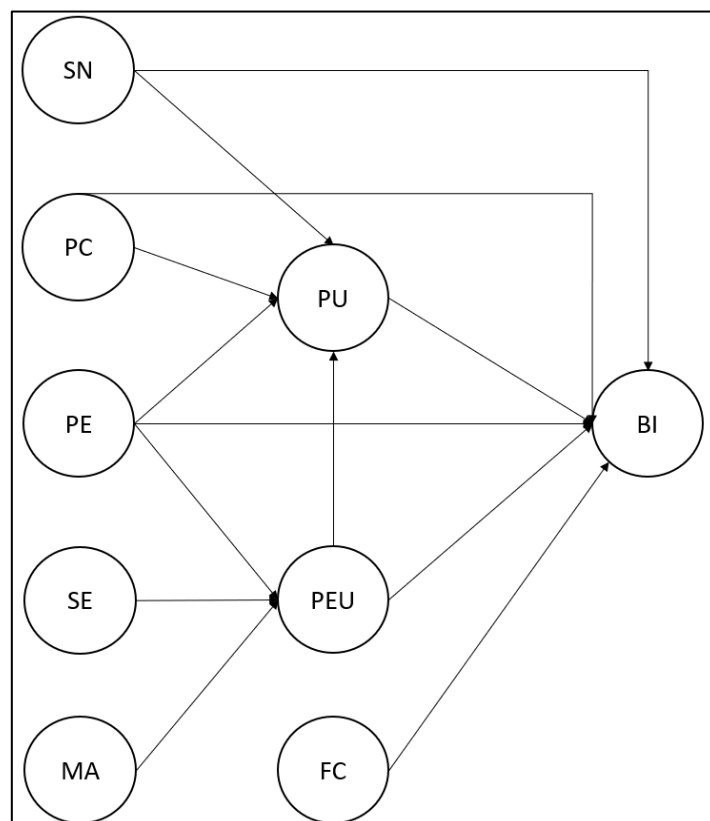




Figure 1. MAM-PET2. Source: Prepared by the author.

This model includes two dimensions from Hofstede's cultural value theory (individualism/collectivism and indulgence) as moderating variables.

Although this model constitutes the main contribution of this doctoral thesis, in compliance of the aims set at the beginning, the nature of the studies conducted between the development of the MAM-PET and the MAP-PET2 means that the results obtained have implications beyond this field of research.

Firstly, the studies conducted with pre-service teachers show a good disposition towards the use of mobile technologies in their future teaching practice, which is evidenced by high mean scores in the three studies, although there still is some room for improvement.

In this sense, this provides evidence of the importance of second-order barriers, which are those related to the internal aspects of the user, for the intention to use these devices. This becomes particularly clear in the third study conducted with pre-service teachers, where the model designed explains 70% of the variance of behavioural intention through a six-factor model composed by compatibility, subjective norm, perceived enjoyment, perceived usefulness, perceived ease of use and behavioural intention.

In this model the effect of three dimensions (perceived usefulness, perceived enjoyment and compatibility with the preferred work style) it is especially relevant. This, together with the limited role of perceived ease of use indicates the convenience of developing a teacher training syllabus that emphasises the didactic applications of these tools in teaching contexts and that highlights their usefulness for the development of key competences, instead of just being limited to convey the necessary technical knowledge to handle mobile technologies for teaching purposes.

These new teacher training programmes should not be focused solely on the benefits related to teaching effectiveness, but also on the recreational aspects of using these technologies in educational processes, given the mixed nature that these devices seem to have.

Thirdly, the results also confirm the influence of the teaching style on technology acceptance. This teaching model is not only transmitted through the contents of training programmes, but also through the methodology that university professors themselves use. Therefore, it is necessary to consider both the contents and the teaching methodologies used in teacher training programmes.

Likewise, the results of the third study also confirm the effect of the subjective norm on the behavioural intention, and they point to the convenience of modelling this construct differentiating between the different sources of social pressure.

On the other hand, the studies on technology acceptance conducted with university professors have confirmed the need to contemplate the influence of cultural values in the technology adoption process. In this regard, it is necessary to conduct further research to study the better way to model this influence, given that in both cases we have achieved validated models that can explain the influence of culture, but which reflect a very limited effect, especially in the case of Spain.

Regarding the factors influencing the technology adoption of university professors, the results confirm the effect of perceived usefulness, behaviour control and subjective norm. However, it is noteworthy that perceived ease of use again does not have any influence on behavioural intention, which leads us to rethink the role of this construct in the acceptance process.

Despite the results obtained, the studies do have some limitations which is necessary to discuss.

In order to carry out the intermediate studies, the sampling process was based on accessibility, which limits the generalizability of the results. Moreover, it is also mentionable that only a sample from the University of Salamanca was used. Although the students came from the different branches of this university, located in three different cities, the relevance of the results might also be affected.

In the case of the studies conducted with university professors, besides the limitations related to the sampling process and the use of self-reports, there are

also limitations related to the low level of variance explained, especially in the second study. This fact suggests that the model should be redefined for future research by incorporating constructs from other theories.

Finally, although the instrument proposed to assess the acceptance of mobile technologies among Primary Education teachers was subjected to a content validation and its constructs and hypotheses were tested in intermediate studies, it has not been tested with a proper pilot study with teachers due to the abovementioned difficulty to access the sample. This matter should be resolved in future research.

The implications and limitations of the studies conducted suggest the following future lines of research:

- **To delve into the study of ease of use:** The low level of influence on technology acceptance shown by this construct, both in pre-service teachers and university professors, hints at the need to delve into the nature of this construct, which is fundamental in the three versions of TAM, in order to ponder its reformulation or removal in some research contexts. This is especially interesting in the case of the technology adoption model presented in the third intermediate study, which was able to predict 70% of the variance of behavioural intention despite ease of use not having any effect on it.
- **To expand the model of intermediate study number 3:** Besides proposing an alternative modelling for perceived ease of use in this model, it would be interesting to expand it with less common constructs from other theories, such as attachment (Teo, Jarupunphol 2015).
- **To use more heterogeneous samples:** One of the main limitations of the intermediate studies was the sampling process, so it would be interesting to apply the research model in other contexts to verify the stability of the results.
- **To delve into the study of the influence of cultural values:** By using alternative, less employed theories in the field of technology

acceptance, such as Schwartz's cultural value theory (2012). Another possible line of research is to replicate the studies with other sampling methods, or with other users within the educational context. This line is already under development, and the collaboration with Professors Huang and Teo has been extended through a study on the acceptance of mobile technologies among university students, which is under review.

- **To verify the functioning of MAM-PET2:** As it has been previously mentioned, the problems related to accessing the sample have hindered the conduction of a pilot study using the technology adoption model designed, which constitutes a possible future line of research.

It is manifest that, despite the initiatives carried out by other researchers and the contributions included in this doctoral thesis, the study of the factors that influence the technology adoption process of educational agents still constitutes an under-explored research topic in which there are plenty of unanswered questions.

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