

Technology Acceptance Among Teachers: An SLR on TAM and Teachers

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ABSTRACT: Nowadays, the introduction of information and communication technologies in formal education contexts is still an interesting study subject for the research community.

The fast technological development entails a constant change process where new information systems and devices emerge on a daily basis. This constant change demands an effort on the part of educational agents in order to adapt to the new possibilities.

Teachers bear a determinant weight in technology innovation processes. Consequently, there is a rising number of studies focused on analysing the attitude of teachers towards the use of ICTs within their classrooms.

Knowing the factors that lead teachers to accept ICTs is especially useful both to guide the development of educational technologies and to design teacher training initiatives.

One of the most used tools to develop studies on technology adoption is the TAM (Technology Acceptance Model). This theory, which comes from the field of behavioural psychology, is widely used in spheres such as organisational sciences, electronic commerce or health technologies, on account of its parsimony and easy adaptation. In the past few decades, the application of TAM and TAM-based models has been extended to the field of education. Today, we can find studies that use these models to explore the attitudes of teachers and students.

Our research is based on the development of a Systematic Literature Review (SLR) of publications related to the use of TAM or TAM-based models to conduct quantitative empirical studies on the acceptance of ICTs on the part of teachers. To this end, we have used three repositories: SCOPUS, ISI WOS, and Google Scholar, where we have introduced the terms TAM AND "technology Acceptance Model" AND "in-service teachers". We have obtained 248 results from all the repositories, to which we have applied several exclusion and inclusion criteria. Once the article selection was made, we carried out a meta-analysis by extracting data regarding different variables, such as the country of the study, the educational level, the technology under study and the model employed. The results offer an overview of the state-of-the-art of the research in this field.

1 INTRODUCTION

The TAM model (Davis, 1989), constitutes a theoretical proposal that tries to give explanation to the technological adoption process of the individuals.

This theory is based on the TRA (Theory of Reasoned Action) (Fishbein & Ajzen, 1975) and it establishes two key constructs, perceived ease of use (PEU) and perceived usefulness (PU), as the main antecedents of the adoption. These two constructs condition the attitude towards the use (A), which conditions the behavioural intention of use (BI), the direct antecedent of the actual use of the technology (AU).

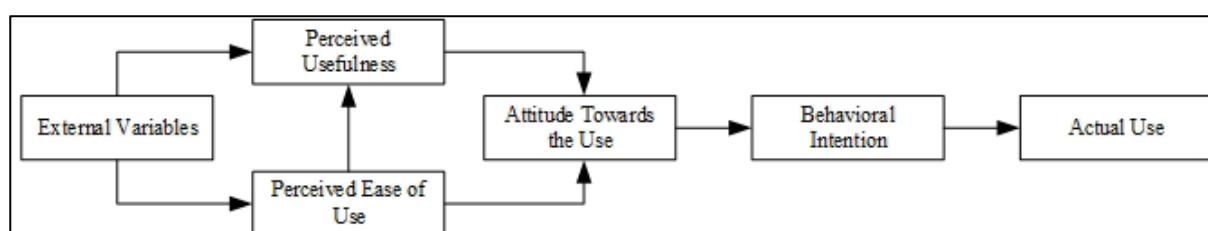


Fig. 1. TAM model (Davis, 1989).

The theoretical soundness of the TAM, joined with its simplicity and adaptability to different contexts and technologies, has caused that nowadays this theory is one of the most frequently used technology adoption models.

With time, the proposal by Davis evolved, giving rise to two new versions of the model: TAM2 (Venkatesh & Davis, 2000) and TAM3 (Venkatesh & Bala, 2008), in addition to a considerable number of TAM-based models that expand TAM with constructs from other theories like TPB (Theory of Planned Behaviour) (Ajzen, 1985) or TFT (Task Technology Fit) (Goodhue & Thompson, 1995).

One of the fields in which the TAM model is starting to be applied with more frequency is the educational one. In this area, we can find an increasing number of researches focused both in students and teachers in all the educational levels (Sánchez-Prieto, Olmos-Migueláñez, & García-Peñalvo, 2016).

The teaching body plays a key role in the success of the programs for the integration of new technologies in formal education. Therefore, the results of these researches may be especially useful both for predicting the future use of a determined technology and for the design of the teacher training programs (Sánchez-Prieto, Olmos-Migueláñez, & García-Peñalvo, 2017).

The lack of researches focused on giving a global and systematic vision of the use of TAM with the teaching body makes possible and useful the performance of a meta-analysis with the objective of analyse the contexts in which it has been applied more frequently, the constructs more used and the method of analysis more extended.

In this communication, we present the results of our research proposal employing the SLR method to conduct a meta-analysis on the mentioned object of study. In order to do this, after this brief contextualization section we will expose the research questions and the review method. Thirdly we will present the results obtained and, lastly, we will close with a brief series of conclusions derived from the study.

2 METHOD

The objective of this systematic literature review is to know the state of the art of the research on the acceptance of new technologies by the teachers using TAM or TAM-based models. In order achieve that objective we have designed a research protocol following the suggestions of Kitchenham and Charters (2007) to answer three research questions:

- RQ1. Which is the current state of the research on the acceptance of ICTs among in-service teachers using TAM or TAM-based models?
- RQ2. Which are the variables used with more frequency?
- RQ3. Which methodology of analysis is the most employed?

Once we have laid out the research questions, we selected a series of terms connected using booleans to compose the search string. After trying different combinations, we finally used the following string: TAM AND "technology Acceptance Model" AND "in-service teachers".

To conduct the searching of research works we employed the scientific databases ISI-WOS, SCOPUS and GOOGLE SCHOLAR, with the intention to cover not only the works published in the most recognized journals and the conference proceedings but also those included in less relevant publications.

Before we began the selection of works we developed a preliminary search to validate both the search string and the selected repositories testing their ability to detect relevant papers previously known by the researchers.

The results of the application of the string in the three repositories were recorded using Google's spreadsheet software. In total, we obtained 248 results, to which we applied the following inclusion/exclusion criteria to guarantee that only the papers relevant to answer the research questions were included in the study.

- **Out of focus:** Publications that were not related to the acceptance of ICTS among in-service teachers or that did not apply TAM or a version of TAM sufficiently close to the original proposal.
- **Theoretical studies:** Contributions with no empirical part.
- **Language:** Studies published in a language other than Spanish or English.
- **Duplicate articles:** Publications that appeared more than one time in the outputs of the repositories.
- **Incorrect format:** The study is focused on articles and conference proceedings that were subjected to a peer review process.

Given the heterogeneity of the variables included in the TAM-based models, we established as an inclusion criteria that the selected studies had at least the variables: PU, PEU and BI. The inclusion of the variable AT was not considered necessary given its elimination in TAM2 and TAM3. Additionally, the researchers did not consider necessary the inclusion of the variable AU due to its scarce presence in the technology acceptance models developed in the educational context.

After the application of the selection criteria we obtained 16 valid results to answer the research questions (table 1) that can be consulted through the following link: goo.gl/o8s.

Source	Number of Initial Results	Rejected	Accepted
SCOPUS	5	3	2
ISI-WOS	2	1	1
GOOGLE SCHOLAR	241	225	16
Total	248	228	21
Total – Duplicates			16

Table 1. Results of the application of the inclusion criteria

Regarding the causes for the exclusion (figure 2), 65% of the researches were rejected because they were focused on a research topic different to the object of study of the present research, either because the researches were not focused on in-service teachers, or because the researches did not applied TAM or TAM-based models. In a second place, 25% of the papers were excluded due to the publication type. Finally, the rest of the criteria were applied in a marginal number of cases.

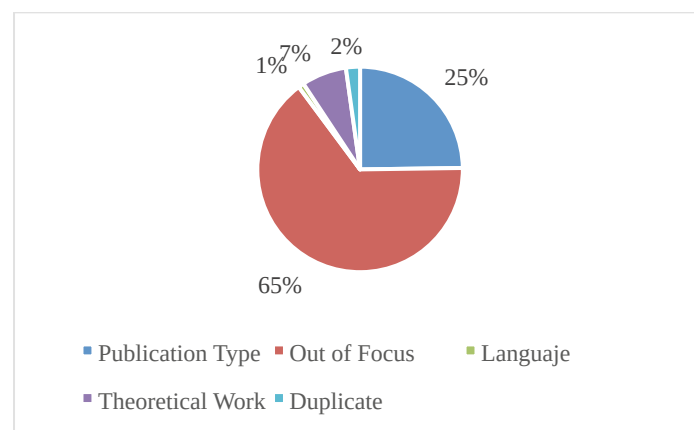


Fig. 2. Exclusion Criteria

3 RESULTS

Once we selected the papers and extracted the relevant information we carried out a descriptive analysis of the data to answer the research questions. Following we present the results for each of them.

3.1 Which is the current state of the research on the acceptance of ICTs among in-service teachers using TAM or TAM-based models?

To answer this question, we paid attention to the countries where the studies took place, the educational level of the teachers, the year of publication of the study and technology analysed.

We begin with the year of publication of the studies. As we can see in the figure 2, the first studies on the acceptance of ICTs among the teachers using TAM begin in the middle of the past decade, although this research topic did not gain the interest of the research community until a few years ago. It is worth noticing that the search of studies took place in October of 2016 which can cause the actual number of publications of that year to be slightly higher.

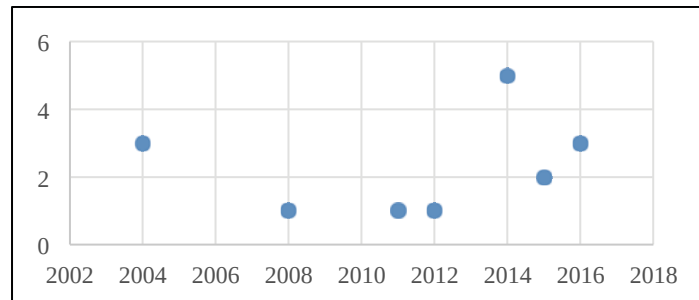


Fig2. Year of Publication

Secondly, the majority of researches included in this SLR are focused on the attitude of primary education teachers or primary and secondary education teachers (table 2). Only one of the researches was developed in Higher education.

Educational Level	Number of Researches
Primary	7
Primary and secondary	6
Secondary	2
Higher education	1

Table 2. Number of researches per educational level.

Thirdly, there is a considerable amount of heterogeneity regarding the technologies analysed in the publications. This way, we can find researches focused on web-based learning (Yuen & Ma, 2004), spatial media (Koutromanos, Styliaras, & Christodoulou, 2014), e-textbooks (Chiu, 2017) or mobile learning (Aljuaid, Alzahrani, & Islam, 2014) among others. However, the topic with the higher number of researches (5) is the acceptance of ICTs in general.

Lastly, we can observe in the geographic distribution of the researches that the vast majority of them take place in Asia (table 3).

Country	Number of Research
China	8
Cyprus	1
Malaysia	1
Iraq	1
Singapur	1
Nigeria	1
Greece	1
The Netherlands	1
Turkey	1

Table 3. Number of researches per country.

3.2 Which are the variables used with more frequency?

In order to answer this question, we analysed two separate aspects of the models of the researches. Firstly, the inclusion or exclusion of the variable attitude, given that this constitutes an open question nowadays among the scientific community due to its limited explanatory power of the behavioural intention (Teo & Noyes, 2011). Therefore, it is interesting to know the number of researches focused on the technology acceptance of in-service teachers that uses this construct. 10 of the researches included in this study uses the attitude as an antecedent of the behavioural intention opposite to 6 that erase it. In all of the 10 cases the results support the hypothesis $AT \rightarrow BI$.

Secondly, we analysed the variables included more frequently in expanded TAM models. 5 of the 16 researches uses TAM without adding constructs precedent from other theories, in all the cases but one the researchers chose to eliminate the construct AT. The constructs more frequently added in the rest of the researches are the self-efficacy (SE), the subjective norm (SN) and the facilitating conditions (FC) followed by the behavioural control and the anxiety. The rest of the variables are used in a marginal number of cases (table 3).

Construct	Number of researches
Self-efficacy	5
Voluntariness	1
Institutional Support	1
Anxiety	2
Subjective Norm	6
Facilitating Conditions	4
Learning fit	1
Visualization Process	1
Research Process	1
Reasoning Process	1
Construction Process	1
Perceived Behavioural Control	3
Technological Complexity	1

Table 4. Number of studies per variable.

3.3 Which methodology of analysis is the most employed?

Lastly, we examined the methodology employed in the selected studies (figure 3). This analysis reveals that most of the researches opt for the application of structural equation models to perform the hypothesis contrast.

The rest of the researches perform regression analysis or analysis at an indicator level using the Student's T statistic.

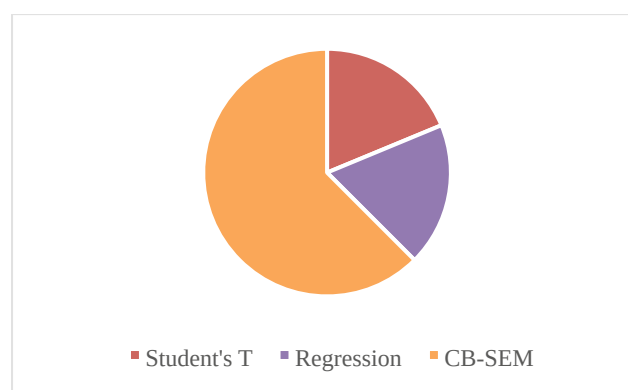


Fig. 3. Analysis method

4 CONCLUSIONS

As we have seen, the TAM model constitutes a useful tool for the analysis of the factors driving the teachers to use a given technology. Although the TAM or TAM-based models did not begin to be used with this collective until the beginning of the last decade, in the past few years the use of this research tools has experienced an important growth, probably supported by both the soundness of the theory and the increasing incorporation to the classrooms of technologies such as mobile devices or learning management systems (Almarashdeh, Sahari, Zin, & Alsmadi, 2011; Sánchez Prieto, Olmos Migueláñez, & García-Peñalvo, 2014). Therefore, the performed SLR leads us to conclude that the application of TAM for the analysis of the attitudes of in-service teachers constitutes a field of growing interest in an early stage of exploration.

Firstly, the majority of the publications selected for this study were carried out in the Asian context, especially in China, which makes it interesting to delve into the technology adoption process of the teachers in other cultural realities. Likewise, we can observe that most of the researches are focused in the teachers of the compulsory education levels which opens the doors to the development of new studies focused in the post-compulsory education teaching body. In consequence, another interesting future line of research could be the design of comparative studies among the teachers of the different educational levels as well as cross-cultural studies. This new researches can follow the example of the previous ones employing structural equation models to conduct the analysis.

Lastly, the answer to the second research question entails a series of implications for the design of teacher training activities and the policies developed by the administration. As we have seen, the three factors more frequently used to extend the TAM are the CF, the SN and the SE. In all of the researches analysed the results supported the significant influence of these three constructs in the technology adoption process. This indicates that, on the one hand, is necessary to develop programs destined to equip the schools with the resources, both humans and technological, necessary for the integration of the desired new technology.

On the other hand, it is also necessary to design teacher training programs focused on conveying not only the technical knowledge necessary to use the devices but the benefits derived from its use in the educational context.

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