Design and Validation of an Emerging Educational Technologies Acceptance and Integration Questionnaire for Teachers

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Abstract: The integration of technology in the teaching and learning processes depends to a large extent on the teaching attitude towards these resources. Thus, our research is focused on the internal beliefs that predisposed teachers to their acceptance and pedagogical use in schools. The main objective of this work was to design and validate a questionnaire for non-university teachers with the main purpose of identifying the most important factors of their teaching attitude towards the use of emerging technological resources. Taking the Theory of Planned Behaviour and its subsequent development as reference behavioural research models, we developed a questionnaire that interrelatedly combines the following factors: *perceived usefulness*, *perceived self-efficacy*, *facilitating conditions* and the *subjective norm*. A total of 661 teachers were recruited from public schools in La Rioja (Spain). Content validity, construct validity, internal consistency and reliability of the questionnaire were undertaken as part of the validation process. The results showed good psychometric qualities in the questionnaire and indicated that the instrument is reliable and a valid measure to identify the factors that explain the teaching attitude towards technological resources. The findings have both theoretical and practical implications for the educational administration, management teams and teachers.

1 INTRODUCTION

For many authors (Johri et al., 2014; Hubalovsky et al., 2019; Navaridas et al., 2020), the acceptance and standardized use of information and communication technologies (ICT) in educational processes in schools are key factors for promoting change and innovation in teaching. The use of ICT allows to transform traditional ways of acquiring, preparing, organizing and transmitting knowledge in the classroom. In accordance with this idea, in recent years there are also various international organizations and institutions that have tried to promote their development to improve access to education and training, raise the quality of learning and promote a culture of collaboration between educational institutions (Commission of the European Communities, 2001; OECD, 2015; UNESCO, 2009). Thus, for example, among the standards proposed by UNESCO (2008, 2011) on ICT skills for teachers, those that refer to the creation of a new "technology-based teaching model" stand out. In this sense, teachers must take full advantage of technological progress in order to create new environments and pedagogical methods focused on learning, to develop innovative didactic material and to exchange experiences of the application of these technologies to teaching, training and research. All this allows to improve the practices and results of current education.

In the current educational scenario, which is affected by the pandemic derived from Covid-19, some research works seem to show that it is not enough to increase investment in ICT (Montenegro et al., 2020) to achieve these objectives. Indeed, despite the efforts made by the Educational Authorities of our region in recent years to provide ICT resources to the basic and compulsory education centres, the results provided by some studies (Santiago et al., 2014; Pérez and Rodríguez, 2016) question whether these

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resources are used effectively for educational purposes. In general, it seems to be observed that teaching decisions related to the use of ICT in teaching and learning processes are largely determined by the teachers' own conceptions of these resources (e.g., perceived usefulness, perceived self-efficacy, perceived availability). In this case, the own experiences and formative experiences of the teaching staff are important elements in their teaching perceptions.

It is essential and necessary that educational institutions develop an energetic training policy for their teaching staff (Fernández-Cruz and Fernández-Díaz, 2016). Thus, for this training to have the desired effect at the teaching level, during the planning process, it may be interesting to start with a study of the teachers' own system of motivations or beliefs as the main components of their attitude and intention to use the technological resources during the teaching and learning processes in the educational centres (Straub, 2009).

In this sense, many of the reviewed studies propose using research models based on the Theory of Reasoned Action -TRA- (Fishbein and Ajzen 1975, Ajzen and Fishbein 1980), which considers that a person's decision to execute a certain *action* is fundamentally conditioned by an *attitudinal component* (understood as the relatively stable predisposition of a person to respond favorably or unfavorably to a specific situation or stimulus) and a component based on *normative beliefs* (understood as the perception of a person about the different pressures to which it may be subjected from the social circles of belonging or reference). According to this premise, one of the models most used to study technological acceptance is the Technology Acceptance Model -TAM- (Davis, 1989; Davis et al., 1989; Venkatesh and Davis, 2000), where *perceived usefulness* and *perceived ease of use* are included as determinants of human behavior.

In an attempt to integrate in a harmonious and related way the different factors considered by the previous models as determinants of the effective implementation of the technology, Venkatesh et al. (2003) formulated the Unified Theory of Acceptance and Use of Technology (UTAUT). Although in a very broad framework of research assigned to different fields of specialization (Cimperman et al., 2016; Khalilzadeh et al., 2017; Khaksar et al., 2019) there seems to be a consensus on the factors that can predict to a greater extent the acceptance and use of technological resources. In the specific context of education, there seems to be some controversy and inconsistent results both in the level of influence and in the relationships established between the identified factors (Scherer et al., 2019). Sensitive to these findings in the educational field, in this research we set the following objective: to design and validate a questionnaire to corroborate its goodness with respect to a theoretical model of research on acceptance and technological integration.

2 METHOD

2.1 Research Model

In accordance with the proposed research objective, and based on a review of the most prominent models of technological acceptance in the specialized literature in this field (Davis, 1989; Venkatesh and Davis, 2000, Venkatesh et al., 2003; Venkatesh and Bala, 2008), we designed a theoretical research model that incorporates the factors that we consider most appropriate and relevant to the context under study. In this sense, the designed model combines the factors highlighted in the TRA, TAM and UTAUT models in an adapted way (Figure 1).

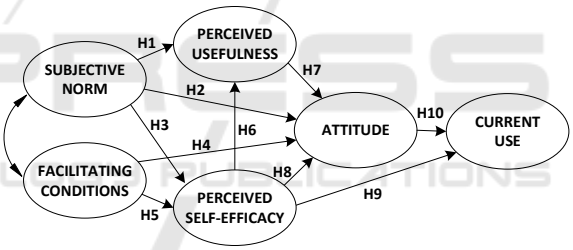


Figure 1: Theoretical research model (own elaboration).

The definition of each of the factors considered is summarized as follows:

- Current use: refers to the degree or frequency of use of technological resources during teaching activity.
- Attitude: this factor refers to the teacher's predisposition to respond favorably or unfavorably to a technological resource.
- Perceived usefulness: refers to the degree to which a teacher believes that the use of technological resources will improve their teaching activity.
- Perceived self-efficacy: the degree to which a teacher believes that he or she possesses the knowledge and skills necessary for the pedagogical use of technological resources.
- Facilitating conditions: this factor refers to the ease of use perceived as a consequence of the teacher's control over external conditions or

variables and the availability of organizational and technical resources.

- Subjective norm: refers to the teacher's beliefs about what most of the people important to him or her think about the use of technological resources during their teaching activity.

Thus, we postulated the following hypotheses that establish the relationships and influences between the factors defined in the theoretical model designed:

H1. The teacher's subjective norm or normative beliefs positively influences perceived usefulness.

H2. The teacher's subjective norm positively influences his or her attitude toward the use of technological resources.

H3. The teacher's subjective norm influences his or her perceived self-efficacy.

H4. Facilitating conditions positively influences the teacher's attitude toward the use of educational technologies.

H5. Facilitating conditions influences the teacher's perceived self-efficacy for the use of technological resources.

H6. Perceived self-efficacy positively influences the teacher's perceived uselfulness of educational technologies.

H7. Perceived uselfulness of technology positively influences the teacher's attitude toward the use of technological resources.

H8. Perceived self-efficacy positively influences the teacher's attitude toward the use of technological resources.

H9. Perceived self-efficacy positively influences the current use of technological resources during teaching activity.

H10. Teachers' attitude positively influences the current use of technological resources during their teaching activity.

2.2 Participants

The aim of the survey is to better understand teachers' own conceptions of the use of technological resources for educational purposes and, thus, to help the educational authorities of our region in the development of an efficient training policy. Since the responsibilities of these local educational authorities are limited to non-university levels, the target population is the total set of employed teachers in non-university centres.

Data were collected from 6 April 2020 to 10 May 2020, i.e., after COVID-19 outbreak. This ensured that the target population had at least a computer at home for educational purposes: some teachers borrowed the technological devices from their own educational centres. The study sample included 661 teachers who carried out their teaching activities from early childhood education to short-cycle tertiary. The demographic information of the respondents shown in Table 1 illustrates the heterogeneity of the sample, which improves the external validity of the study.

Table 1: Demographic characteristics of the participants.

Demographics	Category	Frequency (%)
Gender	Female	438 (62.3)
	Male	223 (33.7)
Age group	21-30 years	57 (8.6)
	31-40 years	172 (26.0)
	41-50 years	241 (36.5)
	51-60 years	183 (27.7)
	> 60 years	8 (1.2)
Teaching experience	≤ 5 years	128 (19.4)
	6-10 years	90 (13.6)
	11-20 years	240 (36.3)
	21-30 years	131 (19.8)
	> 30 years	72 (10.9)
Level of education taught	Early childhood	101 (10.9)
	Primary	266(28.7)
	Lower secondary	246 (26.6)
	Upper secondary	125 (13.5)
	Short-cycle tertiary	102 (11.0)
	Other	86 (9.3)

2.3 Development and Description of the Instrument

As indicated previously, the questionnaire was developed after a review of the main theories and models of technological acceptance and use. It was designed to gather demographic data on the one hand and the measurement items of the selected factors on the other hand. Before its final version, and in accordance with the classic patterns of content validity of a survey (Gómez et al., 2013), it was subjected to the scrutiny of a panel of five experts in the field of educational research. The focus of this panel of experts was to ascertain if the purpose of the questionnaire was clear, if the structure and relevance of the proposed elements (factors and items) were adequate, if questions and language were appropriate and accurate, and if it was necessary to add or remove any element. Also, they were asked to provide an overall rating of the questionnaire.

The questionnaire was amended according to the comments and suggestions of the panel of experts and, thus, the final version of the survey consists of 39 questions (items): 11 questions to collect demographic data and 28 questions related to the six defined factors (see Appendix): (1) subjective norm,

(2) facilitating conditions, (3) perceived usefulness, (4) perceived self-efficacy, (5) attitude and (6) current use. The first four factors are mainly predictive in nature, while the last two refer more to results. The teachers were asked to indicate their agreement or disagreement with each item on a Likert-type scale with five response levels that ranged from 1 (totally disagree) to 5 (totally agree).

2.4 Data Analysis

Data were analysed using the software package R version 4.0.3. First, data coding and cleaning was performed. Then, teachers' responses were analysed using descriptive statistics. Next, factor analysis, along with validity and reliability of construct were performed. Finally, structural equation modelling was used to test the goodness of fit indices in a measurement model and the proposed hypothesis.

3 RESULTS AND DISCUSSION

First, correlations between the measurement items were investigated (Figure 2). It was assessed that inter-items correlations were higher than 0.30 and lower than 0.90, which allows to consider the final items appropriate for the six factors.

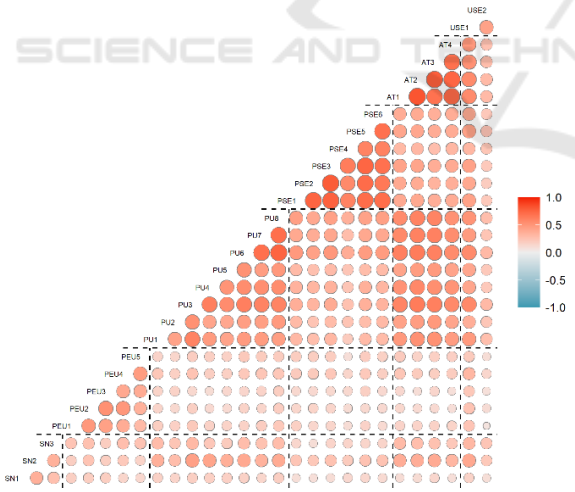


Figure 2: Correlations among measurement items.

3.1 Exploratory Factor Analysis

Exploratory factor analysis was conducted to assess the purification of measurement items. Thus, the Kaiser-Meyer-Olkin (KMO) measure and the Bartlett's test of sphericity were calculated. With values of KMO = 0.95 and Bartlett's test χ^2 = 13650.62, df = 378, and $p < 0.001$, it was confirmed the sample appropriateness, i.e., the sample was adequate and the correlation matrix was significantly different from an identity matrix.

Then, principal component analysis (PCA) with *oblique* rotation was used since we assumed that the factors in the analysis are correlated. This analysis showed that the 28 items were divided into five factors, which had eigenvalues greater than 1 and explained 71.58% of the overall variance. Percentages of total variance explained were 38.65% for the first factor, 25.79% for the second factor, 15.54% for the third factor, 8.49% for the fourth factor, 7.44% for the fifth factor, and 4.10% for the sixth factor.

3.2 Confirmatory Factor Analysis

Confirmatory factor analysis was applied for checking the loadings of observed variables (items) over latent variables (factors or constructs). Also, convergent and discriminant validity and reliability were assessed.

Table 2 shows values for factor loading (FL), composite reliability (CR), average variance extraction (AVE) and the Cronbach's alpha (CA). These results revealed that factor loading values were above the threshold of 0.5 suggested by Hair et al. (2010). Also, it was observed that the CR of subjective norm and current use factors were below the recommended threshold of 0.7 (Straub et al., 2004). The same factors showed Cronbach's Alpha values below the recommended threshold of 0.7 (Nunnally, 1978). However, these results are still within the general accepted rule that values of 0.6-0.7 indicate an acceptable level of reliability (Lam, 2012; Ursachi et al., 2015). Finally, values for AVE were greater than threshold recommended by Hair et al. (2010), i.e., 0.5, except for the subjective norm factor. In this case, since CR is higher than 0.6 AVE, the convergent validity of the factor (construct) is still adequate (Fornell & Larcker, 1981).

Discriminant validity was assessed through the heterotrait-monotrait ratio (HTMT) of the correlations (Henseler et al., 2015). Table 3 shows that most HTMT values are lower than the suggested threshold of 0.85 (Kline, 2011). However, other authors suggest a value of 0.90 (Henseler et al., 2016). Thus, discriminant validity of the proposed model was established.

Table 2: Construct reliability and convergent validity.

Construct	Item	FL	CR	AVE	CA
Subjective Norm	SN1	.57	.66	.42	.65
	SN2	.75			
	SN3	.54			
Facilitating conditions	FC1	.67	.83	.50	.83
	FC2	.80			
	FC3	.72			
	FC4	.72			
	FC5	.59			
Perceived usefulness	PU1	.66	.92	.60	.92
	PU2	.65			
	PU3	.82			
	PU4	.74			
	PU5	.68			
	PU6	.87			
	PU7	.83			
	PU8	.87			
Perceived self-efficacy	PSE1	.90	.95	.75	.95
	PSE2	.89			
	PSE3	.92			
	PSE4	.76			
	PSE5	.88			
	PSE6	.85			
Attitude	AT1	.90	.94	.79	.94
	AT2	.95			
	AT3	.87			
	AT4	.83			
Current Use	USE1	.78	.68	.61	.68
	USE2	.66			

FL: Factor Loading; CR: Composite Reliability; AVE: Average Variance Extracted; CA: Cronbach's Alpha

Table 3: Discriminant validity.

Constructs	SN	FC	PU	PSE	AT	USE
Subjective Norm (SN)	.42					
Facilitating conditions (FC)	.54	.50				
Perceived usefulness (PU)	.65	.39	.60			
Perceived self-efficacy (PSE)	.34	.31	.58	.75		
Attitude (AT)	.53	.28	.87	.53	.79	
Current Use	.63	.40	.77	.58	.73	.61

Diagonal values are AVE and off-diagonals are HTMT values

Finally, the statistical fitness of the model was assessed with three sorts of fit indices used in structural equation modelling (SEM), i.e., absolute, parsimonious and incremental. Table 4 illustrates that the obtained results are within the accepted threshold values for different fit indices, showing the goodness of the proposed model and questionnaire.

Table 4: Summary of fit indices.

	Absolute fit measure	Parsimonious fit measure	Incremental fit measure	
	SRMR	RMSEA	CFI	TLI
Acceptable fit	≤ .08	≤ .06	≥ .90	≥ .90
Obtained fit	.045	.055	.95	.94

SRMR: Standardized Root Mean Square Residual; RMSEA: Root Mean Square Error of Approximation; CFI: Comparative Fit Index; TLI: Tucker-Lewis Index

3.3 Structural Model

Causal relationships were evaluated in the structural model using the open-source lavaan package available in R, which was developed by Roosseel (2012). Thus, Table 5 and Figure 3 present the output generated for the proposed model.

Table 5: Hypothesis testing.

Hypothesis	β values	Status
H1: Subjective Norm → Perceived usefulness	0.517***	Accepted
H2: Subjective Norm → Attitude	0.014	Not supported
H3: Subjective Norm → Perceived self-efficacy	0.279***	Accepted
H4: Facilitating conditions → Attitude	-0.063	Not supported
H5: Facilitating conditions → Perceived self-efficacy	0.172**	Accepted
H6: Perceived self-efficacy → Perceived usefulness	0.419***	Accepted
H7: Perceived usefulness → Attitude	0.889***	Accepted
H8: Perceived self-efficacy → Attitude	0.005	Not supported
H9: Perceived self-efficacy → Current Use	0.270***	Accepted
H10: Attitude → Current Use	0.571***	Accepted

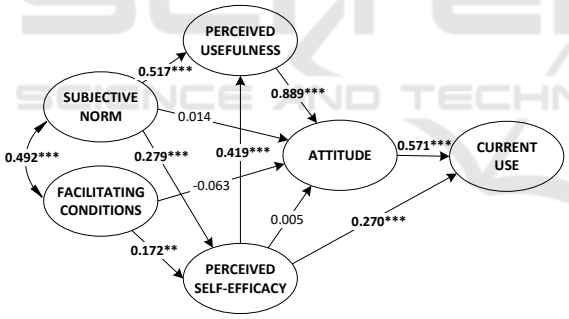
NOTE: significant at: * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

Results inferred the significant acceptance of seven hypothesized relationships:

- The data supported both H1 and H3, which predicted that the subjective norm would positively influence the teachers' perceived usefulness of technology and their perceived self-

efficacy. These results are in line with other works (Abdullah and Ward, 2016; Scherer et al., 2019).

- With respect to H6 and H9, the assumptions that perceived self-efficacy would influence perceived usefulness and current use of technology were individually confirmed.
- The relationship between facilitating conditions and perceived self-efficacy (H5) was also corroborated by the data. In this case, perceptions of possible barriers that are related to external conditions or availability of organizational and technical resources are linked to beliefs about the degree to which a teacher can perform teaching tasks with technology.
- In the case of H7, the results supported the expectation that perceived usefulness would positively influence the teachers' attitude toward the use of educational technologies. This finding agrees with other studies (Venkatesh et al., 2003; Scherer et al., 2015) that emphasize the importance of teachers' perceptions for user attitudes and use intentions toward technology.
- Finally, H10, which predicted that teachers' attitude positively influences their use of technological resources, was also supported. Once again, this finding is consistent with other studies (Nistor and Heymann, 2010; Scherer et al., 2018).



NOTE: significant at: ** $p < 0.01$; *** $p < 0.001$

Figure 3: The results for the suggested model.

Surprisingly, behavioural intention (attitude) toward the use of technological resources was not significantly influenced by facilitating conditions (H4), perceived self-efficacy (H8), or subjective norm (H2). In addition, the negative value of the path coefficient between facilitating conditions and attitude (H4) implies that teachers' attitude toward the use of educational technologies decreases with higher perceptions that using technology will be either free of effort or involve a minimum of effort, which seems counterintuitive. These results could be explained because data were collected after COVID-19 outbreak so there was not an option to choose whether to use of educational technologies for teachers' pedagogical activities or not.

4 CONCLUSIONS

The main objective of this study was to investigate the validity of a questionnaire designed to measure the teachers' acceptance and integration of emerging educational technologies. Also, the study examined the factors influencing teachers' attitude toward the use of educational technologies during their activities and their integration. Specifically, this work examined the subjective norm, facilitating conditions, perceived self-efficacy for technology use, perceived usefulness of integration technology, attitude, and technology use.

Subjective norm and perceived self-efficacy are important predictors of perceived usefulness (H1 and H6). Although the effects vary across studies, there is agreement on these results. In the present work, these variables explained 60% of variance (R^2) in perceived usefulness. Also, perceived usefulness and attitude seem to be critical factors for user attitude toward technology (H7) and current use (H10), respectively. In addition to attitude, perceived self-efficacy seems to play a relevant role of teachers' use of technological resources during their teaching activity (H9). Overall, about 77% of variance in attitude and 56.3% of variance in current use were explained within the proposed model. These results suggest the importance of planning teachers' training programs which focus on improving the perceived usefulness as well as enhancing teachers' self-efficacy in using technology.

Although further analyses and refinement of the tool are planned in the future, the findings presented in this work suggest that the questionnaire effectively measures educational technologies acceptance and use in non-university teachers.

As with most educational research, this study has certain limitations to address and improve in future research. First, the research was conducted in a region with a specific context and, therefore, the results could not be generalized on other regions or countries which have different contexts. In future, the proposed model will be strengthened by considering mediating and moderating variables. Also, the research model will be used and extended to check the acceptance and integration of technology in a variety of different domains (e.g., face-to-face universities, e-health, etc.).

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APPENDIX

Emerging Educational Technologies Acceptance and Integration Questionnaire

Table 6: Questions used to measure the subjective norm.

Label	Item
SN1	In general, families demand the use of technology in learning processes.
SN2	My students expect me to use ICT in the teaching and learning process.
SN3	In general, teachers in my department consider it important to use ICT in the teaching and learning processes.

Table 7: Questions used to measure the facilitating conditions.

Label	Item
FC1	In my opinion, the necessary technical resources to facilitate the use of ICT in educational processes are available.
FC2	In my institution, the availability of classrooms and spaces with technological resources (computers, tablets, digital screens, etc.) is very suitable for the development of digital competence.
FC3	In general, the Educational Authority provides the necessary resources and support (training, advice, etc.) to make effective the use of ICT in educational processes.
FC4	During my teaching activity, I find it easy to use ICT spaces (computer room, classrooms with digital screens, etc.) and ICT resources (educational platforms, free access to websites, YouTube, etc.).
FC5	In my opinion, I have a good service and computer support when I need it.

Table 8: Questions used to measure the perceived usefulness.

Label	Item
PU1	Technological resources are necessary to develop my teaching activities.
PU2	Mobile devices are useful to me and reduce my working time.
PU3	ICTs help me to facilitate the expected learning of my students.
PU4	I am sure that ICTs affect students' motivational aspects such as interest, satisfaction and curiosity.
PU5	ICTs allow me to attend to the diversity of the students more effectively.
PU6	As a teacher I enjoy the use of ICT in the teaching process.
PU7	Technologies allow me to develop professionally.
PU8	I find satisfaction and feelings of well-being with the use of ICT in teaching and learning processes.

Table 9: Questions used to measure the perceived self-efficacy.

Label	Item
PSE1	I believe that I have good digital competence.
PSE2	I have the necessary knowledge to locate relevant information and transform it into knowledge through ICT.
PSE3	I have the necessary knowledge to share and collaborate through digital media.
PSE4	I know the main aspects related to security, digital identity and data protection.
PSE5	I consider myself competent to create digital content for my students.
PSE6	Generally, I am able to solve technical problems through digital means.

Table 10: Questions used to measure the attitude and use.

Label	Item
AT1	I intend to use technology in teaching and learning processes in the short/medium term.
AT2	I think it is a good idea to use technology in my teaching activities.
AT3	Being able to use technology to improve the quality of learning is important to me.
AT4	I am willing to use new technologies for the different teaching and tutoring tasks with my students.
USE1	I use ICT for the general dynamics of my classes.
USE2	Approximate number of hours of technology use per day in my classroom.