Technology Acceptance in Education

The teacher-related barriers to the acceptance of the interactive whiteboards in Portuguese public schools

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Abstract

Teachers are the key factor to successfully integrate technology in the classroom, both students and teachers benefit from this integration, and there has been considerable investment in that sense. This study proposes an extended Technology Acceptance Model (TAM) that integrates students' influence, job satisfaction, technical support, training and age into the original model to explore the factors that affect the usage intention towards the interactive whiteboard by Portuguese teachers. The proposed model was tested using the data collected from a questionnaire developed for this study. The empirical analysis is carried out by the two-step structural equation modeling, assessing the reliability and validity of both the measurement and structural models. The results confirm the positive effects of job satisfaction, perceived ease of use, perceived usefulness, students' influence, and training (through perceived ease of use) in the intention to use the interactive whiteboard. Perceived usefulness had the largest positive influence. It is also suggested by the results that perceived ease of use gains importance as a determinant of intention for older teachers. After two new paths were proposed during the analysis, the model explains 85% of the variance in usage intention.

Keywords: *Technology Acceptance, Usage intention, Structural Equation Modeling, Interactive Whiteboard, Portuguese teachers, Technology in Education.*

1. Introduction

The education has, nowadays, a technological facet never imagined by previous generations of both teachers and students. The technological development brings emerging devices and systems that demand an effort from schools to properly integrate and take advantage of them.

Information Technology (IT) can improve teaching by boosting what is already in practice or by giving professionals new and better ways of teaching. The way teachers prepare their lessons can be improved using technology as access to textual and audiovisual content, which enables to make lessons more complete and attractive, and enhances the active involvement of students. Students exposed to technologies they will likely use later in their professional careers have an increased productivity and better communication with friends and family (Belo et al., 2014). On the other hand, IT can favor knowledge transmission by content sharing platforms or the use of websites during lessons. However, these advantages seem dependent on the way technology is used and integrated into the teaching and learning processes, being the availability of technology not enough to present results on student learning by itself (Comi et al., 2017).

In recent years, many studies highlighted a key factor for a successful integration of technologies in schools: its teachers (Sánchez-Prieto et al., 2017). Knowing the factors that determine the technology acceptance by these professionals is a trump card to develop new educational technologies and design training initiatives (Sánchez-Prieto et al., 2017).

Back in 2007, the Technological Education Plan (TEP) came to scene aiming to place Portugal in the top 5 European countries regarding the technological modernization in education sector within three years. The plan also aimed to train and certify both students and teachers in IT skills (Resolução Conselho de Ministros 137/2007). Such ambitions were followed by an economic crisis that restricted the budget available for public schools to invest in technological modernization (P. Santos, personal communication, March 1, 2018).

Duarte (2015) studied the utilization rates for the assets allocated by the TEP. The interactive whiteboards showed no significant usage by teachers, while the computers and video projectors present a high utilization rate.

The interactive whiteboard is the perfect example of how increasing the availability of a technology does not mean an increased use of it. The fact is that, in Portuguese schools, this kind of board has been used as a projection screen, and the teachers refer the lack of competences for the use of this specific technology (Machado et al., 2016).

Ten teachers involved with the technological plan, members of the school board, or with other essential roles in schools, were interviewed to provide an inside view and important barriers to the use of technology for this study. The teachers were asked about the factors they consider significant barriers to the use of technology by themselves and their colleagues. The ageing of the teaching class was largely referred, along with lack of training and the discouragement with the profession. Also referred as relevant barriers were the perceived usefulness, perceived ease of use, technical support, students influence, and job satisfaction. When asked to identify which technologies were least used in classrooms, teachers were unanimous in referring the interactive whiteboard, having the e-learning platforms, and tablets also been pointed out as not frequently used.

Understanding the determinants of a teacher's intention to use the interactive whiteboard is the main goal of this study.

2. Theoretical background

2.1. Technology Acceptance Model

Fred D. Davis firstly developed the Technology Acceptance Model (TAM) in 1985 for his doctorate proposal. The goal was to understand the user acceptance processes and provide a model for the system designers and implementers to predict acceptance and usage of those systems before their implementation (Davis, 1986). TAM uses as a theoretical backdrop the Theory of Reasonable Action (TRA), proposed by Fishbein in 1967 and analyzed and refined by Fishbein and Ajzen in 1975 (Lai, 2017).

Behavioral intention (BI) is the main determinant of usage. The model recognizes that there may exist other factors influencing the user's decision, besides those considered, and state them as external variables (Lai, 2017). These external variables may refer not only to the design features, but also the training, the nature and implementation process (Venkatesh & Davis, 1996). Perceived usefulness and perceived ease of use, concepts brought by Davis, are defined as the way a professional believes that the use of a specific system would affect his or her job performance (PU) and the belief that a system would not require a physical or mental effort (PEOU) (Davis, 1986). The final version of TAM (Figure 1) removed the attitude toward using (ATU) construct from the TAM's first draft, based on the finding that both perceived usefulness and perceived ease of use have a direct influence on BI and that the effect of attitude decreases over time (Rondan-Cataluña et al., 2015).

The concepts of perceived ease of use (PEOU) and perceived usefulness (PU), brought by Davis in 1986, remained during the years as the key to predict potential users' behavior. Usually TAM is applied in voluntary contexts, where users believe they have a choice regarding the usage or not of a system (Al-Mamary et al., 2016).

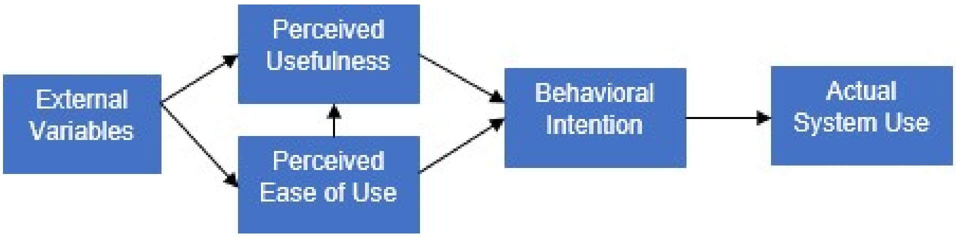

Figure 1 - Technology Acceptance Model. Adapted from Venkatesh & Davis, (1996)

2.2. Extended TAM

There is a multitude of models in the literature for assessing technology acceptance each one with its own strengths and weaknesses. However, the parsimony of TAM was a major strength of this model along with its strong support by previous studies. There are some context-related variables that this study intends to measure as determinants of intention, meaning that an extended TAM is proposed as the research model for this study.

The extensions applied to TAM should also rely on the literature, since using paths consistently supported by previous studies is expected to provide a more robust model. Another important modification to TAM the focus on the usage intention by using it as the main dependent variable, which it was referred to as able to bring a more comprehensive view of the belief systems (Teo et al., 2016), and also more appropriate to the context of this study since some teachers may have strong intention to use the interactive whiteboard, but are allocated to classroom that are not equipped with this technology.

The proposed model (Figure 2) includes the variables training (T), students' influence (SI), perceived usefulness (PU), perceived ease of use (PEOU), technical support (TS), job satisfaction (JS), just as suggested by the previous chapters conclusions. The variable usage intention (UI) is the main dependent variable, and age the moderating variable.

2.2.1. Model constructs

Training

This variable reflects the opportunities took by the professionals to learn about how to use the interactive whiteboard, how to integrate it in the teaching processes, and its benefits.

Students' Influence

Similarly to the concept of subjective norm, this construct respects the perception a teacher has that his/her students think he/she should or should not use the interactive whiteboard.

Perceived Usefulness

This variable reflects the belief a teacher presents that using the technology under study would positively influence his/her work.

Perceived Ease of Use

This variable concerns the perception that using the interactive whiteboard would be free of effort.

Technical Support

This construct respects the perception a teacher has of the level of ready support available in case of need.

Job Satisfaction

This variable reflects how a teacher feels about his/her profession, and how his/her job is being valued. It reflects feelings and motivation of a teacher considering the influence of career conditions and the treatment from its superiors or society.

Age

In this model, age is used as a moderating variable, suggesting that its variance may influence the way a variable affects another variable.

Usage Intention

Refers to the intention a teacher presents to use the interactive whiteboard.

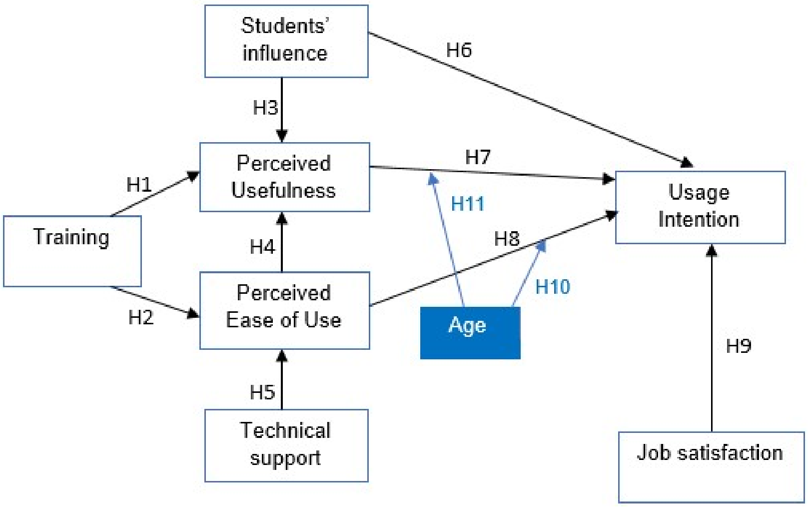

Figure 2 - Research Model.

2.2.2. Research Hypotheses

The Hs in Figure 2 refer to the reseach hypothesis that derive from the literature and can be listed as follows:

H1 - Appropriate training increases perceived usefulness - as "external variables" in TAM by (Davis et al., 1989).

H2 – Appropriate training increases perceived ease of use - as "external variables" in TAM by (Davis et al., 1989).

H3 - Students' influence positively affects the perceived usefulness - as "subjective norm" in TAM2 by (Venkatesh & Davis, 2000).

H4 - Higher levels of perceived ease of use increase perceived usefulness - as in TAM by (Davis el al, 1989).

H5 - Technical support has a positive influence on perceived ease of use - as "perceptions of external control" in TAM3 by (Venkatesh & Bala, 2008).

H6 - Students' influence has a significant influence on usage intention - as "subjective norm" in DTPB by (Taylor & Todd, 1995).

H7 - Perceived usefulness positively affects usage intention - as in TAM by (Davis el al, 1989).

H8 - Perceived ease of use has a positive influence on usage intention - as in TAM by (Davis el al, 1989).

H9 - Higher levels of job satisfaction increase usage intention - as "satisfaction" in modified DTPB by (Tao & Fan, 2016).

H10 - Age strengthens the positive effect that perceived ease of use has in usage intention - as "age" in UTAUT by (Venkatesh et al., 2003).

H11 - Age strengthens the positive effect that perceived usefulness has in usage intention - as "age" in UTAUT by (Venkatesh et al., 2003).

3. Methodology

3.1. Participants

Teachers participation in this study was voluntary, they responded to an e-mail invitation issued by the author and for those who agreed to take part in the study, a website address was given to access an online questionnaire. A total of 406 answers was collected. The main contact was addressed to teachers from primary, middle and high schools in Portugal that were equipped with interactive whiteboards. However, the sharing of the website address ended up reaching 29 teachers from schools without the interactive whiteboard. These 29 answers were deleted since it was considered that the non-availability of the interactive whiteboard could produce biased results and misleading interpretations of the sentences presented in the questionnaire.

3.2. Measures

Participants were asked to measure 30 items on a 7-point Likert-type scale from "strongly disagree" to "strongly agree", being 4 the neutral option "Neither agree or disagree". The items were defined with the support of the existent literature. (Khlaif, 2018; Teo et al., 2016; Rondan-Cataluña et al., 2015; OECD, 2014; Oye et al., 2011; Venkatesh et al., 2003; Davis et al., 1989). It is important to use items, whenever possible, that have been previously validated for a more robust measurement model. Along with these items, the participants were also asked to provide some demographic information, such as age, gender, subject area, and years of experience as a teacher.

3.3. Data analysis

Structural Equation Modeling (SEM) is a widely used statistical modeling technique within the behavioral sciences that combines several traditional multivariate approaches such as factor analysis, regression or path analysis, discriminant analysis, and canonical correlation. This technique focuses on the theoretical constructs represented by the latent factors. The path analysis studies the relationships between the theoretical constructs reflected by its path coefficients and results in a path diagram that allows to graphically visualize the structural model (Hox & Bechger, 1998).

In SEM the model to test must be specified before starting to estimate factor loadings and covariances. This model specification is usually guided by theory and empirical results from previous research. The most widely used method for estimation is Maximum Likelihood which assumes the multivariate normality of the data and a large sample (about 200 observations) (Hox & Bechger, 1998).

The SEM analysis covers two interrelated models, the measurement model and the structural model, both proposed by the researcher. To evaluate the measurement model, SEM uses a confirmatory factor analysis (CFA) in which the observed variables are allocated to the theoretical constructs (latent variables). In what concerns the structural model evaluation, the SEM technique uses path analysis in which the relationships between the latent variables, research hypothesis, are tested (Gefen et al., 2000).

SEM also includes statistical tests such as chi-square to assess how well the model fits the data. If these statistics' results meet the recommended thresholds, the researcher can rely on the results of the estimates. However, these statistical tests vary in their power with the sample size and do not only consider the fit of the model but also its simplicity. A model that specifies all possible paths between all variables will always fits the data perfectly, but it would be just as complex as the observed data it relies on (Hox & Bechger, 1998).

SEM can be performed through the one or two-step approaches. Generally, the two-step approach is preferred. This approach includes a first step in which the measurement model is evaluated, through observing reliability, validity, and a second step in which the structural model is assessed by the path significance between the latent constructs. The one-step approach tests the measurement and the structural models simultaneously, it is recommended to those studies whose measurement items and the model itself are well established in prior research (Hair et al., 2006).

Considering the more confirmatory nature of this study, the covariance-base SEM (CB-SEM) technique was preferred to PLS-SEM. However, it is important to test the multivariate normality of the data, since the sample size requirements were met to perform de CB-SEM.

4. Results

4.1. Descriptive Statistics

The demographic profile of the 377 respondents is summarized in Table 1.

The descriptive statistics for the 30 items were examined for univariate normality by the analysis of skewness and kurtosis and these ranged from -0,809 to 0,724 (skewness) and from -1,538 to -0,284 (kurtosis). The univariate normality is assumed accordingly to what is recommended by Kline (2010) - kurtosis lower than 7 and skewness lower than 3.

Table 1 - Demographic Profile of the respondents.

	Frequency	%
Grade Range		
1st cycle	65	17,2
2nd cycle	55	14,6
3rd cycle	164	43,5
Secondary education	196	52
Age		
20 ~ 29	0	0
30 ~ 39	41	10,9
40 ~ 49	144	38,2
50 ~ 59	159	42,2
60 or above	33	8,8
Gender		
Female	275	72,9
Male	98	26
Prefer not to say	4	1,1
Teaching Experience		
0 ~ 9	21	5,6
10 ~ 19	83	22
20 ~ 29	163	43,2
30 ~ 39	104	27,6
40 or above	6	1,6
School Subject		
Languages	105	27,9
Mathematics	116	30,8
Experimental Sciences	126	33,4
Social Sciences/Humanities	79	21
Physical Education	35	9,3
Arts	42	11,1
Special Education	23	6,1

4.2. *Exploratory Factor Analysis*

An exploratory factor analysis (EFA) was performed to test the measurement items proposed in this study, followed by the CFA used in structural equation modelling to evaluate the measurement model. The extraction method selected was principal component analysis, and the rotation method was promax.

The sampling adequacy was measured by Kaiser-Meyer-Olkin (KMO) test. The value of KMO should be greater than 0,6 suggesting a significant relationship between the items (Tabachnick & Fidell, 2007). The Bartlett's test of sphericity with small values of the significance level suggest that the variables are related and therefore a factor analysis may be useful. The referred thresholds were met in this study's results (Table 2), satisfying the EFA's assumptions. The total variance explained value was 76,561%.

Table 2 - KMO and Bartlett's test of shericity.

Kaiser-Meyer-Olkin test		0,941
Bartlett's test of sphericity	Approx. Chi-Square	10061,611
	df	351
	Sig.	0,000

As a result of the EFA, the items PU1, SI2, and UI2 were removed due to cross-loadings; and the item TS2 loaded with the training items so it was considered for following analysis as an item for this variable.

4.3. *Test of the measurement model*

To test the measurement model, a confirmatory factor analysis (CFA) was conducted with AMOS 25 using the maximum likelihood estimation procedure. This procedure assumes the multivariate normality of the data, so the Mardia's coefficient was examined. The value obtained was 152,329 which is lower than the value of 783 computed based on the formula p(p+2) where p is the number of observed variables in the model (Raykov & Marcoulides, 2008).

The results for the standard estimates (SE), the Cronbach alpha (Cr α), the composite reliability (CR), and the average variance extracted (AVE) are all above the recommended thresholds. The CR values are between 0,827 and 0,956 suggesting the reliability of the measurement scale. The AVE values between 0,546 and 0,844 suggest that there is convergent validity. Finally, the Cronbach's alpha values are between 0,827 and 0,963, suggesting internal consistency. The item JS4 is absent from Table 3 due to low loading (SE = 0,534) and it is deleted from the model.

Discriminant validity was tested by comparing the square root of the AVE for each construct with the correlations between that construct and the others. In Table 4 are presented the values for the square roots (diagonal elements) and those are always greater than the off-diagonal elements of the same rows and columns, which suggests that each construct has a stronger correlation with its items than with the other constructs in the model. (Fornell & Larcker, 1981) Considering this, discriminant validity was assumed.

Following the measurement model reliability and validity assessment, model fit compares the theory with reality by comparing the estimated covariance matrix to the observed covariance matrix. (Hair et al., 2006)

Table 3 - Evaluation of the measurement model. SE standardized estimate. The significance for the t-values is 0,001. ∅ These values were fixed at 1 for model identification purposes.

Variable	Item	SE	t-value	Mean	SD	Cr α	CR	AVE
Job Satisfaction	JS1	0,684	∅	2,81	1,745	0,827	0,827	0,546
	JS2	0,753	12,497	3,18	1,708			
	JS3	0,794	12,991	3,79	2,062			
	JS5	0,720	12,051	3,76	1,798			
Perceived Ease of Use	PEOU1	0,897	∅	4,47	1,764	0,924	0,929	0,766
	PEOU2	0,735	17,976	4,10	1,859			
	PEOU3	0,941	29,991	4,39	1,774			
	PEOU4	0,914	27,946	4,45	1,711			
Perceived Usefulness	PU2	0,841	∅	4,26	2,002	0,896	0,900	0,750
	PU3	0,895	22,234	4,61	1,736			
	PU4	0,861	20,897	5,07	1,832			
Students' Influence	SI1	0,897	∅	4,11	1,882	0,927	0,927	0,808
	SI3	0,875	24,813	3,68	1,959			
	SI4	0,924	28,029	4,52	1,810			
Training	T1	0,908	∅	4,05	2,124	0,963	0,956	0,844
	T2	0,949	33,186	3,95	2,141			
	T3	0,866	25,671	3,84	2,103			
	T4	0,949	33,115	4,10	2,165			
	TS2	0,909	29,141	2,88	1,855			
Technical Support	TS1	0,827	∅	3,97	2,095	0,835	0,841	0,639
	TS3	0,734	14,821	3,40	1,941			
	TS4	0,834	16,856	3,06	1,947			
Usage Intention	UI1	0,949	∅	4,24	2,157	0,945	0,947	0,817
	UI3	0,963	42,312	4,32	2,150			
	UI4	0,836	25,780	3,91	2,023			
	UI5	0,860	27,855	4,46	2,017			
Criteria		> 0,7				> 0,7	> 0,6	> 0,5

Table 4 - Discriminant Validity

	JS	SI	T	PU	PEOU	TS	UI
JS	**0,739**						
SI	0,514***	**0,899**					
T	0,436***	0,329***	**0,919**				
PU	0,500***	0,859***	0,275***	**0,866**			
PEOU	0,626***	0,665***	0,533***	0,679***	**0,875**		
TS	0,602***	0,510***	0,532***	0,443***	0,581***	**0,800**	
UI	0,589***	0,841***	0,363***	0,852***	0,726***	0,553***	**0,904**

JS – Job Satisfaction **SI** – Students' Influence **T** – Training **PU** – Perceived Usefulness **PEOU** – Perceived Ease of Use **TS** – Technical Support **UI** – Usage Intention
*** p value = 0,001

The overall model fit was assessed using the normed chi-squared, the adjusted goodness-of-fit index (AGFI), the root mean square error of approximation (RMSEA), the standardized root mean square residual (SRMR), the comparative fit index (CFI) and the non-normed fit index (NNFI). The obtained results suggested acceptable fit for the measurement model (normed chi-squared = 2,958; AGFI = 0,817; RMSEA = 0,072; SRMR = 0,053; CFI = 0,945; NNFI = 0,935). The recommended thresholds were not met for the AGFI and the NNFI indices (Hair et al., 2006; Hooper et al., 2008; Hu & Bentler, 1999).

4.4. Test of the structural model

Regarding the structural model, an initial test revealed lack of acceptable fit for the proposed model (normed chi-squared = 19,322; AGFI = 0,592; RMSEA = 0,221; SRMR = 0,077; CFI = 0,92; NNFI = 0,699). By examining the modification indices, two additional paths were suggested for JS→PEOU and SI→PEOU. Thus, when teachers are satisfied, they are more willing to try a new technology (i.e. the interactive whiteboard) rising the chances to perceive it as easy to use. Also, when teachers find that their students encourage the use of the interactive whiteboard, they perceive the technology as easier to use due to their students' support.

Only after these modifications were applied, the model fit was achieved: (normed chi-squared = 2,699; AGFI = 0,923; RMSEA = 0,067; SRMR = 0,012; CFI = 0,994; NNFI = 0,972). The modified model explains 68,5% of the variance in perceived ease of use, 84,6% of the variance in perceived usefulness and 85,4% of the variance in teacher's usage intention of the interactive whiteboard.

In Table 5 the estimates and significance results are presented for the research hypotheses. In what concerns moderation hypotheses, teachers' age resulted to have no statistical significance for the effect on the way perceived usefulness relates with usage intention (p value = 0,528), contrary to what happened with the relationship between perceived ease of use and usage intention (p value = 0,096). The maximum p value for the significance of the interaction effect is 0,1 since this kind of effect is often weaker than other effects, so the 90% confidence level is acceptable (Dawson, 2014).

To better understand the moderation effect, researchers usually plot the effect (if there is statistical significance for that hypothesis), so it can be interpreted visually (Dawson, 2014). These plots (Figure 3) are determined based on the estimates of the independent variables (PEOU = 0,124), the moderator (Age = -0,078) and the interaction (PEOUxAge = 0,096). It is possible to understand how the relationship between perceived ease of use and usage intention is always positive, but it is more relevant for older than for younger teachers. Meaning that the easiness of the interactive whiteboard is a more important factor for older teachers.

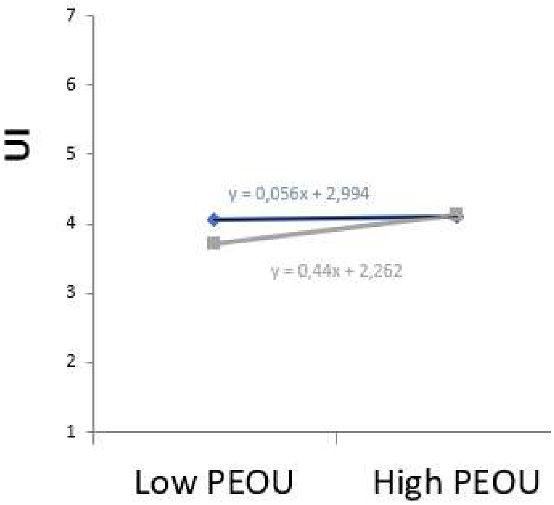

Figure 3 - Moderation effect of age on perceived usefulness. Blue line = low age; Grey line = high age.

High significance was found for almost all paths (Figure 4) with p values equal to 0,001, except for H8 whose p value equals 0,006. The most influential factor in usage intention is perceived usefulness with a path coefficient of 0,456. Two hypotheses were not supported, namely the training influence in perceived usefulness (H1) and the influence of technical support in perceived ease of use (H5). H1 was statistical significant at a 0,001 level, though the path coefficient presented the opposite sign, meaning it was observed the contrary to what was proposed. H5 failed due to lack of statistical significance (p value = 0,496).

Table 5 - Hypotheses Test.

Path	Hypothesis	Path Coefficient	t-value	Conclusion
T→PU	H1	-0,108***	-4,438	Not Supported
T→PEOU	H2	0,216***	6,008	Supported
SI→PU	H3	0,783***	27,51	Supported
PEOU→PU	H4	0,231***	7,195	Supported
TS→PEOU	H5	0,031(NS)	0,68	Not Supported
SI→UI	H6	0,296***	6,121	Supported
PU→UI	H7	0,456***	9,296	Supported
PEOU→UI	H8	0,095**	2,77	Supported
JS→UI	H9	0,158***	5,234	Supported
PEOUxAge→UI	H10	0,046*	1,665	Supported
PUxAge→UI	H11	-0,017(NS)	-0,632	Not Supported
JS→PEOU	H12	0,384***	8,513	Supported
SI→PEOU	H13	0,372***	9,839	Supported
T – training, PU – perceived usefulness, PEOU – perceived ease of use, SI – students' influence, TS – technical support, UI – usage intention, JS – job satisfaction.				

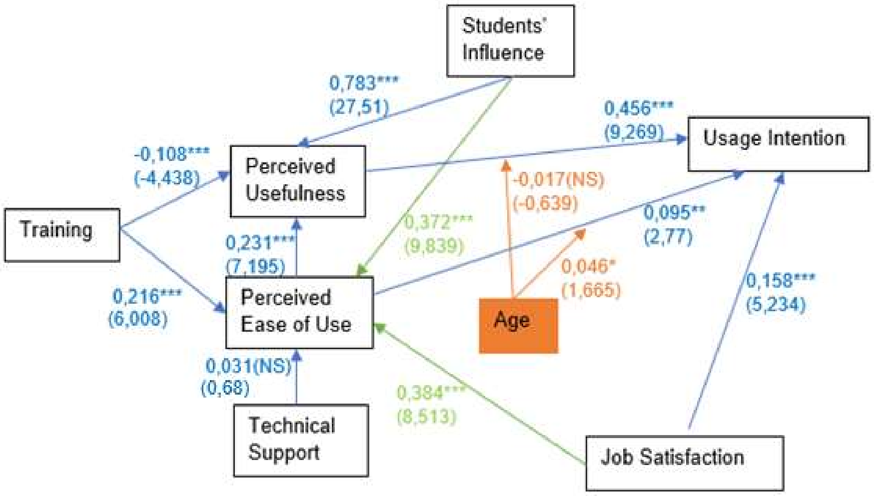

*Figure 4 - Path Diagram. *** p value = 0,001; ** p value < 0,01; * p value < 0,1.*

5. Limitations and Future Work

First, as any statistical study that relies on a sample, the results presented, and the validated paths of the proposed model should be carefully transposed to the population. Regarding the external validity of the current study there is another limitation. The context of this study is unique, it addresses the characteristics of the teaching class in Portugal. Another limitation of this research was the respondents' interpretation of usage of the interactive whiteboard, since previous studies and the interviews conducted for this dissertation noted how this technology is mainly used as a projection screen (Machado et al., 2016), and this study intended to understand the usage intention of the interactive whiteboard exploring its full potential.

Future research may focus on multigroup analyses to better understand the differences between gender; primary, middle and high school teachers; subject areas; or private and public-school teachers. To examine the robustness of the model it would be important to perform a parallel analysis, by testing the path significance and the explanatory power of the model using PLS.

6. Conclusions

Overall, the results of this study made several theoretical contributions. The original TAM was extended by adding some context related variables, such as training, job satisfaction, students' influence, technical support and the moderation of age. Except for the variable technical support, all variables were found relevant factors to explain the usage intention.

So the main question for this study may be answered as: the teacher-related barriers to the acceptance (considering usage intention) of the interactive whiteboard are students' influence (if the teachers believe their students expect them to use the technology), the perceived usefulness, the perceived ease of use, the job satisfaction, the training (through the influence it has on perceived ease of use) and the age (through the raised importance of perceived ease of use for older teachers). After the model modifications needed to achieve model fit were performed, the research model explains around 69% of the variance in perceived ease of use, 85% of the variance in perceived usefulness and 85% of the variance in usage intention.

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