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Explanatory model of barriers to integration of digital technologies in higher education institutions

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Abstract
Digital technologies are powerful resources that have not been globally integrated in higher education teaching. Previous studies have pointed out several barriers that can slow down this integration. This study, therefore, aims to elaborate an explanatory model of the barriers to digital technology integration into university teaching, including both links between them and between social and demographic factors that may be influencing them. Through a mixed method approach, a multiple case study with a sample of 527 teachers was developed in Spain. The results show that there are seven main barriers to technology integration: technophobia, lack of time, absence of planning, lack of incentives, lack of evaluation, work saturation, and university accreditation model. The model will help organizations and teachers to identify both the specific barriers and their linkages to other factors. Thus, they will be able to carry out improvements regarding the integration of digital technologies in higher education.

Keywords Barriers · Educational technology · Higher education · Model · Teaching

1 Introduction

Digital technologies are currently widespread across Spain. According to the latest data from the country's National Institute of Statistics (INE 2019), 80.9% of Spanish dwellings have a computer at home, 90.7% have access to Internet,and 99.6% have at least one mobile phone. These data contrast with the last UNIVERSITIC report (Gómez 2017), which found that 72% of universities do not have a plan for the provision of technological tools. In addition, UNIVERSITIC and other reports, such as Fundación Telefónica (2016), and the studies conducted by Mercader and Gairín

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(2017) and Hernández-Ramos (2019) confirm that although higher education institutions may have such resources, they are underutilized. This is becausepractically all of the professors that use them do so mainly to make visual presentations and to manage the institutional virtual teaching platform. With regard to teacher models vis-à-vis the didactic use of digital technologies (Área-Moreira et al. 2016), we find that professors mostly congregate around the weak model, through which digital technologies are used mainly for exhibition or reproductive tasks. In addition, the technological competency level of teachers is often intermediate or lower (Cuhadar 2018).

The teacher's role in deciding how to use ICT represents a key point in the success of their incorporation (Tejedor et al. 2009). This makes it necessary to investigate why this imbalance exists between common social uses and what higher education is integrating into teaching practice.

Several researchers have analyzed the factors holding back the use of digital technologies in education at all levels, although studies are more widespread in the contexts of primary and secondary education (Área-Moreira et al. 2016; Drent and Meelissen 2008; González-Sanmamed et al. 2017; Zhao et al. 2002). Some of these studies have proposed a classification by area. The most widespread classification is that of the British Educational and Communications Technology Agency (BECTA 2004), shared by Bland (2007) and Magen-Nagar and Maskit (2016), which distinguishes two blocks of barriers: individual or personal, and institutional or organizational. "Individual" refers to aspects of the person, such as a lack of time or training, while "institutional" refers to cases in which the responsibility falls on the organization, such as a lack of benefits or resistance to change. On the other hand, Peansupap and Walker (2006) add group-level considerations to their classification, thus obtaining three types of barriers: individual, organizational, and group. While Buchanan et al. (2013) simplify the classification by distinguishing between individual and contextual barriers, Schulz et al. (2015) extend it to four areas: (1) human factors, such as attitudes or trust; (2) intrinsic values, such as level of interest or satisfaction; (3) requirements of the tool itself, such as adaptation or a learning process; and (4) environmental factors. More succinctly, Ertmer (1999) had already proposed a general categorization, identifying first-order and second-order barriers. First-order barriers refer to those external impediments that are not specific to the person, such as limited resources or lack of technical support, while second-order barriers consist of internal obstacles, such as lack of confidence or attitudes. The author considers second-order barriers to be more complex and harder to eliminate.

Therefore, it is necessary to establish a typology of barriers in order to examine the difficulties in overcoming them. In this way, barriers can be classified into four areas: personal, professional, institutional, and contextual. In each of these areas, there are different barrier types that can help to identify the issues blocking the incorporation of digital technologies into higher education more clearly.

Personal barriers are those that refer to the impediments that the individual himself/herself generates, or that he can resolve on his/her own. These are more closely related to personality traits and individual experience. In the existing literature, technophobia can be identified as one such example, referring to the systematic rejection of the incorporation of technologies (Bland 2007; Maor and Currie 2017), resistance to change itself (Westberry et al. 2015), a lack of motivation (Ertmer 2005; Shelton 2014), willingness to use digital technologies (González-Sanmamed et al. 2017), and

a lack of confidence or security regarding technological tools (BECTA 2004; Morales-Almeida et al. 2018; Shelton 2014).

Professional barriers encompass those impediments that, although directly related to individuals, refer to their profession. The characteristics of the university professor and aspects of his/her performance, can be an impediment to the inclusion of technologies (Romero et al. 2019). Authors such as Prendes (2010) and Tejedor et al. (2009) point out the lack of time available for teachers to carry out the incorporation of changes of such a magnitude, a lack of training in the field of educational technology, and the teachers' own pedagogical conceptions, which can be fundamentally contrary to the incorporation of digital technologies. Related to this last aspect is a lack of knowledge regarding how to teach using digital technologies. According to authors such as Lane and Lyle (2011), Schulz et al. (2015), and Romero et al. (2019), teachers require both support and knowledge regarding how to integrate digital technologies into the classroom in a pedagogical way. Finally, this category also includes a lack of experience in university teaching with these tools, a barrier subscribed to by Drent and Meelissen (2008).

While personal and professional barriers are considered internal constraints, institutional and contextual barriers are linked to external factors. Institutional barriers are those organizational aspects that depend directly on the approaches, values, structures, and systems of relationships within the institution. Referring to institutional approaches, weak or non-existent planning on how to integrate technologies or how to carry out innovation processes with the available technologies generates an important mismatch (Magen-Nagar and Maskit 2016). In this sense, the training that teachers receive must be both appropriate to their needs and offered at opportune times (Ertmer 1999; Porter and Graham 2015). Alignment with the organizational culture (González-Sanmamed et al. 2017) and institutional support (Porter and Graham 2015; Salinas 2008) are especially important for the pioneering faculty member who, despite having few institutional resources (Romero et al. 2019) or incentives (BECTA 2004; Kunda et al. 2018), is striving to integrate technologies into organizations that can sometimes be very rigid (Salinas 2008; Shelton 2014). On the other hand, UNESCO (2011) identifies the leader of the organization as a barrier if he or she is ineffective or does not even exist, since leaders must help generate positive synergies in this regard. Authors such as Salinas (2008) and Vázquez and Sevillano (2015) identify a lack of evaluation and transfer of experience regarding digital technologies. However, the most recurrent institutional barrier in the literature is either an absence of infrastructure or the poor quality of that which exists. The unavailability of quality equipment is a clear impediment to professors' ability to integrate technologies on a regular basis (BECTA 2004; Gisbert 1999; Maor and Currie 2017; Morales-Almeida et al. 2018; Sevillano 2015; Romero et al. 2019, among others).

Finally, external barriers also include both the conditions related to the environment and social context that is influencing the problem. Thus, authors such as Magen-Nagar and Maskit (2016) and Seale (2003) confirm that the rapidity with which digital technologies evolve creates a barrier by preventing teachers from feeling up to date. Likewise, workforce saturation in the teaching profession (Maor and Currie 2017; Shelton 2014), together with the research based university model of accreditation (Geschwind and Broström 2015; Ion and Castro 2017), tip the balance of the management of time to simpler practices or those that do not involve technological innovation.

The existence of all these barriers generates distortion in the incorporation of digital technologies into university teaching. However, the authors cited above point out not only the obstacles but also certain factors that may influence both the incorporation of digital technologies and the barriers themselves. These factors are as follows: age (Lane and Lyle 2011; López de la Madrid 2013), years of teaching experience (Área-Moreira et al. 2016; Ertmer 1999; Monacis et al. 2019), teachers' level of digital competence (Lane and Lyle 2011; Shelton 2014; Mercader 2019), the disciplinary area in which instruction occurs (Shelton 2014; Vázquez and Sevillano 2015; Mercader and Gairín 2020), and (although there is a lack of consensus among the existing studies) gender (BECTA 2004; Bland 2007).

The variety and multiplicity of barriers, as well as the influential factors identified in the literature, suggest the creation of a model that expresses the relationships among them. When analyzing models related to the integration of technologies, TPACK (Koehler and Mishra 2009) is the most well-known model. TPACK focuses on the knowledge teachers need to successfully integrate technology in education, including content knowledge, technological knowledge, and pedagogical knowledge. However, it does not explain the possible barriers and factors that can influence this use. On the other hand, while the Technology Acceptance Model (TAM; Davis et al. 1989) does explain some of the factors that intervene in this process, it is insufficient to understand the specific barriers that exist in universities. Furthermore, it also fails to allow the real creation of facilitating elements for their elimination. Thus, the purpose of the research presented in this study is to identify both barriers to the use of technologies and the factors that influence them through the development of an explanatory Model of Barriers to the Incorporation of Digital Technologies (MBIT) in university teaching.

2 Materials and methods

To achieve the established purpose, a multiple case study was conducted employing a sequential mixed methodology (Morgan 1998). Through this approach, the quantitative data collection is performed before the qualitative data collection. The quantitative information was collected using a questionnaire designed ad hoc with 47 items, of which 14 correspond to descriptive and sociodemographic variables and 33 refer to the perception of barriers on a Likert scale (Cronbach's $\alpha = .874$). The qualitative data were collected using semi-structured interviews.

The questionnaire was administered using the online platform LimeySurvey. The data collected were analyzed using the SPSS v.18 statistical package. The tests performed were descriptive (means and deviations, modes, medians, and percentages), comparative (contingency tables and chi square tests), and correlational (Spearman's rho and Pearson's correlation coefficients).

The interviews were conducted after the quantitative analysis for triangulation. They were carried out at the professors' job locations in order to motivate their agreement to participate, create a climate of trust in a known environment, and intervene as little as possible in their work rhythms (Guest et al. 2013). The duration of the interviews ranged from 20 min to 2 h, depending on the informant. The data were processed using the MAXQDA v.12 program, yielding 53 codes for 1061 units of meaning.

The study was conducted in four universities with participation by 527 professors from different branches of knowledge: arts and humanities (21.1%), social sciences (28.7%), health sciences (30.4%), and science and technology (19.9%). Stratified sampling was employed to achieve representativeness regarding the different universities and branches of knowledge (Collins et al. 2007). Descriptive statistics indicate that 51.4% of the participants were men and 48.6% women. They were aged between 23 and 70 ($M = 46.15$, $SD = 9.92$) and had an average teaching experience of 14.47 years ($SD = 10.29$). 59.2% reported that they had received ICT training for teaching; 50.5% considered that they had average mastery of ICT; and only 11% considered themselves digitally competent.

The sample interviews were selected intentionally from among the subjects that responded to the questionnaire. The sample consists of 29 university professors from the four participating universities. The selection of these participants was made based on the following criteria to ensure all types of profiles were included: university, disciplinary area or branch of knowledge, and level of digital competence.

3 Results

In relation to the identification of barriers, in practically all cases the mode is at the "Largely Agree" level, with a percentage very close to 50% of the sample. In Fig. 1, the means of the different barriers are represented (Likert scale ranging from 1 to 4). The outer part of the graph refers to greater intensity, while the inner part refers to less intensity. In Fig. 1, we can observe how the barriers of technophobia, lack of time, absence of planning, lack of incentives, lack of evaluation, ignorance of methods of teaching with technologies, work saturation, the generation gap, and lack of training have averages that exceed 2.73 points (last quartile >2.726). Tthey are thus considered the greatest barriers to the use of ICT.

The qualitative data coincide in singling out the same barriers, with the exception of a lack of evaluation; the barriers of the university accreditation model preponderated in the interviews. In practically all cases, the professors pointed to the relative importance of university teaching in the higher education system of accreditation as an obstacle to the incorporation of technologies as well as to teaching innovation in general:

> As it is right now, in the university, with the competitiveness that's out there and what they require for you to rise to a position, to a certain labor stability (because teaching is important, but it's that you have a series of things before, that are not teaching), so introducing improvements becomes secondary. (P7, 2016)

In order to verify the relationship between the various factors identified in the literature with the barriers detected, two types of tests were conducted. For the categorical variables "gender," "disciplinary area," and "ICT training for teaching," a chi square test was applied. As the variables "age," "teaching experience," and "mastery of ICT" are on an ordinal, interval, or ratio scale, the Pearson correlation coefficient, which also offers information regarding the strength and direction of the relationship between variables, was used.

The most significant results of the chi square test are summarized in Table 1.

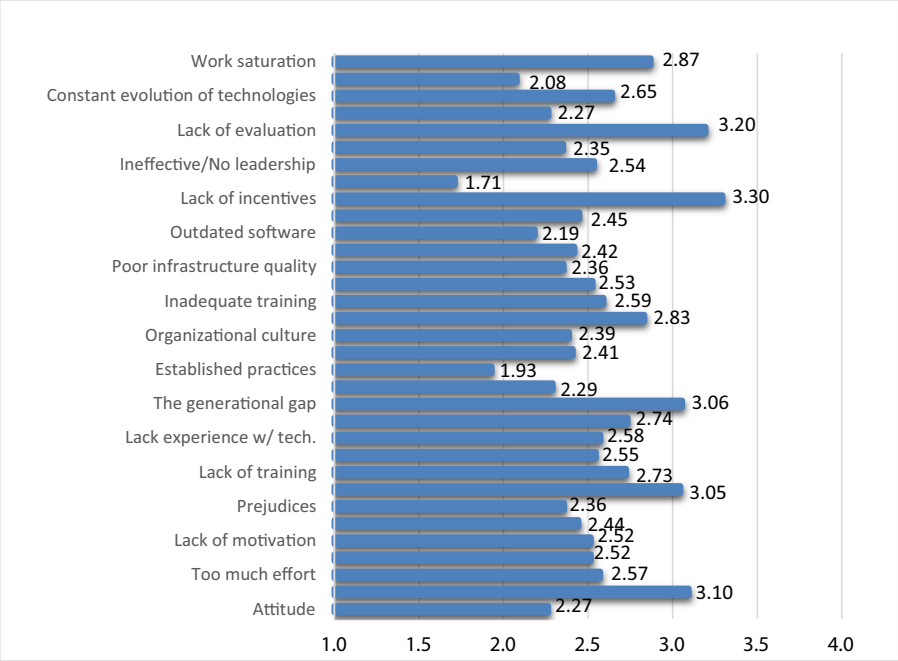

Fig. 1 Means of barriers to digital technology integration

The factor that correlates significantly with the most barriers is training in technologies. As can be seen in Table 1, ignorance of methods of teaching with technologies [$\chi^2(3, N = 527) = 25.15$, $p < .000$], absence of planning [$\chi^2(3, N = 527) = 30.81$, $p < .000$], inadequate training [$\chi^2(3, N = 527) = 83.08$, $p < .000$], untimely training [$\chi^2(3, N = 527) = 78.52$, $p < .000$], lack of training [$\chi^2(3, N = 527) = 111.58$, $p < .000$], poor quality of infrastructure [$\chi^2(3, N = 527) = 19.77$, $p < .000$], institutional rigidity [$\chi^2(3, N = 527) = 28.29$, $p < .000$], ineffective leadership [$\chi^2(3, N = 526) = 30.57$, $p < .000$], lack of institutional support [$\chi^2(3, N = 527) = 31.61$, $p < .000$], and lack of evaluation [$\chi^2(3, N = 527) = 33.04$, $p < .000$] all show correlations with a significance $p < .000$, yielding greater certainty in affirming the link between the barrier and the factor.

Disciplinary area correlates significantly with seven barriers, although only the correlation with pedagogical conceptions [$\chi^2(9, N = 527) = 30.22$, $p < .000$] reaches a level of significance of $p < .010$. In contrast, gender correlates significantly with only four barriers, but two of them reach a level of significance of $p < .010$: lack of evaluation [$\chi^2(3, N = 527) = 17.56$, $p < .001$] and pedagogical conceptions [$\chi^2(3, N = 527) = 11.58$, $p < .009$].

In the case of the factors of age, experience, and digital skills, it can be seen in Table 2 that the significant correlations ($p \leq 0.05$) are mostly negative. This implies that as experience, digital skills, or age increases, this decreases the perception of barriers. Conversely, the lower the age, experience, and competency in ICT, the greater the perception of barriers.

Some relevant correlations are those of mastery with lack of time [$r(525) = -.164$, $p < .000$], lack of training [$r(525) = -.155$, $p < .000$], lack of experience with

Table 1 Significance index (p) of the relationships between barriers and categorical factors (Chi2)

Barriers	Gender	Discipline	Training
Technophobia	.918	.729	.009**
Lack of confidence	.437	.022*	.036*
Generational gap	.299	.018*	.737
Lack of motivation	.293	.055*	.068
Lack of time	.270	.476	.291
Lack of training	.012*	.202	.000**
Pedagogical conceptions	.009**	.000**	.229
Lack of experience with technologies	.273	.033*	.006**
Ignorance of methods of teaching w/ technologies	.079	.853	.000**
Absence of planning	.016*	.252	.000**
Inadequate training	.743	.967	.000**
Untimely training	.098	.281	.000**
Poor infrastructure quality	.437	.127	.000**
Lack of infrastructure	.391	.057	.003**
Lack of incentives	.127	.029*	.013*
Institutional rigidity	.258	.731	.000**
Ineffective leadership	.156	.025*	.000**
Lack of institutional support	.639	.788	.000**
Lack of evaluation	.001**	.451	.000**
Constant evolution of technologies	.308	.440	.851
Work saturation	.882	.211	.435

**$p < .01$// *$p < .05$

technologies [$r(525) = -.152$, $p < .000$], and constant evolution of technologies [$r(525) = -.203$, $p < .000$]. One exception is found in the constant evolution of the ICT barrier, in that its correlations with the factors of age [$r(525) = .235$, $p < .000$], teaching experience [$r(525) = .187$, $p < .000$], and pedagogical conceptions [$r(525) = .096$, $p < .028$] are positive. This is also the case for the correlation of work saturation with teaching experience [$r(525) = .096$, $p < .028$]. The results of the Pearson correlation coefficient indicate that the strengths of the relationships are weak (r less than .250).

In relation to qualitative data, the professors affirm the correlation between each of the factors and the various barriers. In particular, the participants singled out age and the disciplinary area as conditioning factors for the incorporation of digital technologies, while also claiming that these factors influenced each of the barriers mentioned.

> The age group and all that, they gave a vote of confidence to the use of the computer, because they saw that it was a useful tool; but I also understand that there are people who feel imposed upon by the sheer volume of things you run across, who seem to be overwhelmed. (P21, 2016)

Table 2 Pearson's correlation between factors and barriers to technology integration

		Age	Experience	Digital skills
Technophobia	Pearson Correlation	−.034	−.025	.030
	Sig. (bilateral)	.439	.562	.498
Lack of confidence	Pearson Correlation	−.038	−.118(**)	−.046
	Sig. (bilateral)	.383	.007	.296
The generational gap	Pearson Correlation	−.112(**)	−0.83	−.150(**)
	Sig. (bilateral)	.010	.057	.001
Lack of motivation	Pearson Correlation	−.061	−.060	−.141(**)
	Sig. (bilateral)	.165	.172	.001
Lack of time	Pearson Correlation	−.019	.017	−.164(**)
	Sig. (bilateral)	.656	.703	.000
Lack of training	Pearson Correlation	−.073	−.064	−.155(**)
	Sig. (bilateral)	.096	.145	.000
Pedagogical conceptions	Pearson Correlation	.067	.096(*)	−.092(*)
	Sig. (bilateral)	.124	.028	.034
Lack of experience with technologies	Pearson Correlation	−.113(**)	−.151(**)	−.152(**)
	Sig. (bilateral)	.009	.001	.000
Ignorance of methods of teaching w/ technologies	Pearson Correlation	−.039	−.113(**)	−.094(*)
	Sig. (bilateral)	.368	.010	.031
Absence of planning	Pearson Correlation	.026	.033	−.069
	Sig. (bilateral)	.546	.451	.115
Inadequate training	Pearson Correlation	−.055	−.025	−.089(*)
	Sig. (bilateral)	.206	.569	.041
Untimely training	Pearson Correlation	−.038	−.033	−.121(**)
	Sig. (bilateral)	.390	.453	.005
Poor infrastructure quality	Pearson Correlation	.047	.070	−.150(**)
	Sig. (bilateral)	.285	.108	.001
Lack of infrastructure	Pearson Correlation	.063	.065	−.147(**)
	Sig. (bilateral)	.146	.136	.001
Lack of incentives	Pearson Correlation	−.023	−.029	−.053
	Sig. (bilateral)	.604	.507	.227
Institutional rigidity	Pearson Correlation	−.043	−.081	−.086(*)
	Sig. (bilateral)	.323	.064	.050
Ineffective leadership	Pearson Correlation	−.064	−.019	−.062
	Sig. (bilateral)	.141	.656	.157
Lack of institutional support	Pearson Correlation	.004	.045	−.030
	Sig. (bilateral)	.924	.301	.491
Lack of evaluation	Pearson Correlation	−.047	−.026	−.062
	Sig. (bilateral)	.286	.549	.155
Constant evolution of technologies	Pearson Correlation	.235(**)	.187(**)	−.203(**)
	Sig. (bilateral)	.000	.000	.000
Work saturation	Pearson Correlation	.063	.096(*)	−.041
	Sig. (bilateral)	.150	.028	.353

**$p < .01$// *$p < .05$

The results for Spearman's rho coefficient allow us to identify the links between the different barriers in strength, direction, and significance. They show a large number of positive relationships between the barriers, but not all of them are strong enough or reach a significance level of $p < 0.01$. Table 3 shows the pairs of barriers with correlations between .400 and .599 (moderate correlation), or between .600 and .799 (strong correlation).

Institutional barriers are correlated with those in the same field (i.e., inadequate training with untimely training; lack of infrastructure with poor infrastructure quality; lack of institutional support and ineffective leadership; and institutional rigidity or lack of evaluation with absence of planning). To verify whether there is a correlation between the domains, Spearman's rho was calculated between them, which confirmed that there is a significant correlation between the four areas, especially the institutional and professional barriers ($r = .579$, $p = .000$) and the professional and personal ones ($r = .559$, $p = .000$).

The university accreditation model emerges in the qualitative data, and represents an important barrier regarding the incorporation of digital technologies. The professors related this barrier to the absence of planning, ignorance of teaching methods involving technologies, and work saturation. Teachers also established relationships between the other barriers. They understand that there are some barriers that exist because of others, and that even though there is sometimes no causality in the relationship, both must be overcome. It should be noted that in the qualitative data, the discourse itself shows interrelationships between more than two barriers, thereby demonstratingthe complexity of the problem.

> To try to innovate in teaching, it takes time, and you as a teacher have to be clear about what you would like; but at least the institution has to put up the resources and be willing to collaborate, and it could help to promote learning or to make student learning more solid; but this also means that we as teachers must have time to dedicate ourselves to that, and to think that sometimes it is easier to show PowerPoints that you already did before, because nowadays your daily routine consumes your time in calls, mail, administration, research ... (P20, 2016)

The data analyzed show multiple interactions between barriers and factors. In order to both recognize the magnitude of the problem and propose concrete actions to counteract or eliminate existing barriers, it is necessary to have an outline or framework that allows one to consider the factors or barriers associated with each obstacle. Although the proposal is derived from a multiple case study, the sample is sufficiently representative for the proposed model to be considered a model that can be extrapolated to organizations or professors who wish to improve the incorporation of digital technologies.

The Explanatory Model of Barriers to the Incorporation of Digital Technologies in University Teaching (MBIT) graphically represents the relationships both among barriers and between factors and barriers (Fig. 2), which shows all the significant barriers identified by teachers. The arrangement of the barriers is clockwise according to the aforementioned areas. The domain of personal barriers begins with technophobia and ends with the generational gap; the

Table 3 Spearman's Rho test with correlations higher than .400

Barriers		Spearman's Rho
Lack of motivation	Lack of experience w/ technologies	($r = .442$; $p = .000$)
Lack of motivation	Ignorance of teaching w/ tech.	($r = .405$; $p = .000$)
Lack of Training	Lack of infrastructure	($r = .427$; $p = .000$)
Lack of Training	Inadequate training	($r = .593$; $p = .000$)
Lack of Training	Untimely training	($r = .585$; p = .000)
Lack of experience w/ technologies	Ignorance of teaching w/ tech.	($r = .493$; p = .000)
Lack of time	Work saturation	($r = .438$; p = .000)
Institutional rigidity	Ineffective leadership	($r = .422$; p = .000)
Institutional rigidity	Lack of institutional support	($r = .530$; p = .000)
Ineffective leadership	Lack of institutional support	($r = .542$; p = .000)
Ineffective leadership	Absence of planning	($r = .416$; p = .000)
Ineffective leadership	Inadequate training	($r = .421$; p = .000)
Ineffective leadership	Untimely training	($r = .400$; p = .000)
Lack of institutional support	Absence of planning	($r = .479$; p = .000)
Lack of institutional support	Untimely training	($r = .422$; p = .000)
Lack of evaluation	Absence of planning	($r = .568$; p = .000)
Inadequate training	Untimely training	($r = .735$; p = .000)
Lack of infrastructure	Poor infrastructure quality	($r = .638$; p = .000)

$N = 527$

professional barriers range from pedagogical conceptions to ignorance of methods of teaching with technology; institutional barriers range from poor quality of infrastructure to the lack of evaluation; and the contextual barriers range from the constant evolution of technologies to the University model.

The arrows with continuous lines show stronger relationships between the obstacles, depending on the results obtained through both the qualitative and the quantitative data analysis. A dotted line shows an existing but weaker relationship. This means that if an institution wishes to make changes to eliminate any of the barriers it detects, it will need to verify both the established connections and the strength of the relationships, with the aim of making logical and timely decisions suited to their own reality.

At the bottom of the MBIT, the factors associated with the barriers are listed. This is because, if possible, it will be necessary to consider whether or not an obstacle has associated factors that must be addressed before it is eliminated. Thus, the diamond refers to the training in digital technologies for teaching, the circle to the level of ICT skills, the triangle to years of teaching experience, the square to gender, and the star to the disciplinary area taught.

The potential of the MBIT resides in the amount of information it provides in a simple manner, making it possible for institutional managers to consider the different variables that intervene in the elimination of existing barriers to the incorporation of digital technologies.

4 Discussion and conclusions

This study has confirmed the existence of barriers to the incorporation of digital technologies in university teaching, and has also identified the most recurrent one; namely, technophobia, lack of time, absence of planning, lack of incentives, lack of evaluation, work saturation, and university accreditation model. However, unlike the study by Morales-Almeida et al. (2018), we were unable to find sufficient relevance regarding lack of confidence, nor of resistance to change (Westberry et al. 2015) or organizational culture (González-Sanmamed et al. 2017).

However, a large part of the barriers analyzed have been considered as such by the faculty, so it is appropriate to take them into account. In addition, given the statistically significant relationships between them together with the reports generated by the interviews, it would be a mistake to reject them as part of the model. Thus, in the development of the model, the barriers identified in the questionnaire or in the interviews, and/or that have a moderate or strong relationship with some of the most relevant barriers have been considered. On the other hand, the results show that there is not one area of barriers more predominant than the others, which proposes a classification of areas complementary to those previously analyzed (BECTA 2004; Bland 2007; Buchanan et al. 2013; Schulz et al. 2015). The final classification coincides with the others in discriminating between external (or first-order) and internal (or second-order) barriers (Ertmer 1999).

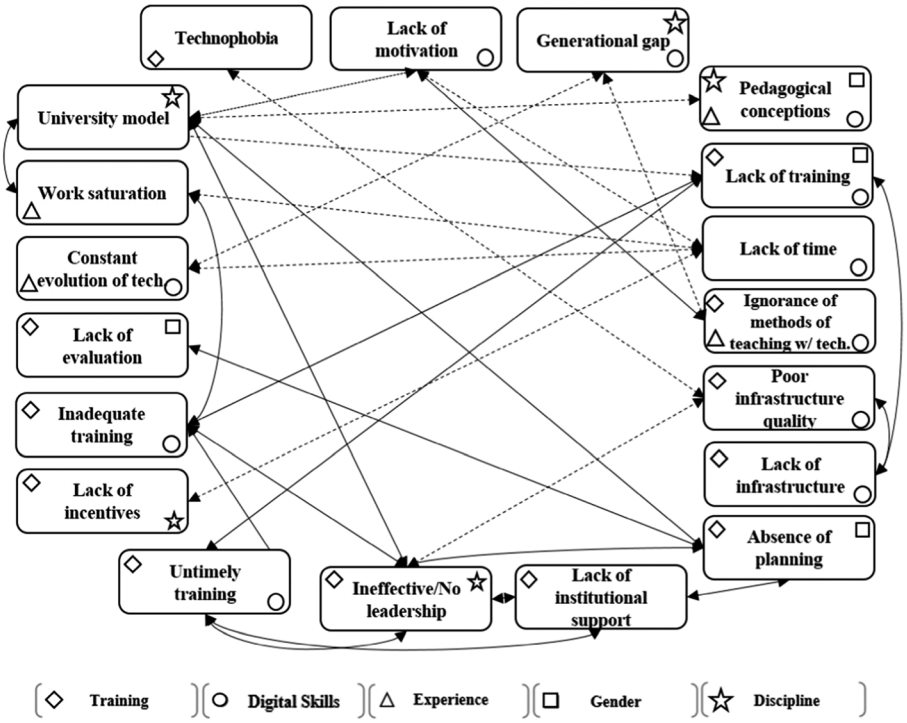

Fig. 2 Explanatory model of barriers to integration of digital technologies in university teaching (MBIT)

The results of the research make it possible to relate sociodemographic and contextual factors with the existence of barriers to the incorporation of digital technologies. In general, professors who have completed ICT training for teaching and are considered to have a high level of digital competence identify fewer barriers than the rest of the teaching staff, thus coinciding with the results of the studies by Lane and Lyle (2011) and Shelton (2014). Indeed, the results clearly show correlations with items that by definition are in some way connected to training and competences: inadequate training, untimely training, lack of training, and lack of experience with technologies. Furthermore, they also correlate with other barriers, such as a lack of institutional support, lack of evaluation, or an absence of planning.

Moreover, in the case of academic discipline, some differences also exist depending on the teaching field. Consequently, the perception of barriers may be related to the content, a conclusion that concurs with the perspective of TPACK (Koehler and Mishra 2009) in taking into account content and pedagogical knowledge. The barriers that are perceived differently depending on the discipline are pedagogical conceptions, leadership, lack of incentives, university model, and the generational gap.

This confirms that both training and the level of digital skills are two factors to consider in the incorporation of digital technologies (González-Sanmamed et al. 2017; Mercader 2019). Considering that the descriptive results confirm that almost half of the faculty have not received training courses on digital technologies that can be applied to teaching, along with the fact that two-thirds of the professors consider themselves to be at a medium-low level of digital competence (in line with the findings of Cuhadar 2018), we confirm that there is a need for training focused on the incorporation of digital technologies in the classroom.

Teaching experience also influences the perception of one barrier or another, although it is not always a proportional or inversely proportional relationship (Área-Moreira et al. 2016; Ertmer 1999). The problems encountered by the most experienced professors are related to work saturation, the constant evolution of technologies, and pedagogical conceptions.

The variables studied for which virtually no relationship has been found with the identification of barriers are gender and age. Clearly, the professors interviewed perceive age as a factor that influences the identification of barriers to the incorporation of technologies. However, the quantitative study does not coincide with this, so it may be a prejudice or erroneous assumption on the part of the teaching staff. In this sense, the study contrasts with the contributions of Lane and Lyle (2011), López de la Madrid (2013), and Hernández-Ramos (2018).

With respect to the gender of the teaching staff as a factor in the incorporation of technologies, much like Salcines et al. (2017), we found no direct relationship. Therefore, this study differs from the conclusions of BECTA (2004) and Bland (2007), in which gender is considered a differentiating element in the incorporation of ICT. Nevertheless, in order to be faithful to the results obtained, the MBIT includes gender as a factor in those cases where the findings indicate this (lack of training, absence of planning, lack of evaluation, and pedagogical conceptions).

The MBIT easily and graphically shows the different existing barriers as well as the relationships among them and the factors that influence them. Both the qualitative and quantitative results show the complexity of the problem by pointing out multiple interrelationships. In addition, the research allows us to corroborate several of the

barriers already identified in the literature, and thus to identify those that are most preponderant. The clarity of the information provided in the MBIT allows organizations and professors themselves to make changes or improvements in their environment, with the goal of integrating technologies into university classrooms in a comprehensive manner.

The main limitation of the study is the fact that it was developed in a specific context. Consequently, future research could replicate it and/or apply the model to test and adapt it if necessary. Another area of future research could involve exploring the different barriers that teachers perceive when using different digital resources. Following this process, an attempt could be made to establish the relationship between barriers and digital tools, which could help us to foresee possible barriers for emerging resources.

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Compliance with ethical standards

Conflict of interest No potential conflict of interest was reported by the authors.

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