Information and communication technology (ICT) skills and job satisfaction of primary education teachers in the context of Covid-19. Theoretical model

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Recommended citation:

Barba-Sánchez, Virginia; **Gouveia-Rodrigues, Ricardo**; **Meseguer-Martínez, Ángel**(2022). "Information and communication technology (ICT) skills and job satisfaction of primary education teachers in the context of Covid-19. Theoretical model". *Profesional de la información*, v. 31, n. 6, e310617.

https://doi.org/10.3145/epi.2022.nov.17

Article received on October 12th 2022
Approved on November 16th 2022

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Abstract

The Covid-19 pandemic has shown that educational systems must have an online component or even a substitute. However, the efforts for this necessary transition fall largely on the teaching staff, who have been forced to quickly adapt their activities to a virtual environment. In this study, a theoretical model for analyzing how teachers' information and communications technology (ICT) skills and the integration of these technologies influence the improvement of teaching and teacher job satisfaction is introduced. The model also pays special attention to the gender gap related to the use of ICT in teaching. At the empirical level, the model is validated on a sample of 257 Spanish primary school teachers, using the partial least squares (PLS) structural equation method. The results of the analysis show that, although the teachers' ICT skills help them improve their teaching activities, such skills do not have a direct impact on teachers' job satisfaction. However, teachers who integrate ICTs into their teaching activities not only improve their results and lighten their workload but also enjoy higher job satisfaction, which translates into more motivated and committed teachers. In addition, teachers' ICT skills influence job satisfaction in different ways depending on gender. Although, for female teachers, the integration of ICT increases their job satisfaction, the results show that, for male teachers, this integration should generate improvements in teaching to yield enhanced job satisfaction. As the main implication, it is recommended to invest in teachers' ICT skills, as these lead to enhanced efficiency and motivation and enable the change toward an ICT-based teaching model.

Keywords

Primary education; ICT skills; ICT integration; Improvement in teaching; Job satisfaction; Gender gap; Partial least squares; Mediating effects; Moderating effects; Covid-19; Coronavirus; Pandemics.

Funding

This work was supported by:

- *Consejería de Educación, Cultura y Deportes*, *Junta of Communities of Castilla–La Mancha*, Spain, and the *European Regional Development Fund* (*ERDF*) under Grant SBPLY/21/180501/000192.
- *Research Centre for Business Sciences* (*NECE-UBI*), and the *Fundação para a Ciência e a Tecnologia* (*FCT*), Portugal, under grant UIDB/04630/202.

1. Introduction

Social evolution implies the digitization of all areas of life. The profound evolution of information and communication technologies in recent years has resulted in the availability of tools that offer highly desirable advantages at the economic and social levels (**Barba-Sánchez**; **Arias-Antúnez**; **Orozco-Barbosa**, 2019). Events such as the Covid-19 pandemic have broken down barriers to the adoption of these technologies, such as the entry costs or resistance to change in organizations, and have irremediably led us to their implementation and use.

The educational sector is unfamiliar with this trend. The current conditions under the effects of Covid-19 pose a major challenge to the sector, which is leading to a change of model to adapt to the environment. In this regard, the pace of adoption of ICTs in the teaching process has soared. The responsibility for the success of this transition falls to a large extent on the teachers, who must face the challenge of adapting rapidly to the virtual environment.

In this sense, we believe that, to be able to be educated about how to accelerate the technological diffusion process, teachers need to have technological capacities, and this must be reflected in the classroom. Following this argument, in this paper, we opted for a novel measure based on the technological capacity of schools and teachers.

In this vein, many studies have considered the integration of ICTs into schools and their effect on students (**Kulik**, 1994; **Corbel**; **Gruba**, 2004); however, they have focused mainly on investment, that is, the acquisition of computers or educational software. The teachers' level of ICT skills is a fundamental issue since it allows them to generate an appropriate educational environment from a digital point of view (**Willis**; **Weiser**; **Smith**, 2016), in which valuable technological knowledge can be transmitted successfully to their students from an educational perspective (**Garmendia** *et al.*, 2021). Thus, the mere availability of ICT resources is not enough for students to benefit from them. Teachers must be able to integrate these technologies to reap the benefits of their potentialities in the educational process (**Kern**; **Warschauer**, 2000). In this vein, the teachers' efficacy in integrating ICT in their classes allows for the pedagogical use of such technologies, resulting in more integrative teaching, particularly in science, technology, engineering, and mathematics (STEM) subjects (**Chai**, 2019). In addition, beyond relevant advantages such as time savings or improved service quality, ICT skills can also lead to key long-term indirect benefits such as job satisfaction (**Murphy**; **Adams**, 2005). For this reason, one of the main current concerns in the educational field is how teachers can acquire computer knowledge to improve their teaching activities and student learning while adapting to the digital world (**Son**, 2004).

In an environment characterized, on the one hand, by a plethora of possibilities and cost savings offered by technological development (**Barba-Sánchez**; **Arias-Antúnez**; **Orozco-Barbosa**, 2019) and, on the other, by the need to update the curriculum of education organizations with tools that steer the educational process toward a digital environment post Covid-19, a response from teachers is necessary to adapt the educational model in such a manner that ICT skills are configured as a key factor (**Özgür**, 2020). Success in identifying the most appropriate technologies as well as their implementation and correct use will depend on teachers and their knowledge of this type of technology. These ICT skills not only ease teaching and administrative tasks (**Sahito**; **Vaisanen**, 2017; **Suárez-Rodríguez** *et al.*, 2018) but also help deal with the new cohorts of digital native students who, despite having access to a multitude of technological resources, lack the skills for educational or work use (**Kennedy** *et al.*, 2008; **Garmendia** *et al.*, 2021). Besides, the use of ICTs ensures that the education provided by teachers is more suited to a demanding and increasingly ubiquitous digital environment, as they improve efficiency (e.g., reducing their burden of administrative work and facilitating contact with parents) and allow teachers to remain effective in educating children in various settings with different levels of presence.

However, in an educational system characterized by the teachers' lack of technological knowledge (**Kovarik** *et al.*, 2013; **Chai**, 2019), the expectations regarding teachers' effective use of ICTs in the educational process results in increased pressure on them, which can lead to decreased motivation due to lack of knowledge and skills and, even, to suffering the well-known teacher's technostress (**Tarafdar** *et al.*, 2015).

In this sense, teacher job satisfaction plays a crucial role in the quest for solutions to adapt to digital change. Teacher job satisfaction improves important aspects such as motivation, degree of involvement, and commitment as well as perfor-

mance. High levels of motivation allow teachers to reduce stress, thus maintaining levels of mental health. Furthermore, this facilitates the learning of new skills, such as ICT skills (**Pepe**; **Addimando**; **Veronese**, 2017). Therefore, a teacher satisfied with their work will be able to better adapt to changes, maximizing their efficiency and the effectiveness of their work. Thus, job satisfaction could make the difference in the effective steering of the educational system toward the needs of the digital society.

Due to the challenges faced by primary education in the current context, it is necessary to delve into the factors that affect both the normal development of teaching activities and the teacher job satisfaction, particularly with regards to the ICT requirements arising from the Covid-19 environment. Thus, our work focuses on analyzing teachers' ICT skills and, especially, on the integration of ICTs in their teaching activities, which is our main contribution. Furthermore, we also focus on the improvement in teaching enabled by the ICT skills and their integration, as well as on the relationships between all of these and the teacher job satisfaction.

Finally, the existing literature identifies a gender gap persistent over time in STEM education (**Stearns** *et al.*, 2020). Such a gap can also be identified in the technological training of teachers of both genders (**Konan**, 2010; **Tafazoli**; **Parra**; **Abril**, 2017). However, the empirical evidence is not conclusive (**González**, 2012). In this regard, our paper provides further empirical evidence on the possible existence of this gender gap and its significance in the field of ICT integration in education.

We believe that ICT skills enable teachers to effectively integrate technologies into their educational environment and, consequently, improve both their professional performance and also the learning outcomes of their students, including students' ICT skills. Thus, we pose the following research questions:

1. Are the ICT skills of primary teachers related to improvement in teaching, both with regards to the learning outcomes and the administrative aspects related to teaching?

2. Do teachers' ICT skills, the integration of ICTs in the teaching process, and the improvement in teaching influence teacher job satisfaction?

3. Is there a gender gap in the teachers' ICT skills? And, if so, does this influence ICT integration, teaching improvement, and job satisfaction?

The remainder of the work is structured as follows: We first review the literature on the relevant concepts and discuss their relationships. Then, the third section describes the methods, the fourth presents the results, and in the last section, the results are discussed, then conclusions are presented.

2. Literature review

2.1. ICT skills, ICT integration, and teaching improvement

ICT skills can be defined as the

> "interest, attitude and ability of people to properly use digital technology and communication tools to access, manage, integrate and evaluate information, build new knowledge and communicate with others to participate effectively in society" (**Martin**; **Grudziecki**, 2006, p. 251).

It has been reported that teachers' ICT skills lead to improvements in the work environment, especially in regard to the coordination and improvement of communication with parents and colleagues but also to the learning outcomes (**Pepe**; **Addimando**; **Veronese**, 2017).

Research shows that teachers with high levels of ICT knowledge tend to make more extensive use of such technologies in their teaching activities (**Willis**; **Weiser**; **Smith**, 2016) and, thus, can improve their teaching (**Kulik**, 1994). Improvement in teaching encompasses, on the one hand, the learning outcomes, in that students learn more and faster when teaching is supported by the use of ICT (**Kosakowski**, 1998; **Kreuzer**, 2001) and, on the other, also improvements in the ICT skills of students.

Additionally, based on their ICT skills, teachers will be able to reap the benefits of technology to improve coordination with colleagues and school management (**Özgür**, 2020). Such skills allow them to perform administrative tasks faster (**Sahito**; **Vaisanen**, 2017), facilitate interactions with parents through telematic channels (**Suárez-Rodríguez** *et al.*, 2018), and help them increase control over their work, which yields higher levels of self-efficacy and enhancement of the work environment (**Ang**; **Soh**, 1997).

Finally, ICT skills help teachers improve their pedagogical competences. For example, regular access to the Internet facilitates more comprehensive skills and competences in the teaching process (**Warschauer**; **Knobel**; **Stone**, 2004), enabling "just-in-time" and individualized learning, easing research, and facilitating empirical investigation (**Warschauer**, 2008). Therefore, having ICT skills leads to improvements in teaching, and based on this, we propose our first hypothesis:

> H1: The ICT skills of primary teachers have a positive influence on improvement in teaching.

However, the teachers' ICT skills and the necessary materials at school, i.e., hardware and software, is a necessary but not sufficient condition for students to leverage the potential of the ICTs for the educational process. For this to happen,

teachers and students must use ICTs in their teaching activities (**Kern**; **Warschauer**, 2000). In this sense, ICT integration refers to the use of technological resources in education, the implementation of teachers' technological knowledge in their teaching activities, and the adaptation of such activities to take advantage of the potential offered by technology (**Senik**; **Broad**, 2011).

Technological development grants teachers the possibility of improving student performance through the effective integration of ICT, not only in planning teaching but also in the design and development of teaching materials and evaluation activities (**Kim**; **Hannafin**, 2011; **Vandeyar**, 2015; **Özgür**, 2020). For students, the integration of ICTs allows them to control their learning by improving interaction, collaboration, and communication among classmates and with teachers, which often makes traditional educational methods obsolete (**Kosakowski**, 1998). This, therefore, reflects the combination of pedagogical and content knowledge with technological knowledge (**Willis**; **Weiser**; **Smith**, 2016) and is considered a key aspect to achieving the necessary adaptation of education to the current and future social, political, and economic challenges (**Hall**, 2001; **Tafazoli**; **Parra**; **Abril**, 2017).

Furthermore, the effective integration of ICT has very desirable effects on the educational process. As commented previously, the effective use of ICT not only facilitates teaching (**Warschauer**; **Knobel**; **Stone**, 2004) but also has positive effects on student learning (**Corbel**; **Gruba**; 2004) and on the increase of the ICT skills of students (**Kreuzer**, 2001), as well as on their preparation for the professional environment (**Goktas**; **Gedik**; **Baydas**, 2013). In this vein, the effective implementation of ICT technologies in the teaching process helps improve the interpersonal relationships of teachers with students, with their peers, and with parents (**Suárez-Rodríguez** *et al.*, 2018; **Özgür**, 2020). Therefore, we propose the following hypotheses:

H2: Teachers' ICT skills have a positive influence on ICT integration.

H3: ICT integration has a positive effect on teaching improvement.

An adequate level of ICT skills grants teachers the capability to identify technological resources valuable to the educational process (**Rilling** *et al.*, 2013). In this regard, teachers who perceive themselves as competent users of ICT are more prepared for ICT integration and are more likely to incorporate these resources into the teaching activities (**González**, 2012; **Willis**; **Weiser**; **Smith**, 2016). It is, thus, necessary for teachers to develop their ICT skills to be able to introduce such technologies into the educational process appropriately (**Tafazoli**; **Parra**; **Abril**, 2017). Thus, the improvement of teaching depends on whether teachers with sufficient ICT skills can effectively integrate these skills into their teaching activities. Hence, the following hypothesis is introduced:

H4: ICT integration mediates the relationship between teachers ICT skills and improvement in teaching.

2.2. Teacher job satisfaction and ICT

Job satisfaction can be defined as a pleasant emotional state that results from the perception that work allows the achievement of desirable job values (**Locke**, 1969). This conceptualization of job satisfaction is commonly used in the literature (e.g., **Ma**; **MacMillan**, 1999; **Ho**; **Au**, 2006) and constitutes the basis for other definitions (**Skaalvik**; **Skaalvik**, 2019).

In the case of teachers, job satisfaction refers to their affective reactions to their work and their teaching role (**Skaalvik**; **Skaalvik**, 2010). In this sense, teachers' satisfaction with their profession has profound effects on the quality of their teaching and the general functioning of their educational centers (**Ostroff**, 1992), as well as student performance (**Griffin**, 2010). Also, teacher job satisfaction is associated with high levels of commitment (**Gersten**, 2001), reduced work stress (**Klassen**; **Chiu**, 2010), and improvements in teaching performance (**Pepe**; **Addimando**; **Veronese**, 2017) and, hence, is a highly desirable aspect, especially in environments characterized by dynamism and uncertainty.

Teachers with sufficient ICT skills will benefit from increases in their competence and self-confidence in their abilities (**Murphy**; **Adams**, 2005). Thus, they will be able to adapt to the digital environment that surrounds them and develop their activities more efficiently. Hence, ICT skills provide teachers with a solid foundation for their professional identity (**Abtahi**; **Motallebzadeh**, 2016). This, in turn, results in increases in their job satisfaction (**Ang**; **Soh**, 1997). Thus, the following hypothesis is introduced:

H5: Teachers' ICT skills exert a positive influence on their job satisfaction.

As mentioned above, ICT integration improves the performance and self-efficacy of teachers in their teaching activities (**Murphy**; **Adams**, 2005). This improves their commitment and motivation levels (**Sahito**; **Vaisanen**, 2017), which, in turn, leads to improved job satisfaction. Additionally, ICT integration also facilitates interactions with colleagues, students, and parents, which helps improve interpersonal relationships and the work environment (**Ang**; **Soh**, 1997). Therefore, it has a positive effect on teacher job satisfaction (**Pepe**; **Addimando**; **Veronese**, 2017). Hence, we introduce the following hypothesis:

H6: ICT integration has a positive effect on teacher job satisfaction.

Furthermore, aspects related to improvement in teaching, such as improved communication with students (**Oliver**; **Corn**, 2008), increased control over student's learning, the possibility of collaborative research and work (**Kosakowski**, 1998), or increased participation (**Tasir** *et al.*, 2012), enhances the relationship between student and teacher. This helps teachers avoid both interaction problems with students, which is a main source of teacher stress (e.g., **Spilt**; **Koomen**;

Thijs, 2011, or **Pepe**; **Addimando**, 2013), and class management problems (**Wubbels**; **Brekelmans**; **Brok**, 2006). In addition, improvements conducive to strengthening relationships with the rest of the teachers improve the work environment (**Ghenghesh**, 2013), which also has a positive effect on the levels of teacher job satisfaction (**Castro** *et al.*, 2015). Hence, the aspects that improve teachers' interpersonal relationships, whether with classmates, parents, or students, play a key role in teacher satisfaction (**Skaalvik**; **Skaalvik**, 2011; **Pepe**; **Addimando**; **Veronese**, 2017). Thus, based on these arguments, we propose the following hypothesis:

H7: The improvement in teaching has a positive effect on teacher job satisfaction.

However, the availability of ICT skills seems to have an indirect impact on teacher job satisfaction, dependent on ICT integration and the improvement in teaching. As mentioned above, beyond merely having ICT skills, teachers must implement such skills effectively in the teaching process, which leads to improvements in teaching. In turn, both the integration of ICTs and improvement in teaching lead to improved job satisfaction. Therefore, for ICT skills to generate increased job satisfaction, technologies must be implemented effectively and the teaching process must have been improved. On this basis, we propose the following hypotheses on the mediation effects on teacher job satisfaction:

H8: ICT integration and improvement in teaching mediate the relationship between the ICT skills and teacher job satisfaction.

H8a: ICT integration mediates the relationship between the ICT skills and teacher job satisfaction.

H8b: The improvement in teaching mediates the relationship between the ICT skills and teacher job satisfaction.

H8c: ICT integration and improvement in teaching mediate the relationship between the ICT skills and teacher job satisfaction.

H8d: Improvement in teaching mediates the relationship between ICT integration and teacher job satisfaction.

2.3. ICT and the gender gap in primary teaching

The literature confirms the existence of a gender gap in the use of technologies in general (**Cai**; **Fan**; **Du**, 2017), and in the teaching field in particular (**Van-Braak**; **Tondeur**; **Valcke**, 2004; **Tafazoli**; **Parra**; **Abril**, 2017). In this line, **Bencheva** and **Kostadinov** (2019) recommend the integration of ICTs, not only to reduce this gender gap but also to foster ICT careers across both genders, given the scarcity of this type of professional in the current labor market (**Botella** *et al.*, 2019).

In the field of teaching, it has been observed that young female teachers with high levels of training have greater ICT knowledge than older, more experienced teachers with lower levels of training (**Konan**, 2010). In this vein, **Mathews** and **Guarino** (2000), and **Abtahi** and **Motallebzadeh** (2016) identify higher levels of ICT skills in male teachers than their female counterparts. However, to date, no consensus exists on the effect of gender on ICT skills in the field of teaching. Thus, authors such as **González** (2012) find that male teachers who are more experience and work in applied subjects –hard-skills subjects– are more reluctant to use ICTs in class than female teachers, especially those who have medium experience and work in less applied subjects –soft-skills subjects. Therefore, we propose the following set of hypotheses:

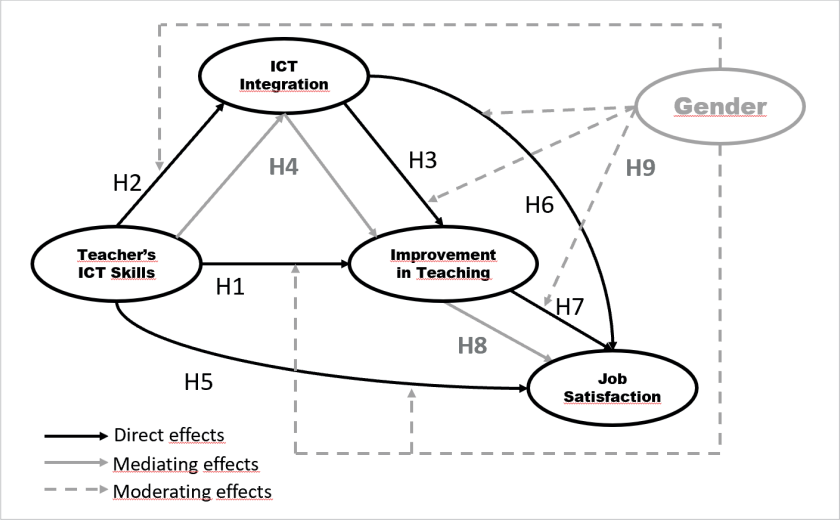

Figure 1. Research model

H9: A gender gap exists in the direct relations of the model.

H9a: A gender gap exists in the relationship between ICT skills and improvement in teaching.

H9b: A gender gap exists in the relationship between ICT skills and ICT integration.

H9c: A gender gap exists in the relationship between ICT integration and improvement in teaching.

H9d: A gender gap exists in the relationship between the ICT skills and teacher job satisfaction.

H9e: A gender gap exists in the relationship between ICT integration and teacher job satisfaction.

H9f: A gender gap exists in the relationship between improvement in teaching and teacher job satisfaction.

In summary, Figure 1 depicts the set of relationships hypothesized in the proposed research model.

3. Methods

3.1. Data collection, sample, and analysis techniques

To examine the relationships between ICT skills, ICT integration, and improvement in teaching, as well as the relations between all the latter and job satisfaction, we gathered information by means of personal interviews with a sample of Spanish teachers. This method was chosen over surveys completed autonomously by the teachers to avoid validity problems (**Meade**; **Craig**, 2012; **Edwards**, 2019).

Table 1. Technical data of the empirical study

Characteristics	Survey
Target universe or population	Spanish primary teachers
Sampling units	Teachers
Sampling size	257
Sampling error/confidence level	5.36%/95%
Fieldwork data	2019-2020 academic year

Table 2. Sample by gender and age

Age (years)	Male	Female	Total
< 30	13	16	29
30-39	30	34	64
40-49	48	54	102
50-59	26	32	58
60-64	0	4	4
> 64	0	0	0
Total	117	140	257

A total of 334 interviews were conducted during the 2019-2020 academic year. With a population of 232,030 primary teachers (*Spanish Ministry of Education and Professional Training* [*MEFP*], 2020), this represents a sampling error of 5.36% ($p = q = 0.5$) at a 95% confidence level (Table 1). Given that the Spanish educational system allows teaching at different levels (primary, nursery, and lower secondary school), we considered responses from teachers active only in primary education to avoid biases driven by the age of the students. Thus, the final sample consisted of 257 observations. To confirm the validity of this sample and subsequent ones (**Barclay**; **Thompson**; **Higgins**, 1995), the required minimum sample size was calculated. Hence, the most complex multiple regression in the proposed model (Figure 1) must be found, that is, the greatest number of paths directed to a dependent variable, which in our case is 3. Subsequently, the minimum sample size required must be checked in the power tables provided by **Cohen** (1992), which in our case is 76 observations, with a statistical power of 0.80 and a significance level (α) of 0.5. Finally, to analyze the gender gap in the model, the sample has been divided into two groups according to gender. Thus, the original sample is split into two subsamples of 117 (men) and 140 (women) observations. The subsamples also meet the required minimum size.

Once the validity of the sample size was confirmed, Table 2 compiled the distributions of the sample by gender and age.

To test the hypotheses, structural equation modelling (SEM) has been applied, as it is especially recommended to test mediation hypotheses (**Nitzl**; **Roldán**; **Cepeda**, 2016). Specifically, we used the partial least squares (PLS) technique with the *SmartPLS 3.2.9* software (**Ringle**; **Wende**; **Becker**, 2015). In addition, to analyze the differences driven by gender groups, the invariance of its measurements must be made using the measurement invariance of composite models (Micom) (**Henseler**; **Ringle**; **Sarstedt**, 2016). After verifying that the differences are not due to the measurement model, we applied multigroup analysis of partial least squares (PLS-MGA) to evaluate the significance of the difference by gender of the estimated parameters (path coefficients) (**Sarstedt**; **Henseler**; **Ringle**, 2011).

3.2. Measures

The variables employed in the study are described in this section. Each item, including its full name and indicators, is explained in Annex 1.

ICT skills

We drew on the scale of **Almerich** *et al.* (2016), which consists of 32 items related to the teachers' knowledge about the management and use of computers, basic computer applications, the use of the Internet, presentations, and multimedia applications as well as other communication tools. For each item, teachers responded on a five-point scale, with endpoints of 1 = null and 5 = expert.

ICT integration

The scale of **Almerich** *et al.* (2016) was also used to measure ICT integration. The scale draws on 11 items related to the frequency of use of ICT tools for the design and planning of teaching activities, and the frequency of communication with the school community. For each item, teachers responded on a five-point scale, with endpoints of 1 = never and 5 = always.

Improvement in teaching

We draw on a seven-item scale adapted from **Skaalvik** and **Skaalvik** (2007). The scale addresses the positive effect of ICTs on student instruction and motivation, cooperation with colleagues and parents, and administrative tasks. Responses were given on a five-point scale (from 1 = never to 5 = always).

Job satisfaction

We used the scale of **Pond** and **Geyer**, (1991), which comprises six items addressing how they feel about their current job. All items were measured on a five-point Likert scale.

Gender

Following the most commonly agreed approach (**Abtahi**; **Motallebzadeh**, 2016; **Tafazoli**; **Parra**; **Abril**, 2017), gender is considered a dichotomous variable (male and female).

4. Results

Before analyzing the structural model, the reliability and validity of the measurement model were tested. Given that all the constructs are reflective, the individual reliability of the items is evaluated first. Based on this, four items of the "Teacher's ICT Skills" scale were discarded, as their values were below the 0.708 threshold (**Hair**; **Sarstedt**; **Ringle**, 2019), namely, skillTIC5-6, skillTIC16-17, skillTIC24-25, and skillTIC31-32. This is natural because scales measuring ICT quickly become obsolete and must be adapted. Then, construct reliability was tested through the Cronbach's alpha, Dijkstrqa–Henseler's rho_A, and the composite reliability and was confirmed, as all values were above the 0.7 threshold (Table 3). Subsequently, the convergent validity of the constructs was also verified through the average variance extracted (AVE), with values above 0.5 in all cases (Table 3). Finally, the discriminant validity of the constructs was also confirmed through the heterotrait–monotrait (HTMT) and Fornell–Lacker criteria (Table 4).

Table 3. Reliability estimates and convergent validity of the measurement model

Construct[1]	Cronbach's alpha	Dijkstrqa–Henseler's rho_A	Composite reliability (CR)	Average variance extracted (AVE)
ICT integration	0.911	0.916	0.925	0.532
Improvement in teaching	0.878	0.880	0.905	0.576
Job satisfaction	0.852	0.886	0.884	0.565
ICT skills	0.956	0.959	0.960	0.501

[1]All constructs are estimated in mode A.

Table 4. Discriminant validity[1] of the measurement model based on Fornell–Larcker and $HTMT_{0.85}$ criteria

Construct	ICT integration	Improvement in teaching	Job satisfaction	ICT skills
ICT integration	**0.730**	*0.719*	*0.389*	*0.686*
Improvement in teaching	0.648	**0.759**	*0.365*	*0.547*
Job satisfaction	0.384	0.361	**0.752**	*0.236*
ICT skills	0.650	0.509	0.235	**0.708**

1. Elements on the diagonal (in **bold**) are the square root of the variance shared between the constructs and their measures (AVE). Values in *italics* above the diagonal elements are $HTMT_{0.85}$ values. Values below the diagonal elements are the correlations between constructs.

To evaluate the structural model, we first check for collinearity problems among the constructs through the variance inflation factor (VIF) values. All the values are below 2, well below the maximum of 5 set in literature (**Hair**; **Sarstedt**; **Ringle**, 2019). The goodness of fit has been verified through the standardized root mean square residual (SRMR), whose values are less than 0.08 (**Benítez** *et al.*, 2020), and so has the significance of the path coefficients through the bootstrapping process (10,000 subsamples) based on the confidence interval percentiles (**Aguirre-Urreta**; **Rönkkö**, 2018).

As observed in Table 5, the results reveal that teachers' ICT skills do not influence job satisfaction significantly (H5: $\beta = -0.055$; $p > 0.05$), although the effect on the implementation of ICTs is positive and significant (H2: $\beta = -0.650$; $p < 0.001$). However, teacher job satisfaction is positively and significantly affected both by ICT integration (H6: $\beta = -0.288$; $p < 0.01$) and by the perceived improvement in teaching resulting from using ICTs (H7: $\beta = -0.202$; $p < 0.05$). Furthermore, both the teachers' ICT skills and the use of ICTs in the classroom have a positive and significant influence on the improvement in teaching activities (H1: $\beta = -0.151$; $p < 0.05$; H3: $\beta = -0.550$; $p < 0.001$, respectively).

Table 5. Direct effects on endogenous constructs

Construct	Direct effect[1]	*t*-value[2]	*p*-value[2]	PCI[2]	Explained variance (R^2)	f^2
Job satisfaction (R^2 = 0.171)						
H5: ICT skills	–0.055	0.779	0.436	[–0.191, 0.088]	–0.013	0.002
H6: ICT integration [b]	0.288	3.424	0.001	[0.125, 0.458]	0.111	0.044
H7: improvement in teaching	0.202	2.348	0.019	[0.028, 0.364]	0.073	0.028
Improvement in teaching (R^2 = 0.434)						
H3: ICT integration [b]	0.550	10.345	0.000	[0.448, 0.656]	0.357	0.309
H1: ICT skills	0.151	2.502	0.012	[0.029, 0.268]	0.077	0.023
ICT integration (R^2 = 0.422)						
H2: ICT skills [a]	0.650	18.571	0.000	[0.580, 0.717]	0.422	0.731

EC = endogenous construct; CV = control variable; PCI = percentile confidence interval.
1. Paths from hypothesis assessed by applying a two-tailed test at a 5% significance level [2.5%, 97.5%].
2. Bootstrapping based on *n* = 10,000 bootstrap samples.

> Effective ICT integration leads to enhanced teaching results, lower workload and increased job satisfaction

As Table 5 shows, the R^2 values of all the endogenous constructs are above the 0.10 threshold (**Falk**; **Miller**, 1992). In particular, the R^2 values of improvement in teaching and ICT integration are above 0.33, and thus, the explanatory power of the model is relatively moderate (**Chin**, 1998). Regarding the individual contribution of the constructs (Table 5), ICT integration is the one that contributes the most to both job satisfaction (0.111) and improvement in teaching (0.357). However, ICT integration is not possible in the absence of ICT skills (0.422). This is confirmed when the degree to which ICT skills contribute to explaining the R^2 of ICT integration is calculated ($f^2 = 0.731$). The size of the effect is relatively high according to **Cohen** (1992; $f^2 \geq 0.35$). Finally, the size of the ICT integration and ICT skills effects on improvement in teaching as well as that of the latter on teacher job satisfaction are all moderate ($0.15 \leq f^2 < 0.35$), while the rest are weak.

With regards to the mediating effects, Table 6 shows the total effects of the ICT skills on improvement in teaching (H4) and job satisfaction (H8a, b, and c), in addition to those of ICT integration in job satisfaction (H8d). In all cases, the total effects are greater than the direct effects, which indicates the existence of mediation or indirect effects (**Sarstedt** *et al.*, 2014). Following **Nitzl**, **Roldan**, and **Cepeda** (2016), significant partial mediation relationships are confirmed between ICT skills and improvement in teaching through ICT integration (H4: $\beta = -0.358$; $p < 0.001$) and between ICT integration and job satisfaction through improvement in teaching (H8d: $\beta = -0.111$; $p < 0.05$). The assessment of the indirect effects of ICT skills on job satisfaction through ICT integration (H8a: $\beta = -0.187$; $p < 0.01$), improvement in teaching (H8b: $\beta = -0.030$; $p > 0.05$), and both together (H8c $\beta = -0.072$; $p > 0.05$) confirm a total mediation, given that, as previously commented, the direct effect is not significant (H5: $\beta = -0.055$; $p > 0.05$). Furthermore, the size of the indirect effects calculated through the variance-accounted-for index (VAF) explains more than 70% of the total effect in some cases (Table 6).

Table 6. Summary of mediating effect tests

Hypothesis	Total effect path (*p*-value)[1]	Direct effect path (*p*-value)[1]	Indirect effects		
			Path (*p*-value)[1]	PCI[2]	VAF (%)
H4: ICT skills → ICT integration → improvement in teaching	0.509 (0.000)	0.151 (0.012)	0.358 (0.000)	[0.281, 0.448]	70.33
H8a: ICT skills → ICT integration → job satisfaction	0.235 (0.000)	−0.055 (0.436)	0.187 (0.001)	[0.082, 0.305]	79.57
H8b: ICT skills → improvement in teaching → job satisfaction			0.030 (0.101)	[0.001, 0.072]	12.77
H8c: ICT skills → ICT integration → improvement in teaching → job satisfaction			0.072 (0.030)	[0.010, 0.140]	30.64
H8d: ICT integration → improvement in teaching → job satisfaction	0.399 (0.000)	0.288 (0.001)	0.111 (0.026)	[0.015, 0.212]	27.82

PCI = percentile confidence interval.
1. Paths from hypothesis assessed by applying a two-tailed test at a 5% significance level [2.5%, 97.5%].
2. Bootstrapping based on $n = 10{,}000$ bootstrap samples.

Next, we checked the moderating effects of gender using a permutation-based multigroup analysis (**Chin**; **Dibbern**, 2010). We draw on the measurement invariance of composite models (Micom) approach to ensure the quality of the measurement model. This involves three steps (**Henseler**; **Ringle**; **Sarstedt**, 2016): configural invariance (step I), compositional invariance (step II), and full measurement model invariance (step III). Given that the items used in each construct, the data treatment, and the algorithm setting are the same, the configural invariance of the constructs is ascertained. Regarding step II, the compositional invariance is assessed by obtaining non-significant permutation *p*-values (Table 7). Finally, in step III, the equality of composite means and variances is calculated, except for ICT integration, for which the variance across male and female groups was not equal. Once the partial measurement invariance has been confirmed (**Cheah** *et al.*, 2020), group differences can be identified through the Micom path coefficients (Table 7).

Table 7. Measurement model invariance assessment based on a Micom approach

Measurement model	Compositional invariance assessment		Full measurement model invariance assessment			
	Original correlation	0.05	Mean difference (F-M)	Confidence interval	Variance difference (F-M)	Confidence interval
ICT integration	0.999	0.997	−0.089	[−0.239, 0.251]	0.313	[−0.306, 0.310]
Improvement in teaching	1.00	0.995	0.111	[−.237, 0.243]	−0.139	[−0.370, 0.368]
Job satisfaction	0.983	0.973	−0.166	[−0.244, 0.239]	−0.121	[−0.499, 0.492]
ICT skills	0.999	0.997	0.204	[−0.248, 0.250]	0.168	[−0.289, 0.268]

The results are based on a two-tailed permutation test at a 5% confidence level [2.5%, 97.5%]. F = Female, M = Male.

> To a large extent, the responsibility of the necessary development of a virtual teaching model falls on the teachers

As displayed in Table 8, significant differences between male and female teachers have been found with regards to how ICTs influence their job satisfaction. While ICT skills positively influence the job satisfaction of male teachers, it has a negative influence on female teachers. However, ICT integration has a clear positive influence on female teachers and a slightly negative influence in the case of male teachers. Finally, results show that the influence of improvement in teaching on job satisfaction was stronger for male teachers than for female teachers.

Table 8. Permutation-based multigroup analysis for path coefficients and indirect effects

Hypothesis	Path coefficients (Male)	Path coefficients (Female)	Path coefficients difference (M-F)	Permutation *p*-values	Hypothesis supported?
H9a: ICT skills → improvement in teaching (H1)	0.081	0.188	–0.107	0.390	No
H9b: ICT skills → ICT integration (H2)	0.724	0.598	0.127	0.066	No
H9c: ICT integration → improvement in teaching (H3)	0.575	0.570	0.005	0.964	No
H9d: ICT skills → job satisfacción (H5)	0.265	–0.228	0.493	0.001	Yes
H9e: ICT integration → job satisfaction (H6)	–0.061	0.474	–0.534	0.001	Yes
H9f: improvement in teaching → job satisfaction (H7)	0.454	0.020	0.434	0.015	Yes

Multigroup test based on 5,000 permutations; two-tailed test at a 5% significance level [2.5%, 97.5%]. M = Male, F = Female.

In summary, the hypotheses proposed in our theoretical model were empirically supported with the exception of H5, H8b, and H9a, b, and c. Figure 2 summarizes the standardized regression coefficients and the proportions of the explained variance (R^2) as a whole. In this case, the verified model explains more than 40% of the variance of ICT integration and improvement in teaching and more than 17% of job satisfaction.

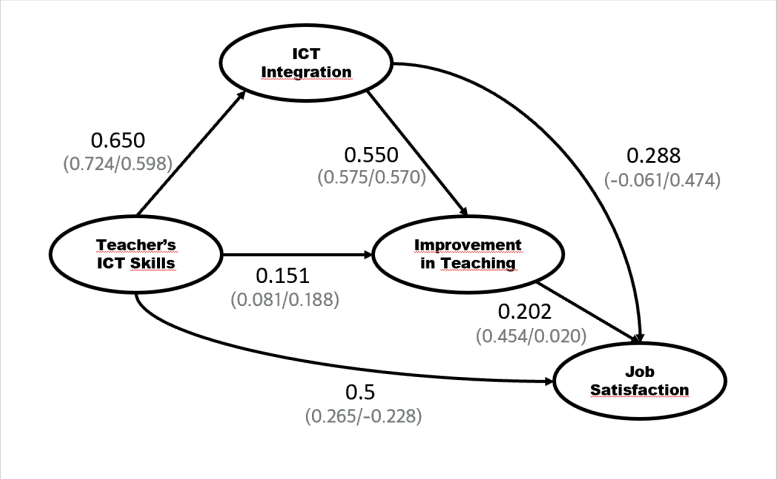

Figure 2. Structural model results

5. Conclusions and discussion

This paper presents an analysis of the ICT skills of primary teachers along with the integration of such skills in their teaching activity and the effect of this on their job satisfaction. The justification for this study stems from the necessary transition to an ICT-based teaching model capable of meeting the needs that Covid-19 has imposed (**Özgür**, 2020). Furthermore, one of the main contributions of this study is the empirical analysis of the positive effects of ICTs on different teaching activities, namely instructing and motivating students, cooperating with colleagues and parents, and carrying out administrative tasks. Traditionally, the focus has been put almost exclusively on how ICT integration affects student results (**Corbel**; **Gruba**, 2004), ignoring the possible positive effects on the rest of the teaching tasks (**Skaalvik**; **Skaalvik**, 2007; **Snoek**; **Dengerink**; **Wit**, 2019).

The results of the analysis are aligned with literature in that (**Kovarik** *et al.*, 2013; **Chai**, 2019) the ICT knowledge of primary school teachers is limited, and this may hamper the adaptation of the educational model to a teaching environment based on ICT. However, teachers seem to be aware of the potential of such technologies for their teaching activities, a key factor for adapting the educational model to the environmental needs (**Özgür**, 2020). The empirical study concludes that ICT skills have a key influence on the integration of ICT. This, in turn, eases teaching tasks in general, leading to increased job satisfaction (Table 2). Thus, teachers' ICT skills are confirmed to be of utmost importance (**Willis**; **Weiser**; **Smith**, 2016) as a necessary condition for the digitization of education, but not sufficient alone, as the integration of ICT is necessary for it to be effective (**Kern**; **Warschauer**, 2000).

Another novelty, compared with previous studies, is the core role of the improvement in teaching as a mediator between both teachers' ICT skills and ICT integration and job satisfaction (Figure 2). Beyond validating this argument and in line with literature (**Sahito**; **Vaisanen**, 2017; **Suárez-Rodríguez** *et al.*, 2018; **Özgür**, 2020), the model indicates that ICT integration helps teachers coordinate with colleagues and parents, reducing the administrative workload and improving the work environment. In turn, this results in improvements in the teaching process, in students' learning, and in teacher job satisfaction. Therefore, the effective integration of ICTs into the teaching process is a key factor for adapting teaching

to the challenging environmental conditions effectively. However, as shown in Table 6, having ICT skills does not improve teacher job satisfaction per se, and in the case of female teachers, it even has a negative effect (Table 8).

> Teacher job satisfaction plays a crucial role in the quest for solutions to adapt to digital change

Additionally, this study contributes to the discussion on the gender gap in the use of technology in general (**Stearns** *et al.*, 2020), and ICTs in particular (**Botella** *et al.*, 2019), with a novel focus on primary school teachers. The results suggest that gender differences regarding how technology affects job satisfaction exist. In case of female teachers, job satisfaction is affected through the improvement in teaching derived from the use of technology; in the case of male teachers, the mere use of technology produces job satisfaction.

Because ICT skills yield greater job satisfaction in male teachers regardless of the effective integration of ICT in their daily teaching practice, our results pose a plausible explanation as to why previous studies identify higher levels of ICT skills in men than women (i.e., **Konan**, 2010; **Abtahi**; **Motallebzadeh**, 2016). However, owing to the more traditional female behavior models focused on the other rather than on the self (**Cai**; **Fan**; **Du**, 2017; **Botella** *et al.*, 2019), female teachers find a higher degree of satisfaction in the usefulness of the ICT skills for their teaching activities through the effective integration of ICTs. In any case, our model does not explain the results obtained by **González** (2012), in which age and the type of subject determine the gender gap. In this sense, a future line of research should incorporate these variables along with gender, to analyze whether the age gap and/or branch of knowledge is more relevant than the gender gap when it comes to having ICT skills and the integration of ICTs within the teaching field.

These findings have several implications for practitioners and academics. Schools and public authorities must foster the acquisition of ICT skills by teachers for them to integrate these skills into all of the teaching tasks. In addition, ICTs can be a source of job satisfaction in the educational field, hence, in line with **Murphy** and **Adams** (2005), ICTs pose a way to improve teachers' motivation, their degree of involvement and commitment, and their job performance in general. Finally, we contribute to the open debate on the gender gap in education, refuting the idea that differences exist between male and female teachers regarding their ICT skills or their ability to integrate such skills into their teaching activities and rather focus the gap on the motivations that drive each group.

Limitations and future research

Regarding the topic just discussed, future research efforts are needed to analyze in depth these motivations as antecedents of job satisfaction, as well as the commitment and degree of implication that such satisfaction has on teachers and their job performance.

Moreover, another line of future research that would enrich the results obtained in this work is related to the analysis of the technostress consequences, following the recommendations of **Tarafdar** *et al.* (2015). In the current work, the positive effects of ICT integration in the different aspects of the primary teaching activities are analyzed. However, the analysis does not address the possible negative effects of the lack of ICT skills or insufficient ICT integration, such as the well-known technostress. This is magnified by the current environment heavily marked by the Covid pandemic (**Ratten**, 2020), and therefore, we acknowledge this as a limitation of our research.

Further limitations to our research stem from the non-inclusion of other possible moderating variables, such as age or the subject taught by the teachers, as mentioned before. Additionally, the geographical scope is limited to a single country, Spain. To ensure the generalizability of the results, it would be helpful to expand this research to other countries.

Finally, the study focuses on primary education, thus limiting the applicability of the results. This raises the question of whether the conclusions of our study could be extrapolated to other educational levels (e.g., secondary school, vocational training, undergraduate studies, and graduate studies) and even whether teachers at these other levels face different problems not included in our model. In this sense, future research would need to collect empirical evidence on other educational levels.

> ICT skills support teachers to improve their teaching and administrative tasks, thus enhancing their teaching

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7. Annex. Items

Items
Job satisfaction (**Pond**; **Geyer**, 1991)
If you had to decide all over again whether to take the job you now have, what would you decide?
If a friend asked if he/she should apply for a job like yours with your employer, what would you recommend?
How does this job compare with your ideal job?
How does your job measure up to the sort of job you wanted when you took it?
All things considered, how satisfied are you with your current job?
In general, how much do you like your job?
Teacher's ICT skills (**Almerich** *et al.*, 2016)
I can handle the windows and dialog boxes/drop-downs of the computer's operating system.
I work with files and folders (create, copy, move, delete, etc.).
I install software on the computer.
I do computer and disk maintenance (check for errors, defragment, and uninstall programs, etc.).
I install and configure hardware components and/or peripherals (printer, sound card, etc.).
I know how to install, configure, and maintain a local network system, such as wi-fi.
I create and edit plain text documents (margins, text and paragraph formatting, tab stops, etc.).
I know how to edit tables and images, using the options that the word processor allows me (border, size, fit with the text, etc.).
I do advanced configuration of text documents (sections with different orientations [vertical and horizontal], columns, headers and footers, footnotes, indexes and tables of contents, etc.).
I create a spreadsheet in which I organize the data, use formulas and functions to perform the calculations, and insert charts from the data.
I create multiple spreadsheets where data is related, edit custom charts, and set multiple sheets to print as one document.
I create simple databases (records, fields, and data), and I know how to use them.

I know how to create and design databases with forms and reports and how to use them.
I know the basic information search strategies (type of content, index topic, etc.) necessary to use informative multimedia applications.
I have a good command of advanced information search systems in documentary bases.
I use digital photography and video cameras to obtain quality audiovisual resources.
I use audio equipment for the recording and composition of sounds.
I know how to use specific graphic and audio design software to obtain quality audiovisual resources.
I make a simple presentation fundamentally with text and some autoshapes.
In presentations, I know how to use images that I have previously reduced, retouched, etc.
In presentations, I use animated gifs and sounds that I have previously recorded and edited.
I know how to use object animation and transitions between slides, and I include interactivity by creating links between them.
I am able to make a presentation that includes audiovisual resources, such as images, videos, narration recording, etc.
I develop simple educational multimedia applications using semi-open or open programs (*Clic*, *HAM*, *Babel*, etc.).
I create multimedia applications using programming languages or authoring systems (*Toolbook*, *Authorware*, etc.).
I know how to access and navigate the internet (access a certain page, use hyperlinks, etc.).
I know how different search engines work to locate information on the internet, and I know how to create favorites folders.
I know how to obtain resources on the internet (open access programs, databases, materials, etc.) and store them properly.
I know how to use email (send and receive email, attach files to emails, create my address book, organize emails in folders, etc.).
I know how to use other forms of communication (discussion forums, chats, distribution lists, videoconference, etc.).
I know how to make simple web pages using a web page editor or by writing HTML code directly.
I know how to design and develop quality web pages in which different internet resources are integrated, using different tools that allow me to integrate static and dynamic images in web pages (graphic design) and sounds.
ICT integration (**Almerich** *et al.*, 2016)
I take into account technological resources in the selection of curricular materials.
I evaluate the technological resources that can be beneficial for the teaching process.
I design curricular materials using technological resources.
I use technology as a means to carry out training activities related to my specialty and the use of ICT in the classroom.
I design learning situations in which I can use ICT.
I create a classroom environment where technology resources are a fully integrated component.
I use technological tools as an instrument for student evaluation.
I use various assistive technologies and/or educational software appropriate for students with diverse educational needs.
I design, coordinate, and participate in the use of technology as a collaborative form and communication between the entire educational community (parents, students, etc.).
I participate in research and innovation projects dealing with the use of different technological resources in the classroom.
I take into account the ethical and legal problems arising from the use of technological resources.
Improvement in teaching (**Skaalvik**; **Skaalvik**, 2007)
Improve student learning
Facilitates coordination between teachers
Reduce my administrative workload
Facilitates interactions with parents
Improve the work environment with colleagues
Facilitates teaching
Improve my job satisfaction