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Teaching practices and organisational aspects associated with the use of ICT

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Abstract

The study of variables related to the use of ICT in the classroom is a topic of interest that has been frequently researched. In this paper, after examining the importance of teacher training in explaining the use of ICT in the classroom, we focused on analysing the weight of variables related to teaching practices and the organisational context of schools, which are variables that are less frequently addressed in the literature. To do so, a secondary analysis was carried out using data provided by the Teaching and Learning International Study (TALIS 2018). Specifically, we worked with a sample of 3,918 principals and 64,899 teachers from a total of 3921 schools in 21 countries. A multilevel binary regression model with random intercept, fixed coefficients and a two-level structure with teachers at level 1 and schools at level 2 was used. The results indicate that the presence of ICT in the classroom is associated with self-efficacy in teaching and the cognitive activation of students and with the organisational aspects of the school, which are scarcely addressed by the existing literature on this topic of interest, such as school climate, educational innovation and cooperation among teachers. Based on these results, we reflect on possible ways to promote the use of ICT in the classroom.

Keywords: Information technology, Teacher education, Teaching practice, School organisation, Educational resources, Secondary education

Introduction

The impact of information and communication technologies (ICT) in today's society has led to a major transformation of academic life. The way young people perceive and manage knowledge has changed, as has the way they acquire and construct their own learning (Lawrence & Tar, 2018). Teaching methods and competence requirements for teachers have also been affected by the continuous development of technology (Artacho et al., 2020). The new forms of digital teaching have led to a paradigm shift that proposes the renewal of strategies focused on the pedagogical potential of ICT (Starkey, 2020) to promote innovation in praxis, active and collaborative work (Blau & Shamir-Inbal, 2017) and flexibility in learning (Sargent & Casey, 2020).

Educational institutions assume the need to integrate ICTs into the curriculum and promote their pedagogical use in the classroom (Caena & Redecker, 2019). They are aware of the changes brought about by technological advances and prioritise the

incorporation of these tools to promote the mastery of ICT skills (Zheng et al., 2020), contribute to constructivist teaching and increase the possibilities for learner participation and collaboration in the knowledge society (Scherer & Siddiq, 2015). Technology has played a central role in learning for years (Uerz et al., 2018), and its adoption by teaching staff is increasingly essential (Taimalu & Luik, 2019).

In recent years, the adoption of education policies to innovate curricula and integrate ICT into the classroom has intensified, especially to address the needs arising from the recent pandemic situation (Baloran, 2020). This also highlights the inclusion of digital literacy in school curricula (So et al., 2020) the adoption of new online methodological approaches (Zainuddin et al., 2019) and the promotion of teacher professional development in ICT skills through initial and continuous training (Artacho et al., 2020). In terms of ICT equipment, infrastructure provision programmes have been developed in schools to enable greater access to digital resources (Farjon et al., 2019).

As a result, students and teachers are expected to acquire sufficient skills to evaluate and deal with online information (Casillas-Martín, et al., 2020), to be competent in the use of ICT (Siddiq et al., 2016) and to be successful in digital environments (Uerz et al., 2018). At the same time, there is confidence in the responsiveness of teachers to the learning needs of the twenty-first century and an assumption that teachers are highly skilled in the adoption and innovative use of ICT as a learning tool (Avidov-Ungar & Forkosh-Baruch, 2018). However, there seems to be a large contradiction between institutional expectations of technology use and actual use by academics (Liu et al., 2020). It has even been argued that teachers' use of ICT in the classroom is arbitrary, superficial and uninnovative (Uerz et al., 2018), especially considering their low level of technological competence to integrate ICT as a means of transforming classroom methodology (Alberola-Mulet et al., 2021).

The IEA international computer and information literacy study shows that current use of ICT by academics in learning environments is low compared to institutional demands. In all countries considered, less than half of teachers used ICT in their practice on a daily basis (Fraillon et al., 2020). However, the level of ICT use and integration seems to vary according to teachers' technological competence, their ICT learning experiences and their beliefs and attitudes towards ICT use (Farjon et al., 2019). Other studies report that teachers' use of technology is widespread and frequent but it is mainly for the systematic transmission or as a resource to support expository practices (Valverde-Berrocoso et al., 2021) rather than for the construction of learning (Pozo et al., 2021).

Ultimately, it seems that few teachers are able and confident to innovate in teaching by making pedagogical use of ICT (Casillas-Martín et al., 2022), especially considering the rapid technological progress (Hsu, 2017). The gap between the institutional goals for ICT literacy and the actual use of learning technologies in classrooms is evident (Guillén-Gámez & Mayorga-Fernández, 2020). In addition, most teacher training strategies in this field are slow and limited, focusing mainly on basic content and technical assistance with technologies (Ottenbreit-Leftwich et al., 2010).

Teacher training and professional development

The scientific literature has shown a growing interest in studying the factors involved in the use of ICT that are related to teacher education and teaching practices. The formal

education received for the management and adoption of technologies by in-service teachers (Mailizar & Fan, 2020; Pareja Roblin et al., 2018) and trainee teachers (Taimalu & Luik, 2019; Tondeur et al., 2017), the absence of experiences in integrating technology into teaching (Farjon et al., 2019; Lawrence & Tar, 2018) and ICT professional development needs (Lee, 2023; Tomczyk et al., 2021) are variables with considerable influence on the incorporation of learning technologies. Also teachers who have a growth mindset and are committed to continuous and lifelong learning tend to have a greater willingness to use ICT (Baharuddin et al., 2024; Belay et al., 2020). König et al. (2020) studied teachers' adaptation to online teaching during the pandemic. The results showed that the most digitally literate and competent teachers over the years were those who reported the best adaptation to the design of online teaching and materials. Taking a broader perspective, Tanak (2020) conducted a follow-up study of beginning teachers who had participated in a course based on Technological Pedagogical Content Knowledge (TPACK). The students were not able to make the link between pedagogy and technology, even though they were highly ICT literate. Furthermore, they reported that the quality of training was limited, impractical and not focused on the process of technology adoption. Lack of renewed ICT competences (Dogan et al., 2021), first-hand experiences and thoughtful demonstrations some of the key professional development needs that teachers encounter for technology integration (Valtonen et al., 2020). For this reason, updating and improving the quality of education for technology use can provide future teachers with useful tools and meaningful experiences to integrate technologies and develop their professional knowledge in ICT (Miguel-Revilla et al., 2020).

Other studies have shown that prior teacher training and competences in ICT use do not have as significant an effect as attitudes and pedagogical conceptions or the quality of experiences with integrating technology into learning (McKnight et al., 2016). Given these results, technological proficiency could be considered a necessary condition for ICT use, but it falls short of explaining the current adoption of technologies in the classroom.

Teachers' characteristics and conceptions of teaching

Gender, age (Guillén-Gámez & Mayorga-Fernández, 2020), teaching experience (Hsu, 2017) and the type of teaching (Lawrence & Tar, 2018) all influence the use of learning technologies. Technology adoption appears to be higher for younger male teachers (Vanderlinde et al., 2014) with more teaching experience who teach applied disciplines (Claro et al., 2018). However, the work of Keržic et al. (2021) and Tondeur et al. (2018) found no effect of gender, age and teaching experience on technology adoption.

Teachers' attitudes and beliefs (Drossel et al., 2017; Okagbue et al., 2023), self-efficacy in ICT use (Ifinedo et al., 2020; Spiteri & Chang Rundgren, 2020), perceived ease of use (Perienen, 2020) and prior conceptions of teaching (Vongkulluksn et al., 2018) are also variables that have been studied for their important implications for the technology adoption. Teachers who feel more technologically capable and have a positive attitude towards change are more comfortable and confident in using ICT. Negative attitudes such as fear or distrust hinder the adoption process (Tomczyk et al., 2021). Some authors use the term willingness or autonomy to define teachers' attitudes (Brabander & Glastra,

2021; Farjon et al., 2019). These studies suggest that higher levels of classroom autonomy conditions or willingness to use ICT are positively related to technology integration.

Other important factors in explaining teachers' use of ICT are beliefs about the importance of technology (Karaca et al., 2013; Nelson & Hawk, 2020) or pedagogical ideals (Liu et al., 2020). Two main dimensions of pedagogical beliefs can be distinguished. On the one hand, traditional ones, centred on the teacher as the main source of knowledge. On the other hand, constructivist beliefs focus on the learner and are oriented towards their cognitive development and the promotion of active learning (Chan & Ellitott, 2004). Considering the usefulness of ICT for educational innovation and cognitive activation (Scherer & Siddiq, 2015), it is proposed that constructivist beliefs are positively associated with technology integration, while traditional beliefs are negatively associated. Previous studies support this hypothesis (Almerich et al., 2023; Arancibia et al., 2020; Prestridge, 2017; Teo et al., 2018) and others claim that teachers with constructivist beliefs use technology more frequently for the purpose of fostering higher-order learning, while those with traditional beliefs used it primarily to access data and content (Chai, 2010; Hsu, 2016). Cheng et al. (2021) and Pareja Roblin et al. (2018) found no significant effects of pedagogical beliefs on technology integration. However, they point out that the process of technology adoption will be enhanced when ICT tools are aligned with teachers' conceptions and beliefs about their usefulness.

Infrastructure provision and organisational aspects

In the past, the lack of ICT infrastructure has been a conditioning factor in the use of this type of technology in the classroom. Currently, the provision of technological resources in schools has expanded considerably. In most education systems, schools are equipped with computer resources for teaching and internet connection. Previous studies have pointed to a decreasing importance of infrastructure in explaining ICT use (Gil-Flores et al., 2017) compared to variables such as institutional support for technology innovation (Atman Uslu & Usluel, 2019; Moreira-Fontán et al., 2019), school leadership (A'mar & Eleyan, 2022; Liu et al., 2020), school climate and organisation (Pareja Roblin et al., 2018; Sofwan et al., 2021). Teachers who perceive school support (Gerick et al., 2017) and a leadership culture focused on technology innovation (Eickelmann, 2011; Lomos et al., 2023) show more favourable attitudes towards technology integration (Ye et al., 2022) and are motivated to use technology more frequently (Spiteri & Chang Rundgren, 2020). Also teachers in schools that prioritise technological development and innovation, with an effective ICT leadership and coordination system (Fernández-Cruz et al., 2018) tend to share the same emphasis and use ICT more in their classroom practice.

Despite the scarce literature addressing the influence of variables such as school innovation, teacher collaboration and teacher-student relationships on technology integration, it seems that collaboration between educational agents is a facilitating factor for its use (Lomos et al., 2023; Thoma et al., 2017). The study by Xu et al. (2023) examined the impact of school variables such as organisational climate, teacher collaboration and innovation for ICT use. The results show that teacher professional collaboration is a potential predictor of teachers' technology use, while educational climate and innovation were not significant variables.

Although recent research results have demonstrated the importance of teacher training, beliefs or experience in the integration of technologies, few studies have focused on the practical dimension of teaching or organisational aspects of the school. Technology integration cannot be understood as an individual task of teachers, as their own characteristics or beliefs are influenced by the context and culture of the school (Petko et al., 2018). This study focuses on the role of variables linked to the teaching staff and the organisation and operation of educational institutions. The aim of this work is to identify variables that explain the use of ICT. This objective is translated into the following research questions:

- What school-level variables are relevant in explaining ICT use?
- What teacher variables contribute to the explanation of ICT use?

In accordance with the literature review, we start from a series of hypotheses that guide the development of the study. (a) Variables related to school organisation, such as cooperation between teachers, teacher innovation, school leadership, classroom climate or teacher-student relationships are relevant factors in explaining ICT use; (b) variables related to teacher training (training received and training needs in relation to ICT) and teaching practice (autonomy, self-efficacy and pedagogical beliefs oriented towards cognitive activation) are relevant in explaining ICT use.

Method

Methodologically, this work consists of a secondary analysis of data obtained from surveys administered to representative samples of secondary school teachers and principals in the framework of the Teaching and Learning International Survey (TALIS 2018), which is promoted by the Organisation for Economic Co-operation and Development (OECD). The purpose of this survey is to obtain international indicators on teachers and teaching to serve as a basis for the review and development of policies aimed at improving teaching and learning (OECD, 2018). The database and the questionnaires that were used are available at (https://www.oecd.org/education/talis/talis-2018-data.htm).

Participants

We worked with a sample of 3,918 principals and 64,899 teachers from 3,921 schools in 21 countries (see Table 1) who completed the questionnaire administered as part of the TALIS 2018 study. Of the total number of countries participating in TALIS 2018, only data from the 21 countries (see Table 1) in which the percentage of principals reporting a shortage or inadequacy of digital technology for instruction does not exceed 25% have been considered for the analysis. This value, taken as a threshold for country selection, is the average percentage for the OECD countries participating in TALIS 2018. These are countries where in the opinion of school leaders, the availability of technology is not a problem for most schools and is therefore not a possible cause of low ICT use in classrooms.

Table 1 Distribution of participants by country

Countries	Schools	Principals	Teachers	Countries	Schools	Principals	Teachers
Australia	238	238	3578	Netherlands	126	127	1895
Austria	277	277	4286	New Zealand	191	190	2262
Chile	179	179	1963	Norway	193	193	4162
Croatia	195	195	3365	Singapore	169	169	3280
Czech Republic	219	219	3447	Slovak Republic	181	180	3019
Denmark	148	148	2008	Slovenia	134	134	2096
England	157	157	2384	Spain	399	399	7407
Estonia	195	195	3004	Sweden	184	183	2785
Finland	148	148	2851	Turkey	198	198	3954
Korea	165	165	2933	United States	167	166	2561
Malta	58	58	1659				

Variables

The variables selected for the study bring together items from the questionnaire answered by ISCED2 teachers and indices available in the TALIS 2018 database. These indices are scale scores obtained by latent modelling from confirmatory factor analysis. The scale scores were standardised in such a way that the value 10 corresponds to the midpoint of the scale (OECD, 2018).

The dependent variable is *ICT use in the classroom*. The information was provided by the teachers, who indicated how often their students used ICT for projects or class work. Teachers' responses were originally expressed on a four-level scale ("never or almost never", "occasionally", "frequently", "always"). For the purpose of analysis, the two lower and two upper levels of the response scale were grouped together, resulting in a binary variable, with the categories low use (0) and high use (1).

Among the independent variables, the first group of four variables, measured at the teacher level, refers to teacher education: *formal education for ICT use, quality of education for ICT use, professional development in ICT use in the last 12 months, and needs for professional development in ICT*. The teachers' responses were originally expressed, as appropriate, on a dichotomous scale (0 "not" and 1 "yes") or on a four-level scale. For the purposes of this analysis, the nondichotomous variables were dichotomised (see Table 2).

A second set of variables, measured at the teacher level, reports on teachers' practices: scores on three indices provided in the TALIS data were considered. These scales have been constructed using confirmatory factor analysis based on questionnaire items (OECD, 2018). The three indices are as follows:

- *Class autonomy*. Measured on five items indicating the degree to which the teacher feels they have control over the areas of their planning and teaching (e.g., "Selecting teaching methods").
- *Self-efficacy in instruction*. The four items used to construct this index reflect the degree to which teachers are able to flexibly employ a variety of activities in the development of the teaching–learning process (e.g., "Getting pupils to believe that they can do well in schoolwork"). The items were measured on a four-point scale.

Table 2 Variables and descriptive statistics

Variable	Coding	Descriptive statistics
ICT use in the classroom	0 = Low use 1 = High use	48.7% 51.3%
Teacher education		
Formal education for ICT use	0 = Not 1 = Yes	44.5% 55.5%
Quality of education for ICT use	0 = Not at all or somewhat 1 = Well or very well	58.6% 41.4%
Professional development in ICT use in the last 12 months	0 = Not 1 = Yes	38.7% 61.3%
Needs for professional development in ICT	0 = No need or low level of need 1 = Moderate or high level of need	44.1% 55.9%
Teaching practices		
Class autonomy	Continuous	M = 12.7; SD = 2.00
Self-efficacy in instruction	Continuous	M = 12.6; SD = 1.97
Cognitive activation	Continuous	M = 10; SD = 1.96
School organisation		
Teacher cooperation	Continuous	M = 9.9; SD = 0.77
Innovativeness	Continuous	M = 11.3; SD = 0.78
School leadership	Continuous	M = 11.0; SD = 2.03
Disciplinary climate	Continuous	M = 8.8; SD = 0.84
Teacher-student relations	Continuous	M = 13.2; SD = 0.76

M mean, *SD* standard deviation

– *Cognitive activation*. The index was measured by four items administered to teachers. These include the frequency with which the teacher develops activities that promote the cognitive development of students (e.g., "I present tasks for which there is no obvious solution").

Finally, the third set of variables, measured at the school level, corresponds to aspects of school organisation. Five indices constructed by confirmatory factor analysis from items in the questionnaire (OECD, 2018) were considered. As the other scales considered in this study, these are indices generated in TALIS and available in the database used as a source. Some of these indices are based on the answers given by school principals, while others are constructed from teachers' responses. To obtain school-level scores, the teacher indices are based on the average of the index values achieved by teachers in the same school:

– *Teacher cooperation*. Measured by eight teacher items indicating the extent to which teachers cooperate with each other in teaching students (e.g., "Discuss the learning development of specific students").
– *Innovativeness*. The four items of the teacher questionnaire used to construct this index reflect the degree of agreement with regard to the commitment of the school's teaching staff to educational innovation processes (e.g., "Most teachers in this school strive to develop new ideas for teaching and learning"). The items were measured on a four-point scale.

- *School leadership*. The index was measured by three items administered to principals. These reflect the frequency with which the director carried out certain leadership activities (e.g., "I took actions to ensure that teachers feel responsible for their students' learning outcomes").
- *Disciplinary climate*. The index was measured by four items administered to teachers. They reflect the teacher's degree of agreement or disagreement with certain statements about school climate (e.g., "When the lesson begins, I have to wait quite a long time for students to quieten down").
- *Teacher-student relations*. The index was measured by four items administered to teachers, who expressed their degree of agreement or disagreement with regard to the relationship between students and teachers (e.g., "Teachers and students usually get on well with each other").

Table 2 shows a list of the variables considered in the study, together with the response modalities considered in each case and the corresponding descriptive statistics for the 21 countries considered in this study. In the case of continuous variables, means and standard deviations are given, while for categorical variables, percentages are presented.

Data analysis

To fulfil the objective of testing whether variables related to the characteristics of the organisational context and the activity conducted by teachers explain the use of ICT, we have constructed a multilevel binary regression model with random intercept, fixed coefficients and a two-level structure with teachers at level 1 and schools at level 2. The adoption of the multilevel approach is based on two premises. The first is that there are statistically significant associations of both teacher and school variables with ICT use in classrooms, which are observable when integrated into a multivariate model. The second is that some of the observed differences in ICT use between the classrooms of different teachers are due to differences between schools. The two-level model allows us to simultaneously assess the effects of individual and school variables on ICT use in classrooms. To arrive at a final model, we estimated a sequence of several models of increasing complexity. Initially, we estimated the null model without including explanatory variables. This model is useful because it allows us to estimate how much of the observed variation in the dependent variable is due to differences between teachers and how much is due to differences between schools. Subsequently, explanatory variables for teachers and schools were introduced in the successive models, considering variables related to teacher training, to teacher performance and to school organisation. Those variables whose effects are not significant are not considered in the estimation of the following model. Formally, the full logit model for the probability π_{ij} that a teacher i in school j makes high use of ICT in his or her classroom, including two-level variables, is expressed as follows:

$$logit\left(\pi_{ij}\right) = \beta_0 + \sum_{k=1}^{K} \beta_k X_{kij} + \sum_{h=1}^{H} \beta_h Y_{hj} + \mu_{0j}$$

where X and Y are the vectors of K first-level explanatory variables and H second-level explanatory variables, respectively. The term μ_{0j} is the unexplained deviation of school j from the average of all schools. It is assumed to be an independent random variable with a mean equal to zero and variance equal to $\sigma^2_{\mu 0}$, which represents the between-school variance. The parameters of the model have been estimated using the penalized quasi-likelihood (PQL) method with MLwiN 2.36 software (although very useful for our purposes, it does not permit the use of sampling weights or replication methods). The statistical significance of these parameters was determined using the Wald test, with which the null hypothesis that the parameter value is zero was tested. The same test was used to assess whether each set of variables added in the successive models made a significant contribution. Odds ratios have been calculated from the β coefficients, which are obtained as exp(β) and reflect how the probability of frequent ICT use varies as the value of an explanatory variable increases by one unit. In the case of dichotomous variables, odds ratios express the ratio between the odds of high ICT use in the classroom for value 1 of the explanatory variable and for value 0.

Results

The estimation of the empty or null model, in which no explanatory variables are involved, allows us to estimate the variance between schools, which reaches the value $\sigma^2_{\mu 0} = 0.787$ ($\chi^2 = 29.390$, df = 1, $p < 0.001$). In a logistic distribution, the variance of the residuals within each school is $\pi^2/3 = 3.29$. Therefore, the proportion of the total variance that corresponds to the between-school variance is $(0.787/(0.787 + 3.29)) = 0.193$. This implies that 19.3% of the total variance corresponds to the effect of schools, which supports the suitability of the multilevel approach for the analysis of these data.

In the first model, variables relating to teacher training were incorporated, both in terms of their initial training and their subsequent professional development. Table 3 shows that these variables are significantly associated with the use of ICT in the classroom (see Table 3). The quality of the initial training is more relevant than the presence of ICT skills. Thus, a high use of ICT in the classroom is associated with the teacher having received quality training on how to use ICT in teaching ($\beta = 0.407$; $p < 0.001$). The positive effect of continuous training is also significant, such that the presence of this topic in the professional development activities conducted in the last 12 months

Table 3 Multilevel logistic regression results (Model 1)

	β	SE	p	Odds-ratio
Effects				
Intercept	−0.362	0.029		
Formal education for ICT use[a]	0.052	0.024	0.030	1.053
Quality of education for ICT use[b]	0.407	0.025	0.000	1.502
Professional development in ICT use in the last 12 months[a]	0.576	0.022	0.000	1.779
Needs for professional development in ICT[c]	−0.131	0.022	0.000	0.877

Dependent variable: ICT use in classroom

[a] Reference category: "not"

[b] Reference category: "not at all or somewhat"

[c] Reference category: "no need or low level of need"

($\beta = 0.576$; $p < 0.001$) is linked to the use of ICT in the classroom. On the other hand, the teacher's perceived need for training in ICT skills applied to teaching has a negative impact ($\beta = -0.131$; $p < 0.001$), reducing the likelihood of students using ICT to carry out classroom exercises.

With the variables of initial training as control variables, variables measured at the school level, all of which refer to aspects of school organisation, were introduced into the second model (see Table 4). Although the joint effect of these variables added to the model is significant (Wald $\chi^2 = 120.096$, $df = 5$, $p < 0.001$), considered separately, not all of them can be considered to be associated with ICT use in the classroom. Aspects such as the intensity of leadership exercised by the school head or the relationship between teachers and students were not found to be relevant. On the other hand, high ICT use in the classroom is more likely when the teaching staff coordinate and collaborate in the delivery of classes ($\beta = 0.147$; $p < 0.001$) and when the school's teaching staff are open to change and to the application of new ideas in teaching ($\beta = 0.123$; $p < 0.001$). The relationship is negative with the disciplinary climate in schools ($\beta = -0.117$; $p < 0.001$), which implies that disruptive behaviour and an inadequate disciplinary climate for the development of classes is an obstacle to the use of ICT in teaching. The introduction of these variables measured at the school level in Model 2 reduced, albeit moderately, the value of the interschool variance, which stands at $\sigma^2_{\mu 0} = 0.722$.

To estimate the final model, adopting a criterion of parsimony in the explanation, we eliminated the variables of school leadership and teacher-student relations, whose contribution was not significant in the previous model. The variables referring to the teaching practices developed by the teachers were incorporated into this last model, which represents a statistically significant increase in the explanation of the dependent variable (Wald $\chi^2 = 2409.182$, $df = 3$, $p < 0.001$). According to the results shown in Table 5, the inclusion of variables relating to teaching practices means that the presence of ICT skills in initial teacher training, which in previous models had been the

Table 4 Multilevel logistic regression results (Model 2)

	B	SE	p	Odds-ratio
Effects				
Intercept	−1.827	0.473		
Formal education for ICT use[a]	0.051	0.025	0.038	1.052
Quality of education for ICT use[b]	0.403	0.025	0.000	1.496
Professional development in ICT use in the last 12 months[a]	0.568	0.023	0.000	1.765
Needs for professional development in ICT[c]	−0.126	0.022	0.000	0.882
Teacher cooperation	0.147	0.025	0.000	1.158
Innovativeness	0.123	0.029	0.000	1.131
School leadership	0.009	0.009	0.902	1.009
Disciplinary climate	−0.117	0.023	0.000	0.890
Teacher-students relations	−0.028	0.031	0.366	0.972

Dependent variable: ICT use in classroom

[a] Reference category: "not"

[b] Reference category: "not at all or somewhat"

[c] Reference category: "no need or low level of need"

Table 5 Multilevel logistic regression results (Model 3)

	β	SE	p	Odds-ratio
Effects				
Intercept	−5.496	0.388		
Formal education for ICT use[a]	0.043	0.025	0.086	1.044
Quality of education for ICT use[b]	0.293	0.026	0.000	1.340
Professional development in ICT use in the last 12 months[a]	0.506	0.023	0.000	1.659
Needs for professional development in ICT[c]	−0.129	0.022	0.000	0.879
Teacher cooperation	0.104	0.026	0.000	1.110
Innovativeness	0.107	0.026	0.000	1.113
Disciplinary climate	−0.070	0.022	0.002	0.932
Class autonomy	−0.007	0.006	0.215	0.993
Self-efficacy in instruction	0.098	0.006	0.000	1.103
Cognitive activation	0.248	0.006	0.000	1.281

Dependent variable: ICT use in classroom

[a] Reference category: "not"

[b] Reference category: "not at all or somewhat"

[c] Reference category: "no need or low level of need"

least relevant aspect within the block of variables on teacher training, is no longer significant. The variables of teacher cooperation, innovativeness and disciplinary climate maintain significant effects on the use of ICT in the classroom. Among the variables referring to the teaching practices developed by teachers, the greatest effect corresponds to cognitive activation ($\beta = 0.248$; $p < 0.006$), an approach to complex tasks that require students to use their own procedures and the application of critical thinking. A high use of ICT in the classroom is favoured by the teacher's use of this type of task and, although to a lesser extent, by the teacher's perception that he or she is capable of flexibly employing a variety of instructional strategies that make him or her effective in his or her teaching ($\beta = 0.098$; $p < 0.001$).

In the interpretation of this complete model, we also consider the odds ratios finally estimated. According to these values, the frequent use of ICT by students to carry out class work and exercises is 65.9% more likely when teachers have taken part in professional development activities related to this subject in the last twelve months (odds-ratio = 1.659) and 34% more likely when they consider that their initial training prepared them well or very well for the use of ICT in teaching (odds-ratio = 1.340). Those with a moderate or high need for professional development in this area are 12.1% less likely to use ICT frequently in their classrooms (odds-ratio = 0.879) than those who express little or no need. Apart from training, the most decisive aspect in the use of ICT has to do with the planning of activities that promote cognitive activation. For each unit increase in the cognitive activation index, the probability of high ICT use increases by 28.1% (odds-ratio = 1.281). The profile of teachers who make frequent use of ICT in the classroom also includes variables related to the organisational context in which they carry out their work. This frequent use is 11.3% and 11.0% more likely when the rates of innovation (odds-ratio = 1.113) and cooperation between teachers in the school (odds-ratio = 1.110) increase by one unit, respectively.

Discussion and conclusions

Assuming the importance of teacher training in explaining the use of ICT in the classroom, the aim of this paper was to analyse the role of variables related to teaching practices and the organisational context of schools. In light of the results presented and coinciding with the findings of previous research (Baharuddin et al., 2024; Belay et al., 2020; Mailizar & Fan, 2020; Pareja Roblin et al., 2018; Taimalu & Luik, 2019; Tomczyk et al., 2021; Tondeur et al., 2017), it is confirmed that initial and continuous teacher training, especially the latter, have a high weight in explaining the use of ICT in the classroom. Teachers who have a growth mindset and use this resource to a greater extent are characterised by having recently participated in professional development activities in this area and having received quality training on ICT use.

While it is true that the provision of technological resources in schools is a widespread reality and that the frequent use of ICT occurs in approximately half of the classes (Fraillon et al., 2020), it is true that ICT is not always efficiently integrated into the teaching and learning processes, and its use is often limited to the mere transmission of knowledge (Valverde-Berrocoso et al., 2021), bureaucratic activities or the presentation of information (Avidov-Ungar & Forkosh-Baruch, 2018). Arguably, there is still a basic and limited use of ICT linked to traditional and uninnovative teaching and learning models, which is insufficient compared to the technological integration developed in other fields (Fraillon et al., 2020; Hsu, 2017; Liu et al., 2020; Uerz et al., 2018).

Addressing this situation requires adequate teacher training in the use of ICT in the classroom. Although the design adopted in this study does not allow us to conclude the existence of a causal relationship, the association detected between training and ICT use makes it advisable to pay attention to this factor. In this sense, the examination of teaching practices that appear to be significantly linked to the use of ICT points to some guidelines that could be considered in teacher training. In line with previous studies (Almerich et al., 2023; Ifinedo et al., 2020; Liu et al., 2020; Prestridge, 2017; Spiteri & Chang Rundgren, 2020; Teo et al., 2018), our results indicate that the frequent presence of ICT in classroom activity is associated with teaching self-efficacy and students' cognitive activation. It can therefore be argued that quality training in the use of ICT in the classroom could focus on enabling teachers to integrate ICT into a variety of activities used flexibly in teaching and learning processes. In addition, teachers should develop competences related to constructivist beliefs (Hsu, 2016) to propose complex or high-level tasks in the classroom that require critical thinking and promote students' cognitive activation (Pozo et al., 2021).

Other contextual variables at the school level, related to school management and organisation (Pareja Roblin et al., 2018; Sofwan et al., 2021), ICT coordination (Fernández-Cruz et al., 2018), school leadership (A'mar & Eleyan, 2022; Liu et al., 2020), perceived institutional support for innovation (Atman Uslu & Usluel, 2019; Moreira-Fontán et al., 2019) and collaborative work (Blau & Shamir-Inbal, 2017; Xu et al., 2023), also play a relevant role in the process of efficient ICT integration in the classroom. In the work we present here, we have found that certain organisational aspects of the school are significant in explaining the use of ICT, although their weight is less than that attributed to the training received or the characteristics of teacher performance in the classroom. Specifically, the results obtained show that the integration of ICT in the daily

work conducted in the classroom is more likely when there is a positive school climate, disruptive behaviour is minimised, and the school's teaching staff engage in educational innovation and carry out their work in cooperation with the rest of the teaching staff.

This finding has important implications for the development of policies aimed at continuous teacher training on the use of ICT. Training actions aimed at individual teachers should be secondary to training strategies in schools. In-school training involves teaching teams and can encourage the coordinated and cooperative adoption of innovative ways of integrating ICT into teaching and learning processes in the classroom.

Among the strengths of this work, we highlight the breadth and representativeness of the international sample of teachers and school principals used in the TALIS study, generated through rigorous sampling procedures. The quality of the data used and the simultaneous work with variables measured at the teacher and school levels are additional aspects to be highlighted. Some limitations can also be noted, given the nature of the design adopted. As this was a secondary analysis, the variables used were only those available in the database used as a source of information. Furthermore, the MLwiN program used to estimate the model parameters does not permit the use of sampling weights and replication methods, which implies that the results of this study should be seen as preliminary. For future research, it is suggested to repeat the analysis using the sampling weights and replication methods recommended to be used with the TALIS data.

On the other hand, the correlational approach used allows us to identify relationships between ICT use and the variables studied but does not allow us to affirm causal relationships. As a complement to the quantitative methodology adopted here, future work could be approached from a qualitative perspective. Qualitative case study designs will provide insight into teachers' perspectives on ICT use in the classroom and deepen understanding of the personal and contextual factors that promote or constrain it.

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Author contributions
JGF: conceptualization, methodology, formal analysis, investigation, data curation, writing-original draft, supervision, writing-review & editing. JRS: conceptualization, methodology, formal analysis, investigation, writing- original draft, supervision, data curation, writing-review & editing. COV: conceptualization, methodology, investigation, writing-original draft, writing-review & editing.

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Availability of data and materials
The datasets generated and/or analysed during the current study are available in the [TALIS, 2018] repository, [https://www.oecd.org/education/talis/talis-2018-data.htm].

Declarations

Competing interests
The authors declare that they have no competing interests in this section.

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