

Design and validation of an instrument to measure teacher training profiles in information and communication technologies

Diseño y validación de un instrumento de medida del perfil de formación docente en tecnologías de la información y comunicación

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Abstract:

Introduction: this study is part of a research project concerning the teacher training in information and communication technologies (ICT) profile. Its aim is to develop and validate an instrument for measuring this profile in primary and secondary schools. **Methodology:** after developing the instrument and administering it to a sample of 1,433 teachers in the Community of Madrid, its reliability, content, and construct validity were analysed (the latter using Structural Equation Models with the IBM SPSS-AMOS program). **Results:** the reliability analysis gave Cronbach's Alpha = 0.973 for the whole of the instrument. For each dimension this figure was: Curricular Aspects, 0.738; Planning and Evaluation, 0.878; Methodological Aspects, 0.903; Use of ICT, 0.935; and ICT Training, 0.894. The discrimination coefficient values of the final instrument items ranged from 0.33 to 0.74. The Confirmatory

Factor Analysis demonstrates a good fit of the model to the data (CMIN/DF = 5,138; CFI = 0,905; RMSEA = 0,056; PRATIO = 0,928). **Conclusions:** this instrument has therefore shown that it has the necessary technical characteristics to be considered a valid and trustworthy tool for measuring the teacher training profile in ICT.

Keywords: teacher competencies, digital competency, ICT standards, teacher, factor analysis.

Resumen:

Introducción: el presente estudio forma parte de una investigación acerca del perfil de formación docente en Tecnologías de la Información y Comunicación (TIC). El objetivo, en este caso, es elaborar y validar un instrumento de medida de dicho perfil en centros de Pri-

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maría y Secundaria. Metodología: tras la elaboración y aplicación del instrumento a una muestra de 1433 docentes de la Comunidad de Madrid, se analizó la fiabilidad, la validez de contenido y de constructo (esta última a través de Modelos de Ecuaciones Estructurales con la aplicación informática IBM SPSS-AMOS). Resultados: Los resultados obtenidos en el análisis de fiabilidad Alfa de Cronbach = 0.973 para la totalidad del instrumento y en cada dimensión: 0.738 Aspectos Curriculares; 0.878 Planificación y Evaluación; 0.903 Aspectos Metodológicos; 0.935 Uso de las TIC; 0.896 Gestión Recursos TIC y 0.894 Formación TIC, oscilando los valores del

coeficiente de discriminación de los ítems del instrumento final entre 0.33 y 0.74. El Análisis Factorial Confirmatorio demuestra un buen ajuste del modelo a los datos (CMIN/DF = 5.138, CFI = 0.905, RMSEA = 0.056, PRATIO = 0.928). Conclusiones: por todo ello, el instrumento presentado reúne las características técnicas exigidas para ser considerada una herramienta válida y fiable para medir el perfil de formación docente en TIC.

Descriptores: competencias del docente, competencia digital, estándares TIC, profesorado, análisis factorial.

1. Introduction

Numerous studies have considered the impact of plans to integrate information and communication technology (ICT) in non-university education. Some of them (Tejedor and García-Valcárcel, 2006; Becta, 2004) consider the reasons these plans fail, including:

- Substandard teacher training.
- Lack of methodological coordination/innovation and team work.
- Lack of ICT coordination.
- Lack of technological infrastructure and educational resources.

Similarly, the establishment of decentralised educational policies has had a very uneven impact on the conditions in which plans for integrating ICT in centres have been applied (De Pablos, Colás, and González, 2010; Area, Hernández, and Sosa, 2016), and so each autonomous region with full educational powers has im-

plemented different integration measures with very varied outcomes.

We could be forgiven for thinking that the presence of technological resources in schools is an important differentiating factor for genuine change in the integration and development of digital competencies in teachers and students alike. However, several pieces of research indicate that this factor is not as decisive as initially supposed (Area, 2005; Marchesi et al., 2005).

In fact, according to other studies (García-Valcárcel, 2003; Cabero, 2000; Sancho, 2002), one factor for success in improving digital integration in schools is the establishment of a comprehensive programme of technological implementation that is taken up and led by the members of the management team and teaching staff, which has an impact on the implementation of innovative learning strat-

egies in the use of ICT. Accordingly, improvements that combine incorporating technological resources and introducing innovative learning methodologies give better results in student performance and in the digital competencies of their teachers (Espuny, Gisbert, and Coiduras, 2010; Aguaded and Tirado, 2010; Cebrián, Ruiz, and Rodríguez, 2007; Garrido, Fernández, and Sosa, 2008; Pérez, Aguaded, and Fandos, 2009; Fernández-Cruz and Fernández-Díaz, 2016; Area, Hernández, and Sosa, 2016).

Nonetheless, one of the main obstacles encountered when integrating technology into education is the low level of teachers' digital competencies (Fernández-Cruz and Fernández-Díaz, 2016; Mueller, Wood, Willoughby, Ross, and Specht, 2008; Ramboll Management, 2006). The lack of initial training or of continued training to improve and expand digital skills through teachers' careers (Marcelo and Estebaranz, 1999; Prensky, 2001) and the failure to incorporate more active, innovative and effective teaching methodologies (Gewerc, 2002; Fernández and Álvarez, 2009; García-Valcárcel and Tejedor, 2010) are the most obvious reasons for the lack of impact of ICT in learning outcomes and in the digital competencies of the teaching staff, this latter aspect being of special relevance in this study.

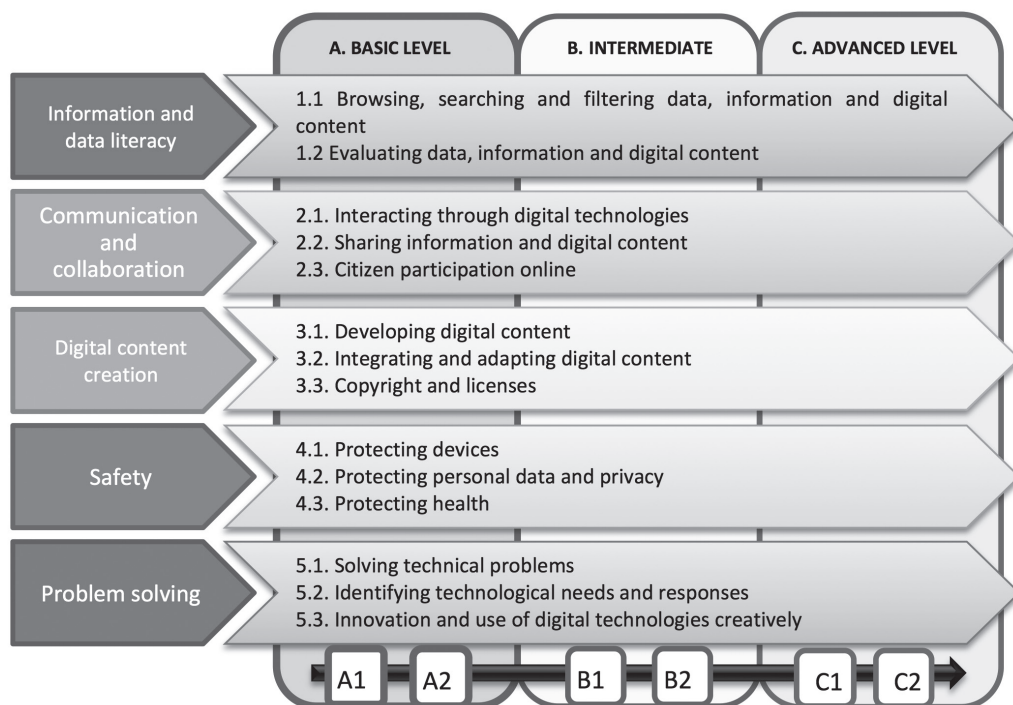
Taking into account their great relevance, the technological competencies of teachers continue to be a crucial element in educational performance. These are understood as the set of knowledge and skills an individual re-

quires, to be able to use these technological tools as educational resources that are better integrated in their day-to-day classroom work (Suárez-Rodríguez, Almerich, Díaz-García y Fernández-Piqueras, 2012).

The educational importance that digital competencies have acquired has, on the one hand, been backed up by improved legislation recognising the need for the curriculum to include ICT skills as a vital learning tool (Organic Law 2/2006, Organic Law 8/2013), and on the other hand, by the development of various models of ICT competency standards for teaching staff. These have been created by a variety of government and non-governmental bodies (Department of Education of Victoria, 1998; International Society for Technology in Education, 2008; Proyecto Enlace del Ministerio de Educación de Chile, 2006; North Carolina Department of Public Instruction, 2000; UNESCO, 2008; 2011; Almerich, Suárez, Orellana, Belloch, Bo, and Gastaldo, 2005).

Within the European Union, the development of the «Common Digital Competence Framework for Teachers» (INTEF, 2017) is worth noting. This has been in force in Spain since 2012 as a result of the implementation of the European Digital Competence Framework for Citizens v2.1 (DigComp: JCR, 2017) and the Digital Competence Framework for Educators (DigCompEdu: JCR, 2017). The outline of the levels of development and the dimensions of competency on which this model is based are set out in Table 1:

TABLE 1. Common Digital Competence Framework for Teachers (INTEF, 2017).



Source: INTEF (2017).

Without wishing to downplay how important the implementation of the Common Digital Competence Framework for Teachers in Spain has been, one of the international institutions that has worked hardest to develop clear structures to contribute to training teachers in digital capacities is UNESCO. This organisation prepares and publishes the ICT competency framework for teachers (UNESCO, 2008; 2011) with the aim of improving their practice in all areas of their work, combining ICT skills with innovations in pedagogy, the syllabus, and the organisation of schools. It is also intended that teachers will use ICT competencies and resources to improve their

teaching, cooperate with colleagues, and, ultimately, be able to become leaders in innovation in their respective institutions. The overall aim of this project is not just to improve the practice of the teachers, but to do this in a way that helps improve the quality of the educational system so that it can encourage the economic and social development of the country (UNESCO, 2011). To this end, UNESCO has defined three levels of knowledge deepening in ICT skills for teacher training:

- Understanding technology, integrating technological skills into syllabuses (1st level: basic knowledge of technology).

— Using knowledge with the aim of adding value to society and the economy, applying this knowledge to solve complex and real problems (2nd level: knowledge deepening).

— Producing new knowledge and exploiting it (3rd level: knowledge creation).

These three focusses (UNESCO, 2011) correspond to alternative visions and national policy objectives for the future of education. However, each level has different characteristics according to the dimension being studied (Table 2):

1) Policy and vision: curriculum aspects of ICT.

2) Syllabus and evaluation: ICT planning and evaluation.

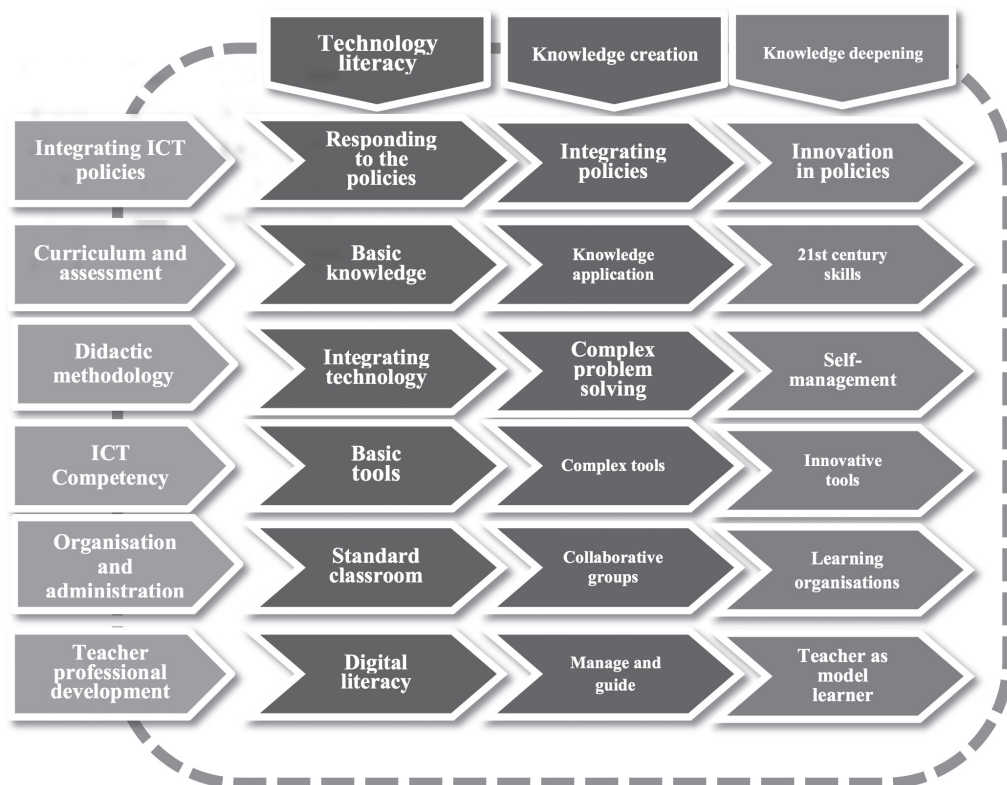
3) Pedagogy: methodological aspects in ICT.

4) ICT: using and handling technology.

5) Organisation and administration: managing ICT resources.

6) Professional training for teachers: professional development in ICT.

TABLE 2. UNESCO competency standards modules for teachers (UNESCO, 2011).



Source: UNESCO (2011).

2. Method

2.1. Objectives

In light of this situation, the main objective of this piece of work is to design and develop a valid and reliable measurement instrument based on a conceptual and operational definition that brings together the technical features required to measure the profile of teacher training in ICT in Spain.

2.2. Population and Sample

The study population comprises 1844 primary and secondary schools from the Autonomous Region of Madrid (CAM), comprising a total of 24,338 teachers (Consejería de Educación de Madrid, 2015-16). For this purpose, a total of 3992 teachers from 80 schools in the different areas of the Autonomous Region of Madrid (north, south, east, west, and centre) were contacted using convenience sampling. Of these, 1433 eventually participated voluntarily in the study, giving a response rate of 35.90%. Hair, Anderson, Tathan, and Black (2009) state that, as a general rule, it is advisable to have, as a minimum, a number of observations five times greater than the number of variables. However, the acceptable size is a ratio of ten to one. Our sample comprises 1433 observations and the measurement instrument, as shown below, comprises 63 items, giving an observations/variables ratio of 22.75.

The teachers were selected using a convenience sample, with the result that 64.34% ($n = 922$) are from state-funded independent schools, 25.4% ($n = 364$) are

from state schools, and 10.26% ($n = 147$) are from private schools. This distribution matches the population distribution of the Autonomous Region of Madrid (Consejería de Educación de Madrid, 2009), both in types of school and area. The distribution by areas of the teachers shows that 3.56% ($n = 51$) are from the north area of the Region, 33.91% ($n = 486$) from the south area, 5.58% ($n = 80$) from east area, 20.66% ($n = 296$) from the west area, and 36.28% ($n = 520$) from the central area.

As for the sociodemographic characteristics, the sample comprises 954 women (66.57%) and 479 men (33.43%). As for age, 48.15% of the sample were under 36, while 30.1% of the subjects were aged between 36 and 45, and 21.84% were 46 or older.

Finally, regarding their professional profile, 35.52% of the sample have 5 years or less teaching experience, 24.42% have between 6 and 10 years, and 22.47% have between 11 and 20 years. The remaining 17.58% have 21 years or more of experience as a teacher.

2.3. Instrument

The ICT teacher training profile was measured in accordance with UNESCO's standards using an instrument prepared expressly for the occasion, comprising items that refer to the dimensions established by UNESCO and shown in Table 2. The questionnaire included a total of 63 items (see Table 3) which the teacher had to answer using a 1-5 Likert scale (where 1 indicates Not at all or Never and 5 indicates A lot or Always) for all of the items from the different dimensions. In

this study, the 5-point scale is treated as a «fine-grained ordinal» or «quasi-interval» scale (Weaver, 2015; Del Río, 2013; Pérez Juste, 1985), permitting the use of exploratory and confirmatory factorial analyses instead of item response theory or parallel analysis.

2.4. Preparing the Questionnaire

To prepare the scale for measuring teacher training in ICT, a system was designed using dimensions, sub-dimensions, and indicators based on the standards drawn up by UNESCO (2008, 2011). These specifications were adapted to Spain's educational context and to the digital teaching capacities of primary and secondary teachers. Accordingly, the instrument comprised six large dimensions, each split into three levels of deepening (Table 3):

— Curricular Aspects in ICT (CA), relating to how teaching staff in the stages being studied understand the «policy» or curriculum component that refers to digital competency as something that leads to changes in teacher training and as something required when changing the methodology used in the task of teaching their students. The three levels in this profile are:

- CA-1 Knows what «Digital Competency» is but does not use it in their work with students.
- CA-2 Knows about and works on «Digital Competency» in the delivery of their areas with students.
- CA-3 Implements new types of intervention and activities for working on «Digital Competency» with students.

— ICT Planning and Evaluation (PE) that impacts on how teaching staff include developing digital competencies in the work their students do by planning and evaluating these activities. The three levels in this profile are:

- PE-1 The teacher plans and evaluates activities so that their students use ICT while doing their activities in class.
- PE-2 The teacher uses different programs depending on the areas and evaluates the students' performance in relation to performance categories.
- PE-3 The teacher knows how students perform complex learning and plans new innovative activities so that they collaborate on this learning using ICT and so that they self-evaluate.

— Methodological Aspects in ICT (MD). This dimension refers to the teaching staff's methodological strategies for using ICT in the classroom and developing their students' digital competencies. The three levels in this profile are:

- MD-1 Teachers understand the use of ICT tools and use them to perform their teaching work when explaining content.
- MD-2 Teachers perform activities using ICT tools for comprehensive and collaborative work by their students and implement projects in collaboration with other teachers.
- MD-3 Teachers innovate new activities and materials for classroom work, implementing projects and new technological tools.

— Use and handling of technology (IT). This refers to the level at which teachers use ICT in the world of education, from digital literacy to technological innovation. The three levels in this profile are:

- ICT-1 The teacher understands the use of ICTs at a user level and looks for ICT tools for use in class.

- ICT-2 The teacher prepares ICT tools for their areas and uses ICT to manage, monitor, and evaluate their students.

- ICT-3 They teach their students to use complex virtual environments to create their own activities and collaborate with each other.

— ICT resource management (RM). This indicates the teacher's level in managing the technological resources in the centre, coordinating them, and helping other teachers in their use of these measures. The three levels in this profile are:

- RM-1 They use the schools computer room and manage their own classroom to work methodologically with ICT.

- RM-2 They install and organise resources so that students use ICT to do projects and collaborate.

- RM-3 They help other teachers, train them, and encourage them to perform teaching innovation projects using ICT.

— Professional Development in ICT (PD). This dimension indicates how much the teaching staff continue training in the use of ICT in teaching as a personal and professional requirement, understanding that the field of technology is constantly expanding and changing. The three levels in this profile are:

- PD-1 They use technological resources to train themselves in their subjects.

- PD-2 They use ICT resources to search for and share resources, access forums, and develop their teacher training.

- PD-3 They evaluate their teaching practice to improve it and present innovation projects in professional forums.

Once the structure of the questionnaire had been split into dimensions, indicators, and items, a group of experts was selected to check the validity of the content of the instrument. This group of assessors comprised experts in educational research with extensive knowledge of preparing and analysing scales who evaluated the suitability of the items and how they were expressed and the general design of the questionnaire. It also included academics who are experts in initial teacher training to interpret the usefulness and appropriateness of the teacher training factors included in the questionnaire. Experts in educational technology were also included to help establish the most relevant ICT training criteria for current teachers.

To help them perform this task they were informed of the purpose of the instrument and the rationale behind its content and were given a validation instrument where they had to evaluate on a scale of 1 to 5 the relevance (level of significance or importance of the item with regards to the dimension it is in) and the clarity of each item on the questionnaire. Finally, there were some open-ended questions concerning the advisability of including,

changing, or removing some of the items presented in the evaluation tool.

The relevant analyses were performed on the evaluation provided by this group of assessors and the questionnaire was restructured taking into account the criteria established by authors like Tejero (2006), Tejero, Fernández, and Carballo (2010), and Cortada de Kohan (1999),

eliminating items that did not exceed an average of 4 in clarity and relevance, or that had a standard deviation of 1.5, provided that the quantitative evaluations of the experts recommended this. The changes suggested by the experts were minor (concerning grammar and wording) and almost all of the items were of high relevance. The items included in the questionnaire are shown in Table 3.

TABLE 3. Dimensions, indicators, and items in Teacher Training in ICT (TTICT).

Dimensions	Indicators	Items
General curriculum aspects	CA-1 Basic knowledge of technology	1. I understand the meaning of «Digital Competency» set out in the Curriculum Decrees for my educational level.
	CA-2 Knowledge deepening	2. I work on «Digital Competency» in my areas/subjects doing practical activities that require the use of ICT.
	CA-3 Knowledge creation	3. I implement teaching innovation projects in my centre relating to «Digital Competency».
Planning and evaluation	PE-1 Basic knowledge of technology	4. When planning my classes I include software tools to deliver them. 5. I help my students use technological resources in my areas/subjects. 6. I use ICT to evaluate my students.
	PE-2 Knowledge deepening	7. I differentiate between specific technological resources and activities by area/subject. 8. I use assessment scales to evaluate my students' level of acquisition of the objectives.
	PE-3 Knowledge creation	9. I know what the different ways in which my students learn are (handling information, reasoning, planning, reflecting, problem solving, collaborating, etc.). 10. I plan activities to make my students use ICT to reason, plan, reflect, solve problems, and collaborate. 11. I teach my students to use ICT to search, manage, analyse, integrate, and evaluate information. 12. I teach my students to use ICT to communicate and cooperate with each other. 13. I teach my students technological tools to self-evaluate their performance in my areas/subjects.

Dimensions	Indicators	Items
Methodological and didactic aspects	MD-1 Basic knowledge of technology	14. I know methodological and technological strategies to ensure students meet the objectives in each area/subject. 15. I carry out activities with technological tools (presenting content, practical work, demonstrations, etc.). 16. I use presentations and other IT resources in my teaching work: presenting topics, giving examples, etc.
	MD-2 Knowledge deepening	17. I am familiar with the collaborative learning methodology based on projects and ICT. 18. I select problems from my students' real life to introduce projects in class. 19. I prepare online (virtual) resources that help to deepen my students' understanding of the areas/subjects. 20. I provide tasks to make my students collaborate to solve a project or problem. 21. I suggest teamwork projects that include IT tools so that my students reason, dialogue, and solve problems. 22. I collaborate with other teachers to develop classroom projects and solve real-life problems.
	MD-3 Knowledge creation	23. I know what my abilities are in reasoning, problem-solving, and creating knowledge and activities for each of my areas/subjects. 24. I prepare online materials and activities so that students will collaborate on problem solving, research tasks, and creative activities. 25. I help my students create their own learning activities, projects, research or creative activities. 26. I teach my students to use technological tools for their own projects. 27. I help my students reflect on their own learning.
Knowledge and use of ict	ICT-1 Basic knowledge of technology	28. I am familiar with the basic functioning (hardware) of desktop computers, laptops, printers, scanners, etc. 29. I know how to use word processors (editing, formatting, and printing texts). 30. I know how multimedia presentations work (slide-shows). 31. I know how to use graphics editing software such as Photoshop. 32. I know how to use a browser to access a web page on the internet. 33. I know how to use search engines like Google to find websites dedicated to specific topics. 34. I can set up an email account. 35. I know computer programs (tutorial software, instructional software, practices) for each area/subject that I teach. 36. I know how to find pre-prepared educational ICT applications, evaluate them, and adapt them to my students' needs.

Dimensions	Indicators	Items
Knowledge and use of ict	ICT-1 Basic knowledge of technology	37. I use some online resources (intranet, educational platform, virtual classroom, webpage, etc.) to monitor attendance, give marks, tutor students, etc. 38. I use different technology tools for communication and collaboration (exchanging texts, videoconferencing, blogs, chats, forums).
	ICT-2 Knowledge deepening	39. I use specific technological tools in my areas/subjects so that the students use them to explore. 40. I evaluate the precision and usefulness of on-line technological resources for learning based on projects in each area/subject. 41. I use authoring tools (JClic, Constructor, Quadernia, etc.) to prepare online educational activities in my areas/subjects. 42. I use ICT to manage, monitor, and evaluate my students' learning progress. 43. I use ICT to communicate and cooperate with students, colleagues, parents, etc. 44. I use a network (intranet, virtual classroom, etc.) so that my students collaborate inside or outside school. 45. I use internet search engines, online databases, blogs, or email to find collaborators to develop research or innovation projects in my areas/subjects.
	ICT-3 Knowledge creation	46. I show computer programs so that my students innovate and create their own activities (web editing, picture editing, etc.). 47. I use virtual environments (virtual classroom, knowledge building environments) so that my students create their own activities. 48. I show my students technological tools to help them plan self-learning activities.
Managing ict resources	MR-1 Basic knowledge of technology	49. I use the computer room to complement the teaching delivered in my classroom. 50. I know the most appropriate methodological organisation to use technological resources in class (workshop, corner, individually, etc.). 51. I organise my own classroom so that my students work with ICT resources in class.
	MR-2 Knowledge deepening	52. I install computers and technological resources so that my students collaborate in class (laptops, tablets, interactive whiteboards, etc.). 53. I provide the appropriate organisation and technological resources for running project-based activities.
	MR-3 Knowledge creation	54. I help other teachers to integrate ICT in their areas/subjects and in their teaching practice. 55. I collaborate in innovation in my school and in continuous ICT training for my colleagues. 56. I help train my colleagues to integrate ICT in their classes.

Dimensions	Indicators	Items
Teacher professional development in ict	TT-1 Basic knowledge of technology	57. I use technological resources (text editors, spreadsheets, databases, email, blogs, etc.) in my day-to-day teaching and administration work to improve my performance in all tasks. 58. I use technological resources (online courses, etc.) in my training in my areas/subjects (methodology, evaluation, planning, etc.).
	TT-2 Knowledge deepening	59. I use ICT to find and share resources that support the development of educational activities and my teacher training. 60. I use ICT to access expert forums and learning communities relating to my teaching activity. 61. I use ICT to search for, process, analyse, integrate, and evaluate information for my own teacher training.
	TT-3 Knowledge creation	62. I continuously evaluate my teaching practice to innovate and improve in the educational field. 63. I present ideas for innovation and improvement in the integration of ICT in professional forums.

Source: Own elaboration.

2.5. Data collection and Analysis Procedure

To maximise the number of participants in the study, the research team sent the questionnaires to the schools on hard copies. The printed format was chosen in preference to online questionnaires to improve the response rate for the sample gathered, as some authors have attributed low response rates to online questionnaires (de Rada, 2012). The questionnaires were accompanied by a letter providing information about the objective of the study. Once completed they were returned to a letter box provided for this purpose to protect the anonymity of the participants. Finally, the members of the management team were told that at the end of the study, they would be given a detailed analysis of the results for the teaching staff from their school, comparing them with the rest of the sample that took part in the study so that

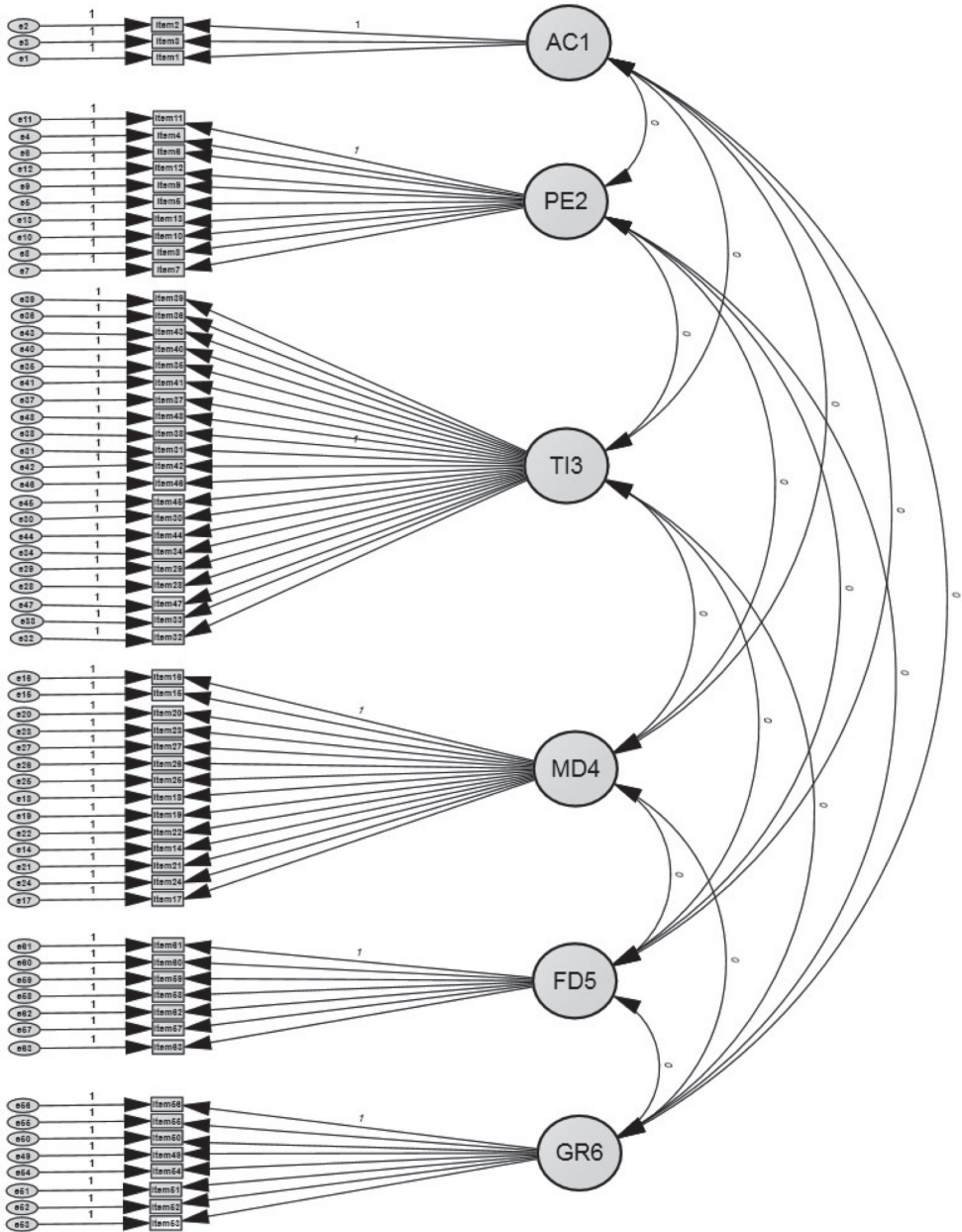
the centres would derive a genuine benefit from the diagnosis of their teaching staff's digital competencies.

3. Results

3.1. Reliability of the Instrument

When interpreting the overall Alpha of the instrument for measuring teachers' ICT training profile, an excellent level was obtained (Cronbach's $\alpha = .973$) according to the valuations established by George and Mallery (2003, p. 231). This was also the case for the indices of homogeneity for the items («Corrected item-to-total correlation»). These values were greater than .3 (frequencies: 0.3-0.39 = 1 item; 0.4-0.49 = 11 items; 0.5-0.59 = 15 items; 0.6-0.69 = 30 items; 0.7-0.79 = 6 items), indicating that the distribution of the frequencies of the items displays significant

GRAPH 1. Initial model for measuring teachers' ICT training.



Source: Own elaboration.

variability. The analyses of the reliability of each of the dimensions individually gave reasonably good results. The excellent levels for dimensions that are very

important for the construct studied stood out. For example, Methodological Aspects (MA - $\alpha = .903$) and use of ICT (ICT - $\alpha = .935$). In contrast, the General Cur-

riculum Aspects (CA - $\alpha = .738$) have acceptable values that could be improved in future, either by improving their preparation, or by increasing the number of items in this specific dimension. The values of the discrimination coefficient of the final items varied between .334 and .743.

3.2. Construct Validity (Confirmatory Factor Analysis)

Once the theoretical foundation had been prepared through a literature review that made it possible to establish the structure of the questionnaire (Table 3) and after validating its content through expert evaluation, confirmatory factor analysis was performed by using structural equation modelling to evaluate the construct validity of the instrument. To do so, the rules for correspondence and relationships between the latent and ob-

served variables that this questionnaire measures were specified. Accordingly, the initial measurement model was proposed (Graph 1), including all of the indicators set out in the theory. This model comprises 6 latent variables, 63 observed variables (these correspond to the items on the questionnaire from Item 1 to Item 63) and 63 error terms (from e1 to e60). Similarly, 63 factor loadings and 63 regression weights were defined among the error terms and their associated variables. The six correlations between the main latent factors were included and all of the error terms were regarded as un correlated.

In order to assume multivariate normality, the kurtosis coefficient and its critical ratio were used (Mardia's normalized estimate of multivariate kurtosis), giving values below 5 for all items (Table 4), figures that reflect multivariate normality (Byrne, 2010; Bentler, 2005).

TABLE 4. Multivariate Normality: Multivariate Kurtosis and critical ratio.

	Min.	Max.	Kurtosis	Critical Ratio
Item28	1	5	0.306	2.368
Item1	1	5	-0.479	-3.702
Item3	1	5	-0.379	-2.929
Item2	1	5	-0.58	-4.48
Item29	1	5	0.554	4.28
Item30	1	5	-0.403	-3.112
Item31	1	5	-1.02	-7.882
Item34	1	5	0.37	2.858
Item39	1	5	-0.786	-6.073
Item40	1	5	-0.531	-4.107
Item41	1	5	0.295	2.283
Item43	1	5	-1.088	-8.41
Item44	1	5	0.302	2.332
Item45	1	5	-0.749	-5.784

	Min.	Max.	Kurtosis	Critical Ratio
Item46	1	5	0.357	2.755
Item47	1	5	0.895	4.643
Item48	1	5	0.048	0.373
Item56	1	5	-0.591	-4.566
Item55	1	5	-0.661	-5.104
Item54	1	5	-0.544	-4.202
Item53	1	5	-0.198	-1.526
Item52	1	5	0.081	0.623
Item51	1	5	-0.698	-5.395
Item50	1	5	-0.788	-6.09
Item49	1	5	-1.061	-8.202
Item62	1	5	-0.841	-6.502
Item61	1	5	-0.819	-6.331
Item60	1	5	-0.917	-7.085
Item59	1	5	-0.674	-5.209
Item58	1	5	-0.86	-6.643
Item57	1	5	-0.554	-4.278
Item26	1	5	-0.54	-4.171
Item25	1	5	-0.776	-5.999
Item24	1	5	-0.096	-0.743
Item22	1	5	-0.797	-6.156
Item21	1	5	-0.698	-5.393
Item19	1	5	-0.218	-1.688
Item17	1	5	-0.7	-5.411
Item16	1	5	-0.964	-7.447
Item15	1	5	-0.796	-6.152
Item7	1	5	-0.784	-6.06
Item13	1	5	-0.041	-0.316
Item12	1	5	-0.72	-5.561
Item11	1	5	-0.85	-6.568
Item5	1	5	-0.846	-6.535
Item10	1	5	-0.795	-6.143

Source: Own elaboration.

Next, after specifying the model, its parameters were estimated using the maximum likelihood method (ML). This is the most efficient and unbiased method when

the assumptions of multivariate normality are met, and it is sufficiently robust not to be affected by small variations from the multivariate normal distribution (Hayduk, 1996).

Among the results from this model (Table 5), we can see how the indices of fit of the CFI model (= .607) and IFI model (= .607) are below the 0.90 required according to Kline

(2010). This is partly due to factor loadings for items 8, 9, 23, 6, and 27 below the value of 0.5 identified as necessary by Byrne (2010), and so these items were eliminated.

TABLE 5. Summary of the indices of fit of the initial and final models for measuring the teacher training profile in ICT.

Measure	Recommended level of fit	Value Initial Model	Value Final Model
CMIN/DF	2-5	14,031	5,138
IFI	> .9	.607	.905
CFI		.607	.905
PRATIO	> .7	.968	.928
PNFI		.57	.824
PCFI		.587	.841
RMSEA	< .06	.095	.056
LO90		.094	.052
HI90		.096	.055
HOELTER.05	> 200	108	300
HOELTER.01		110	310

Source: Own elaboration.

To continue with the process of checking the model's fit, the table of modification indices was used to evaluate the inclusion of some covariances between error terms that would reduce the chi-squared statistic markedly, some of them being justifiable from a theoretical position. A significant correlation was observed between various terms: the ones

that correspond to our dimensions and to UNESCO's subdimensions or profiles. In light of this, given the high number of correlations found between error terms, it appeared to be advisable to create latent factors intended to fit these correlations between the error terms, using the theoretical definition of each of the items in the questionnaire to do so.

TABLE 6. Modification indices.

Modification indices			M.I.	Par Change
e1	<-->	eIT1	78.774	.175
e45	<-->	e44	57.645	.165
eIT1	<-->	Teacher Training	112.079	.155

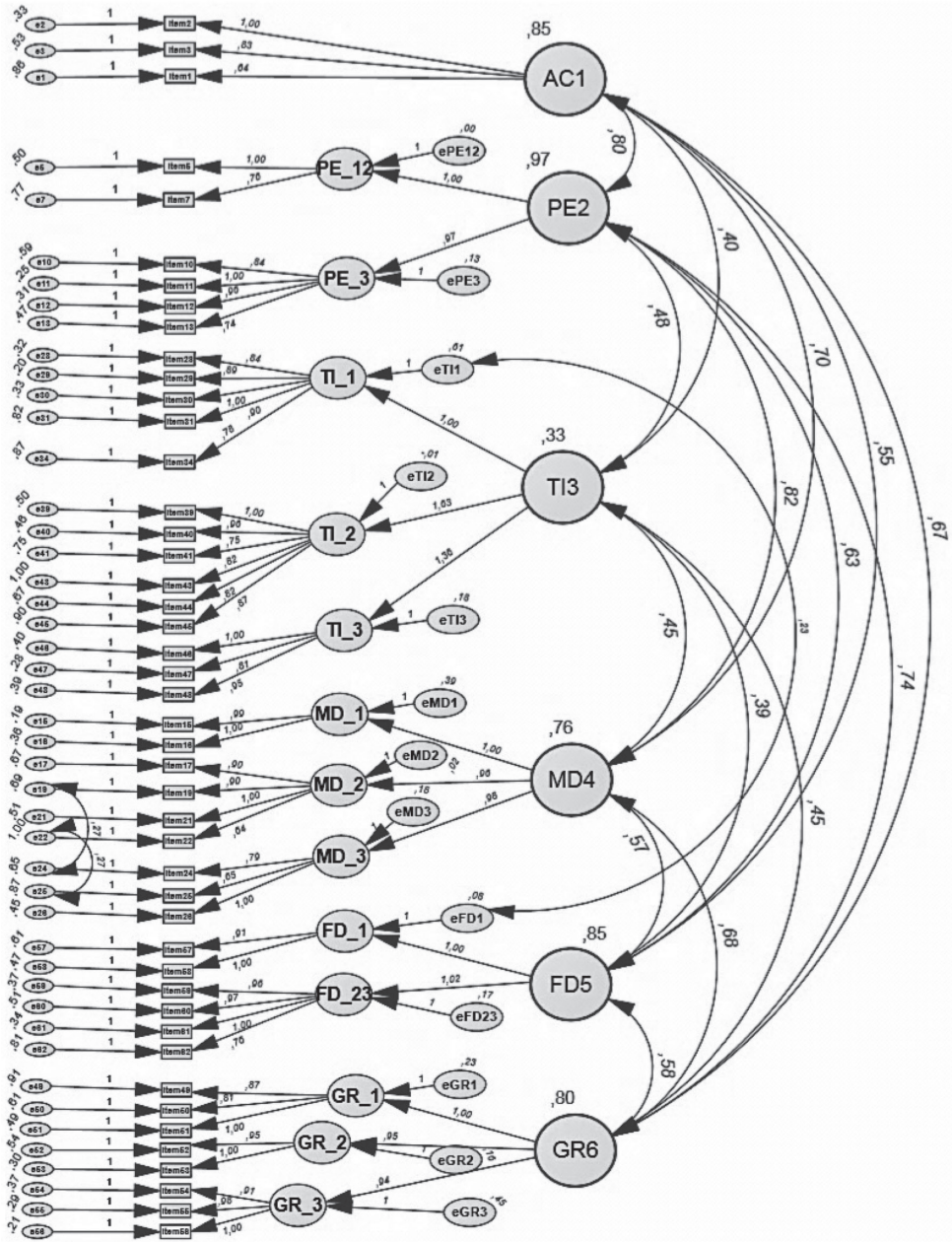
Modification indices			M.I.	Par Change
e1	<-->	Teacher Training	72.3	.154
eIT1	<-->	eTT23	97.42	.138
e17	<-->	e1	41.542	.137
e44	<-->	eIT3	94.905	.131
e51	<-->	e52	52.046	.13
e50	<-->	e1	34.021	.124
e31	<-->	e30	56.978	.122
e41	<-->	e31	30.294	.122
e47	<-->	e44	82.654	.12
e5	<-->	e49	32.08	.116
e22	<-->	e62	20.305	.107
e43	<-->	eIT1	24.621	.105
e26	<-->	e46	48.556	.104
e50	<-->	eIT1	35.029	.104
e45	<-->	e43	15.587	.104
e51	<-->	eRM2	47.858	.102
e49	<-->	ePE12	31.679	.102
e22	<-->	eRM3	25.455	.102
e57	<-->	e43	20.165	.102
e47	<-->	e45	42.666	.1
e26	<-->	e45	22.58	-.097
e43	<-->	e41	16.24	-.097
eIT3	<-->	Teacher Training	72.808	-.099
e3	<-->	eRM1	41.041	-.101
e44	<-->	eGR1	36.803	-.103
e45	<-->	e39	32.19	-.11
e54	<-->	eRM3	65.013	-.111
e49	<-->	e45	22.025	-.123

Source: Own elaboration.

When the new factors are included in the model, the modification indices showed the advisability of some covariances between error terms that would reduce the chi-squared statistic markedly, some of which are justifiable from a theoretical position. Specifically, cor-

relations were possible between error terms e19 and e24, as both refer to the preparation of digital educational resources, and between e22 and e26 as they refer to the development of work and collaboration projects with teachers and students.

GRAPH 2. Final model for measuring teachers' ICT training.



Source: Own elaboration.

Consequently, a FINAL Model was devised which has a very good level of fit (Graph 2) and includes all of the changes

made, with RMSEA values very close to 0.05 and no modification index involving a significant change in the fit indices (Table 6).

Accordingly, a recursive model is obtained, estimated using a sample of 1,433 subjects, with 124 variables of which 46 are observed variables (corresponding with the items) and 78 are latent variables (19 are factors, 46 are error terms, and 13 are disturbance terms). Of these 124 variables, 65 are exogenous (46 error terms and 19 factors), and 59 are endogenous (46 indicators and 13 factors). In addition, 121 are parameters to be estimated, and so the model comprises 960 degrees of freedom, giving an overidentified model that can be estimated.

The indices of fit are satisfactory with a CFI of .905 and an IFI of .905. As for the residuals, a RMSEA of 0.056 is obtained and the sample size is adequate, as Hoelter's index is 300 (above 200). The parsimony ratios are also high (PRATIO = 0.928, PNFI = 0.824, and PCFI = 0.841, above 0.7).

Finally, it is worth noting the theoretical model's good fit with the definition already made through the confirmatory factor analysis regarding structural equation models. As stated above, the dimensions and profiles previously established have a reasonably good fit with the model analysed. After rejecting the items that were problematic, the fit with the theoretical model was fairly good, taking into account that UNESCO establishes three profiles for each of the dimensions in this questionnaire.

4. Discussion and Conclusions

This work contains an in-depth analysis of the results from the validation of an instrument to evaluate the ICT train-

ing profile of primary and secondary teachers, the theoretical basis and operational definition of which based on the standards developed by UNESCO (2008; 2011). As a result of this, six dimensions are considered in it (curriculum aspects of ICT, ICT planning and evaluation, methodological aspects in ICT, using and handling technology, managing ICT resources, and professional development in ICT). Each of these has three defined levels of development.

Specific references were found that consider in greater depth the specification of dimensions, standards, and levels of development for evaluating the digital competency of teachers in Europe (INTEF, 2017), but the study performed here has made it possible to construct its own structure of subdimensions, standards, and items based on the categories established by UNESCO (2011) at an international level. Accordingly, the relevance of this research lies in the preparation of precise standards, indicators, and items (not the ones prepared by UNESCO) that have made it possible to construct one of the few statistically robust, reliable, and valid tools available for evaluating teachers' digital competency (Tourón, Martín, Navarro-Asencio, Pradas, and Íñigo, 2018).

The theoretical approach, based on UNESCO's global standards, is based on a rigorous literature review and has made it possible to obtain optimal results in regards to the technical characteristics of the questionnaire. Its overall reliability is excellent, as is the reliability of the separate dimensions. It also has high internal consistency. In addition, it is worth not-

ing that the instrument has good content validity, supported by the consistency and rigour of the theoretical foundations and the assessment of it by a panel of experts in educational research, university academics who are experts in initial teacher training, and specialists in educational technology who evaluated the relevance to the study of the items initially proposed in the questionnaire and their clarity.

Furthermore, its construct validity was supported by the confirmatory factor analysis study, with results that showed the consistency and robustness of the factors that comprise the initial structure of the items, dimensions, and relationships that make up the questionnaire supported by the theory presented. Nonetheless, the possible impact on the results obtained of the type of sampling and sample size (Hair et al., 2009) must be considered. This highlights the desirability of expanding the study to a larger sample to increase the study's power of generalization.

Confirmatory factor analysis using the structural equation method made it possible to modify the initial model to use a structure that better fitted the construct from which it derives, UNESCO's standards of ICT competencies. Nonetheless, the results for the Curricular Aspects in ITC dimension are less consolidated results, both in the analysis of its reliability and in the confirmatory factor analysis itself, suggesting that it is necessary to improve the existing items and be more specific in the dimension by increasing the number of items that comprise it, establishing a structure in three progressive levels, as defined in the UNESCO standards.

Another of the proposed modifications to the structure of dimensions and levels of the initial teacher training profile in ICT corresponds to profiles 1 and 2 of the «planning and evaluation of the area/subject» dimension and to profiles 2 and 3 of the «teacher professional development in ICT» dimension. The correlation between its terms has made it possible to regroup them as there are no significant discrepancies in the model and because of the impossibility of leaving a factor measured by just one variable. Similarly, it is important to consider the obvious relationship between profile 1 of the «Knowledge and Use of ICT» dimension (eIT1) and the «Teacher Professional Development in ICT» dimension (eTT1), noting that both fields have a narrow variability. This is explained because the indicators that define initial digital competency involve basic knowledge of using technological resources outside pedagogical use, something that has an obvious correlation with the type of continuous training in ICT at this same level. To solve this problem, a more precise definition of each of the items that comprise the levels of these dimensions will be suggested, reiterating the need to modify the model taking into account its own theoretical basis. Similarly, future comparative studies between different models for evaluating teachers' digital competencies such as those of IN-TEF (2017) and UNESCO (2011) can be proposed.

In summary, the proposed instrument for measuring the teacher training profile in ICT is a relevant addition, from a theoretical perspective, because of the need to evaluate the digital competency of the

teachers who must implement the skills of the 21st century, and for their importance and reputation as standards developed by UNESCO. Similarly, the technical characteristics relating to its reliability and validity are robust and excellent, showing the consistency of the instrument through its construct validity and the satisfactory dimensional structure proposed. Therefore, in conclusion, it can be said that this study has made a contribution to the academic field of study of the digital, technological, and pedagogical competencies profile of teachers in primary and secondary education by drawing up a measurement instrument that is different, valid, and reliable and meets the objective proposed at the start of the study. The suggested construct and its operationalisation in a diagnostic tool that contributes to detecting training requirements relating to the technological gap between teachers and students require further study.

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