Revista ELectrónica de Investigación y EValuación Educativa

RELIEVE

ISSN: 1134-4032

e-Journal of Educational Research, Assessment and Evaluation

# Validation of a tool to measure the digital competence of secondary school teachers in initial teacher training

***Validación de una herramienta para medir la Competencia Digital Docente del profesorado de educación Secundaria en formación inicial***

**Validação de uma ferramenta para medir a Competência Digital Docente dos professores do ensino secundário em formação inicial**

*对测验处在培养初期的未来中等教育阶段教师数字化能力的工具进行验证*

**التحقق من صحة أداة لقياس كفاءة التدريس الرقمي لمعلمي التعليم الثانوي في التدريب الأولي**

**Palau, Ramon**[1]; **Fretes, Gabriela**[1]; **Mogas, Jordi**[1,2]; **Usart, Mireia**[1]

[1] Rovira i Virgili University, Tarragona, Spain.

[2] Valencian International University - VIU, Valencia, Spain.

## Abstract

Education has become even more dependent on information and communication technologies (ICT) in today's post-pandemic era, and there is a growing awareness of the need to promote and assess teachers' digital competence. Different techniques and tools have been used to try to measure and assess digital competence, but there is still no specific tool that can measure it among secondary school teachers completing their initial training. The aim of this paper is to validate a tool that is able to objectively assess the digital competence and knowledge of future secondary school teachers. In this paper, therefore, we adapt and validate the existing tool known as COMDID-C, currently used for future primary school teachers. In the first phase, 21 experts in the field worked on adapting the tool to suit secondary education. In a second pilot phase, 667 trainee secondary school teachers completed the test. The reliability analysis yielded ordinal alpha results indicating that the factors are not wholly internally consistent. However, this may be attributed to the fact that the analysis was carried out on the basis of randomised pairs of questions, without the possibility of establishing any other system of equivalence. In any case, bearing in mind the internal consistency, it is clear that the tool's structure is comparable to that of its predecessor. This tool will make it possible to ascertain future teachers' digital competence and reflect on their level of training at the start and at the end. It will also mean we can use this data to design and adapt training plans that improve the acquisition of these digital skills.

**Keywords:** Digital competence, Questionnaire validation, Secondary education, Teaching, Secondary school teacher training.

## Resumen

En el contexto educativo actual, el uso de las Tecnologías de la Información y la Comunicación (TIC) después de la pandemia todavía ha tomado mayor importancia. Cada vez existe más conciencia de la necesidad de fomentar la adquisición de la Competencia Digital Docente (CDD) y así mismo de su evaluación. La CDD se ha intentado medir y evaluar con diferentes técnicas e instrumentos, pero todavía no existe una herramienta específica para medirla en docentes de educación secundaria en formación inicial. El objetivo de este trabajo es validar un instrumento para evaluar de forma objetiva los conocimientos de la CDD de los futuros docentes de educación secundaria. Así, en este trabajo se adapta y valida la existente herramienta COMDID-C, utilizada con futuros maestros y maestras. En una primera fase se realizó la adaptación del instrumento al contexto de educación secundaria, con la participación de 21 expertos en la materia. En una segunda fase piloto, 667 docentes de educación secundaria en formación respondieron la prueba. Aunque el análisis de fiabilidad arrojó resultados del alfa ordinal que indican que los factores no tienen buena consistencia interna, se puede explicar debido a que el análisis se realizó a partir de pares de preguntas aleatorizadas, no pudiéndose establecer ningún otro sistema de equivalencias para su análisis. En cualquier caso, y teniendo en cuenta la consistencia interna, se puede constatar que el instrumento mantiene una estructura equiparable al instrumento predecesor. Esta herramienta permitirá conocer la CDD de los futuros docentes, al mismo tiempo permitirá reflexionar sobre el nivel, tanto de partida o salida, de la formación de estos, y a partir de estos datos diseñar y adecuar los planes de formación para una mejor adquisición de esta competencia.

**Palabras clave:** Competencia digital docente, Validación de cuestionario, Enseñanza secundaria, Docencia, Formación de docentes de secundaria.

| **Received/*Recibido*** | Jul 8, 2022 | **Approved /*Aprobado*** | May 1, 2023 | **Published/*Publicado*** | Dec 11, 2023 |
|---|---|---|---|---|---|

***Corresponding author / Autor de contacto:*** Jordi Mogas. Universidad Rovira i Virgili. Carretera de Valls s/n, 43007, Tarragona (España); correo-e: jordi.mogas@urv.cat

**Resumo**

No atual contexto educativo, a utilização das tecnologias da informação e da comunicação (TIC) após a pandemia tornou-se ainda mais importante. Existe uma consciência crescente da necessidade de fomentar a aquisição da Competência Digital Docente (CDD) e também a sua avaliação. Foram feitas tentativas para medir e avaliar a CDD com diferentes técnicas e instrumentos, mas ainda não existe uma ferramenta específica para a medir em professores do ensino secundário em formação inicial. O objetivo deste trabalho é validar um instrumento para avaliar objetivamente os conhecimentos da CDD dos futuros professores do ensino secundário. Assim, neste trabalho, adapta-se e valida-se a ferramenta COMDID-C existente, utilizada com futuros professores. Numa primeira fase, o instrumento foi adaptado ao contexto do ensino secundário, com a participação de 21 peritos na matéria. Numa segunda fase piloto, 667 professores de ensino secundário em formação fizeram o teste. Embora a análise de fiabilidade tenha produzido resultados do alfa ordinal que indicam que os fatores não têm uma boa consistência interna, tal pode ser explicado pelo facto de a análise ter sido realizada com base em pares de perguntas aleatórias, não tendo sido possível estabelecer qualquer outro sistema de equivalência para a sua análise. Em todo o caso, e tendo em conta a consistência interna, pode-se constatar que o instrumento mantém uma estrutura comparável à do instrumento antecessor. Esta ferramenta permitirá conhecer a CDD dos futuros professores e, ao mesmo tempo, permitirá refletir sobre o nível, tanto de partida como de saída, da sua formação e, com base nestes dados, conceber e adequar os planos de formação para uma melhor aquisição desta competência.

**Palavras-chave:** Competência digital docente, Validação de questionário, Ensino secundário, Docência, Formação de professores do ensino secundário

**摘要**

在现在的教育环境下，即使是在疫情结束后，信息通讯技术的使用仍然承担着重要的作用。与此同时，教师数字化能力的获取及评估意识也在日益加强。现已有测量和评估教师数字化能力的工具众多，可针对处在培养初期的未来中等教育教师数字化能力的测量工具却一个也没有。所以该研究的主要目的是验证一项对未来中等教育教师的数字化能力进行客观评估的工具。研究对已存在的 COMDID-C 工具进行调整和验证，来对未来教师的数字化能力进行测量。在研究的第一阶段，根据中等教育背景，由 21 名专家参与对工具进行调整。在研究的第二拓展阶段，667 名仍处在学习阶段的未来中学教师参与了实验。研究信度分析中的定序变量结果显示因素间缺少内部一致性，导致该结果的原因很明确，就是分析样本由随机性问题组成，无法建立对等系统进行分析，但即便如此，通过内部一致性，也可以证实研究使用的调整工具与原工具保持结构一致性。这项工具不但让我们对未来教师数字化能力得到了解，还同时允许我们对这些未来教师在培养初期及培养结束时的水平进行反思。因此，研究可以在这些数据的基础上，调整设计出能够更好地提高教师数字化能力的培养计划。

**关键词**：教师的数字化能力、问卷验证、中等教育、教师、中等教育阶段的教师培养

**ملخص**

بعد الوباء أكثر أهمية .هناك وعي متزايد بالحاجة إلى (TIC) في السياق التعليمي الحالي ,أصبح استخدام تكنولوجيا المعلومات والاتصالات ,وتقييمها .وقد بذلت محاولات لقياس وتقييم التنمية المجتمعية باستخدام تقنيات وأدوات مختلفة (CDD) تعزيز اكتساب كفاءة التدريس الرقمي ولكن لا توجد حتى الآن أداة محددة لقياسها لدى معلمي التعليم الثانوي في التدريب الأولي .الهدف من هذا العمل هو التحقق من صحة أداة لتقييم الحالية ,المستخدمة ,مع COMDID-C لمعلمي التعليم الثانوي في المستقبل .وبالتالي ,في هذا العمل ,تم تكييف أداة CDD موضوعي معرفة معلمي المستقبل ,والتحقق من صحتها .وفي المرحلة الأولى ,تم تكييف الأداة مع سياق التعليم الثانوي ,بمشاركة 21 خبيرا في هذا المجال .وفي المرحلة التجريبية الثانية ,أجاب على الاختبار 667 معلماً في التعليم الثانوي قيد التدريب .على الرغم من أن تحليل الموثوقية أظهر نتائج ألفا الترتيبية التي تشير إلى أن العوامل ليس لديها اتساق داخلي جيد ,إلا أنه يمكن تفسير ذلك لأن التحليل تم إجراؤه باستخدام أزواج من الأسئلة العشوائية ,ولم يكن من الممكن إنشاء نظام آخر للتكافؤلتحليلك.على أية حال ,ومع الأخذ في الاعتبار الاتساق الداخلي ,يمكن ملاحظة أن الأداة تحافظ على هيكل مماثل للأداة السابقة .ستسمح لنا هذه الأداة بمعرفة مهارات التطوير المهني لمعلمي المستقبل ,وفي الوقت نفسه ستسمح لنا بالتفكير في مستوى تدريبهم ,سواء في البداية أو الخروج ,وبناء على هذه البيانات، تصميم وتكييف خطط التدريب من أجل تحسين اكتساب هذه الكفاءة

**الكلمات الدالة:** الكلمات الدالة :تدريس الكفاءة الرقمية ,التحقق من صحة الاستبيان ,التعليم الثانوي ,التدريس ,تدريب المعلمين الثانوي

# Introduction

Today's educational context increasingly demands greater digital competence from all teachers (Palau y Mogas, 2022a; 2022b). As such, it is necessary to create tools capable of measuring the digital competence of different teaching profiles, which will help to address the training provided to the educational community (Palau et al., 2019; Palau et al., 2021).

The unexpected and immediate pandemic (Sangrà, 2020) marked a point of no return, and represents an opportunity to boost the digitisation of education systems (European Commission, 2021). The OECD (2021) describes digital technologies as capable of providing new responses to new needs for more personalised and autonomous learning, and the European Commission (2021) is launching a new strategy on digital education. The OECD (2022) invites us to reconsider what education will look like in 15-20 years, and to harness the innovations that emerged during the pandemic to empower teachers to be more autonomous, participate actively in designing learning environments, and to be skilled and proactive in the use of technology, among other things (Schleicher, 2022).

Digital competence is fundamental for meeting the challenges posed by digitisation, and education is the key to fostering its development (Ilomäki et al., 2016). Digital competence has become a major focus of education policy given today's technology-driven society and workplaces (Lucas et al., 2021). It is essential to prepare future teachers for today's increasingly digitalised schools by helping them become digitally competent (Starkey, 2020).

It is therefore clear that in this post-pandemic era, the education sector is still learning about the need for educators' training in digital skills (Palau et al., 2021), in line with the inclusion of digital literacy in the Sustainable Development Goals (UN, 2015). Teachers must be able to use digital technologies as part of a well-developed teaching theory in order to enhance students' learning and help them develop their own digital skills (Redecker & Punie, 2017). It should not be forgotten that a basic knowledge of information and communication technologies (ICT) does not translate into competent teaching. This underlines the importance of introducing pedagogical and contextual criteria (Krumsvik, 2008; 2014). Learning designs need to be continually reviewed as the technologies used in schools change continuously and rapidly (Starkey, 2020).

Secondary school teachers need to have sufficient technical expertise and skills to work and teach using ICT, as well as to help students develop applicable technological skills (Pérez-Navío et al., 2021). Castañeda et al. (2018) underline the need to understand that digital competence should be a priority from the initial stages of teacher training.

In the last 15 years, the concept of the digital competence of teachers has been worked on in a variety of frameworks. These frameworks include Enlaces (2008; 2011) by the Chilean Ministry of Education, NETS-T by the International Society for Technology in Education (ISTE, 2008), UNESCO's ICT Competency Standards (2008; 2019), DigiLit by Fraser et al. (2013), the different frameworks developed by the Spanish Institute for Educational Technology and Teacher Training (INTEF, 2014; 2017; 2022), the ARGET reference framework published by Lázaro and Gisbert (2015), the framework developed by the Government of Catalonia (2016) or DigComp by Redecker and Punie (2017) developed for the European Commission. The latter could be considered the most popular project focused on developing and improving the understanding of digital competence (Ferrari, 2013). The European Commission (2018a) established a consensus among European countries on digital skills, based on the idea that a shared framework sends a clear message about how important they are.

As teachers' digital competence has evolved and increased, so has the need for individual digital competence to be evaluated

and taken it into account when planning, teaching and evaluating training activities (Tejada & Ruiz, 2016). At the same time, teacher's digital competence must be learning-oriented and feedback must play a key role (Cosi et al., 2020). It should also be noted that, according to Revuelta-Domínguez et al. (2022), this high level of interest is most evident among members of the Spanish scientific community, who have published extensively on the assessment of digital competence among teachers in work and in training.

In this regard, including self-assessment processes as part of formative assessments during the initial stages of teacher training is key to helping future teachers become aware of their own competence level (Cosi et al., 2020). Regarding initial teacher training, Lázaro and Gisbert (2015) and the Government of Catalonia (2018) highlight that the first level of digital competence is that which trainee and novice teachers should have acquired by the end of their initial teacher training.

Current mechanisms for measuring teachers' digital competence are based on dimensions, descriptors and indicators taken from the above-mentioned frameworks. In recent years, several studies and tests have been developed to assess and analyse teachers' and trainee teachers' level of digital competence (Cai et al., 2017). These tests include the Wayfind Teacher Assessment (Banister y Reinhart, 2012), a self-evaluation on teachers' use of technology. The test created by Viberg (2018), based on the Theory of Acceptance and Use of Technology (TAM). SELFIE, one of the best-known tests based on self-perception that applies the European Commission's DigCompEdu framework (Redecker & Punie, 2017; European Commission, 2018b) as a reference standard. Tourón et al. (2018) also developed a questionnaire based on the self-perception model, much like COMDID-A (Lázaro & Gisbert, 2015) or ACDC (Andía-Celaya et al., 2020).

As far as the assessment of secondary school teachers' digital competence is concerned, fewer studies have been conducted here than on the digital competence of primary school teachers. Among the studies carried out on secondary school teachers, we would like to highlight Prieto-Ballester et al. (2021), Jiménez-Hernández et al. (2020), and Portillo et al. (2020), who included teachers from various stages of education, and whose tests are all based on self-perception. Although tools such as those mentioned above do exist, we also need a valid instrument that can assess the development of teachers' digital competence, which is based on more than just self-perception (Palau et al., 2019).

The present article presents the work carried out to validate an instrument that can objectively assess future secondary school teachers' digital competence by adapting the COMDID-C tool currently used for primary school teachers. The reason we propose this update is that COMDID-C questions are currently designed specifically for primary school teachers. As such, it is necessary to propose a more objective tool with questions that can be answered by trainee secondary school teachers. Guided by this evident requirement and objective, we hereby present the method we have followed, the results obtained, and finally a discussion about the results in order to draw conclusions.

## Method

Using the structure of the tool COMDID-C for measuring future teachers' digital competence (Lázaro et al., 2019) as a basis, and supported by the literature review, this study followed a two-phase procedure: first adapting the COMDID-C and subsequently validating it for assessing future secondary school teachers' level of digital competence. First of all, it was adapted following the criteria of a group of experts using a qualitative methodology. Second, the tool was trialled online in a pilot phase with students from the Master's Degree in Teacher Training for Compulsory Secondary and Upper Secondary Education, Vocational Training and Language

Teaching (MUFP) of the eleven Catalan public universities that offer these programmes. A construct validity and reliability assessment was then carried out based on the data obtained.

The research process respected all ethical standards. Participants were informed of the research project and were asked to expressly agree to answer the questionnaire by signing informed consent form, thereby respecting their free will. The MUPF coordinators from each participating university gave their authorisation for the study to be carried out. Participants' data were anonymised and stored in a database within the Univesitat Rovira i Virgili's computer system, to which access was limited to certain members of the research team.

### *Sample*

The study is part of the Master's Degree in Teacher Training (MUFP), so all participants were either teachers and researchers or students from one of the eleven participating universities. We therefore used non-probability sampling for convenience. The participating universities are: Universitat Rovira i Virgili (URV), the University of Barcelona (UB), Universitat Autònoma de Barcelona (UAB), Universitat Oberta de Catalunya (UOC), Universitat Politècnica de Catalunya (UPC), Universitat Politècnica de Catalunya (UPC), Pompeu Fabra University (UPF), the University of Lleida (UdL), Ramon Llull Univeristy (URL), the University of Girona (UdG), and the Interuniversitari de Matemàtiques (UPC-UOC).

The study consisted of two phases, in which the following participants took part:

Phase 1: In order to study the validity of the new tool's content, 21 professionals (women, n=10 and men, n=11) collaborated in its adaptation. The initial adaptation and validation were carried out by 14 researchers and teachers, specifically, the master's degree coordinators from each institution, working at the university. All of them proved to have advanced knowledge in initial teacher training and digital teacher competence training. Of these 14, six were involved in adapting the previous tool to suit a secondary school context (n=6), while the remaining eight reviewed the changes and the new proposal in depth in order to detect areas for improvement. Then, seven secondary school directors and experts in initial teacher training and digital competence training also reviewed the proposed tool to ensure the questions and responses were appropriate (i.e., the adaptation was validated by n=15 experts). Interactions between each group were carried out anonymously via Microsoft Forms. Those involved in adapting the tool received the reports and completed the phase by implementing the changes suggested in the adaptation.

Phase 2: In order to study the construct validity and measure the reliability of this version, the questionnaire was answered by MUFP students. The sample consisted of 667 students. However, 197 of these students failed to complete the entire questionnaire and were considered ineligible. Thus, the effective sample was n=470. The mean age was 31.16 years, the median was 28 and the mode was 24, with participants ranging from 22 to 59 years old. Participants aged over 54 were considered as outliers. In terms of gender, 263 were female (56%), 197 male (42%) and 10 other (2%).

### *The tool's design*

As with the other versions of the COMDID questionnaire, this one is divided into the four dimensions of teachers' digital competence: D1 "Didactic, curricular and methodological aspects"; D2 "Planning, organisation and management of digital technological resources and spaces", D3 "Ethical, legal and security aspects", and D4 "Personal and professional development". The criteria for adapting it to suit secondary school teachers were: 1) Adapt questions and answers to secondary school settings by adapting the situations or adjusting them to suit secondary schools. One of the main instructions was to follow the same linguistic style without making any major changes to avoid creating a completely different questionnaire; 2) The new questionnaire is a tool for evaluating initial training, and not for working teachers; 3) In previous versions of COMDID-C, the same question could have several graded correct answers (for example, one answer marked as 100% correct, another marked as 75% correct, another as 50% correct, and the final answer as

0%). When adapting the tool and following advice from previous experiences, we decided that this questionnaire should always have one correct answer and three incorrect options.

One example that demonstrates the need to reconsider how these questions are posed would be:

*You are in a classroom with primary school students aged 10-12 years old. You want to encourage them to participate in your presentation of theoretical content. The activity should be used as an initial assessment to find out what prior knowledge they have on a given topic. Which of these digital resources do you think would be most suitable?* [Followed by four possible answers].

In this particular case, the proposed response options could be maintained, but the focus was shifted from "with primary school students aged 10-12 years old" to "students in secondary education". The questions are posed as a situation to be addressed by the teachers, thus avoiding an evaluation of their own performance as far as possible. By way of example, one question asked in D1 is: "When proposing an activity to be carried out collaboratively and online, which digital resource would you consider most appropriate?" The possible answers are, a. Educational videos (Youtube, Khan Academy, etc.); b. 2.0 applications (blogs, Wikipedia, Google Docs, etc.); c. Desktop applications (Word, PowerPoint, Photoshop, etc.), or d. None of the above.

The original COMDID-C questionnaire asked 88 questions in order to assess teachers' digital competence. In previous versions of this tool, researchers suggested that it was difficult to answer due to its length. What's more, the validity study conducted by Lázaro et al. (2019) claims that splitting the tool into two 44-question questionnaires is just as valid. As such, the questionnaire for future secondary school teachers was designed in the same way (i.e., with 88 questions), but each student was presented with just one question for each pair of questions corresponding to the same descriptor (with the help of the technological tool, Alchemer, which was used to implement the test). This means that each student received only one randomly selected question from pair 1-2, one question from pair 3-4, and so on.

In addition to the main guidelines, the validators only suggested changes related to grammatical mistakes, confusing wording of some questions or outdated examples in the proposed answers (for example, naming a digital tool that is no longer available).

The experts who validated the tool were asked to rate each question based on how easy it is to understand, its relevance and importance on a Likert scale of 1 to 4. Most questions were rated highly in all three aspects, and in no case low enough to omit or completely rephrase any of the questions. The experts reported that some questions were too obvious and easy, but they were kept in the final version in order to be consistent with the previous questionnaires and pending statistical analysis with specific results for the validation of this adaptation.

### *Data analysis*

The data was analysed using SPSS Statistics 27.0, JASP 0.16.3 and Excel, depending on the tests. A confirmatory factor analysis (CFA) was carried out, and the questionnaire was also tested for reliability, quality and difficulty. Four factors were defined for the CFA based on the four dimensions already formulated in the COMDID-A. The factors were not rotated.

## Results

Before proceeding to the factor analysis, we assessed whether the data were appropriate. We applied the KMO (Kaiser-Meyer-Olkin) measure of sampling adequacy, which gave us a result of KMO=0.910, and Bartlett's Test of Sphericity ($\chi 2$=4118.598, gl=946, p=.000). The results indicated that factorisation could proceed, given the KMO of more than 0.80 (Kaiser, 1970), as well as the high values obtained from Bartlett's test. As such, we carried out a confirmatory factor analysis (CFA) in order to corroborate the four dimensions of the previous version of the COMDID-C questionnaire for teachers. The factor loading matrix obtained is presented below (Table 1).

Table 1. Factor loading matrix

| | | | | | | | 95% Int. consistency | |
|---|---|---|---|---|---|---|---|---|
| **Factor** | **Indicator** | **Symbol** | **Estimated** | **Std. Error** | **Value-z** | **p** | **Highest** | **Lowest** |
| Factor 1 (D1) | 1-2 | λ11 | 0.173 | 0.018 | 9.586 | < .001 | 0.137 | 0.208 |
| | 3-4 | λ12 | 0.299 | 0.020 | 15.260 | < .001 | 0.261 | 0.338 |
| | 5-6 | λ13 | 0.295 | 0.021 | 14.245 | < .001 | 0.255 | 0.336 |
| | 7-8 | λ14 | 0.268 | 0.022 | 12.434 | < .001 | 0.226 | 0.310 |
| | 9-10 | λ15 | 0.194 | 0.023 | 8.327 | < .001 | 0.149 | 0.240 |
| | 11-12 | λ16 | 0.197 | 0.023 | 8.496 | < .001 | 0.151 | 0.242 |
| | 12-13 | λ17 | 0.311 | 0.020 | 15.875 | < .001 | 0.272 | 0.349 |
| | 15-16 | λ18 | 0.139 | 0.023 | 6.059 | < .001 | 0.094 | 0.185 |
| | 17-18 | λ19 | 0.170 | 0.022 | 7.581 | < .001 | 0.126 | 0.214 |
| | 19-20 | λ110 | -0.032 | 0.024 | -1.312 | 0.189 | -0.080 | 0.016 |
| | 21-22 | λ111 | 0.295 | 0.021 | 14.148 | < .001 | 0.254 | 0.336 |
| | 23-24 | λ112 | 0.125 | 0.020 | 6.140 | < .001 | 0.085 | 0.164 |
| Factor 2 (D2) | 25-26 | λ21 | 0.318 | 0.019 | 16.892 | < .001 | 0.281 | 0.355 |
| | 27-28 | λ22 | 0.306 | 0.021 | 14.733 | < .001 | 0.266 | 0.347 |
| | 29-30 | λ23 | 0.015 | 0.019 | 0.803 | 0.422 | -0.022 | 0.052 |
| | 31-32 | λ24 | 0.228 | 0.014 | 16.039 | < .001 | 0.200 | 0.256 |
| | 33-34 | λ25 | -0.004 | 0.021 | -0.181 | 0.857 | -0.045 | 0.037 |
| | 35-36 | λ26 | 0.157 | 0.020 | 7.977 | < .001 | 0.118 | 0.195 |
| | 37-38 | λ27 | 0.288 | 0.015 | 19.611 | < .001 | 0.259 | 0.317 |
| | 39-40 | λ28 | 0.190 | 0.016 | 11.848 | < .001 | 0.159 | 0.222 |
| | 41-42 | λ29 | 0.016 | 0.021 | 0.797 | 0.426 | -0.024 | 0.057 |
| | 43-44 | λ210 | 0.191 | 0.022 | 8.812 | < .001 | 0.148 | 0.233 |
| Factor 3 (D3) | 45-46 | λ31 | 0.048 | 0.023 | 2.087 | 0.037 | 0.003 | 0.094 |
| | 47-48 | λ32 | 0.065 | 0.021 | 3.123 | 0.002 | 0.024 | 0.106 |
| | 49-50 | λ33 | 0.315 | 0.023 | 13.762 | < .001 | 0.270 | 0.359 |
| | 51-52 | λ34 | 0.102 | 0.025 | 4.126 | < .001 | 0.054 | 0.151 |
| | 53-54 | λ35 | 0.118 | 0.023 | 5.062 | < .001 | 0.072 | 0.164 |
| | 55-56 | λ36 | 0.071 | 0.025 | 2.917 | 0.004 | 0.023 | 0.120 |
| | 57-58 | λ37 | 0.027 | 0.023 | 1.179 | 0.239 | -0.018 | 0.073 |
| | 59-60 | λ38 | -0.072 | 0.025 | -2.950 | 0.003 | -0120 | -0.024 |
| | 61-62 | λ39 | 0.116 | 0.023 | 5.117 | < .001 | 0.072 | 0.160 |
| | 63-64 | λ310 | 0.055 | 0.019 | 2.883 | 0.004 | 0.018 | 0.093 |
| Factor 4 (D4) | 65-66 | λ41 | 0.120 | 0.022 | 5.455 | < .001 | 0.077 | 0.163 |
| | 67-68 | λ42 | 0.135 | 0.021 | 6.291 | < .001 | 0.093 | 0.177 |
| | 69-70 | λ43 | -0.027 | 0.025 | -1.089 | 0.276 | -0.076 | 0.022 |
| | 71-72 | λ44 | 0.302 | 0.020 | 14.829 | < .001 | 0.262 | 0.342 |
| | 73-74 | λ45 | 0.109 | 0.020 | 5.547 | < .001 | 0.070 | 0.147 |
| | 75-76 | λ46 | 0.154 | 0.019 | 8.136 | < .001 | 0.117 | 0.191 |
| | 77-78 | λ47 | 0.069 | 0.017 | 3.949 | < .001 | 0.035 | 0.103 |
| | 79-80 | λ48 | 0.265 | 0.020 | 12.963 | < .001 | 0.225 | 0.305 |
| | 81-82 | λ49 | -0.137 | 0.024 | -5.579 | < .001 | -0.185 | -0.089 |
| | 83-84 | λ410 | 0.263 | 0.021 | 12.672 | < .001 | 0.222 | 0.304 |
| | 85-86 | λ411 | 0.022 | 0.025 | 0.895 | 0.371 | -0.027 | 0.071 |
| | 87-88 | λ412 | 0.264 | 0.023 | 11.398 | < .001 | 0.219 | 0310 |

Regarding the model's fit, the $\chi 2$/d.f. value was 4269.111/946 ($p<.001$), with a significant discrepancy between the expected and observed variables. This value is considered acceptable (Hooper et al., 2008).

Table 2. Chi-squared test

| Model | $X^2$ | df | P |
|---|---|---|---|
| Baseline model | 4269.111 | 946 | |
| Factor model | 1050.024 | 896 | < .001 |

With regard to other goodness-of-fit model parameters relevant to this study, results were good. The goodness of fit index (GFI) was 0.908, while the acceptable minimum is generally considered to be 0.90 (Hooper et al., 2008); the Root Mean Square Error of Approximation (RMSEA) and the Standardised Root Mean Residual (SRMR) are considered acceptable with values less than 0.6 and less than 0.08, respectively (Fan & Sivo, 2007; McDonald & Ho, 2002). The results from our model are RMSEA=0.019 (CI=0.014 and 0.024) and SRMR=0.04, indicating a good fit.

In order to determine the internal consistency of each of the four dimensions, we applied the ordinal alpha coefficient as the most appropriate alternative if the requirements for applying Cronbach's alpha were not met, due to the fact that in this case the study variables are ordinal and not continuous (Elosua & Zumbo, 2008), and there should be at least five response categories (Domínguez-Lara, 2018). In order to calculate the ordinal alpha, we used the Excel module designed by Domínguez-Lara (2018). In dimension D1 "Didactic, curricular and methodological", the result was α=0.359, in dimension D2 "Planning, organisation and management of digital technological resources and spaces " was α=0.243, in dimension D3 "Ethical, legal and security aspects" was α=0.065, and in dimension D4 "Personal and professional development", α=0.183. The ordinal coefficient alpha is interpreted in the same way as the alpha, so these results would point to low internal consistency, which means the items should be revised, as discussed below.

The quality of the items was calculated for each dimension using the biserial correlation coefficient, which determines the degree to which the competencies measured by the tool are also measured by the item (Backhoff et al., 2000). Ebel and Frisbie (1986), cited in Backhoff et al. (2000), show the values for determining the quality of the questions, based on the discrimination index: > 0.39 excellent; 0.30 - 0.39 good; 0.20 - 0.29 fair; 0.00 - 0.20 poor, and, < -0.01 very poor.

According to these criteria, question pair 19-20 in D1 would not meet an adequate quality standard (table 3).

Table 3. Biserial correlation item - Dimension 1

| Questions | Biserial correlation | SD |
|---|---|---|
| 1-2 | 0.394 | 0.392 |
| 3-4 | 0.521 | 0.457 |
| 5-6 | 0.514 | 0.477 |
| 7-8 | 0.463 | 0.485 |
| 9-10 | 0.308 | 0.501 |
| 11-12 | 0.365 | 0.497 |
| 12-13 | 0.561 | 0.461 |
| 15-16 | 0.259 | 0.484 |
| 17-18 | 0.295 | 0.479 |
| 19-20 | -0.041 | 0.501 |
| 21-22 | 0.536 | 0.480 |
| 23-24 | 0.241 | 0.427 |

We note that the question pairs 29-30, 33-34 and 41-42 in D2 would not be appropriate.

Table 4. Biserial correlation item - Dimension 2

| Items | Biserial correlation | SD |
|---|---|---|
| 25-26 | 0.551 | 0.452 |
| 27-28 | 0.487 | 0.483 |
| 29-30 | 0.068 | 0.391 |
| 31-32 | 0.531 | 0.339 |
| 33-34 | 0.010 | 0.432 |
| 35-36 | 0.303 | 0.421 |
| 37-38 | 0.592 | 0.369 |
| 39-40 | 0.414 | 0.361 |
| 41-42 | 0.081 | 0.424 |
| 43-44 | 0.344 | 0.468 |

In D3, all items except pair 49-50 show deficits in quality.

Table 5. Biserial correlation item - Dimension 3

| Items | Biserial correlation | SD |
|---|---|---|
| 45-46 | 0147 | 0.466 |
| 47-48 | 0.088 | 0.420 |
| 49-50 | 0.268 | 0.440 |
| 51-52 | 0.125 | 0.500 |
| 53-54 | 0.090 | 0.472 |
| 55-56 | 0.091 | 0.494 |
| 57-58 | -0.041 | 0.467 |
| 59-60 | -0.077 | 0.495 |
| 61-62 | 0.096 | 0.460 |
| 63-64 | 0.138 | 0.387 |

Finally, D4 shows pairs of lower-quality items such as 69-70, 77-78, 81-82 and 85-86.

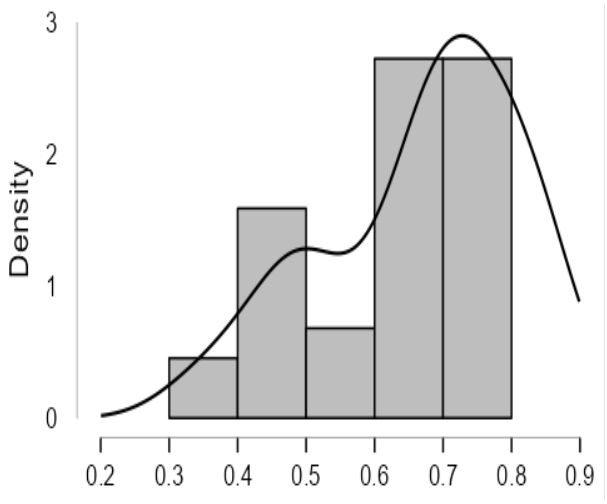
Table 6. Biserial correlation item - Dimension 4

| Items | Biserial correlation | SD |
|---|---|---|
| 65-66 | 0.246 | 0.447 |
| 67-68 | 0.254 | 0.441 |
| 69-70 | 0.002 | 0.499 |
| 71-72 | 0.411 | 0.461 |
| 73-74 | 0.211 | 0.399 |
| 75-76 | 0.260 | 0.396 |
| 77-78 | 0.169 | 0.352 |
| 79-80 | 0.394 | 0.450 |
| 81-82 | -0.129 | 0.500 |
| 83-84 | 0.362 | 0.456 |
| 85-86 | 0.038 | 0.500 |
| 87-88 | 0.404 | 0.501 |

With regard to item difficulty, understood as the proportion of people who answer a test question correctly, we calculate the difficulty index (DI= correct responses / correct responses + errors) based on the percentage of correct and wrong answers in the sample. The mean test difficulty is p=0.668 (SD=0.143), with a minimum of 0.19 and a maximum of 0.92. The mode and median coincide at 0.7. By dimensions, we find DI (D1) = 0.604, DI (D2) = 0.767, ID(D3) = 0.621, DI (D4) = 0.629.

As shown in the graph, the difficulty variable P is not distributed normally, it is negatively skewed and a large number of questions are clustered around 0.7. This means that there are more easy questions than difficult ones.

Figure 1. Distribution of item difficulty




According to Backoff et al. (2000), different difficulty levels can be established: >0.86 = Very easy, 0.74 to 0.86 = Moderately easy, 0.53 to 0.73 = Medium difficulty, 0.33 to 0.52 = Moderately difficult, <0.33 = Very difficult. As shown in table 7, the majority are either of medium difficulty (18 items, 41.04%) or moderately easy (15 items, 34.2%), followed by moderately difficult (10 items, 22.8%). In terms of the two extremes of the scale, there is just one very difficult item (2.28%), and no very easy items.

Finally, in order to assess the digital competence of the sample, we needed to establish a cut-off point, which we set at 70%. As in the questionnaire that served as a model for this adaptation (Lázaro et al., 2019), we applied the Angoff method (Mahias Finger & Polloni Erazo, 2019), which involves experts in the assessed subject matter estimating the proportion of participants who would answer each of the test items correctly or at least to an acceptable level.

Table 7. Item difficulty index

| Criteria | Interpretation | Questions | P |
|---|---|---|---|
| < 0.32 | Very difficult | 31-32 | 0.87 |
| 0.33 to 0.52 | Moderately difficult | 53-54 | 0.33 |
| | | 15-16 | 0.37 |
| | | 59-60 | 0.42 |
| | | 11-12 | 0.44 |
| | | 69-70 | 0.45 |
| | | 51-52 | 0.49 |
| | | 87-88 | 0.49 |
| | | 9-10 | 0.5 |
| | | 19-20 | 0.5 |
| | | 85-86 | 0.52 |
| 0.53 to 0.73 | Medium difficulty | 81-82 | 0.53 |
| | | 55-56 | 0.58 |
| | | 7-8 | 0.62 |
| | | 27-28 | 0.63 |
| | | 17-18 | 0.64 |
| | | 21-22 | 0.64 |
| | | 5-6 | 0.65 |
| | | 45-46 | 0.68 |
| | | 57-58 | 0.68 |
| | | 13-14 | 0.69 |
| | | 71-72 | 0.69 |
| | | 3-4 | 0.7 |
| | | 61-62 | 0.7 |
| | | 83-84 | 0.7 |
| | | 25-26 | 0.71 |
| | | 65-66 | 0.72 |
| | | 79-80 | 0.72 |
| | | 67-68 | 0.73 |
| 0.74 to 0.86 | Moderately easy | 49-50 | 0.74 |
| | | 33-34 | 0.75 |
| | | 23-24 | 0.76 |
| | | 41-42 | 0.76 |
| | | 35-36 | 0.77 |
| | | 47-48 | 0.77 |
| | | 73-74 | 0.8 |
| | | 75-76 | 0.8 |
| | | 1-2 | 0.81 |
| | | 29-30 | 0.81 |
| | | 63-64 | 0.82 |
| | | 37-38 | 0.84 |
| | | 39-40 | 0.85 |
| | | 77-78 | 0.85 |
| | | 43-44 | 0.86 |

## Discussions and conclusions

The aim of this research was to validate a tool to objectively assess the digital competence and knowledge of future secondary school teachers by adapting the primary school teachers' version of the COMDID-C tool. We can confirm that the initial assessment tool for teachers' digital competence has now been created. In total, 11 universities, 21 experts and 667 future secondary school teachers participated. This tool means that the digital competence of future teachers can be assessed using cases and not self-perception, as previous studies on digital competence had suggested was a necessity (Palau et al., 2019), or as Revuelta-Domínguez et al. (2022) demonstrated.

As previous studies point out (Pallisera et al., 2010; Lázaro et al., 2019), competence assessment is complex and it is recommended to use different techniques and methods. Therefore, this tool can be a part of these techniques and methods, and makes it possible to check data.

Although in principle 667 is a sufficient sample number considering that the questionnaire offers 44 questions in four dimensions (i.e., there are more than 10 observations per item), the tool randomly shows only one question from each item pair, which means that each question has only been answered by half the sample. This means that the analysis of the responses could not be completed using the same techniques that were used for the primary school teachers' version of COMDID-C. The main limitation of this decision seems to lie in the distorted reliability analyses, although the randomisation is generally assessed positively.

The fact that the tool's internal consistency was calculated using Alchemer's randomisation, in which each participant answered one of every two questions, may have interfered in the analysis. In the reliability analysis, according to the results of the ordinal alpha index, the factors do not have good internal consistency (values below 0.4), which means that this aspect should be reviewed and improved. Based on the analysis and the sound process of developing and validating the tool described above, the most plausible explanations for this are, first, that the analysis

has been carried out using randomised pairs of questions. Given that they are always random, no other system of equivalence can be established for their analysis and the benefits of a decision such as this one may have limited the final analysis. Second, each of the four dimensions includes sub-dimensions and many items, which could affect internal consistency.

Nonetheless, the quality is acceptable for the vast majority of items, and those that have not achieved an adequate score can either be revised in depth or discarded. On a related note, Dimension 3, "Ethical, legal and security aspects", obtained a lower consistency and quality score, which suggests that there is a component of subjectivity which, again, may be distorted by randomisation and the pairing of equivalent items more so than in other dimensions, which may measure more objective aspects such as knowledge or ability.

In any case, taking the internal consistency identified during the confirmatory factor analysis into account, we can see that the tool maintains a similar structure to its predecessor, the COMDID-C version for primary school teachers (Lázaro et al., 2019).

The difficulty of the items is deemed to be adequate. A high proportion are rated as medium difficulty and there is a tendency for them to be slightly easier. A small number are very easy or difficult, so it would be advisable to adjust the wording and/or the incorrect answer options.

As far as the limitations are concerned, the first is that the sample was selected for reasons of convenience, which leads to low representation. Secondly, the decision to use Alchemer's randomisation may give results that are different from those of other techniques. For future research, we suggest choosing a different randomisation method, and using a larger and more varied sample of participants. By validating this tool, the hope is to evaluate the digital competence of different profiles of teachers from different contexts.

Finally, the study's findings can be relevant at different levels and in different decision-making settings. As regards future secondary school teachers, it allows them to see their level of digital competence, establish a plan for improvement and become more digitally competent following a process of reflection. With regards to managing and coordinating master's degrees in teacher training in secondary education, this tool would allow students to see their initial and final level, depending on whether it is administered as a pre-test or post-test and, based on these data, allow programme directors and coordinators to design and adapt training programmes to help Master's students acquire this competence. Regarding the education authorities, they could, for example, use the tool to assess the future training needs of novice teachers and collaborate with the universities that teach them in order to establish coordination and collaboration mechanisms that help students adapt to the demands of the education market.

## Acknowledgements

This article is a result from the project "CERTICDOCENT: Certificació de la Competència Digital Docent del professorat d'educació secundària en formació inicial", Ajuts de recerca per a la millora de la formació inicial de mestres i professorat de secundària, AGAUR. Coord.: Ramon Palau, Universitat Rovira i Virgili. Ref.: 2020 ARMIF 00006.

## References

Andía-Celaya, L.A., Santiago-Campión, R., & Sota-Eguizábal, J. M. (2020). ¿Estamos técnicamente preparados para el flipped classroom? un análisis de las competencias digitales de los profesores en España. *Contextos Educativos*, *25*, 275-311. http://doi.org/10.18172/con.4218

Backhoff, E., Larrazolo, N., & Rosas, M. (2000). Nivel de dificultad y poder de discriminación del Examen de Habilidades y Conocimientos Básicos (EXHCOBA). *REDIE. Revista Electrónica de Investigación Educativa*, *2*(1). https://www.redalyc.org/articulo.oa?id=15502102

Banister, S., & Reinhart, R. (2012). Assessing NETS-T performance in teacher candidates: Exploring the Wayfind teacher assessment. *Journal of Digital Learning in Teacher Education, 29*(2), 59-65. https://doi.org/10.1080/21532974.2012.10784705

Cai, Z., Fan, X., & Du, J. (2017). Gender and attitudes toward technology use: A meta-analysis. C*omputers & Education, 105*, 1-13. https://doi.org/10.1016/j.compedu.2016.11.003

Castañeda, L., Esteve, F., & Adell, J. (2018). ¿Por qué es necesario repensar la competencia docente para el mundo digital? *Revista de Educación a Distancia*, *56*, 1–20. https://doi.org/10.6018/red/56/6

Comisión Europea. (2018a). *DigCompOrg: Digitally Competent Educational Organisations.* https://bit.ly/2AM8gQH

Comisión Europea. (2018b). *SELFIE (Self-Reflection on Effective Learning by Fostering the Use of Innovative Educational Technologies)*. https://education.ec.europa.eu/selfie/about-selfie

Comisión Europea. (2021). *Plan de Acción de Educación Digital (2021-2027).* https://education.ec.europa.eu/es/plan-de-accion-de-educacion-digital-2021-2027

Cosi, A., Voltas, N., Lázaro, J. L., Morales,P., Calvo, M., Molina, S., & Quiroga, M. A. (2020). Formative assessment at university through digital technology tools. *Profesorado, Revista De Currículum Y Formación Del Profesorado*, *24*(1), 164-183. https://doi.org/10.30827/profesorado.v24i1.9314

Domínguez-Lara, S. (2018). Fiabilidad y alfa ordinal. *Actas Urológicas Españolas*, *42*(2), 140-141. https://doi.org/10.1016/j.acuro.2017.07.002

Elosua P, & Zumbo B. (2008). Coeficientes de fiabilidad para escalas de respuesta categórica ordenada. *Psicothema, 20*(5), 896–901.

Enlaces. (2008). *Estándares TIC para la Formación Inicial Docente: Una propuesta en el contexto Chileno*. Ministerio de Educación, Gobierno de Chile.

Enlaces. (2011). *Competencias y estándares TIC para la profesión docente*. Ministerio de Educación, Gobierno de Chile.

Fan, X., & Sivo, S. A. (2007). Sensitivity of fit indices to model misspecification and model types. *Multivariate Behavioral Research, 42*, 509–529. http://doi.org/10.1080/00273170701382864

Ferrari, A. (2013). *DIGCOMP: A Framework for Developing and Understanding Digital Competence in Europe*. JRC-IPTS.

Fraser, J., Atkins, L., & Richard, H. (2013). *DigiLit leicester. Supporting teachers, promoting digital literacy, transforming learning.* Leicester City Council.

Generalitat de Catalunya (2018). *Competència digital docent del professorat de Catalunya.* Departament d'Ensenyament. https://bit.ly/37AJH5f

Hooper, D., Coughlan, J., & Mullen, M. R. (2008). Structural equation modelling: Guidelines for determining model fit. *Electronic Journal of Business Research Methods*, *6*, 53–60.

Ilomäki, L., Paavola, S., Lakkala, M., & Kantosalo, A. (2016). Digital competence – an emergent boundary concept for policy and educational research. *Education and Information Technologies, 21*, 655–679. https://doi.org/10.1007/s10639-014-9346-4

INTEF. (2014). *Marco Común de Competencia Digital Docente. Instituto Nacional de Tecnologías Educativas y de Formación del Profesorado.* http://educalab.es/documents/10180/12809/MarcoComunCompeDigiDoceV2.pdf/e8766a69-d9ba-43f2-afe9-f526f0b34859

INTEF. (2017). *Marco Común de Competencia Digital Docente.* http://educalab.es/documents/10180/12809/MarcoComunCompeDigiDoceV2.pdf

INTEF. (2022). *Marco de referencia de la Competencia Digital Docente.* https://intef.es/wp-content/uploads/2022/03/MRCDD_V06B_GTTA.pdf

ISTE. (2008). *National educational technology standards for teachers*. Washington DC: International Society for Technology in Education.

Jiménez-Hernández, D., González-Calatayud, V., Torres-Soto, A., Martínez Mayoral, A., & Morales, J. (2020). Digital Competence of Future Secondary School Teachers: Differences According to Gender, Age, and Branch of Knowledge. *Sustainability*, *12*(22), 9473. https://doi.org/10.3390/su12229473

Krumsvik, R. J. (2008). Situated learning and teachers' digital competence. *Education and Information Technologies, 13*(4), 279–290. https://doi.org/10.1007/s10639-008-9069-5

Krumsvik, R. J. (2014). Teacher educators' digital competence. *Scandinavian Journal of Educational Research, 58*(3), 269-280. https://doi.org/10.1080/00313831.2012.726273

Lázaro, J. L., & Gisbert, M. (2015). Elaboración de una rúbrica para evaluar la competencia digital del docente. *UTE. Revista de Ciències de l'Educació, 1,* 30–47. https://doi.org/10.17345/ute.2015.1.648

Lázaro, J. L., Usart, M., & Gisbert, M. (2019). Assessing Teacher Digital Competence: the Construction of an Instrument for Measuring the Knowledge of Pre-Service Teachers. *Journal of New Approaches in Educational Research, 8*(1), 73-78. https://doi.org/10.7821/naer.2019.1.370

Lucas, M., Bem-Haja, P., Siddiq, F., Moreira, A., & Redecker, C. (2021). The relation between in-service teachers' digital competence and personal and contextual factors: What matters most? *Computers & Education* (160), 104052. https://doi.org/10.1016/j.compedu.2020.104052

Mahias Finger, P., & Polloni Erazo, M. P. (2019). Cuadernillo técnico de evaluación educativa Desarrollo de instrumentos de evaluación: pruebas. Centro de Medición MIDE UC. Instituto Nacional para la Evaluación de la Educación. https://www.inee.edu.mx/wp-content/uploads/2019/08/P2A354.pdf

McDonald, R. P., & Ho, M. (2002). Principles and practice in reporting structural equation analysis. *Psychological Methods*, *7*, 64–82. https://doi.org/10.1037/1082-989x.7.1.64

OECD. (2022). *Trends Shaping Education 2022*. OECD Publishing, Paris. https://doi.org/10.1787/6ae8771a-en

ONU. (2015). *Agenda for Sustainable Development. Resolution Adopted by the General Assembly on 25 September 2015* (A/70/L.1). http://sustainabledevelopment.un.org/post2015/transformingourworld

Palau, R., & Mogas, J. (Eds.). (2022a). *La competència digital docent al màster de formació del professorat de les universitats de Catalunya*. Octaedro. https://doi.org/10.36006/82001-1

Palau, R., & Mogas, J. (Eds.). (2022b). *Activitats per al desenvolupament de la competència digital docent al màster de formació del professorat*. Octaedro. https://doi.org/10.36006/82002-1

Palau, R., Fuentes, M., Mogas, J., & Cebrián, G. (2021). Analysis of the implementation of teaching and learning processes at Catalan schools during the Covid-19 lockdown. *Technology, Pedagogy and Education, 30*(1), 183-199. https://doi.org/10.1080/1475939X.2020.1863855

Palau, R., Usart, M., & Ucar, M. J. (2019). La competencia digital de los docentes de los

conservatorios. Estudio de autopercepción en España. *Revista Electrónica de LEEME* (44). https://doi.org/10.7203/LEEME.44.15709

Pallisera, M., Fullana Noell, J., Planas Lladó, A., & Valle Gómez, A. D. (2010). La adaptación al Espacio Europeo de Educación Superior en España: los cambios/retos que implica la enseñanza basada en competencias y orientaciones para responder a ellos. *Revista Iberoamericana de Educación*, *52*(4), 1-13. http://hdl.handle.net/10256/3547

Pérez-Navío, E., Ocaña-Moral, M. T., & Martínez-Serrano, M. del C. (2021). University Graduate Students and Digital Competence: Are Future Secondary School Teachers Digitally Competent? *Sustainability*, *13*(15), 8519. https://doi.org/10.3390/su13158519

Portillo, J., Garay, U., Tejada, E., & Bilbao, N. (2020). Self-Perception of the Digital Competence of Educators during the COVID-19 Pandemic: A Cross-Analysis of Different Educational Stages. *Sustainability*, *12*(23), 10128. https://doi.org/10.3390/su122310128

Prieto-Ballester, J.-M., Revuelta-Domínguez, F.-I., & Pedrera-Rodríguez, M.-I. (2021). Secondary School Teachers Self-Perception of Digital Teaching Competence in Spain Following COVID-19 Confinement. *Education Sciences*, *11*(8), 407. https://doi.org/10.3390/educsci11080407

Redecker, C. & Punie, Y. (2017). *European Framework for the Digital Competence of Educators: DigCompEdu.* Publications Office of the European Union.

Revuelta-Domínguez, F.-I., Guerra-Antequera, J., González-Pérez, A., Pedrera-Rodríguez, M.-I., & González-Fernández, A. (2022). Digital Teaching Competence: A Systematic Review. *Sustainability*, *14*(11), 6428. https://doi.org/10.3390/su14116428

Sangrà, A. (2020). Tiempo de transformación educativa. *Revista Innovaciones Educativas*, *22*, 22-27. http://dx.doi.org/10.22458/ie.v22iespecial.3249

Schleicher, A. (2022). *Building on COVID-19's Innovation Momentum for Digital, Inclusive Education, International Summit on the Teaching Profession*. OECD Publishing, Paris. https://doi.org/10.1787/24202496-en

Starkey, L. (2020). A review of research exploring teacher preparation for the digital age. *Cambridge Journal of Education*, *50*(1), 37-56. https://doi-org/10.1080/0305764X.2019.1625867

Tejada, J., & Ruiz, C. (2016). Evaluación de competencias profesionales en Educación Superior: retos e implicaciones. *Educación XX1*, *19*(1) 17-38. https://doi.org/10.5944/educXX1.12175

Tourón, J., Martín, D., Navarro, E., Pradas, S., & Iñigo, V. (2018). Construct validation of a questionnaire to measure teachers' digital competence (TDC). *Revista Española de Pedagogía*, *76*(269), 25-54. https://doi.org/10.22550/REP76-1-2018-02

UNESCO. (2008). *Estándares de competencia en TIC para docentes*. http://www.eduteka.org/EstandaresDocentesUNESCO.php

UNESCO. (2019). *Marco de competencias de los docentes en materia de TIC.* https://bit.ly/3bkUp0u

Viberg, O., Mavroudi, A., Khalil, M., & Bälter, O. (2020). Validating an instrument to measure teachers' preparedness to use digital technology in their teaching. *Nordic Journal of Digital Literacy*, *15*(1), 38-54. https://doi.org/10.18261/issn.1891-943x-2020-01-04

| Authors / Autores |
|---|
| **Palau, Ramon** (ramon.palau@urv.cat) 0000-0002-9843-3116<br><br>Ramon Palau holds a PhD in Educational Technology and currently works as a researcher in the research group ARGET (Applied Research Group in Education and Technology) at the Universitat Rovira i Virgili, and as a lecturer and academic coordinator of the Master's Degree in Teaching at the same university. His lines of research are around digital competence in teaching, intelligent learning spaces and applications of technology in education. |
| **Fretes Torruella, Gabriela** (gabriela.fretes@estudiants.urv.cat) 0000-0002-8395-7945<br><br>Gabriela Fretes Torruella is a PhD student in Educational Technology at the Universitat Rovira i Virgili (URV). Previously, she completed the Master in Education and ICT (UOC) and is a psychologist and psychopedagogue. She currently lives in Chile and works as a teacher development coordinator at the Universidad del Desarrollo. Her research lines are intelligent learning environments, the influence of environmental variables on teaching, and digital competence in teaching. |
| **Mogas Recalde, Jordi** (jordi.mogas@urv.cat) 0000-0003-3385-5534<br><br>Jordi Mogas Recalde holds a PhD in Educational Technology and a Bachelor's in Information and Documentation with mention in information systems management. He is a lecturer at the Department of Pedagogy at the Universitat Rovira i Virgili – URV, and in the studies of Education at the Valencian International University – VIU. He belongs to ARGET (Applied Research Group in Education and Technology) and his main research lines are: Smart Learning Environments, Virtual Learning Environments and Self-Regulated Learning. |
| **Usart Rodríguez, Mireia** (mireia.usart@urv.cat) 0000-0003-4372-9312<br><br>Mireia Usart is Lecturer in Research Methods at the Department of Pedagogy at the Rovira i Virgili University (URV). Degree in Physics (University of Barcelona), certificate of pedagogical aptitude in mathematics (Polytechnic University of Catalonia), Master and Doctorate in Education and ICT (Open University of Catalonia). She is a member of the research group ARGET since 2018. She is the academic coordinator of the inter-university master's in educational technology, and has directed doctoral theses in the field of educational robotics. She has also participated as a researcher in numerous European and Spanish R+D+i projects since 2011. She is currently leading an international research project (MindGAP, LCF/PR/SR19/52540001), funded by the La Caixa Foundation, on the digital divide of gender in education in Spain. |


RELIEVE

**R**evista **EL**ectrónica de **I**nvestigación y **EV**aluación **E**ducativa

***E-Journal of Educational Research, Assessment and Evaluation***

[ISSN: 1134-4032]