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# Teachers' Profiles according to Self-Perceived Digital Competence and Use of Technology: A Cluster Analysis

## Perfiles docentes según la competencia digital autopercibida y el uso de la tecnología: un análisis de clústeres

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**Abstract**

*Even when the educational use of digital technology has increased considerably in recent years, there is still a need to achieve a greater methodological transformation, which requires further teacher training in digital competence. The aim of this study is to analyse self-perceived teacher digital competence and the educational use of digital technology among 1399 preschool, primary, and secondary teachers in Spain, considering their profiles according to these variables. To do so, a quantitative research approach, with a non-experimental survey design was conducted. Using descriptive statistics and cluster analysis, four teacher profiles were identified based on competence levels and technology use. Overall, teachers rated their digital competence as medium-expert and reported a more frequent use of technology for planning than for implementing classroom activities. Cluster analysis yielded four teacher profiles, which varied according to school level, gender, age, and teaching experience, revealing different gaps and needs across the groups. These findings offer a comprehensive view of the teachers' digital skills, informing specific training approaches to support the integration of digital tools in education and to drive methodological transformation.*

*Keywords:* teacher digital competence; digital technology; preschool, primary, and secondary education; cluster analysis.

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## Resumen

*Aunque el uso educativo de las tecnologías digitales ha aumentado considerablemente en los últimos años, todavía es necesario lograr una mayor transformación metodológica, para lo que se requiere una mejor formación en competencia digital docente. El objetivo de este estudio fue analizar la competencia digital docente autopercibida y el uso educativo de las tecnologías digitales entre 1399 docentes de educación infantil, primaria y secundaria en España, así como sus perfiles en función de estas variables. Se llevó a cabo una investigación cuantitativa con un diseño no experimental de encuesta. Mediante estadísticas descriptivas y análisis de clústeres, se identificaron cuatro perfiles docentes con base en los niveles de competencia y el uso de la tecnología. En general, el profesorado evaluó su competencia digital en un nivel medio-experto e informaron de un uso más frecuente de la tecnología para la planificación que para la implementación de actividades en el aula. Por último, a partir del análisis de clústeres se obtuvieron cuatro perfiles docentes que variaron en función del nivel educativo, el sexo, la edad y la experiencia docente, revelando brechas y necesidades entre los distintos grupos. Estos resultados ofrecen una visión global de las competencias digitales del profesorado, que sirve de base para el planteamiento formación específica que facilite la integración de las herramientas digitales en la educación e impulse la transformación metodológica.*


*Palabras clave:* competencia digital docente; tecnologías digitales; educación infantil, primaria y secundaria; análisis de clústeres.

## Introduction

In recent decades, digital technology (DT) has become a key element in education worldwide, supported by numerous international initiatives (European Commission, 2011). Due to the lack of consensus on the definition of "educational use of DT", this study defines it as practices related to teaching and learning, including lesson preparation, classroom activities, and administrative tasks (Ward & Parr, 2010). Despite the wide availability of DT for schools and teachers, its educational uses remain limited. Although DT use by teachers increased during the COVID-19 emergency remote teaching period (Beardsley et al., 2021), activities tended to be more teacher-centred than student-centred (Pozo et al., 2021).

Studies show that teachers use DT more often for planning than for classroom activities (European Commission, 2013; Romero-Tena et al., 2020). However, measuring DT use varies depending on the tools employed, with most research focusing on either specific technologies or overall usage frequency. Research indicates a tendency for greater personal-professional use of DT compared to student-related use (Romero-Tena et al., 2020; Suárez-Rodríguez et al., 2018). Common uses include supporting presentations, preparing lessons and materials, and information searching (Abedi, 2023; Kaarakainen & Saikkonen, 2021; Lomos et al., 2023), while assessment, collaborative or cooperative activities, and attention to diversity are less frequent purposes (Lomos et al., 2023; Valverde-Berrocoso et al., 2021). Despite widespread DT integration, its pedagogical use remains limited, primarily focusing on information delivery without significant methodological change (Abedi, 2023; Lomos et al., 2023).

Teachers' digital competence (TDC) plays a critical role in DT integration. It encompasses a complex professional competence that binds together a combination of knowledge, abilities, and attitudes that teachers must have and mobilise to use DT in their professional practice, and it is related to didactic and methodological aspects, management of spaces and resources, communication, ethics, and professional development (Lázaro Cantabrana et al., 2019). In the Spanish context, the Common Digital Competence Framework for Teachers (INTEF, 2022) provides a national framework that adapts the European DigCompEdu model to the Spanish educational system. At the regional level, the TDC framework developed by the Department of Education of Catalonia (Generalitat de Catalunya, 2018), is one of the most notable initiatives.

Since self-efficacy influences in-service teachers' practices (Hatlevik, 2017) and there is a lack of tools to objectively assess TDC (Verdú-Pina et al., 2021b), it is currently measured in terms of self-perception. Self-perceived TDC could determine teachers' educational use of DT, as competence is key to feeling confident in its application (Aivazidi & Michalakelis, 2023; Lucas et al., 2021). However, evidence on its role in shaping DT use remains limited. While some studies report a positive link between DT use and self-perceived TDC (Konstantinidou & Scherer, 2022; Momčilović & Ninković, 2024), others do not (Kaarakainen & Saikkonen, 2021). Research also suggests that higher self-perceived TDC is associated with specific educational uses of DT, particularly with constructivist teaching activities (Sailer et al., 2021). Knowing more about TDC and how it is reflected in the use of DT becomes essential in a context where the use of DT is intensive, and teachers need to be digitally competent to foster students' digital skills (Caena & Redecker, 2019).

To better understand TDC and DT use, examining related variables is essential (Backfisch et al., 2021). Teacher profiles based on these factors can highlight inequalities and inform targeted interventions. Variables such as gender, age, teaching experience or school level have been linked to both self-perceived TDC and educational DT use (Hämäläinen et al., 2021; Lucas et al., 2021; Portillo et al., 2020; Prieto-Ballester et al., 2021; Romero-Tena et al., 2020). These variables should be further explored alongside TDC and DT use, as most studies examine them separately and findings are sometimes inconsistent.

Most TDC research focuses on university educators (Guillén-Gámez et al., 2023) or pre-service teachers (Ortega-Sánchez et al., 2020). Among practicing teachers, studies report a medium TDC level (Lucas et al., 2021; Mas García et al., 2024; Vidal Esteve et al., 2025), with lower self-perception in pedagogical aspects compared to technical skills (Krumsvik et al., 2016; Suárez-Rodríguez et al., 2018). Specifically, higher self-perception is commonly found in informational literacy, communication, and collaboration (Pozo Sánchez et al., 2020; Prieto-Ballester et al., 2021), whereas digital content creation and security are perceived as weaker areas (Pozo Sánchez et al., 2020; Rojo-Ramos et al., 2020). Nevertheless, some authors also report low self-perception in communication and collaboration (Rojo-Ramos et al., 2020; Segura Rondan et al., 2022). The most recent Spanish studies also highlight professional engagement, digital resources, and empowering learners as teachers' strongest areas, while revealing greater weaknesses in facilitating students' digital competence, digital pedagogy, and assessment and feedback (García-Delgado et al., 2023; Vidal Esteve et al., 2025).

Differences in TDC and DT use by gender, age, and teaching experience have been reported, although these variables are often examined separately. Regarding gender and educational DT use, studies are limited and show mixed results. Research in Serbia and China (Momčilović & Ninković, 2024; Xu & Zhu, 2023) found that male teachers report more frequent classroom use of DT than females. However, this contrasts with other European studies (Lomos et al., 2023; Pozo et al., 2021), which found no significant gender-based differences. In terms of TDC, Spanish studies consistently reveal gender disparities in self-assessment. Portillo et al. (2020) and Prieto-Ballester et al. (2021) found that women rated their TDC lower than men. These patterns may reflect a tendency for women to assess their abilities more modestly, whereas men may overestimate theirs (Fong et al., 2016). Recent studies focusing on specific dimensions of TDC show contradictory results regarding digital resources, with men reporting higher competence in Mas García et al. (2024) and women in Li et al. (2024).

Previous research reports mixed findings on age and teaching experience differences in DT use and TDC self-perception among teachers. While Lomos et al. (2023) and Xu & Zhu (2023) found no significant differences in use frequency in Luxembourg and China, Hämäläinen et al. (2021) reported more frequent use and a lower self-perceived TDC among younger teachers across Europe. Similar patterns were observed in Portugal and Spain (Lucas et al., 2021; Mas García et al., 2024; Romero-Tena et al., 2024), where younger and less experienced teachers reported higher TDC self-perception. Regarding DT use, research conducted in Spain and Serbia (Momčilović & Ninković, 2024; Pozo et al., 2021; Romero-Tena et al., 2020) found greater use among less experienced teachers, whereas González-Rodríguez et al. (2022) in Spain and Xu & Zhu (2023) in China reported the opposite, with more experienced teachers using DT more frequently. It should be noted that teaching experience and age are often correlated.

Few studies examine differences across school levels. In Spain, Ramírez Orellana et al. (2016) found variations in DT-related activities between preschool and secondary school teachers: DT use in preschool focused more on habit and behaviour formation, while in secondary education it centred on academic tasks such as homework and content explanation. Regarding TDC, teachers at higher stages reported better self-perception in Spain (Portillo et al., 2020; Vidal Esteve et al., 2025). However, preschool and primary school teachers perceived themselves as more competent in digital content creation, and primary teachers also in communication (Pozo Sánchez et al., 2020). In contrast, secondary teachers reported higher self-perception in information and digital literacy, assessment, and supporting students' digital competence (Hurtado-Mazeyra et al., 2022; Pozo Sánchez et al., 2020). Conversely, Li et al. (2024) found lower TDC at higher stages in China, particularly in professional engagement and digital resources.

While variability in study results may partly reflect cultural or contextual factors, differences in frameworks and tools for assessing TDC are also crucial. Applying a unified framework to Spain's context would enable a comprehensive understanding of DT use in education and clarify the diverse current approaches. Additionally, it would provide an updated benchmark for similar contexts, facilitating comparisons to identify differences and similarities in technology integration across educational systems.

Given the key role of self-efficacy in the educational use of DT, updating teachers' knowledge and skills through targeted training programs is essential (Aivazidi & Michalakelis, 2023). To date, few studies have examined both TDC and DT use while considering specific dimensions alongside variables such as gender, age, teaching experience, and school level. This study aims to offer an integrated perspective on these factors to better tailor teacher training strategies to the diverse needs of different teacher profiles.

Therefore, the aim of this study is to characterise teacher profiles based on their self-perceived TDC and educational DT use. To address this objective, three research questions are established:

1. RQ1: What is the self-perceived TDC level of preschool, primary, and secondary education teachers in Spain?
2. RQ2: What is the typology and frequency of educational DT use among these teachers?
3. RQ3: What teacher profiles emerge regarding self-perceived TDC and educational DT use considering gender, age, teaching experience, and school level?

This analysis will help identify gaps and inform strategies to promote equity in developing TDC and educational DT use. It will offer valuable insights for institutions to guide policy planning related to teacher training, aiming to enhance TDC and effective DT integration in teaching and learning. By understanding the specific needs of diverse teacher profiles, training resources can be allocated more efficiently, enabling personalized solutions to foster TDC development and improve DT use in education.

## Methodology

### Participants

Quota sampling technique was applied to ensure representativeness by gender, age, experience, region, and school type (public/private; urban/rural), following guidelines by Cohen et al. (2018) and Saunders et al. (2009). The study sampled 1399 teachers from 112 Spanish schools, including 215 preschool teachers (15.4%), 531 primary school teachers (38%), 499 lower-secondary school teachers (35.7%), and 154 upper-secondary school teachers (11%). The sample is representative of Spain's non-university general education population for the 2020-2021 school year (Ministerio de Educación y Formación Profesional [MEFP], 2022). In terms of school type, 68% of participants worked in public schools and 32% in private or semi-private schools; 74% were from urban areas and 26% from rural areas. Regarding gender, 983 participants identified themselves as women (70.3%), 383 as men (27.4%), 12 as non-binary (0.9%), and 21 did not answer (1.5%), closely reflecting national demographics (MEFP, 2022). The average age was 43.05 years (SD=9.25), and the average teaching experience was 17.24 years (SD=11.9). The data by age range can be found in Table 1.

Table 1

*Distribution of data by age range*

| Age range | *N* | % |
|---|---|---|
| Less than 30 | 104 | 7.6 |
| 30-39 | 400 | 29 |
| 40-49 | 496 | 36 |
| 50-59 | 342 | 24.8 |
| More than 59 | 35 | 2.5 |

## Instruments

Self-perceived TDC was assessed using the COMDID-A questionnaire (Lázaro Cantabrana & Gisbert Cervera, 2015). This questionnaire is aligned with the main national and international frameworks (Verdú-Pina et al., 2021b). It comprises 22 items across four dimensions (Appendix 1):

- D1: Didactic, curricular, and methodological (six items).
- D2: Planning, organisation, and management of digital technological spaces and resources (five items).
- D3: Relational, ethics, and safety (five items).
- D4: Personal and professional (six items).

Responses were rated on a five-point scale reflecting levels of TDC development (initial, medium, expert, and transformative), and a baseline (not yet started). Construct validity was confirmed via exploratory factor analysis (EFA) by Palau et al. (2019). The sample adequacy was very good (KMO=.973), using Bartlett's test of sphericity (sig.=.000). The factorial analysis met the 4 theoretical dimensions (D1 to D4) covering a total of 75.36%, greater than the minimum proposed by Hair et al. (2014) of 60% of the variance. The dimensional structure was measured using CFA. First, the goodness of fit of the model was determined with absolute measurements. The Chi-square test was used to contrast hypotheses ($\chi$2 / DF=4.983), obtaining values between 2 and 5 that indicate an acceptable fit. Additionally, to determine incremental fit, the most common comparative fit index was used (CFI=.937), yielding values higher than 0.900 that indicate a good fit (Hair et al., 2014). Finally, the root-mean-square error of approximation was calculated (CI RMSEA=.061–.073), yielding values lower than 0.08 that indicate a good fit of the model for our sample size (Hair et al., 2014). Cronbach's Alpha for each dimension was very high: $\alpha$(D1)=.917; $\alpha$(D2)=.891; $\alpha$(D3)=.882; $\alpha$(D1)=.943. The alpha of the instrument is .969, therefore, we consider that this self-perception instrument is valid and reliable for the sample of the present study.

DT use was measured using a validated *ad hoc* questionnaire (23 items) developed from a literature review, as detailed in Verdú-Pina et al. (2021a). Three dimensions are identified, two of which were analysed in this study:

- U2: DT use for the planning of teaching-learning activities (8 items).
- U3: DT use for the implementation of teaching-learning activities (12 items).

Responses were rated on a five-point frequency scale (never to daily use). The instrument was piloted in a sample of 250 teachers and an EFA was made using principal component analysis and Promax rotation. The three dimensions of DT use were confirmed based on the results of psychometric analysis. After that, the dimensional structure of the instrument was studied using CFA in a sample of 1021 teachers. The goodness of fit of the model was first determined with absolute measurements. In order to contrast hypotheses, the Chi-square test was used ($\chi 2$ / *DF*=4.128), obtaining values between 2 and 5 that indicate an acceptable fit. To determine incremental fit, the most common comparative fit index was used (CFI=.976) with values greater than 0.900, indicating a good fit. The root-mean-square error of approximation (CI RMSEA=.071–.083) was also calculated, indicating a good fit of the model for our sample size (Hair et al., 2014). Cronbach's alpha values for each factor and for the entire instrument indicate an adequate reliability of the tool: $\alpha$(U1)=.88; $\alpha$(U2)=.84; $\alpha$(U3)=.94; $\alpha$(instrument)=.91.

The two questionnaires were distributed as a single survey among participants. Complementary demographic data was gathered (12 questions), including gender (male, female, non-binary, NR/DK), based on The GenIUSS Group (2014), school level, age, and teaching experience.

## Procedure

This research was carried out through a quantitative approach, with a non-experimental, cross-sectional survey design, implementing two questionnaires aimed at measuring TDC and DT use. First, a descriptive statistical analysis was carried out to determine the overall TDC level and the frequency and type of DT use in the sample of teachers. Finally, a cluster analysis was performed to identify teacher profiles regarding TDC and educational use of DT.

Data collection occurred from June 2020 to June 2021 via email, participants provided informed consent and received details on procedures. Responses were anonymised and stored in a secure database. Ethical standards were adhered to, following the British Educational Research Association (2018). The study protocol was approved by the university Ethics Committee (Ref: CEIPSA-2021-PR-0046).

## Data analysis

After screening for incomplete or invalid responses, 1377 cases were retained. Descriptive statistics were used to identify trends. A hierarchical cluster analysis was performed to identify the most relevant teacher profiles in terms of TDC and DT use. This analysis was carried out with R software (version 4.1.2) and its integrated development environment RStudio (version 1.3.959).

The dimensions D1-D4, U2, and U3 were standardised and used for clustering, as a simplified representation of the variables TDC and DT use in a smaller number of factors. Following Hair et al. (2014), teachers' profiles were built according to

their proximity to the six factors. Differences between clusters were calculated using Ward's method at each step of the agglomerative hierarchical clustering procedure. This method was used to explore and identify major relationships between TDC and DT use in the classroom, following Hair et al. (2014). Once the clusters were obtained, a characterisation of them was made based on the rest of the variables (gender, age, teaching experience, and school level). The usage frequency of the individual items from U2 and U3 was also added to the characterisation of the clusters to obtain more accurate data about the type of DT use from each teacher profile.

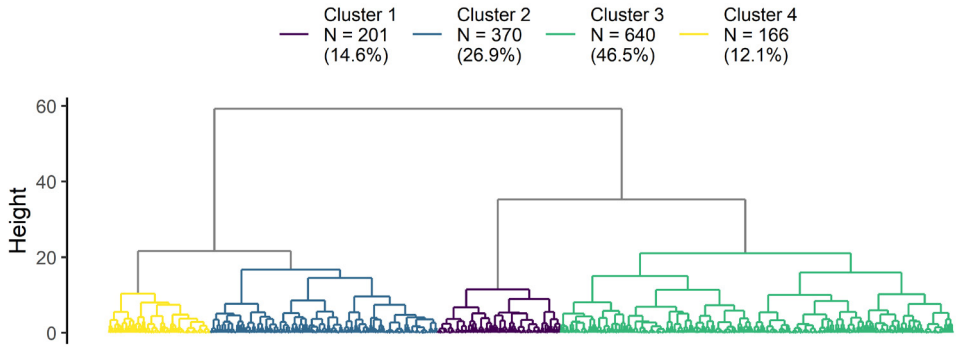
## Results

### Hierarchical clustering

The hierarchical clustering results include a dendrogram (Figure 1), illustrating the progressive merging of observations at each step. Four clusters were selected, based on the need for sufficient variety to enable theoretical interpretation.

Figure 1

*Dendrogram resulting from hierarchical clustering (Euclidean distance, Ward's linkage, original order)*



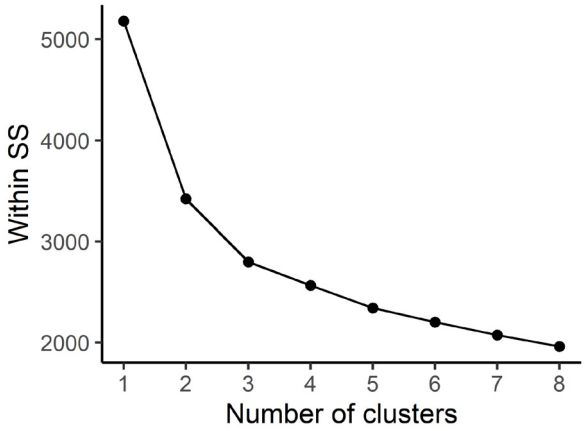

To determine the optimal number of clusters, the elbow method was applied (Marutho et al., 2018). The inflection point in the slope of within-group homogeneity improvement (Figure 2) supports the selection of four clusters.

Subsequently, the frequency of use of individual items from U2 and U3 was analysed within clusters, alongside gender distribution, school level, teaching experience, and age (in years). These variables, while not used in cluster formation, were examined to explore relationships with the use of DT and TDC.

Significant differences in gender distribution across clusters were observed ($\chi 2$ (3, $N$=1346)=38.19, $p$=.000), as well as in school level distribution ($\chi 2$ (9, $N$=1377)=91.95, $p$=.000). Non-parametric Kruskal-Wallis test was carried out due to the non-normal distribution of the data in the variables, revealing statistically significant differences in teaching experience ($\chi 2$ (3, $N$=1377)=53.94, $p$=.000) and age ($\chi 2$ (3, $N$=1377)=58.49, $p$=.000) across clusters.

Figure 2

*Determining the number of clusters using the hierarchical algorithm with elbow method of within sums of squares (WSS)*

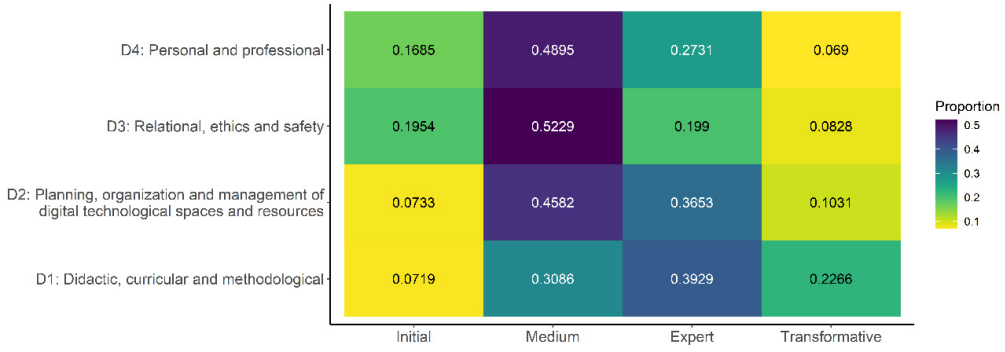



## Teachers' digital competence (RQ1)

Figure 3 presents a heatmap of teachers' self-perceived TDC across dimensions. D1 (Didactic, curricular, and methodological) showed the highest competence levels, with 31% at the medium, 39% at the expert, and 23% at the transformative level. D2 (Planning, organisation, and management of digital technological spaces and resources) had 46% of the teachers at the medium, 37% at the expert, and 10% at the transformative level. D3 (Relational, ethics, and safety) was the one with the lowest self-perception: 52% of the teachers perceived themselves at the medium level, 20% at the expert and initial level, and 8% at the transformative level. Finally, D4 (Personal and professional) was similar, with 49% at the medium, 27% at the expert, and 7% at the transformative level.

Figure 3

*TDC self-perception by dimensions*



## Teachers' educational uses of digital technology (RQ2)

Regarding DT usage (Figure 4), teachers reported higher use for planning (U2=3.4 out of 5), than for implementation (U3=3.2 out of 5), both ranging between "several times a month" and "several times a week". Frequently used planning tasks (Figure 5) included searching, selecting, designing materials (U201, U203, U204), and colleague communication (U208). Less frequent tasks included online sharing (U207) and designing assessment activities (U205).

Figure 4

*Descriptive view of the DT use factors, as box plots: U2-Uses for planning; U3-Uses for implementing teaching-learning activities.*

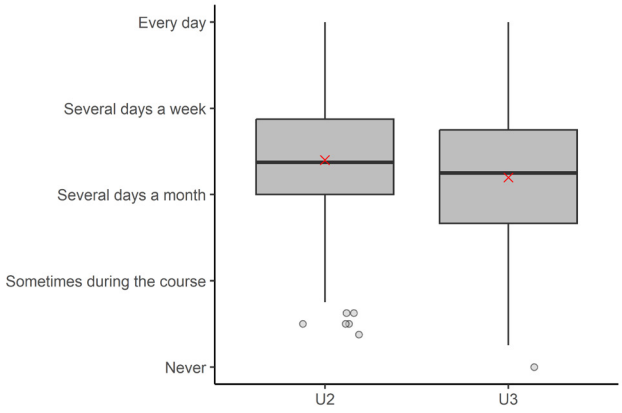
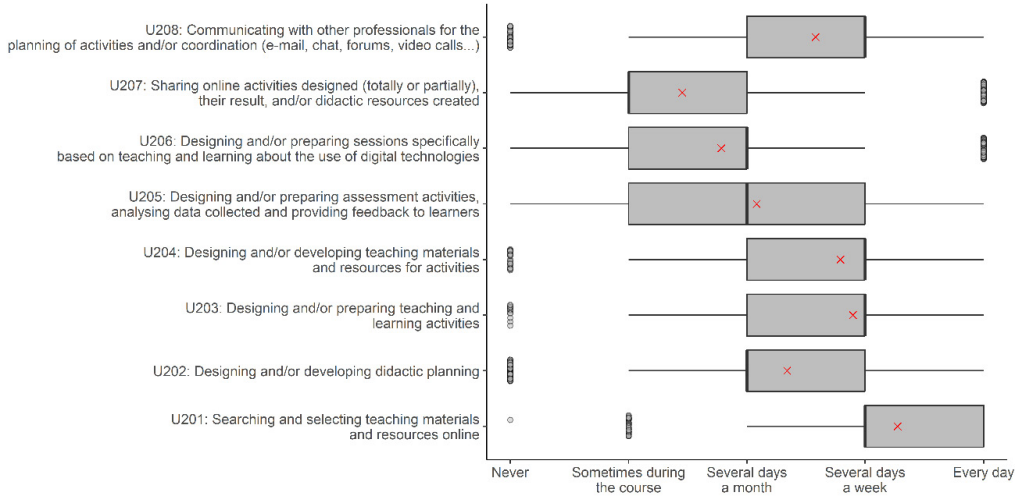



Figure 5

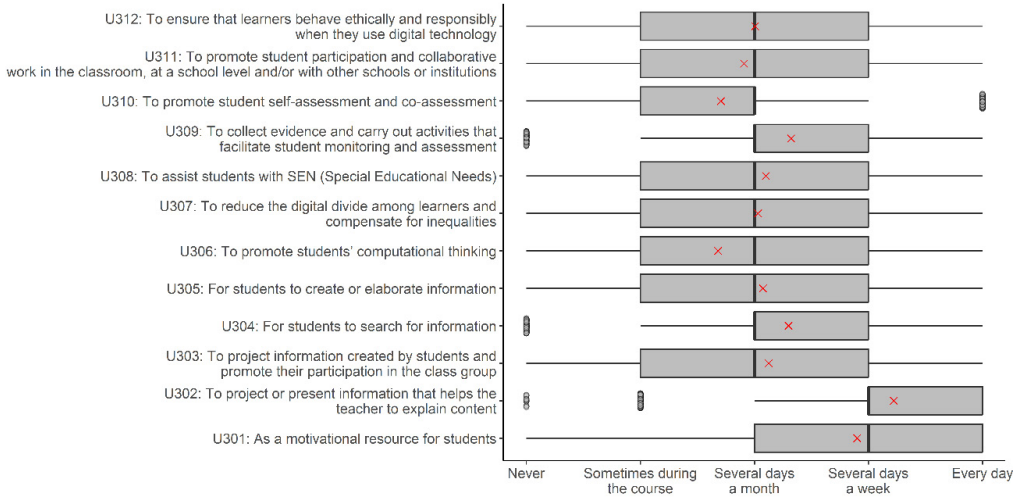
*Descriptive view of the items of DT use for planning (U2), as box plots.*



For implementation (Figure 6), frequent uses included presenting information (U302) and motivational tools (U301), while promoting computational thinking (U306), self-assessment and co-assessment (U310), and fostering student participation and collaboration (U311) were less frequent.

Figure 6

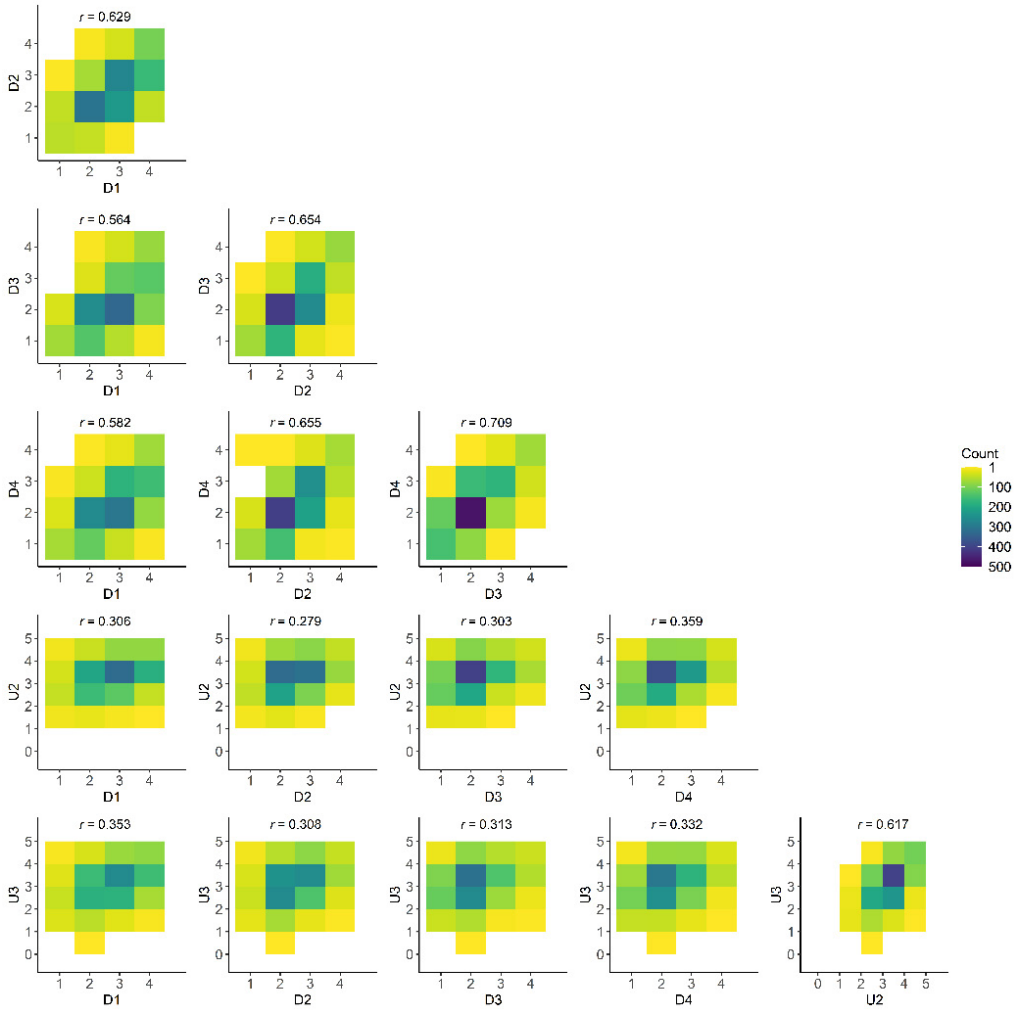
*Descriptive box plots of the items of DT use for implementing teaching-learning activities (U3).*




Correlation analysis (Figure 7) showed strong positive relationships within TDC and DT use dimensions, with weaker correlations between them. The highest correlations linked D4 (Personal and professional) with U2 (Uses for planning) and D1 (Didactic, curricular, and methodological) with U3 (Uses for implementing activities).

Figure 7

*Descriptive view of all six factors separated out, as heatmaps.*




## Cluster profiles (RQ3)

Teachers in all clusters reported higher self-perceived competence in D1 (Didactic, curricular, and methodological), and lower competence in either D3 (Relational, ethics, and safety) or D4 (Personal and professional), depending on the cluster (Figure 8). DT use was more frequent for planning than for implementation across clusters (Figure 9, 10, and 11). This difference was less pronounced in clusters 1 and 4. Gender distribution across clusters shows a predominance of females, with non-binary and other categories in the minority (Figure 12).

Figure 8

*Distribution of teachers in the different factors and levels of TDC for each cluster.*

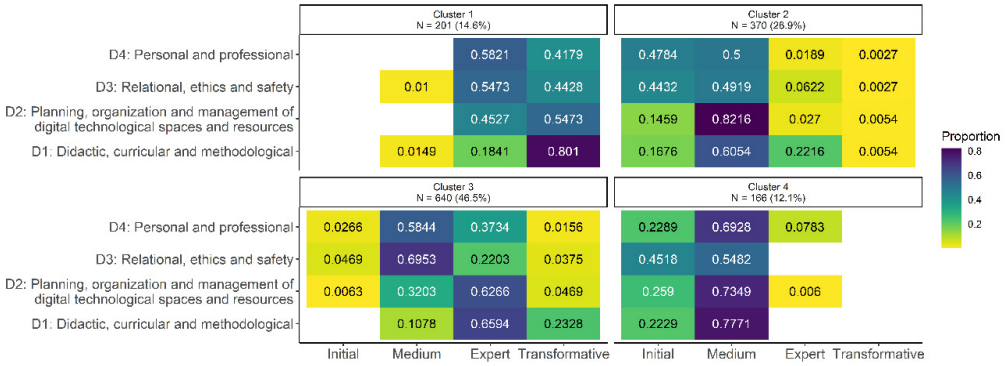



Figure 9

*Descriptive view of the DT use factors per cluster, as box plots: U2-Uses for planning; U3-Uses for implementing teaching-learning activities.*

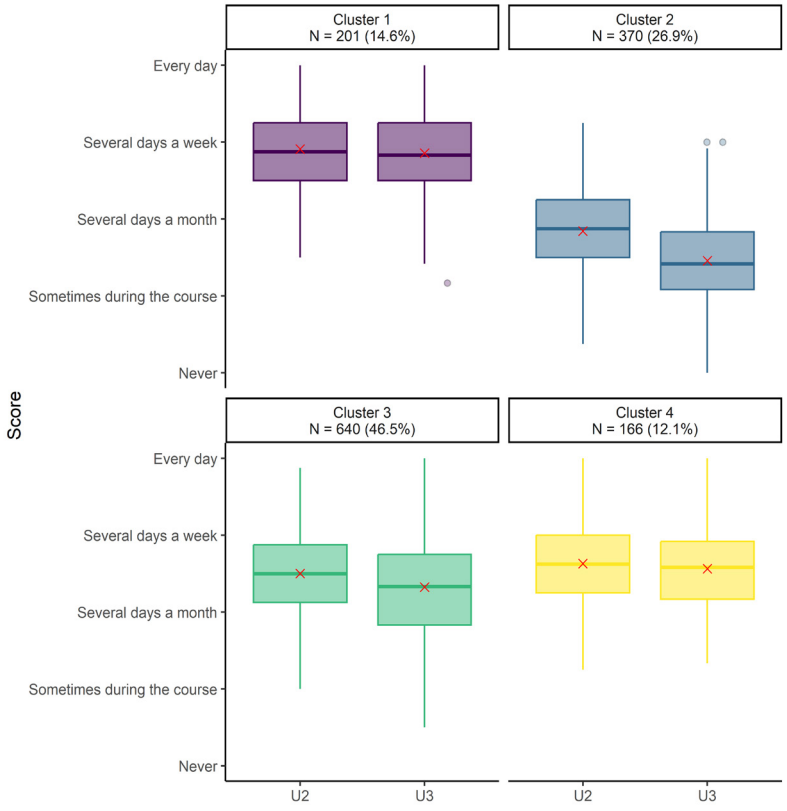


Figure 10

*Descriptive view of the frequency of DT use items for planning (U2), per cluster.*

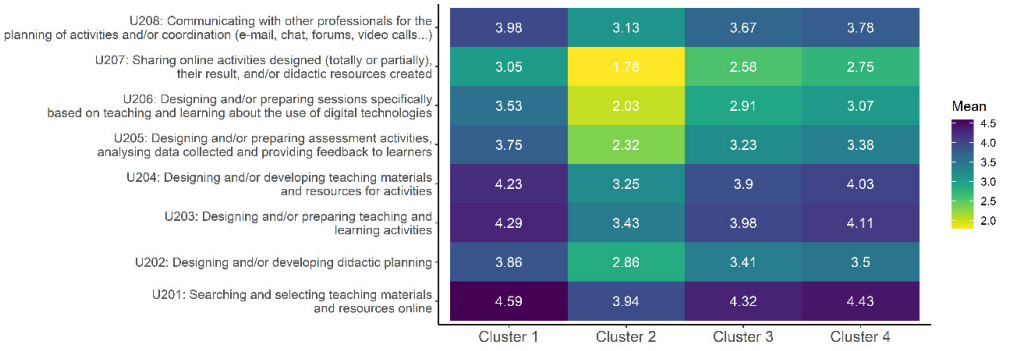



Figure 11

*Descriptive view of the frequency of DT use items for implementing teaching-learning activities (U3), per cluster.*

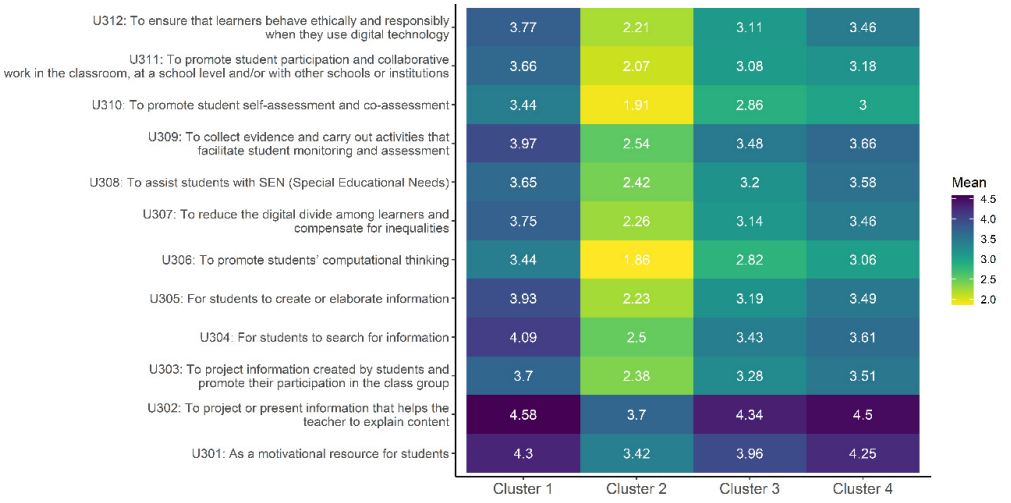
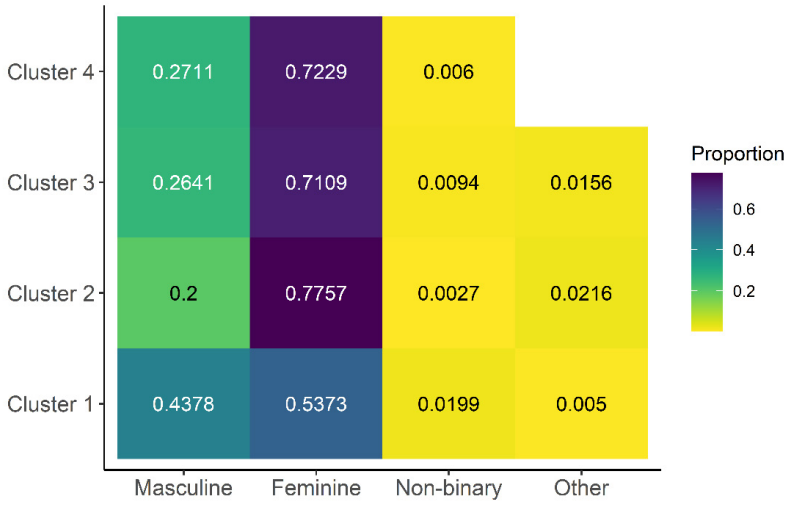


Figure 12

*Gender distribution in each of the four clusters.*




Primary and lower-secondary school teachers dominate in all clusters. However, cluster 2 has the highest representation of preschool teachers, being similar to the proportion of teachers in lower-secondary school (Figure 13). Teaching experience and teachers' age display consistent trends across clusters, with clusters 2 and 4 comprising older and more experienced teachers, while clusters 1 and 3 include younger, less experienced ones (Table 2).

Figure 13

*Distribution of teachers' school level in each of the four clusters.*

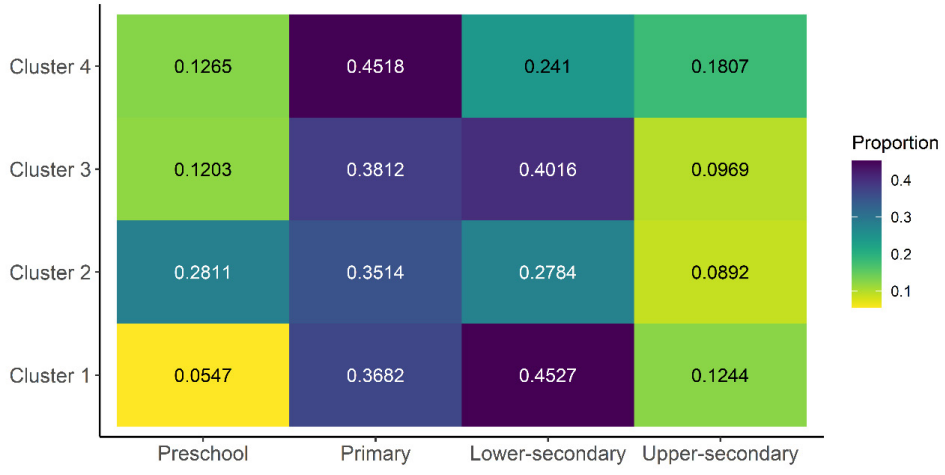


Table 2

*Mean and standard deviation (SD) of teaching experience and teachers' age in each cluster.*

| | **Experience** Mean (*SD*) | **Age** Mean (*SD*) |
|---|---|---|
| **Cluster 1** | 15.6 (10.2) | 41.6 (8.55) |
| **Cluster 2** | 20.8 (12.6) | 45.9 (8.94) |
| **Cluster 3** | 15.4 (11.6) | 41.6 (9.24) |
| **Cluster 4** | 18.3 (12) | 44.4 (9.46) |

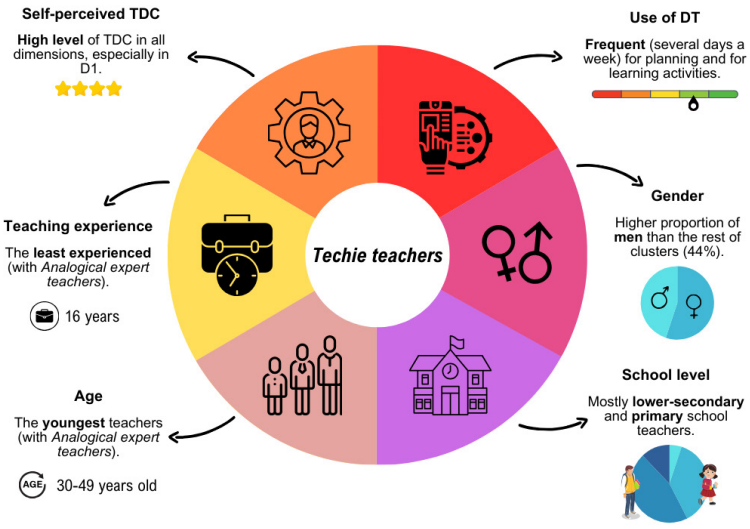
From these results, the four clusters are interpreted and described, as follows:

*Cluster 1: Techie teachers*

Comprising 201 participants (14.6%), these teachers report high TDC levels, particularly in D1. A high proportion of teachers perceive themselves as transformative across dimensions, though slightly less in D3 and D4. These teachers also report the most frequent (averaging several days a week) and balanced use of DT, both for planning (U2) and for implementing activities (U3). Due to their high TDC self-perception and their frequent and balanced reported use of DT, this group was named "techie teachers". Men are more represented in this cluster (44%), with most teaching at lower-secondary (45%) and primary (37%) levels. These teachers are relatively young (30–49 years old) and less experienced, with an average of 15.6 years of teaching (Figure 14).

Figure 14

*Techie teachers*



*Cluster 2: Technologically amateur teachers*

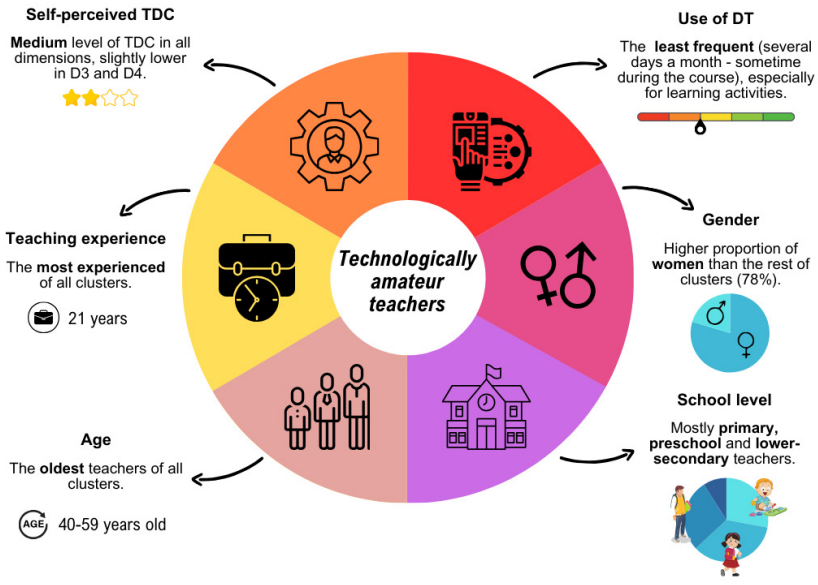
This group (*N*=370, 26.9%) reports the lowest TDC levels together with cluster 4, particularly in D3 and D4, where most are at the medium or initial level while in D1 and D2 they are mostly at the medium level (60% in D1 and 82% in D2). Their DT usage is infrequent, especially for implementing activities (U3), falling between several days a month and sometimes during the course. The difference in frequency between the use of DT for planning (U2) and for implementing (U3) is the highest of all clusters. These teachers seldomly use DT in their lessons and have a low perception of their own capacities regarding these tools. For this reason, this group was named "technologically amateur teachers".

Concerning DT use items, in U2 they mainly use DT for searching, selecting, and designing teaching materials (U201, U203, U204) and communicating with other professionals (U208). Regarding U3, they mainly use DT as a motivational resource (U301) and to present information (U302), while the remaining items have a much lower frequency.

This cluster is predominantly female (78%). It has the highest proportion of preschool teachers (28%), though participants grouped in this cluster mostly teach at a primary school level (35%). Cluster 2 groups the oldest (mainly 40–59 years old) and the most experienced participants (average 20.8 years) (Figure 15).

Figure 15

*Technologically amateur teachers*



*Cluster 3: Analogical expert teachers*

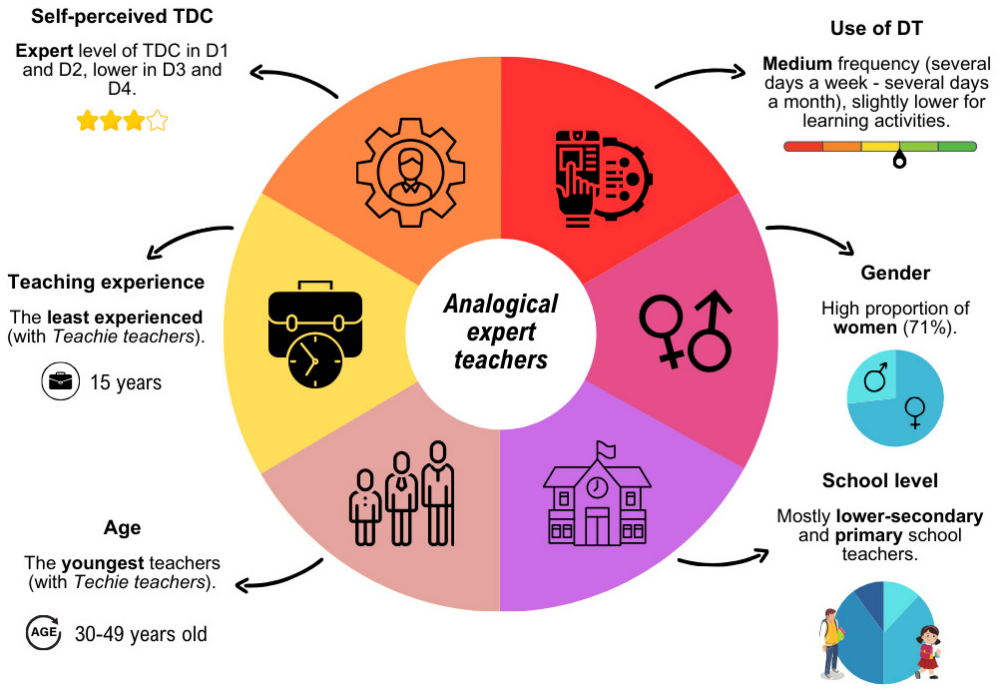
This largest group (N=640, 46.5%) reports high TDC levels in D1 (66%) and D2 (63%), and medium levels in D3 (70%) and D4 (58%). Their DT usage is moderate (between several days a month and several days a week) slightly prioritising planning (U2) over implementation (U3). We cautiously interpret that, although these teachers might feel relatively competent in using DT, they prefer other activities that do not make use of DT as often in their teaching. Therefore, this group was named "analogical expert teachers".

When analysed per item, the frequency of use in nearly all the items of U2 is above several days a month, except for preparing sessions about the use of DT (U206) and sharing online activities (U207). These teachers occasionally use DT for student self-assessment and co-assessment (U310) and promoting computational thinking (U306).

Predominantly female (71%), they mainly teach at lower-secondary (40%) and primary (38%) levels. They are relatively young with limited teaching experience (mean 15.4 years) (Figure 16).

Figure 16

*Analogical expert teachers*



*Cluster 4: Intermediate user teachers*

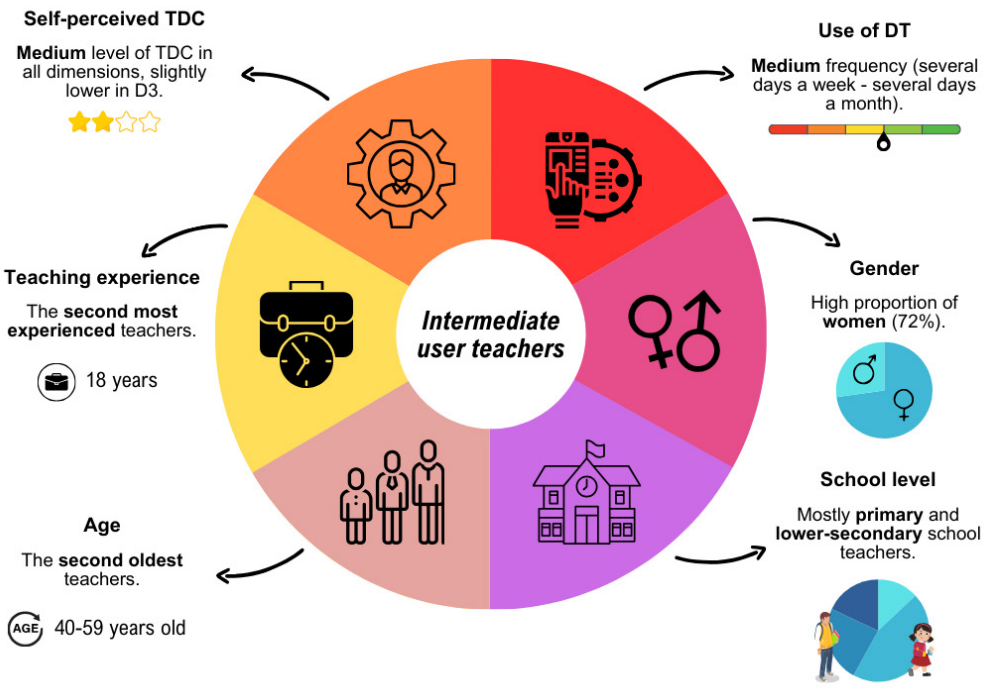
This group (N=166, 12.1%) reports moderate TDC levels in all dimensions, with many at the initial level in D3 (45%). Their DT usage is moderate (several days a week – several days a month), with slightly more focus on planning (U2) than implementation (U3). Due to these traits, this group was named "intermediate users".

The frequency of use in U2 items is above several days a month, except for sharing online activities (U207). Regarding U3, all items are above several days a month, although the least frequent are the use for student self-assessment and co-assessment (U310), to promote computational thinking (U306), and to promote student participation and collaborative work (U311).

Predominantly female (72%), they mostly teach at primary school (45%) and lower-secondary school level (24%). There is also a notable proportion of teachers from the upper-secondary level (18%). Moreover, this cluster groups teachers among the oldest (mainly 40–59 years old) and most experienced (averaging 18.3 years) together with cluster 2 (Figure 17).

Figure 17

*Intermediate user teachers*



## Discussion

This study aimed to identify teacher profiles based on self-perceived TDC (RQ1) and educational DT use (RQ2). To address RQ1, TDC levels were analysed. Most teachers rated their TDC as medium or expert across dimensions, in line with prior national and international studies (Lucas et al., 2021; Sailer et al., 2021; Vidal Esteve et al., 2025), and particularly in D1 (Didactic, curricular, and methodological) and D2 (Planning, organisation, and management of digital technological spaces and resources). These dimensions align with areas such as information management or basic digital skills, consistent with findings from other previous studies (Pozo Sánchez et al., 2020; Sailer et al., 2021), as well as other areas, such as developing students' DC, assessment and digital pedagogy, where previous national and international studies have reported lower levels (Han et al., 2025; Romero-Tena et al., 2024; Vidal Esteve et al., 2025).

Conversely, teachers reported lower competence in D3 (Relational, ethics, and safety) and D4 (Personal and professional), which encompass communication, collaboration and content creation, reflecting trends in prior research (Rojo-Ramos et al., 2020; Segura Rondan et al., 2022). While cross-study comparisons remain difficult due to variations in TDC frameworks and instruments, COMDID-A's alignment with reference frameworks and its inclusion of distinctive elements such as digital inclusion, leadership and digital identity (Verdú-Pina et al., 2021b) adds robustness to these results.

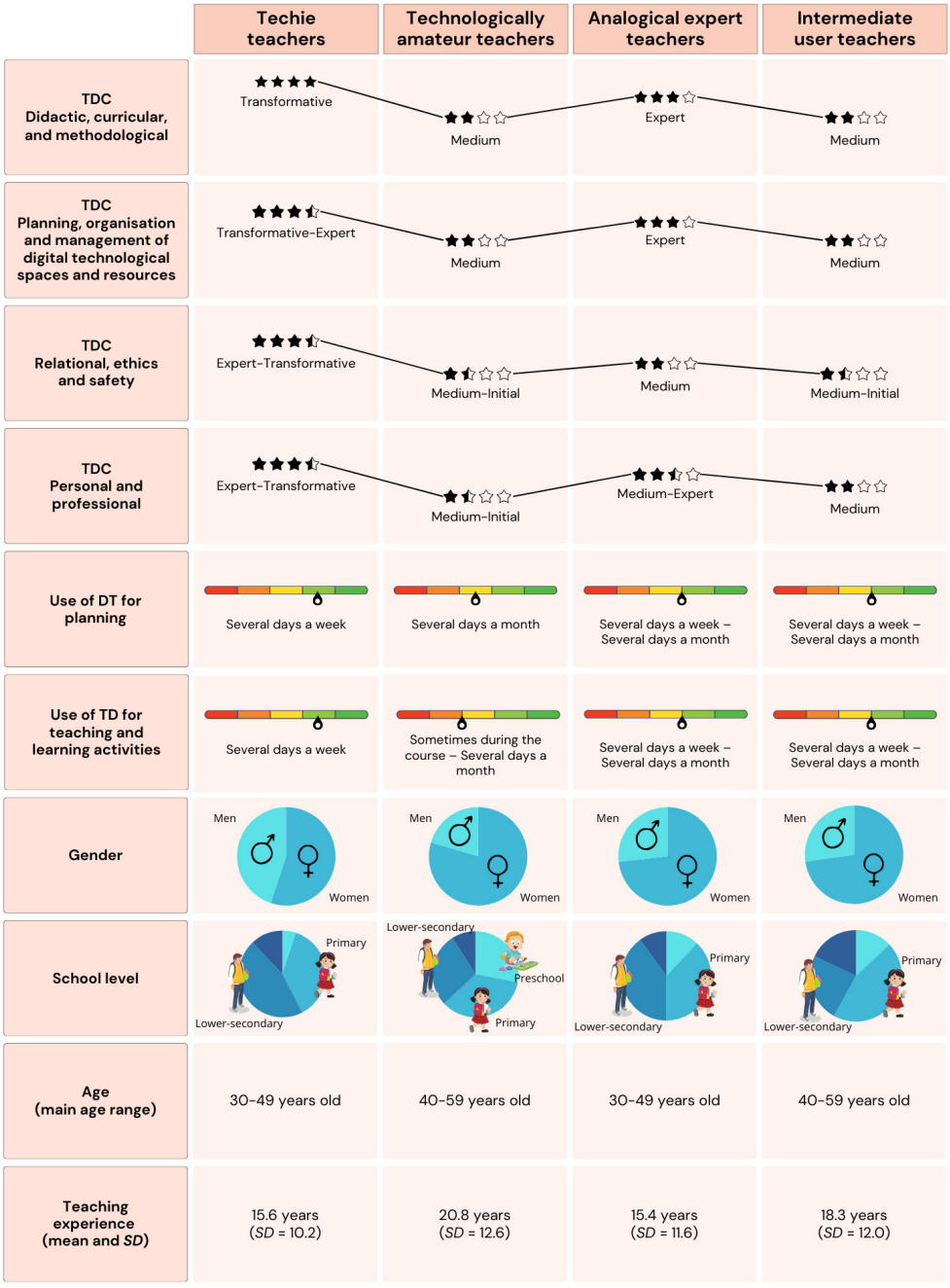
To address RQ2, the frequency and types of DT use were analysed. DT was used more frequently for planning than for implementation, aligning with previous research (Romero-Tena et al., 2020; Suárez-Rodríguez et al., 2018). A key strength of the instrument used in this study (Verdú-Pina et al., 2021a) is its detailed assessment of educational DT use, covering a broad range of items for both planning and implementation. In planning (U2), DT is most often used to design teaching materials, while sharing online activities and resources is less common. These patterns align with findings from national and international studies (Kaarakainen & Saikkonen, 2021; Romero-Tena et al., 2020). In implementation (U3), DT is primarily used for presenting information and enhancing motivation, whereas its use for fostering computational thinking and collaboration is limited. These findings reflect the continued emphasis on passive learning approaches (Han et al., 2025; Pozo et al., 2021; Sailer et al., 2021). The application of this new questionnaire thus enriches previous research by offering more nuanced insight into the types of DT-supported activities.

To address variation masked by aggregate analyses, RQ3 utilized a cluster analysis, yielding four teacher profiles: *techie teachers, technologically amateur teachers, analogical expert teachers, and intermediate user teachers* (Figure 18).

These teacher profiles reveal that higher self-perceived TDC aligns with more frequent DT use—especially in planning—and with a more balanced use across planning and implementation. This supports previous findings linking TDC to higher DT use frequency (Konstantinidou & Scherer, 2022; Momčilović & Ninković, 2024). Notably, this study provides a more detailed view of how TDC relates to specific types of DT use.

Figure 18

*Summary of the four teacher profiles from the cluster analysis.*



Despite reporting medium-high TDC self-perception, *analogical expert teachers* use DT less frequently for implementing activities than *intermediate user teachers*. This discrepancy suggests that self-perceived competence may not always reflect actual competence. Teachers may overestimate or underestimate their abilities, and factors such as gender, school level, age, and teaching experience may influence both TDC and DT use. The significant cluster differences across these variables validate this characterization.

Clusters with a higher proportion of women (*technologically amateur teachers* and *intermediate user teachers*) tend to exhibit lower self-perception across TDC dimensions, consistent with prior studies showing higher self-perception among men (Hershkovitz et al., 2023; Portillo et al., 2020). However, *techie teachers,* which has the highest TDC self-perception, includes women with high self-perceived TDC, indicating gender is not determinative and highlighting the need to consider additional variables. Regarding DT use, *technologically amateur teachers* (predominantly women) report the lowest usage, especially for implementing activities. This supports some international findings (Xu & Zhu, 2023), but contrasts with studies from Spain and other European countries reporting no gender differences (Hämäläinen et al., 2021; Lomos et al., 2023; Pozo et al., 2021).

In terms of school level, *technologically amateur teachers* include the highest proportion of preschool educators, the lowest frequency of DT use, and the highest proportion of teachers at the initial TDC level. These findings align with Vidal Esteve et al. (2025) and Hurtado-Mazeyra et al. (2022), who observed higher TDC levels at higher educational stages. Regarding DT use, Pozo et al. (2021) reported less frequent DT use among teachers in the early years of primary education compared to teachers in higher stages. Notably, existing literature exploring the relationship between TDC, DT use, and school level (especially preschool) is limited, making the present study a valuable contribution to this under-researched area.

Finally, *techie teachers* and *analogical expert teachers*, the youngest and least experienced teachers of all clusters, exhibit the highest levels of TDC. Meanwhile, *technologically amateur teachers*, the oldest and most experienced ones, report the lowest self-perceived TDC and least frequent DT use. These findings concurred with Romero-Tena et al. (2024) and Lucas et al. (2021), who found that older and more experienced teachers tend to be less digitally competent. Given mixed evidence on age effects (e.g., Lomos et al., 2023; Hershkovitz et al., 2023), the importance of integrated analyses that consider multiple variables is highlighted, rather than relying on isolated correlations.

## Limitations and future research

The results of this study provide a solid empirical basis for future research, particularly as they capture a unique educational context during the COVID-19 pandemic (2020–2021). Although this period disrupted normal teaching routines, evidence indicates that it did not substantially affect the development of digital competence or the typology of digital uses, but rather their frequency (Pozo et al., 2021). Digital competence requires sustained training and practice, which was not widely implemented during the pandemic (Beardsley et al., 2021). Our focus on the diversity of

uses to characterize teacher profiles assumes proportional increases in usage across the board. A logical next step would be to conduct comparative studies between this cohort and subsequent academic years (e.g., 2023/24 or 2024/25) to examine whether the patterns observed persist in more stable contexts. Similar research suggests that these profiles remain consistent, reinforcing the relevance of our findings (Pozo et al., 2021). Additionally, developing multivariate models could deepen the interpretation of relationships between variables.

Another primary limitation is the sample's focus on Spain, which restricts the generalisability of findings. Future research should extend internationally, adapting instruments to different contexts. COMDID has been applied in Latin America and Europe, and the DT use questionnaire could be similarly adapted worldwide. Institutional support remains essential to facilitate school participation in data collection.

## Conclusions

This study integrates multiple variables, providing nuanced teacher profiles based on teachers' digital competence self-perception and educational use of digital technology highlighting both strengths and areas for development. These profiles offer insight into the interaction between the different variables and provide valuable information on their strengths and weaknesses. Such findings can inform decisions on ongoing professional development and support required for the effective educational use of digital technology.

The present research characterized teacher profiles regarding self-perceived teachers' digital competence and educational use of digital technology. In response to RQ1, most teachers reported medium-expert digital competence, with higher levels in didactic, curricular, and methodological aspects, and planning, organization, and management of digital resources. Lower competence was observed in relational, ethics, and safety, and personal-professional dimensions. Digital technology use (RQ2) was more frequent for planning than for implementation, with teacher-centred practices—such as information presentation and motivational tools—being more common than student-centred uses, including computational thinking, self/co-assessment, and collaboration. Unlike previous research, this study offered a more pedagogically nuanced understanding of digital technology use, moving beyond tool usage frequency to examine specific types of educational practices

Addressing RQ3, teacher profiles differed by gender, school level, age, and experience. Generally, higher teachers' digital competence correlated with greater digital technology use and more balanced usage across planning and implementation. However, *technologically amateur teachers* reported notably low use of digital technology for computational thinking and self/co-assessment.

Gender influenced the profiles, with female-dominated clusters exhibiting lower teachers' digital competence and digital technology use, although combined factors (school level, age, experience) produced varied patterns. Preschool teachers reported lower self-perceived digital competence and digital technology use compared to those at higher levels. Younger, less experienced teachers (*techie teachers*) showed the highest digital competence and digital technology use, whereas *analogical expert teachers* (similar

in age and experience) reported lower digital competence and digital technology use, especially in student-centred activities, possibly due to a higher proportion of women and preschool teachers in this group.

These findings align with existing literature while offering a more nuanced analysis. The results indicate that neither the teachers' digital competence level nor the use of digital technology respond to a single variable; rather, they are complex constructs influenced by the interaction of multiple variables. This cluster analysis can inform tailored training strategies by policymakers. Additionally, identifying demographic patterns in teachers' digital competence and digital technology use helps address gaps and foster equity. For instance, teachers with advanced skills may benefit from specialized programmes, while those with basic skills may require more foundational training. Involving *techie teachers* in these initiatives could be valuable, as they can share their expertise and experiences, acting as role models or "coaches" for their peers (Yurtseven Avci et al., 2020).

There is a need to strengthen teachers' digital competence training, particularly in relational, ethics and safety, and personal and professional dimensions, especially for *technologically amateur* and *intermediate user teachers*. It is also recommended to promote the use of digital technology (especially for implementing student-centred activities) among *technologically amateur, analogical expert* and *intermediate user teachers*. These insights support targeted interventions to reduce inequalities from initial teacher training to in-service professional development.

Ultimately, this study offers a more comprehensive and integrative understanding of teachers' needs and strengths regarding their digital competence and the educational use of digital technology, which enhances insight into the interaction of various variables and provides valuable information to inform educational decision-making.

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## Appendix

COMDID-A in-service teachers: Dimensions and indicators of the questionnaire. (https://doi.org/10.34810/data881)