# Digital Technologies: Identification of Patterns and Teachers' Profiles in the Catalan Context

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## Abstract

The purpose of this article is to understand the perspectives of Catalan teachers regarding the role of digital technologies in Education. The analysis relied on questionnaire survey data, using multivariate statistical analysis (principal component analysis or PCA) in order to understand patterns in teacher perspectives about digital technologies. This was followed by employing a clustering technique to identify teacher profiles of perspectives on the relationship between digital technologies, teaching and learning based on those patterns (using principal component scores). During a later stage, those profiles were characterized by relating them with teacher characteristics, digital competence levels, and usage of digital technologies in teaching practices. Our findings suggest that there are 5 main patterns that structure teachers' perspectives on this relationship: usefulness for networked learning, usefulness for effective learning, usefulness in the learning process, threats for learning and importance of combining new technologies with traditional methods. In addition, six teacher profiles were identified based on the teachers' positioning regarding these five perspective patterns.

**Keywords**: Digital Technologies, Teachers, Digital Competence, Teachers' perspective, training methods, Teachers' Patterns

## Introduction

The recent developments in Information and Communication Technologies (ITCs) are transforming how we live, work, produce knowledge and learn. This transformation is visible in the educational field as well, since there has been a profound process of implementation of ICTs in educational institutions as reported by authors such as Area et al. (2014) or Paredes et al. (2015). In the case of Catalonia, the education department of the government has supported the integration of ICT in education, considering it in the in the Education Law of Catalonia (LEC), in which ICTs are addressed explicitly and, according to the Article 52, "to train students for

the critical analysis of the media and the use of new technologies" is a main objective. In addition, it states that curricula "should be oriented towards the acquisition of basic skills, which should contribute to the personal development of students and to the practice of active citizenship, and must incorporate information and communication technologies in the learning processes". Thus, a critical perspective on ICTs usage and its connection to citizenship is already included in the LEC of 2009.

The education department defined the students' digital competence back in 2013 and how it should be integrated in the educational curricula. Considering the previously cited law, this emphasis on student digital competence must not be isolated from a change in the role of teachers, which the law also mentions. In article 104 on teaching function it is indicated that "the teachers and professors have, among others, the functions of … using information and communication technologies, which they must know and master as a methodological tool". Also, with respect to teacher training in the text, it is specified that "initial teacher training should include … mastery of information and communication technologies". In the legal text's framing of ICTs in teaching, technologies themselves are not considered the primary vector of intervention but become subordinated to the roles of the teacher and pedagogical methodology.

It is known that teachers' perceptions greatly impact their teaching practices (Domingo & Garganté, 2016). There have been qualitative studies on teacher views of ICTs (Alonso, Guitert & Romeu, 2014; Area et al., 2014). This paper deals with the same phenomena in a quantitative approach, while trying to be faithful to the original complexity and heterogeneity of teacher perspectives on the relation between digital technologies, teaching and learning. The method employed was an international online questionnaire survey, undertaken in the frame of the DECODE, (DEvelop COmpetences in Digital Era) research project. This article focuses on the questionnaire and the data from Catalonia.

## Method

The design of the research is based on a quantitative perspective (Cohen, Manion, & Marrison, 2007) with the use of an online survey as a data gathering tool that was designed following the current bibliography on the field.

The survey was sent to the directorate of non-higher education Catalan schools (kindergarten, primary, secondary and vocational training), who were asked to share it among each schools' teaching staff (total sample size of 425 after filtering out

incomplete cases). Two questions containing sets of Likert-scaled items were used to measure teachers' perceptions about technology. The first set of items is related to the usefulness of technologies in learning and teaching. Respondents were asked to rate them according to a 5-point scale ranging from *Not at all* to *Very useful*. The second set of items consisted on phrases related to the impact of technology in learning and teaching. These items were rated according to a 4-point scale ranging from *Totally disagree* to *Totally agree*. The Likert-scaled items were then treated as quantitative (interval) variables. In order to make sense of the variables related to the personal views of teachers regarding educational technologies, we performed a dimension reduction technique called principal component analysis (PCA). It allows the identification of principal components, which are a linear combination of variables that reduce complexity and help the analytical process. The PCA statistical technique (Jolliffe, 2011) uses an orthogonal transformation to convert observations of possibly correlated variables into values of linearly uncorrelated (not directly observed) variables called principal components. This transformation is defined such that the first principal component has the largest possible variance (i.e., accounts for as much of the variability in the data as possible), and each succeeding component has the highest variance possible – under the constraint that it is orthogonal to the preceding components. The result is a new orthogonal coordinate system that optimally describes variance in a dataset: reducing a large set of variables to a smaller set while containing most of the original information.

The resulting components were then used for creating teacher profiles, using a clustering (segmentation) technique, on the basis of their perspectives on the relationship between technology teaching and learning. The cluster analysis was carried out using the standardized principal component scores resulting from the abovementioned PCA and the k-means partition method (Aldenderfer & Blashfield, 1984; Hartigan, 1975). The *optimal* number of clusters was identified using the traditional approach of calculating the cluster solution for the various numbers of clusters and plotting the within-cluster error for each. The resulting *scree plot* should show an *elbow* – point in which the relative change in error stops diminishing substantially as the number of clusters in the solution increases – at the correct number of clusters s (Gierl & Schwanenberg, 1998; Gower, 1975). Finally, these profiles were characterized in relation to professional and socio-demographic variables, digital competence, internet usage patterns, and the adoption of digital tools in their teaching practices. The questionnaire contained the digital competence Likert-scaled indicators from the European Framework for the Digital Competence of

Educators: DigCompEdu (Redecker, 2017), which were treated quantitatively and averaged to create a single digital competence index.

## Results

### *Principal Component Analysis (PCA)*

The PCA used 21 items (the previously mentioned employability skills) and was performed in R (version 3.4.0) using the Principal components analysis (*principal*) function of the Procedures for Psychological, Psychometric, and Personality Research (*psych*) package (version 1.8.4). The overall Kaiser-Meyer-Olkin (KMO) measure of sample adequacy (MSA) is 0.91 and the same measure for each variable has a minimum value of 0.73 which means the sample is adequate for performing a PCA (minimum acceptability threshold is 0.6). The PCA resulted in 4 principal components with an Eigenvalue bigger than one, the rule of thumb for identifying the number of components, but we decided to retain a fourth (its Eigenvalue was 0.88, thus close to one). Finally, the PCA used the varimax orthogonal rotation method. The high values of variable loadings (variable loadings in each principal component translate the covariance/correlation between the original variables and the components) allow the characterization of the different components. The naming of each component resulted from the interpretation of the associated variables (presented in the order of the highest loadings):

The first component was mainly associated with the following variables:

- improve communication, collaboration and coordination between colleagues, students and institutions;
- strengthen continued professional development (CPD) as a teacher;
- involve other actors in the learning process;
- link school activities with work experience practices;
- integrate formal, non-formal and informal learning.

Since it seemed to point to the usefulness of ICTs for making connections in the pedagogic process, both within the classroom and with the exterior environment, we named it *networked learning*.

The second component was mainly associated with the following variables:

- to make students more autonomous;
- to make students more active in their own education;
- to make the learning process more meaningful for students;
- to make the learning process more effective (students who have achieved superior results than expected);
- to make the learning process more efficient (success with less effort and / or lower costs).

This component also seems to be related to the pedagogic process, but mostly refers to the effects of technology in terms of autonomy and content knowledge meaningfulness and acquisition. Thus, we named it *Active learning*

The third component was mainly associated with the following variables:

- the use of digital technologies promotes the development of responsible digital and media skills;
- the use of digital technology promotes positive learning outcomes by influencing how students behave;
- the use of digital technology promotes the development of basic skills (reading, writing, understanding);
- the use of digital technologies helps when designing and organizing educational materials.

The third component, like those before, is also associated with the pedagogical possibilities of technology: the acquisition of basic digital, media, reading and writing skills, positive impact in student behavior, in addition to material design and organization as well as student self-evaluation. Therefore, we chose the name Effective learning in order to denote the more operational aspects of these items.

The fourth component was mainly associated with the following variables:

- the use of digital technologies is a distraction for students;
- the use of digital technologies increases the level of cyberbullying;
- digital technologies do not improve the processes of teaching and learning.

This component is clearly related to a negative view of technology, so we termed it *Threats of technology for learning*.

The fifth and last component was mainly associated with the following variables:

- it is necessary to integrate e-learning into teaching activities, along with traditional classroom-based teaching methods;
- the use of digital technologies does not have to replace traditional methods of teaching;
- the daily use of technology in the classroom is not enough, students need to learn how to use books.

The component is most associated with variables that relate to the irreplaceability of traditional teaching methods by technology, which led us to name it *Complementary with traditional methods*.

### *Cluster analysis*

The following section refers to the comparative characterization of teacher profiles found through cluster analysis (see Table 1):

Table 1: Teacher profiles and averages of the principal component scores used as inputs in the cluster analysis

| Cluster | N | % | Usefulness for networked learning | Usefulness for effective learning | Usefulness in the learning process | Threats for learning | Useful only when combined with traditional methods |
|---|---|---|---|---|---|---|---|
| 1 | 120 | 28 | 0.20 | 0.58 | -0.65 | 0.15 | -0.57 |
| 2 | 96 | 23 | 0.19 | 0.09 | 0.06 | -0.80 | 1.07 |
| 3 | 81 | 19 | 0.63 | -0.41 | 0.80 | -0.34 | -0.70 |
| 4 | 55 | 13 | -1.83 | -0.03 | 0.20 | 0.16 | -0.11 |
| 5 | 40 | 9 | -0.06 | -1.67 | -1.02 | 0.61 | 0.15 |
| 6 | 33 | 8 | 0.30 | 0.71 | 1.12 | 1.61 | 0.65 |
| Total | 425 | 100 | 0 | 0 | 0 | 0 | 0 |

### *Profile 1*

Teachers in the most common profile, containing 28% of the total sample, consider technology useful for effective learning but not useful in the teaching-learning process and tend to neglect the importance of combining it with traditional teaching methods. The digital competence of these teachers does not differ from the overall sample. This seems to suggest an idealized but not applicable perspective on the relationship between technology, teaching and learning. In terms of socio-demographic and professional characterization, teachers in this profile seem to follow the overall sample distribution except for gender, containing a higher percentage of women. Personal digital technologies usage also tends to follow the overall sample distribution except

that these teachers tend not to use said technologies for leisure. Finally, their usage of digital tools for teaching practices is also typical, except for a higher usage of tools for audio/video/graphic edition.

### *Profile 2*

The second most common profile contains 23% of the sample and is the profile that mostly considers the importance of combining digital technologies with traditional methods while, at the same time, the one which least associates it with learning barriers. This profile's perspectives on digital technologies' usefulness for learning (networked learning, effective learning and learning process) are close to the overall sample mean and it shows higher values of digital competence. Thus, it denotes a balanced position that stresses the importance of traditional methods. It does not differ greatly in terms of professional and socio-demographic characteristics from the whole sample, except that it tends to contain more school digital coordinators. Personal digital technologies usage is similar to the first profile except that these teachers tend to use them for leisure. Comparatively, a greater diversity of tools are also more frequently used in their teaching practices: tools for audio/video/graphic edition, office and similar programs, learning/communication/collaboration environments, and relevant multimedia programs.

### *Profile 3*

In third place, containing 19% of the sample, comes the profile that most neglects the importance of combining digital technologies with traditional methods. It tends to emphasise formal usefulness (aiding in networking and in the learning process) of digital technology for learning but not its pedagogical effectiveness. The digital competence level of this profile tends to be close to that of the overall sample. These teachers tend to be older and teach in lower level schools. Personal digital technology usage is associated with professional networks and personal/professional development. Digital tools usage in teaching follows the overall sample distribution but the profile shows a greater tendency for using digital forms of self- and co-assessment, and also using digital rubrics for assessment.

### *Profile 4*

The fourth profile contains 13% of the sample and is characterized by average values (close to 0) in all component scores except for usefulness in networked learning. This profile is thus characterized by a sceptical view about technology's ability to connect learning to other spheres of activity. The digital competence level of this profile is

comparatively lower. The profile contains less women and less school digital coordinators. These teachers tend to be younger and teach in higher level schools (secondary overrepresented). In terms of digital technology usage in learning, they tend (somewhat expectedly) not to create blogs and websites nor to use learning/communication/collaboration environments. They are also characterized for not using coding/computational thinking in teaching nor digital portfolios for assessment.

### *Profile 5*

The fifth profile, containing 9% of the sample, is characterized by the lowest scores in the usefulness for effective learning and in the teaching-learning process, accompanied by a significantly higher identification of technology with threats to learning. The level of digital competence in this group is lower than the overall sample. These teachers tend to be older, contain less women, teach in higher level schools (VET highly overrepresented), and contain less school digital coordinators. They exhibit the tendency not to use digital technologies: for personal usage / as tools for teaching or assessment.

### *Profile 6*

Finally, the sixth profile, which contains 8% of the sample, shows both the highest values in terms of considering digital technologies useful for effective learning and the learning process, as well as the highest values concerning the threats they may pose to learning. In addition, it also tends to highlight the importance of combining these technologies with traditional methods. These teachers tend to be older, contain more women, teach in higher level schools (secondary schools are overrepresented), and contain less school digital coordinators. This group exhibits the highest level of digital competence of all the identified profiles and a higher tendency to engage in all personal uses of digital technologies (social networks, professional networks, personal/professional development, and leisure). Finally, these teachers tend to use all sorts of tools more frequently than their counterparts except for resources for creating blogs and websites, and a high proportion of them uses all the digital assessment tools mentioned in the survey.

## Conclusions

The performed PCA suggests that there are five main big patterns that organize Catalan teachers' perceptions on the relationship between digital technologies and education. The first three are related to the pedagogic usefulness of technologies: one related to the possibilities of a more open and socially inclusive education model (networked learning), another to the successful acquisition of knowledge and skills (effective learning), and the last is associated with improvements in pedagogical situations (learning process). There are, however, other patterns in teacher perspectives that do not associate digital technology with usefulness but with dangers (threats for learning) and with the older, traditional teaching and learning methods (importance of combining digital technologies with traditional methods).

In order to better understand the heterogeneous reality of these perspectives, it is not enough to identify agglomerating patterns in terms of perspectives on technology and education. It is important to describe how the teachers position themselves in relation to these axes. This is the rationale behind the creation of the teacher profiles. The recent development of computing and other digital technologies has been rapidly changing the daily lives of an increasing amount of the world's population. In the field of educational technology, like in many other fields of scholarship that deal with the impact of emerging technologies, there is a *default logic* which associates computing with a general tendency towards improvement (Bigum, Bulfin, & Johnson, 2015). This *default logic* is not limited to research about education and technology but also to the perception of most Catalan teachers: the most common profile (profile 1) seems to have a positive view on technology but not on the possibility of implementing it into their teaching practices (learning process).

The second most common profile, however, is related to the importance of integrating and combining new technologies with traditional methods, referring to a more balanced and nuanced perspective on this relationship. The third profile sees the formal benefits of technology but not it's pedagogical effectiveness. The fourth tends to be sceptical of the networking and connecting possibilities of digital technologies in education. The fifth profile comprises those who tend to be critical of digital technology's usefulness for teaching and learning. Finally, the sixth and smallest profile comprises the teachers who are advanced users of digital technologies. The identification of those teachers is useful in the sense that they can be ascribed an orienting role in training programmes to foster their colleagues methodological digital

competence and critical awareness of both the possibilities and the dangers that technologies pose to learning.

The profiles identified can be useful in the detection of teachers' training needs for the design of training proposals in digital competences. Further research can be focused on the relationship between the identified profiles with teachers' level of digital competence in order to design training proposals adapted to each of these profiles.

## References


1. Aldenderfer, M. S., & Blashfield, R. K. (1984). Cluster analysis. *Sage University Paper series on Quantitative Applications in the Social Sciences, No. 07-044.* Newbury Park, NJ: Sage.
2. Area, M., Alonso, C., Correa, J. M., Moral, M. E. D., Pablos, J. D., Paredes, J., ... & Valverde, J. (2014). Las políticas educativas TIC en España después del Programa Escuela 2.0: las tendencias que emergen. *RELATEC: Revista Latinoamericana de Tecnología Educativa, 13*(2), 11-34.
3. Alonso, C., Guitert, M., & Romeu, T. (2014). Los entornos 1x1 en Cataluña: entre las expectativas de las políticas educativas y las voces del profesorado. *Educar, 50*(1), 41-64.
4. Bigum, C., Bulfin, S., & Johnson, N. F. (2015). Critical Is Something Others (Don't) Do: Mapping the Imaginative of Educational Technology. In S. Bulfin, N. F. Johnson, & C. Bigum (Eds.), *Critical perspectives on technology and education.* NY: Palgrave.
5. Cohen, L., Manion, L. & Marrison, K. (2007). *Research Methods in Education* (6th ed.). New York: Routledge.
6. Departament d'Ensenyament de la Generalitat de Catalunya (2013). Competencies bàsiques en l'àmbit digital Barcelona: Generalitat de Catalunya.
7. Domingo, M. G., & Garganté, A. B. (2016). Exploring the use of educational technology in primary education: Teachers' perception of mobile technology learning impacts and applications' use in the classroom. *Computers in Human Behavior, 56*, 21-28.
8. García-Valcárcel, A., & Tejedor, F. J. (2017). Percepción de los estudiantes sobre el valor de las TIC en sus estrategias de aprendizaje y su relación con el rendimiento. *Educación XX1, 20*(2), 137-159. doi: 10.5944/educxx1.19035

9. Gierl, H., & Schwanenberg, S. (1998). A comparison of traditional segmentation methods with segmentation based upon artificial neural networks by means of conjoint data from a Monte Carlo simulation. In I. Balderjahn, R. Mathar, & M. Schader (Eds.), *Classification, data analysis, and data highways* (pp. 386–392). Berlin: Springer.

10. Gower, J. C. (1975). Generalized Procrustes analysis. *Psychometrika, 40*, 33–51.

11. Hartigan, J. (1975). *Clustering algorithms.* New York: John Wiley.

12. Jolliffe, I. (2011). Principal component analysis. In M. Lovric (Ed.), *International encyclopedia of statistical science* (pp. 1094-1096). Berlin, Heidelberg: Springer.

13. Paredes, J., Guitert M., & Rubia B. (2015). La innovación y la tecnología educativa como base de la formación inicial del profesorado para la renovación de la enseñanza. *Revista Latinoamericana de Tecnología Educativa, 14*(1), 101-114.

14. Redecker, C. (2017). *European Framework for the Digital Competence of Educators: DigCompEdu.* EUR 28775 EN. Publications Office of the European Union, Luxembourg. http://dx.doi.org/10.2760/159770.