Study Regarding the Teacher Training Related to Digital Technology in Romanian Educational System

Dumitrel-Victor Tița[1], Nicolae Bold[2], Doru Anastasiu Popescu[3], Mirela Georgiana Oprea[4], Claudia Ionela Trușcă[5]

Abstract: Technology plays an essential role in modernizing education, facilitating access to information, diversifying teaching methods, and increasing student involvement in the learning process. This study investigates teacher training in digital technology, analyzing the level of training, current skills and challenges encountered in the process of integrating technology into the educational process. The analysis was made on the Romanian educational system actors on a period extending on the first part of 2025. The study was developed in order to assess the level of skills and competencies of teachers related to the usage of digital technology in their role as a teacher and it is based on current competencies frameworks used at a national, European and global level, such as DigCompEdu. Some associations related to group profile and other professional indicators are made using statistical and

[1] Lecturer, PhD, University of Agronomic Sciences and Veterinary Medicine Bucharest, Faculty of Management and Rural Development, Slatina Branch, Slatina, Romania, E-mail: victortita@yahoo.com.
[2] University Assistant, PhD, National University of Science and Technology Politehnica Bucharest, Pitești University Center, Faculty of Sciences, Physical Education and Computer Science, Department of Computer Science, Pitești, Argeș, Romania, Corresponding author: bold_nicolae@yahoo.com.
[3] Lecturer, PhD, National University of Science and Technology Politehnica Bucharest, Pitești University Center, Faculty of Sciences, Physical Education and Computer Science, Department of Computer Science, Pitești, Argeș, Romania, E-mail: dopopan@gmail.com.
[4] University Assistant, PhD Student, University of Agronomic Sciences and Veterinary Medicine Bucharest, Faculty of Management and Rural Development, Slatina Branch, Slatina, Romania, E-mail: mirelaamatei@gmail.com.
[5] University Assistant, PhD Student, West University of Timișoara, Timișoara, Romania, E-mail: claudiaa.trusca@icloud.com.

unsupervised learning for specific results, such as classification. By extrapolation, the results can lead to the definition of several perspectives related to the design of training related to digital technology and its various usages.

Keywords: teacher training; digital; digital competency; supervised learning

1. Introduction

Digital technology plays a key role in modernizing education, facilitating access to information and diversifying teaching methods. In Romania, the effective integration of technology depends on teachers' digital skills. The main problem is the gap between the need for digital teaching and the current level of teachers' digital competence.

Previous studies, especially in Europe, using the DigCompEdu framework, show that teachers often overestimate their skills and that digital integration depends on both training and institutional support. However, there are few large-scale analyses focused on Romanian teachers.

This study analyzes the current level of training, existing skills and challenges faced by teachers, based on the European DigCompEdu framework and statistical methods to identify adapted training needs. In this study, we evaluate the digital skills of 3,079 Romanian teachers based on the DigCompEdu model. We used an online questionnaire, statistical analysis and cluster methods to compare self-perceived and actual competence levels.

The results show significant gaps between perception and reality, and reveal two main digital profiles among teachers. These findings provide new evidence about training needs and offer a clearer basis for designing targeted professional development programs.

Future work should focus on personalized digital training, monitoring progress over time and improving access to technology, especially in schools with limited resources.

2. Literature Review

Teacher quality and continuous professional development are essential for improving student outcomes (Harris & Sass, 2011). In the digital age, teacher education must focus on 21st-century skills and digital competence (Gümüş, 2022; Røkenes & Krumsvik, 2014). The DigCompEdu framework has become a key

reference for assessing and enhancing teachers' digital skills (Builds et al., 2024; Figueira & Dorotea, 2022; Rubio-Gragera et al., 2023; Pettersson, 2018), while systematic reviews show that educators often overestimate their proficiency compared to measured results (Pinto-Santos et al., 2022).

Digital competence also depends on contextual and institutional factors such as access to infrastructure, collaboration, and school culture (Engen, 2019; Zabolotska et al., 2021; ElSayary, 2023; Popa, 2025). Recent studies emphasize that digital transformation in education requires both technical and pedagogical innovation to sustain teachers' motivation and confidence (Røkenes & Krumsvik, 2014; Pettersson, 2018).

For quantitative analysis, data mining approaches have been effectively applied in education research. Orange Data Mining, an open-source Python platform, is particularly suited for clustering, correlation, and pattern discovery in large educational datasets (Demšar et al., 2013). This tool was used to determine several conclusions of the statistical and analytical study. In this study, it was used to analyze teacher self-assessments and identify digital competence profiles within the Romanian educational system.

3. Material and Method

3.1. Data Description

Data was collected using the Moodle platform, as part of an educational project conducted in the first half of 2025. The questionnaire focused on teachers' self-assessment of digital competencies, based on the DigCompEdu framework.

Data analysis was performed using tools from the Orange Data Mining platform, including:

- Descriptive and correlational analysis;
- Unsupervised classification through Hierarchical Cluster Analysis (HCA) to identify patterns and competence groups and k-means to check HCA validity.

The data collection process has the next characteristics:

- Data Source: Collected via Moodle platform in early 2025, as part of a national teacher training project;

- Sample Size: 80 variables across multiple digital competence areas;
- Framework Used: Based on the DigCompEdu framework;
- Content:
    - Teacher self-assessment of digital skills;
    - Access to digital infrastructure and school support;
    - Use of online tools, experimentation with new technologies;
    - Institutional and peer support for digital integration.

The data had the next characteristics:

- Total Responses: 3,079;
- Average Teaching Experience: 19.2 years;
- Average Pre-Training Digital Level: 2.29 (on a 1–6 scale);
- Standard deviation ranges between 0.4 – 1.1, indicating moderate diversity in digital skill levels;
- Most questions have 0% missing data, ensuring high response reliability.

These characteristics show that the database used is solid, relevant and representative for the Romanian education system. The large number of responses, the lack of missing values and the diversity of variables allow for rigorous statistical analyses and the identification of significant patterns regarding the level of digital competence of teachers. The integration of DigCompEdu as a reference framework provides coherence to the assessment of digital competences, and the use of methods such as descriptive, correlational analysis and unsupervised clustering allows not only the description of the phenomenon, but also the differentiation of teachers according to competence profiles. Thus, the applied methodology provides a solid basis for interpreting the results and formulating relevant recommendations for the creation of digital training for teachers.

3.2. DigCompEdu Framework Highlights

The DigCompEdu framework is structured into six key areas: Professional Engagement, Digital Resources, Teaching and Learning, Assessment, Empowering Learners, and Facilitating Learners' Digital Competence.

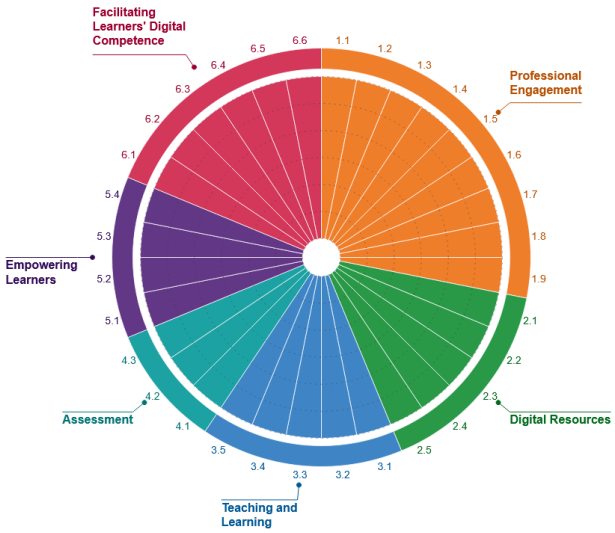

Figure 1. A Graphical Depiction of DigCompEdu Framework

It provides a comprehensive guide for educators' digital development, guiding the effective integration of technology in teaching, learning, and professional development.

4. Results

4.1. Statistical Analysis

The demographic analysis of the participants provides a clear picture of the profile of the teachers included in the study and allows understanding of the context in which digital skills are developed and applied. Variables such as gender, the level of education they teach, geographical distribution and seniority in education directly influence the way in which technology is perceived, used and integrated into the teaching activity. Thus, the presentation of this data is essential for the correct interpretation of the results on digital skills and for the substantiation of training programs adapted to the reality in schools.

The vast majority of participants are female (2,692), while only 381 are male. This reflects the gender composition of the Romanian teaching workforce, especially in

primary and secondary education.

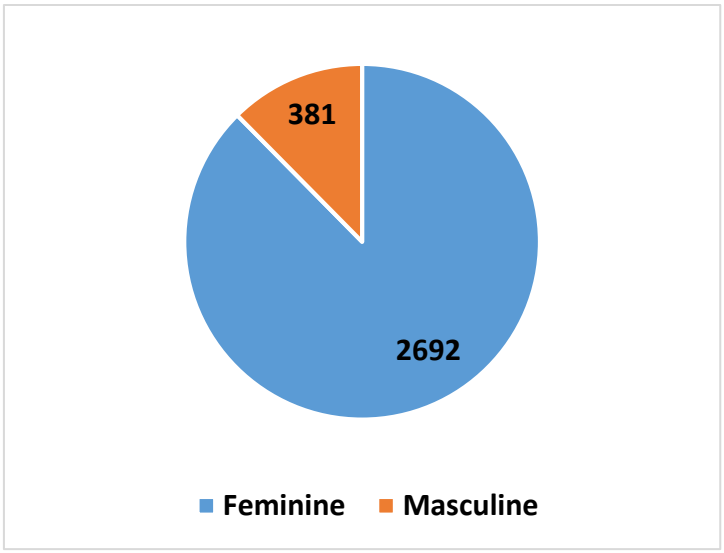

Figure 2. Gender Distribution

The vast majority of participants are female (2,692), while only 381 are male. This reflects the gender composition of the Romanian teaching workforce, especially in primary and secondary education. This gender imbalance highlights the importance of tailoring digital training programs to the dominant demographic. Understanding the needs and preferences of female educators can improve the effectiveness and engagement of professional development initiatives.

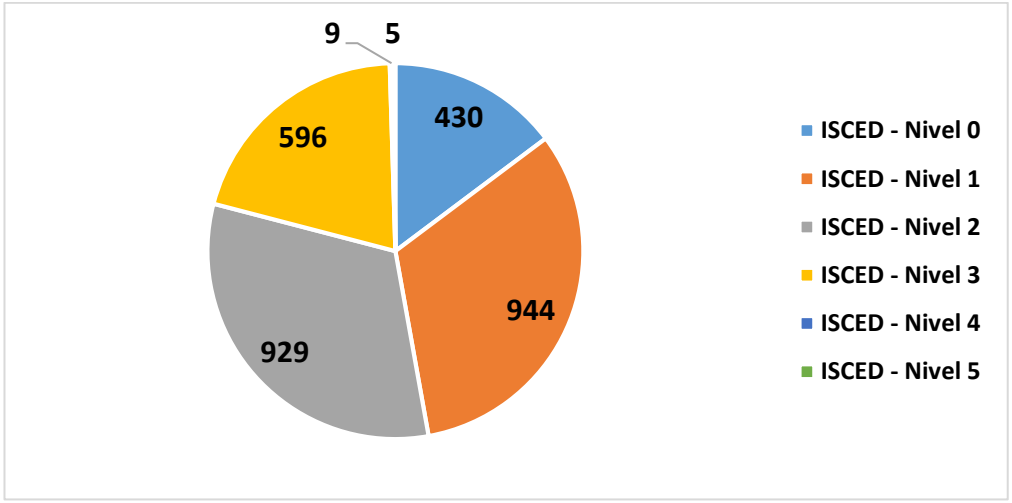

Figure 3. Level of Teaching

Most respondents work in primary (ISCED 1 – 944) and lower secondary education (ISCED 2 – 929). A smaller number are involved in pre-primary (ISCED 0 – 430) and upper secondary education (ISCED 3 – 596). Only a few teach at post-secondary (ISCED 4 – 9) and tertiary levels (ISCED 5 – 5). This distribution confirms the study's focus on compulsory education levels, where digital training needs are most pronounced.

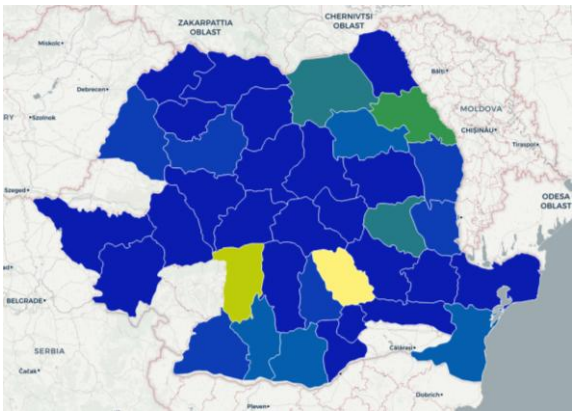

Figure 4. Geographical Distribution

The map shows the geographic spread of teacher responses across Romanian counties. Higher participation was recorded in Vâlcea, Dâmbovița, Iași and Prahova, as indicated by lighter colors (yellow-green). Most other counties show moderate participation (shades of blue), ensuring a broad national coverage and representativity across diverse educational regions.

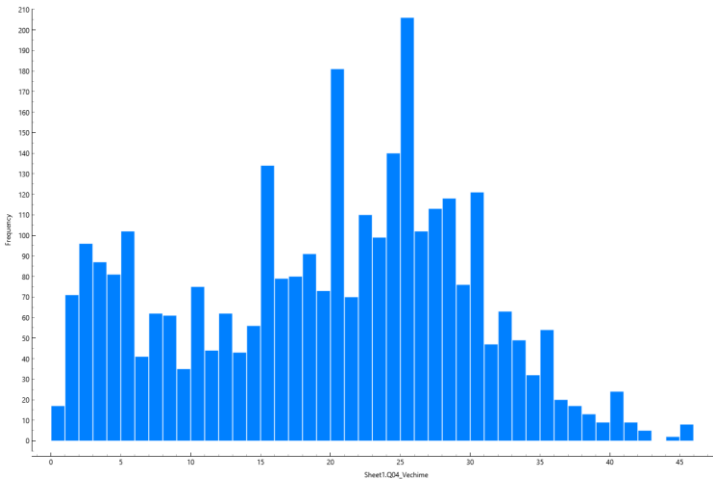

Figure 5. Work Age Distribution

The histogram illustrates the distribution of respondents by years of teaching experience. Most teachers have between 15 and 30 years of experience, with peaks around 20–25 years. This indicates a predominantly experienced teaching workforce, which may influence both the adoption pace and the training needs for digital competencies.

Overall, the demographic data highlights a predominantly female teaching staff, with long experience in education and concentrated mainly in compulsory education cycles. The balanced geographical distribution confirms the national relevance of the study, and the diversity in terms of seniority and work environment indicates the existence of varied digital training needs. These demographic characteristics must be taken into account when designing professional development programs, as they influence motivation, the pace of technology adoption and the effectiveness of digital skills training.

4.2. Competency Analysis

To better understand how teachers, perceive their digital competencies compared to their actual performance, the study analyzed both self-assessed levels and measured results using the DigCompEdu framework. This comparison provides valuable insight into how teachers evaluate their digital abilities before and after reflection, as well as how these perceptions align with objective assessment. Such analysis is essential for identifying possible overestimations or underestimations of digital skills and for designing appropriate training strategies.

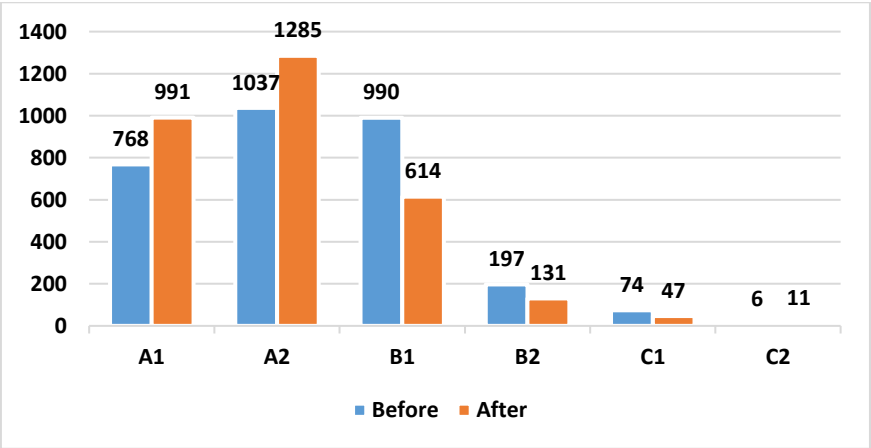

Figure 6. Autoperceived Level of Digital Knowledge

The comparison between self-assessed competency levels before and after the

DigCompEdu questionnaire shows a clear shift toward lower levels becoming less frequent and middle levels more dominant. While initially Level 1 (A1) and 2 (A2) were most common (768 and 1,037 responses respectively), after responding Level 2 (A2) and 1,285 responses at Level 2 remain dominant, but there's a significant increase in Level 1 to 991. This suggests increased awareness and recalibration of digital skills after structured reflection.

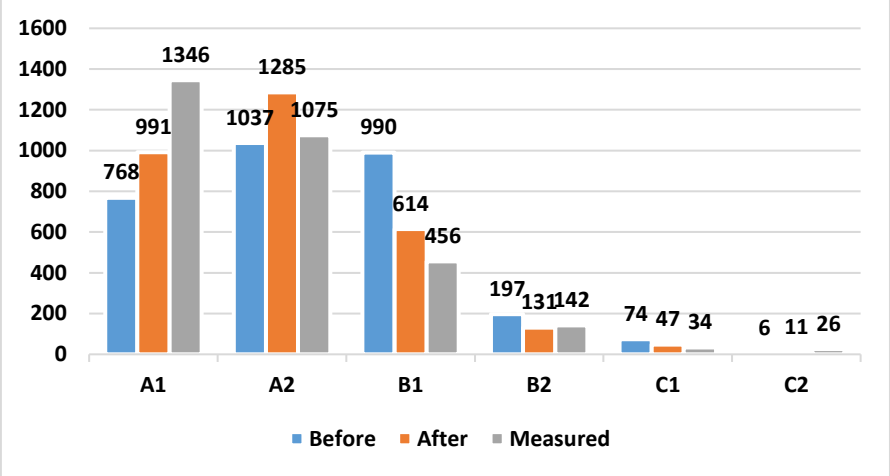

Figure 7. Autoperceived and Measured Level of Digital Knowledge

The comparison shows that the measured digital competency levels differ notably from self-perceptions: while many teachers rated themselves higher after training, the actual evaluation (Measured) places most participants in the A1 and A2 bands (1346 and 1075). Higher self-assessed levels such as B1, B2, and C1 are overestimated compared to measured results, suggesting a gap between perception and actual digital proficiency.

In summary, the findings reveal a clear difference between perceived and actual digital competence. Although self-evaluations show improvement after reflection, many teachers still overestimate their skills when compared to measured results. The concentration of measured competencies in the A1 and A2 levels indicates that real digital proficiency remains at a basic stage for a large part of the sample. These results highlight the need for practical, evidence-based training programs that not only build skills but also promote realistic self-awareness among teachers.

5. Discussions

5.1. General Results

To place the results into a broader European context, it is essential to compare the digital competence levels of Romanian teachers with EU benchmarks and to further investigate internal patterns within the national dataset. This section examines how Romanian educators perform across the six DigCompEdu areas relative to the European average and identifies structural differences that may influence digital teaching practices. Additionally, it explores how teachers can be grouped based on their digital behavior and skill levels, using statistical clustering methods.

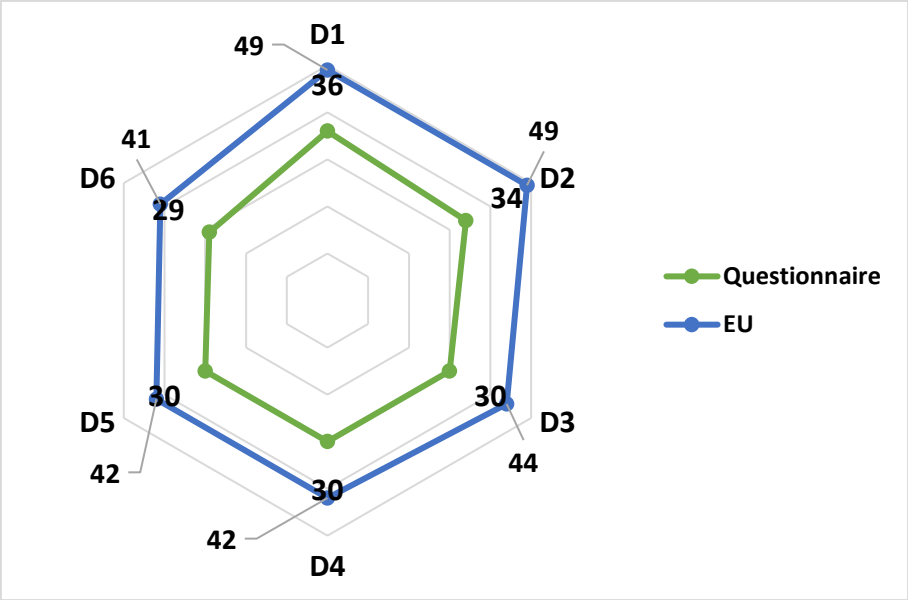

Figure 8. Comparison of Domain Level of Knowledge with EU Average

In all six DigCompEdu competence areas, the percentage of Romanian respondents reaching proficiency levels is slightly below the EU average — for example, 36% vs. 49% in D1 (Professional Engagement) and 29% vs. 41% in D6 (Facilitating Learners' Digital Competence) — indicating key gaps in digital teaching readiness.

These differences suggest that Romanian teachers may have more limited digital integration in key pedagogical areas compared to the European average, highlighting the need for targeted training and support in developing advanced digital competencies.

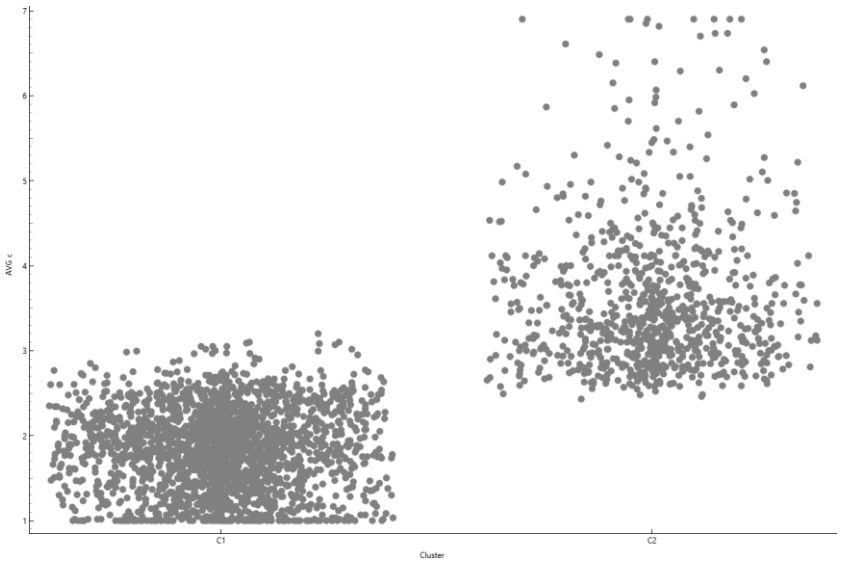

Figure 9. The Obtained Clusters Distributed by Competence Level

To explore underlying patterns in teachers' digital competence profiles, we applied a Hierarchical Cluster Analysis (HCA) using self-reported data. The analysis included only numerical responses and used Ward's method to group participants based on similarity across multiple digital competency dimensions.

The resulting dendrogram suggested an optimal division into two main clusters, reflecting distinct digital behavior patterns, allowing for a deeper understanding of differences in confidence, school context, and digital integration practices.

Overall, the comparison with EU data and the results of the cluster analysis reveal important structural gaps in digital readiness within the Romanian teaching workforce. Romanian teachers tend to achieve lower proficiency levels in all DigCompEdu areas, suggesting reduced integration of technology in pedagogical practice compared to the European average. At the same time, the identification of two distinct clusters confirms that digital competence is unevenly distributed and strongly influenced by access to resources, confidence levels, and institutional support. These findings highlight the need for differentiated professional development strategies—both to strengthen advanced digital skills and to support teachers who remain at basic levels of digital use.

5.2. Cluster Dynamics

Based on the statistical results and the application of Hierarchical Cluster Analysis (HCA), two distinct groups of teachers were identified according to their digital competencies, attitudes, and work environments. These clusters highlight the contrast between teachers who are still in the early stages of digital integration and those who are more advanced and confident in using technology in education. Understanding these profiles allows for better-targeted training strategies and more efficient allocation of educational resources.

Table 1. Mean Scores for the two Clusters for the main Domains of DigCompEdu

DigCompEdu Domain	C1 – Mean Score	C2 – Mean Score
D1 – Professional Engagement	3.41	2.17
D2 – Digital Resources	3.52	1.89
D3 – Teaching & Learning	3.78	1.94
D4 – Assessment	3.69	1.69
D5 – Empowering Learners	3.49	1.56
D6 – Facilitating Students' Digital Competence	3.77	1.87

The first cluster (C1) is the largest group and is characterized by lower digital confidence and limited technological integration:

- Number of Respondents: 2,236;
- Profile: Teachers in this group display moderate or low confidence when using digital tools, especially in key areas such as adapting digital content, digital assessment, and using technology to support and empower learners;
- Environment: They report inconsistent access to digital devices, average or weak institutional support, and in some cases insufficient infrastructure. These conditions make it more difficult to integrate technology in daily teaching practices.
- Attitudes:
    - Less involvement in online professional communities;
    - Rare or cautious experimentation with digital applications and platforms;
    - Training needs are higher and should focus on practical, step-by-step guidance rather than theoretical content.

The second cluster (C2) is smaller but is characterized by strong digital confidence and active use of technology in education:

- Number of Respondents: 843;
- Profile: Teachers in this group report higher self-perceived digital competence, especially in areas like digital communication, content creation, online collaboration, and integrating technology into their lessons;
- Environment: They work in schools with better digital infrastructure, stable internet connection, and greater institutional support from both school leadership and colleagues.
- Attitudes:
    - High participation in online educational communities and networks;
    - Frequent experimentation with new digital tools and platforms;
    - Strong alignment with DigCompEdu principles and innovative teaching practices.

The identification of these two clusters provides a clearer understanding of the diversity that exists within the Romanian teaching community in terms of digital readiness.

Table 2. Infrastructure and Institutional Support (C1 vs. C2)

Indicator	C1	C2
Use of the internet in educational activities	4.41	4.15
Digital equipment available in classroom	4.35	4.25
Reliable & fast internet in school	4.23	4.15
Students have access to digital devices	3.62	3.41
Students have internet-accessible devices	4.05	3.82
School leadership supports digital integration	4.44	4.32
School offers digital professional development	3.95	3.72
Colleagues actively use digital tools	4.18	4.02

Cluster C1 reveals a majority of teachers who require structured, practice-oriented support and better access to digital infrastructure, while Cluster C2 demonstrates that, where resources and institutional encouragement are present, digital competences can develop consistently and effectively. These results show that a uniform training approach is not sufficient. Instead, professional development programs should be differentiated—offering foundational support for teachers in C1 and advanced, innovation-focused opportunities for those in C2. By aligning digital policies with these distinct profiles, educational decision-makers can foster a more inclusive, balanced, and sustainable digital transformation within the national education system.

6. Conclusions

The study confirms that teachers' digital competencies vary significantly, with notable gaps between self-perceived and measured levels of proficiency. While some educators demonstrate confidence and active use of technology, others show limited readiness, particularly in advanced digital teaching practices.

The clustering analysis identified two main profiles: one group is digitally confident and benefits from strong institutional support, while the other requires targeted, practical training and improved access to digital tools and infrastructure.

7. Acknowledgments

This research was developed within the DIGITREND project, implemented by Pro Euro Cons and funded through Romania's National Recovery and Resilience Plan (PNRR).

Data collection and training activities were carried out via the dedicated platform: https://proeurocons.eu/digitrend/.

References

Harris, D. N. & Sass, T. R. (2011). Teacher training, teacher quality and student achievement. *Journal of Public Economics*, *95*(7–8), 798–812.

Gümüş, A. (2022). Twenty-first-century teacher competencies and trends in teacher training. *Y. Alpayd*, 243–267.

Builes, S., Viñoles-Cosentino, V., Esteve-Mon, F. M., & Sánchez-Tarazaga, L. (2024). Digital training in university teaching induction programmes in Spain: a comparative analysis based on DigComp and DigCompEdu. *Educación XX1*, *27*(2), 37–64.

Figueira, L. F. & Dorotea, N. (2022). Digital competence: DigCompEdu Check-In as a digital literacy diagnostic tool to support teacher training. *Educação & Formação*, 7, Universidade Estadual do Ceará.

Rubio-Gragera, M., Cabero-Almenara, J. & Palacios-Rodríguez, A. (2023). Digital innovation in language teaching—Analysis of the digital competence of teachers according to the DigCompEdu framework. *Education Sciences*, *13*(4), 336.

Pinto-Santos, A. R., Pérez Garcias, A. & Darder Mesquida, A. (2022). Development of Teaching Digital Competence in Initial Teacher Training: A Systematic Review. *World Journal on Educational Technology: Current Issues*, 14(1), 1–15.

Røkenes, F. M. & Krumsvik, R. J. (2014). Development of student teachers' digital competence in teacher education – A literature review. *Nordic Journal of Digital Literacy*, *9*(4), 250–280.

Demšar, J., Curk, T., Erjavec, A., Gorup, Č., Hočevar, T., Milutinović, M., Možina, M., Polajnar, M., Toplak, M., Starič, A., Štajdohar, M., Umek, L., Žagar, L., Žbontar, J., Žitnik, M. & Zupan, B. (2013). Orange: Data Mining Toolbox in Python. *Journal of Machine Learning Research, 14,* 2349–2353.

Engen, B. K. (2019). Understanding social and cultural aspects of teachers' digital competencies. Comunicar: *Media Education Research Journal*, *27*(61), 9–18.

Zabolotska, O., Zhyliak, N., Hevchuk, N., Petrenko, N. & Alieko, O. (2021). *Digital competencies of teachers in the transformation of the educational environment.*

Pettersson, F. (2018). On the issues of digital competence in educational contexts – a review of literature. *Education and Information Technologies*, *23*(3), 1005–1021.

ElSayary, A. (2023). The impact of a professional upskilling training programme on developing teachers' digital competence. *Journal of Computer Assisted Learning*, *39*(4), 1154–1166.

Popa, D. (2025). Education in the digital age – The benefits and challenges of technology in the learning process. *EIRP Proceedings*, *20*(1), 393–401.