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## Digital competence of school principals in compulsory education: a meta-framework

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### **Abstract**

Digital transformation has intensified the demands placed on school leadership, requiring school principals to coordinate pedagogical, organisational, and ethical dimensions of digital change. While several digital competence frameworks have been developed in recent years, most focus on teachers, organisations, or citizens, offering limited guidance for the specific professional role of school principals in compulsory education. This study addresses this limitation by developing a meta-framework of digital competences tailored to school leadership. A systematic literature review, conducted following adapted PRISMA guidelines, including identification, screening, eligibility, and inclusion stages, was combined with reflexive thematic analysis to identify, cluster, and consolidate digital competences across existing international frameworks. The analysis resulted in a meta-framework comprising eight competence areas and forty consolidated competences, reflecting the multifaceted nature of digital leadership, including strategic governance, teaching and learning practices, infrastructure management, assessment, communication, professional development, and

digital citizenship. An Aggregation Number Indicator was applied as a heuristic device to support the interpretation of thematic convergence across frameworks. Rather than replacing existing models, the proposed meta-framework offers a leadership-specific and integrative reference that complements established frameworks and contributes to conceptual consolidation in the field. The findings provide a structured basis for future research, policy development, and professional training initiatives focused on digital leadership in compulsory education.

**Keywords:** digital leadership; school principals; digital competence frameworks; educational management; compulsory education.

## **[es] La competencia digital del director escolar en la educación obligatoria: un metamarco**

### **Resumen**

La transformación digital ha intensificado las exigencias del liderazgo escolar, requiriendo que los directores coordinen las dimensiones pedagógicas, organizativas y éticas del cambio digital. Aunque en los últimos años se han desarrollado diversos marcos de competencia digital, la mayoría se centra en el profesorado, las organizaciones o la ciudadanía, ofreciendo una orientación limitada para el papel específico de los directores en la educación obligatoria. Este estudio aborda esta limitación mediante el desarrollo de un metamarco de competencias digitales para el liderazgo escolar. Para ello, se combinó una revisión sistemática de la literatura, basada en principios inspirados en PRISMA, incluyendo las etapas de identificación, cribado, elegibilidad e inclusión, con un análisis temático reflexivo orientado a identificar, agrupar y consolidar competencias digitales procedentes de marcos internacionales. El análisis dio lugar a un metamarco compuesto por ocho áreas competenciales y cuarenta competencias consolidadas, reflejando la naturaleza multifacética del liderazgo digital, incluyendo gobernanza estratégica, enseñanza y aprendizaje, gestión de infraestructuras, evaluación, comunicación, desarrollo profesional y ciudadanía digital. Además, se aplicó un indicador de número de agregación como recurso heurístico para interpretar la convergencia temática entre marcos. El metamarco propuesto ofrece una referencia integradora y específica para el liderazgo, contribuyendo a la consolidación conceptual, a la investigación futura, a las políticas educativas y a la formación profesional.

**Palabras clave:** liderazgo digital; directores escolares; marcos de competencia digital; gestión educativa; educación obligatoria.

**Summary:** 1. Introduction. 2. Methodology. 2.1. Systematic Literature Review. 2.2. Qualitative Analysis Procedures. 3. Results. 4. Discussion. 4.1. Meta-framework areas. 4.2. Meta-framework competences. 4.2.1. Phase 1 – Competence clustering. 4.2.2. Phase 2 – Competence consolidation. 4.3 Overview of framework and competences contributions. 5. Conclusions. References.

### **1. Introduction**

Digital transformation has reshaped educational systems beyond classroom technology use, encompassing organisational structures, governance, and leadership practices. In this context, school principals play a critical role in mediating the meaningful, ethical, and sustainable integration of digital technologies, as they are increasingly required to articulate strategic visions, support pedagogical innovation, manage infrastructures, and align technology adoption with institutional priorities and societal values. These demands became particularly evident in the post-pandemic context, when digital competence emerged as a central requirement for ensuring continuity, inclusion, and organisational resilience in education (Freitas Vieira, 2023).

Digital competence is widely understood as a combination of knowledge, skills, and attitudes (KSA) that enable the critical, ethical, and effective use of technologies (Ferrari, 2012). Although several international frameworks have been developed for citizens, educators, organisations, and consumers (Brecko & Ferrari, 2016; Kamylyis et al., 2015; Redecker, 2017; Vuorikari et al., 2022),

they offer limited guidance for the specific professional role of school principals. Existing frameworks insufficiently operationalise leadership-specific competences, often conflating leadership with pedagogical or organisational dimensions, which limits their applicability to the complex and strategic role of school leadership. In particular, DigCompEdu frames leadership as an advanced pedagogical competence, whereas DigCompOrg addresses organisational digital maturity without defining a leadership-specific competence profile. Consequently, leadership-focused digital competence remains conceptually fragmented and underdeveloped in the literature (Carolino et al., 2024).

In response to this gap, this study addresses the following research question: What digital competences and reference frameworks are associated with the role of school principals in compulsory education? To answer this question, it develops a meta-framework that integrates and systematises leadership-related digital competences from existing international frameworks. By consolidating dispersed conceptual contributions, the study advances the theoretical clarification of digital leadership and provides a structured reference for future research, policy development, and professional training initiatives.

## 2. Methodology

This study adopts a qualitative research design based on document analysis, which supports the systematic examination and synthesis of conceptual models and theoretical frameworks. This approach is commonly used in educational research to identify patterns, convergences, and conceptual gaps across bodies of literature (Mattar & Ramos, 2021). In line with Creswell and Creswell (2018), a qualitative approach was selected to enable an interpretative analysis of meanings embedded in digital competence frameworks, rather than a quantitative aggregation of indicators.

The methodological design comprises two sequential stages: (1) a systematic literature review (SLR) to identify digital competence frameworks related to school leadership in compulsory education, and (2) a qualitative thematic analysis of the identified frameworks, leading to the development of a meta-framework of digital competences for school principals.

### 2.1. Systematic Literature Review

The review adopted a structured and transparent selection logic inspired by PRISMA flow principles, adapted for conceptual framework synthesis rather than for exhaustive synthesis of empirical evidence. In this context, adapted PRISMA guidelines were used to document the stages of identification, screening, eligibility, and inclusion, while the final selection was guided by conceptual relevance, explicit engagement with competence-based models, and transferability to school leadership in compulsory education.

The review focused on school principals working in compulsory education, including primary and secondary education contexts. Searches were conducted using the EBSCO database aggregator, which was selected for its coverage of peer-reviewed journals in education and the social sciences. The search was carried out on October 3, 2024, using a structured search string combining terms related to digital competence and school leadership, as presented below:

AB ( "digital competenc\*" OR "digital skills\*" OR "digital literacy" OR "media literacy" OR "ICT competenc\*" OR "technological proficiency" OR "e-skills" OR "digital citizenship" OR "EdTech competenc\*" OR "cyber literacy" ) AND AB ("educational administration" OR "school management" OR "school organization" OR "participatory management" OR "school leader" OR "school manager" OR "school principals" OR "school heads").

The identification stage yielded 106 publications using the expanders options “search within the full text of the articles” and “apply equivalent subjects” to broaden the results. Subsequently, the inclusion criteria (Table 1) were applied using EBSCO filters, reducing the selection to 77 articles.

**Table 1**

*Inclusion criteria*

Criterion	Parameter	Results
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Publication Date	Last 5 years (2019 – 2024)	106
Language	English, Portuguese or Spanish	94
Duplicate Removal	One entry accepted for each identified publication	77

The full texts and metadata of the 77 articles were downloaded, tabulated, and then proceeded to the exclusion stage, considering the parameters listed in Table 2. The results refer to the number of articles excluded for each parameter.

**Table 2**

*Exclusion criteria*

Criterion	Parameter	Results
Thematic	Deviates from the intended theme	58
Nature	Data are not of primary nature	3
Full text	Full text unavailable	2
Language	Not written in English, Portuguese or Spanish	4

During screening and eligibility assessment, articles were excluded if they did not address both digital competence and school management, lacked conceptual relevance, or did not engage explicitly with competence-based frameworks. This process resulted in a final corpus of 10 articles selected for qualitative analysis, which are presented in the Results section. The review did not aim to be exhaustive, but rather to prioritise conceptual relevance and explicit engagement with digital competence frameworks, in line with the study’s objective of theoretical synthesis. Thus, the relatively small corpus (n=10) reflects the application of strict inclusion criteria requiring explicit engagement with competence-based frameworks and leadership relevance. This approach prioritised conceptual depth and analytical coherence over quantitative breadth, aligning with the study’s objective of theoretical synthesis.

**2.2. Qualitative Analysis Procedures**

The frameworks identified in the systematic literature review were analysed using Braun and Clarke’s (2006) reflexive thematic analysis, enabling the identification and interpretation of recurring patterns of meaning across competence statements. Following this approach, the analysis combined systematic coding, theme refinement, and interpretative synthesis, while maintaining reflexivity regarding the researchers’ role in meaning construction.

The analytical process comprised two sequential phases: Competence Clustering and Competence Consolidation. In the first phase, competences from the selected frameworks were semantically coded according to their explicit meaning and grouped through an inductive–deductive logic, combining recurring themes emerging from the data with analytical dimensions derived from the research question and the digital leadership literature. This procedure enabled the comparison of competences originating from different professional profiles while preserving analytical consistency.

In the consolidation phase, clustered competences were examined for conceptual overlap, redundancy, and thematic convergence. Similar competences were merged into broader statements that preserved their core meaning, guided by principles of conceptual clarity, internal coherence, and applicability to school principals’ professional role in compulsory education. Terminology was standardised to strengthen interpretative consistency and transferability across educational contexts.

To enhance analytical transparency, the Aggregation Number Indicator (A.N.I.) was applied throughout both phases as a heuristic resource indicating the number of original competences contributing to each consolidated area or competence. Its purpose is not to imply statistical measure or quantitative validation, but to enhance analytic transparency by making visible the density of thematic convergence across frameworks. This systematic and reflexive process enabled the development of a theoretically grounded and analytically robust meta-framework.

### 3. Results

The articles selected by the systematic literature review were recorded and categorized in an Excel datasheet, considering their objectives, theoretical foundation, methodological approach, participants, locus, and study results. Table 3 presents the selected articles, their authors, and the frameworks used to support concepts of digital competence among school principals.

**Table 3**

*Articles selected for full reading*

Title	Authors	Framework
Assessing digital leadership of junior high school principals	Ofita et al. (2024)	Not mentioned
Digital Leadership in Education: A Progressive Roadmap for Public Secondary School Principals in the Division of Pangasinan I	Esteron (2024)	ISTE Standards (2018)
Evaluation of primary school managers' duties in digital transformation	Dagli et al. (2023)	Not mentioned
Leadership competencies for teacher professional development: perspectives of Namibian principals, heads of departments and teachers	So-oabeb & du Plessis (2023)	Not mentioned
Madrasah principal digital leadership innovation in digital learning transformation	Umah et al. (2023)	Not mentioned
Management Competence of School Heads in the Age of Industrial Revolution 4.0: A Phenomenology	Celestino (2024)	Not mentioned
Navigating Through Disruption: How are School Principals Leading Digital Learning in Secondary Schools in Ireland	Kilcoyne (2024)	ISTE Standards (2018)
Same, but Different? Digital Transformation in Swiss Vocational Schools from the Perspectives of School Management and Teachers	Rauseo et al. (2023)	MMEO (Ifenthaler & Egloffstein, 2020).
Technology Leadership Competencies of School Principals	Diñç & Göksoy (2020)	NETS-A (2002)
The Impact of School Heads' Technology Leadership on Teachers' Technological Proficiency and Academic Optimism	Cantos & Callo (2022)	TSSA (2001)

Among the 10 articles selected for full reading, five of them do not refer to a specific framework to support their study. Although some studies do not explicitly adopt formal digital competence frameworks, they were retained due to their conceptual relevance to leadership practices and their contribution to identifying implicit competence domains addressed in empirical research. Based on Table 3, three frameworks were analysed in this article, as indicated in Table 4 and described below.

**Table 4**

*Frameworks identified in the systematic literature review*

Framework	Authors	Source article
TSSA/NETS-A	Technology Standards for School Administrators (2001) and National Educational Technology Standards for Administrators (2002)	Cantos & Callo (2022); Diñç & Göksoy (2020)
ISTE Standards	International Society for Technology in	Esteron (2024); Kilcoyne

	Education (2018)	(2024)
Maturity Model for Educational Organizations (MMEO)	Ifenthaler & Egloffstein (2020)	Rauseo et al. (2023)

In addition to the three frameworks identified in the systematic literature review, the development of the meta-framework also includes the DigCompOrg (Kampylis et al., 2015) and DigCompEdu (Redecker, 2017) frameworks. The inclusion of DigCompEdu and DigCompOrg should be understood as a deliberate theory-driven extension of the review corpus. Although not directly retrieved in the final set of empirical studies, both frameworks were incorporated due to their high conceptual proximity, international recognition, and relevance for bridging individual, pedagogical, and organisational dimensions of digital leadership.

Although these frameworks do not specifically address the digital competence of school principals, the theoretical foundations they present provide relevant contributions for assessing individual, collective, and organizational levels of digital competence. They also guide self-reflection on the incorporation of digital technologies in educational institutions and support public policies related to the development, implementation, and promotion of digital training programs for European Union countries (Pedro et al., 2023). Thus, the DigComp structure can provide a consistent basis for the professional development of digital competences for school principals. Therefore, the development of the meta-framework is based on the five frameworks, which totalized 170 competences distributed among 30 areas, as shown in Table 5:

**Table 5**  
*Frameworks' structure*

Framework	Number of areas	Number of competences
TSSA/NETS-A	6	31
ISTE Standards	5	22
MMEO	6	22
DigCompOrg	7	74
DigCompEdu	6	21
Total	30	170

## 4. Discussion

### 4.1. Meta-framework areas

To start the thematic analysis (Braun & Clarke, 2006), an identification process was carried out, which involved recording and categorizing the data presented by the selected frameworks. The data was tabulated in an Excel spreadsheet, resulting in 30 areas and 170 digital competences, with each entry recorded on the tab corresponding to its respective document. Each framework was assigned a specific colour, allowing easy identification of which document each competency belongs to.

Thus, in meta-framework's development, an effort was made to systematize the areas listed by each framework, considering both the theme and the frequency with which each area was mentioned. Table 6 presents the systematization process, which resulted in eight areas of competence and their respective descriptors, the Aggregation Number Indicator (A.N.I.), and the sources that support them.

**Table 6**  
*Meta-framework areas*

Area	Description	A.N.I.	Source
Teaching and Learning Practices	Ensure an environment where teachers and students are encouraged to use technology for improving their teaching	5	TSSA/NETS-A: 1.2 DigCompOrg: 2.2 DigCompEdu: 3.3

	and learning practices.		ISTE: 4.3 MMEO: 5.6 TSSA/NETS-A: 1.4 DigCompOrg: 2.7 DigCompEdu: 3.2 ISTE: 4.4 MMEO: 5.1
Infrastructure and Digital Resources	Ensure that the infrastructure and the digital resources available support the effective use of technology.	5	
Leadership and Organisational Strategy	Engage with stakeholders in a shared purpose and commitment to the school's educational plan, fostering a favourable environment to achieve the goals collectively established.	4	TSSA/NETS-A: 1.1 DigCompOrg: 2.1 ISTE: 4.2 MMEO: 5.5
Continuous Professional Development	Promote different continuous professional development opportunities to improve teachers' and other staff abilities, remain current with the latest technology, and expand their knowledge.	4	TSSA/NETS-A: 1.3 DigCompOrg: 2.3 ISTE: 4.5 MMEO: 5.4
Assessment and Evaluation	Use technology to critically assess, evaluate and reflect on the schools' educational plan to make corrections in their programmes/subjects, improve their management skills, the staff's professional practices, and students' learning process.	3	TSSA/NETS-A: 1.5 DigCompOrg: 2.4 DigCompEdu: 3.4
Content and Curricula	Adapt curricula to integrate learning objectives, educational content, and pedagogical approaches enabled by technology.	3	DigCompOrg: 2.5 DigCompEdu: 3.6 MMEO: 5.3
Communication, Collaboration and Engagement	Consider communication as a priority to nurture a collaborative environment, which may promote knowledge exchange, innovative practices and mutual support among teachers, students, families and third parties.	3	DigCompOrg: 2.6 DigCompEdu: 3.1 MMEO: 5.5
Empowerment and Citizenship	Understand the social, political and ethical issues related to learning in a digital age, ensuring inclusion, autonomy and civic participation through technology implementation and digital competences development.	3	TSSA/NETS-A: 1.6 DigCompEdu: 3.5 ISTE: 4.1

## 4.2. Meta-framework competences

The methodological process described in Section 2.2 applies reflexive thematic analysis (Braun & Clarke, 2006), offering a structured yet flexible approach to identify and interpret patterns within qualitative data. Its reflexive nature acknowledges the researchers' role in data interpretation, supporting the development of a concise and contextually relevant meta-framework. The results are presented in the next section, following two phases: "Phase 1 – Competence Clustering", and "Phase 2 – Competence Consolidation".

### 4.2.1. Phase 1 – Competence clustering

The clustering phase integrated digital competences from the analysed frameworks. After recording and categorisation, competences were assigned to the meta-framework's eight predefined areas (Table 6), aligning with their core content rather than the original classifications. For instance, DigCompEdu

competence 1.4, initially under “Professional Engagement,” was reassigned to “Continuous Professional Development” for better alignment. This phase ensured a coherent and logically structured meta-framework covering relevant digital competences for school management. By its conclusion, 170 competences were organised within the eight areas, forming the basis for the next phase, Competence Consolidation, which aimed to refine and synthesise them into a more concise and manageable set.

#### 4.2.2. Phase 2 – Competence consolidation

The consolidation phase reduced the 170 digital competences into single, comprehensive statements that captured their shared core concepts while preserving their original conceptual integrity. Redundant competences within the eight areas were examined, as overlaps indicated their relevance (Minayo, 1998). Similar competences were merged into comprehensive statements, ensuring clarity, coherence, and alignment with the frameworks. For example, competence statements related to data use, monitoring, and evidence-informed planning from TSSA/NETS-A, DigCompOrg, and ISTE were consolidated into the competence “Data-Driven Evaluation” within the area Leadership and Organisational Strategy. Terminology and definitions were standardized for broader applicability across diverse educational contexts. By the end of this phase, the competences were refined into a final set of 40, distributed across the eight areas, forming a streamlined yet comprehensive meta-framework of digital competences for school principals in compulsory education.

**Table 7**

*Meta-framework systematization*

Meta-framework area	Competence Clustering	Competence Consolidation
Leadership and Organisational Strategy	51	8
Communication, Collaboration and Engagement	25	5
Teaching and Learning Practices	23	5
Infrastructure and Digital Resources	19	4
Assessment and Evaluation	18	4
Content and Curricula	15	4
Continuous Professional Development	10	5
Empowerment and Citizenship	9	5
Total	170	40

Below is the full content of the meta-framework. The areas are displayed in table format, considering the competences that comprise them, their respective descriptions, the Aggregation Number Indicator (A.N.I.) based on their theme, and the sources that support them. It is important to highlight that the areas and competences are systematized according to their relevance, considering the frequency with which each theme is mentioned in the analysed frameworks.

Table 8 presents the competence area “Leadership and Organisational Strategy”. In this area, it is expected that school principals engage stakeholders around a shared purpose and a collective commitment to the school’s educational plan, fostering organisational conditions that support strategic alignment and goal achievement. This area comprises eight digital competences, consolidated through the thematic analysis of 51 prior competences.

**Table 8**

*Leadership and Organisational Strategy*

Competence	Description	A.N.I.	Source
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Responsible Technology Use	Encourage responsible use of technology among staff and students, addressing aspects related to privacy, security, and ethical and legal online practices.	12	TSSA/NETS-A: 6B – 6C – 6D – 6E; DigCompOrg: 18 – 65 – 72; DigCompEdu: 2.3 – 6.4; ISTE: 3.1.D – 3.4.C; MME0: 1.3.
Innovative Change	Promote change and efficiency in the educational plan through technology implementation, addressing resources that enable innovation and remove barriers to its application.	10	TSSA/NETS-A: 1C – 3A – 3F – 4B – 4C; DigCompOrg: 10 – 12; MME0: 5.1 – 5.2; ISTE: 3.4.D.
Digitalisation Focus	Prioritise digitalisation in the educational plan and communicate the potential of technologies to enhance digital-age learning.	8	DigCompOrg: 1 – 2 – 3 – 8; MME0: 2.1 – 2.2 – 6.3; TSSA/NETS-A: 3E.
Data-Driven Evaluation	Monitor the educational plan to evaluate the impact of technology implementation, utilising research-based data in decision-making processes.	7	DigCompOrg: 13 – 14 – 15 – 16; TSSA/NETS-A: 1B – 1D – 1E;
Policy Alignment	Align the educational plan with policies and guidelines to stay current on innovations and emerging technologies for digital-age learning.	5	TSSA/NETS-A: 4A – 4D – 4E; ISTE: 3.5.A; MME0: 2.3.
Collaborative Vision	Establish the educational plan on a shared vision among stakeholders, integrating technology into pedagogical practices to achieve overall goals.	4	DigCompOrg: 5 – 9; TSSA/NETS-A: 1A; ISTE: 3.2.B.
Democratic Management	The organisational strategy is based on democratic management, empowering stakeholders with autonomy to collaborate in decision-making processes.	3	DigCompOrg: 6; ISTE: 3.2.A; MME0: 2.4.
Clear Accountability	Assign responsibilities clearly and reward staff efforts with recognition, incentives, and opportunities.	2	DigCompOrg: 7 – 11.

Table 9 refers to the competence area “Teaching and Learning Practices”. In this area, it is expected that school principals create conditions in which teachers and students are encouraged to use digital technologies to enhance teaching and learning processes. The area includes five digital competences, derived from the synthesis of 23 prior competences.

**Table 9**  
*Teaching and Learning Practices*

Competence	Description	A.N.I.	Source
Digital Resource Integration	Provide digital resources to expand teaching and learning strategies, adapting to different pedagogical approaches.	6	DigCompOrg: 22 – 23 – 24; MME0: 6.1 – 6.2;

Personalised Learning	Promote personalised learning through technology, selecting appropriate resources to meet specific objectives, contexts, and students' needs, such as varying learning paces, interests and styles.	6	DigCompEdu: 3.1. TSSA/NETS-A: 2A – 2C; DigCompEdu: 2.1. – 5.2; DigCompOrg: 25; MMEO: 4.2.
Collaborative Expression	Encourage students to express themselves and collaborate with peers by creating or modifying content through digital means.	6	DigCompEdu: 2.2 – 3.3 – 6.3; DigCompOrg: 27 – 43; TSSA/NETS-A: 2B.
Inclusive Learning	Leverage technology to support the diverse learning, cultural, and social and emotional needs demonstrated by students.	3	DigCompOrg: 28; ISTE: 3.3.D; MMEO: 4.3.
Skill Development	Engage students in critical thinking, creative expression, decision-making, and problem-solving skills through technology-enriched learning environments.	2	DigCompOrg: 26; TSSA/NETS-A: 2D.

Table 10 presents the competence area “Infrastructure and Digital Resources.” Here, it is expected that school principals ensure that digital infrastructure and resources effectively support the use of technology within the school. This area consists of four digital competences, systematised through the thematic analysis of 19 prior competences.

**Table 10**  
*Infrastructure and Digital Resources*

Competence	Description	A.N.I.	Source
Infrastructure Investment	Ensure sufficient technology, infrastructure and investment to meet the school's demands.	7	DigCompOrg: 66 – 73 – 74; ISTE: 3.4.A – 3.4.B; MMEO: 3.1 – 3.3;
Flexible Learning	Enable different times and spaces for teaching and learning practices through digital resources.	6	DigCompOrg: 49 – 51 – 64 – 67; ISTE: 3.3.C; MMEO: 1.2;
Digital Support	Support teaching and learning practices with digital devices during regular classes.	3	DigCompOrg: 63 – 68; MMEO: 1.1;
Support Implementation	Provide technical and pedagogical support related to technology implementation in the school.	3	DigCompOrg: 70; MMEO: 3.2 – 3.4.

Table 11 outlines the competence area “Assessment and Evaluation”. In this area, it is expected that school principals use digital technologies to support critical assessment, evaluation, and reflection on the school's educational plan, informing programme adjustments, management practices, professional development, and students' learning processes. The area comprises four digital competences, consolidated from 18 prior competences.

**Table 11***Assessment and Evaluation*

Competence	Description	A.N.I.	Source
Data-Driven Assessment	Incorporate learning analytics as a crucial aspect of assessment and evaluation, providing consistent evidence to measure students' performance and facilitate corrections on subjects aligned with the school's educational plan.	10	DigCompOrg: 39 – 40 – 41 – 42; TSSA/NETS-A: 5A – 5B – 5D; ISTE: 3.2.C – 3.3.E; DigCompEdu: 4.2.
Reflective Practice	Encourage teachers and students to individually and collectively reflect on their digital practices to support personal and professional growth.	4	DigCompOrg: 36; TSSA/NETS-A: 5C ISTE: 3.5.C; DigCompEdu: 1.3.
Diverse Assessment	Utilise technology to enhance the diversity and suitability of different assessment formats.	3	DigCompOrg: 34 – 35; DigCompEdu: 4.1.
Prior Knowledge	Acknowledge prior knowledge acquired from diverse learning contexts during assessment.	1	DigCompOrg: 38.

Table 12 refers to the competence area “Communication, Collaboration and Engagement”. In this area, it is expected that school principals prioritise communication to foster collaboration, knowledge exchange, and engagement among teachers, students, families, and external stakeholders. This area includes five digital competences, derived from the thematic analysis of 25 prior competences.

**Table 12***Communication, Collaboration and Engagement*

Competence	Description	A.N.I.	Source
Knowledge Exchange	Organise events and activities to enable knowledge and experience exchange among staff and community members.	12	DigCompOrg: 21 – 54 – 55 – 57 – 58 – 61. ISTE: 3.2.E – 3.5.B; TSSA/NETS-A: 2E – 3C; DigCompEdu: 1.2; MME0: 4.4.
Enhanced Communication	Employ technology to enhance open communication among staff, families, students, and community members.	5	DigCompOrg: 59; ISTE: 3.2.D; TSSA/NETS-A: 3B; DigCompEdu: 1.1; MME0: 5.3.
Student Support	Provide technology that facilitates interaction between students and teachers outside the classroom, delivers personalized feedback, and offers support to address students' queries.	5	DigCompEdu: 3.2 – 3.4 – 4.3; DigCompOrg: 37; MME0: 6.4.
Networking and Partnerships	Engage students and staff in networking and educational partnerships.	2	DigCompOrg: 56 – 62;

Online Presence	Maintain a strong online presence to disseminate important announcements, share event updates, and highlight students' achievements.	1	DigCompOrg: 60.
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Table 13 presents the competence area “Content and Curricula”. In this area, it is expected that school principals support curricular adaptation by integrating learning objectives, educational content, and pedagogical approaches enabled by digital technologies. The area comprises four digital competences, derived from 15 prior competences.

**Table 13**  
*Content and Curricula*

Competence	Description	A.N.I.	Source
Resource Utilisation	Utilise content repositories and open educational resources among students and teachers, adhering to license and copyright requirements.	6	DigCompOrg: 4 – 44 – 45 – 46 – 47; TSSA/NETS-A: 1F;
Digital Competence Integration	Integrate the development of digital competences throughout the curriculum and the educational plan.	6	DigCompOrg: 17 – 19 – 20 – 53; ISTE: 3.1.A; MMEO: 4.1;
Hybrid Learning	Provide hybrid and online regularly as part of standard classes.	2	DigCompOrg: 50 – 52;
Interdisciplinary Approach	Promote online tools to support interdisciplinarity and foster more integrated approaches between subjects.	1	DigCompOrg: 48.

Table 14 outlines the competence area “Continuous Professional Development”. In this area, it is expected that school principals promote diverse professional development opportunities to strengthen teachers' and staff members' digital competences, remain current with technological developments, and expand institutional knowledge. This area includes five digital competences, systematised from 10 prior competences.

**Table 14**  
*Continuous Professional Development*

Competence	Description	A.N.I.	Source
Goal Alignment	Align continuous professional development with the goals of the educational plan.	4	DigCompOrg: 31; ISTE: 3.3.A – 3.3.B – 3.5.D;
Professional Growth	Encourage commitment to attending continuous professional development activities.	2	DigCompOrg: 29; TSSA/NETS-A: 3D;
Technology Integration	Relate continuous professional development to various themes concerning technology implementation in educational contexts.	2	DigCompOrg: 32; DigCompEdu: 1.4;
Digital Competence Growth	Provide continuous professional development opportunities tailored to different levels of digital competence	1	DigCompOrg: 30;

Expert Certification	proficiency. Certify continuous professional development opportunities through specialists in the subject matter being lectured.	1	DigCompOrg: 33;
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Table 15 presents the competence area “Empowerment and Citizenship”. In this area, it is expected that school principals engage with the social, political, and ethical dimensions of digital-age learning, ensuring inclusion, autonomy, and civic participation through the implementation of digital technologies and the development of digital competences. This area comprises five digital competences, consolidated from 9 prior competences.

**Table 15**  
*Empowerment and Citizenship*

Competence	Description	A.N.I.	Source
Digital Inclusion	Address digital inclusion and equal access as a priority, ensuring all students have the technology and connectivity needed to participate in various learning opportunities.	3	DigCompOrg: 69; ISTE: 3.1.B; TSSA/NETS-A: 6A;
Civic Engagement	Support activities that encourage students, teachers, staff, and other community members to engage in debates and discussions, exploring diverse perspectives and emphasising the importance of civic participation and reflection for positive social change.	2	DigCompEdu: 6.2; ISTE: 3.1.C;
Assistive Technology	Provide assistive technologies for students with special needs.	2	DigCompOrg: 71; DigCompEdu: 5.1;
Critical Reflection	Use technology to promote reflection on current affairs related to political, cultural, and social discussions, engaging students’ critical thinking on complex topics.	1	DigCompEdu: 5.3;
Media Literacy	Associate the development of digital competences with media literacy, requiring students to find, analyse, and interpret online information to evaluate the credibility and reliability of the content and its source.	1	DigCompEdu: 6.1;

Finally, the figure below presents the systematization of the meta-framework in its final version, considering the eight areas and the 40 digital competences that comprise it.

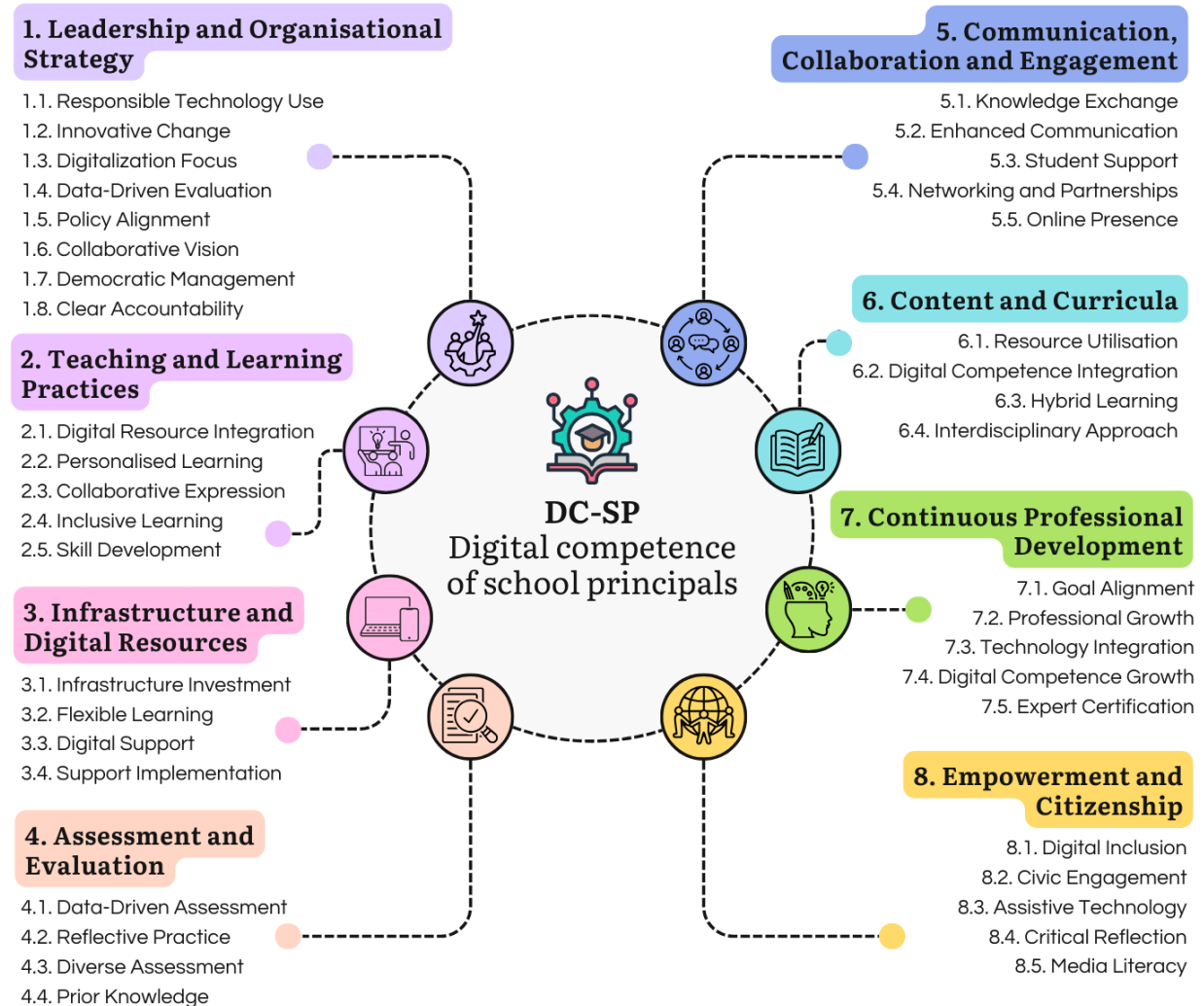
### 4.3. Overview of framework and competences contributions

The resulting meta-framework is structured around eight competence areas that collectively reflect the multifaceted nature of digital leadership in compulsory education. These areas encompass pedagogical, organisational, infrastructural, ethical, and civic dimensions, reinforcing the view that digital leadership is a complex and systemic phenomenon rather than a set of isolated technical skills (Ferrari, 2012; Kamylyis et al., 2015). By integrating these dimensions, the meta-framework aligns with contemporary understandings of school leadership as a mediating practice that connects policy,

organisational structures, and teaching and learning processes in digitally mediated environments (Araújo da Silva; Behar, 2023).

**Figure 1**

*Meta-framework final version*



The prominence of Leadership and Organisational Strategy reflects a recurrent emphasis on vision-setting, ethical governance, and data-informed decision-making across the analysed frameworks. The aggregation of competences related to responsible technology use indicates sustained attention to data protection, cybersecurity, and ethical accountability within educational institutions, themes widely addressed in both research and policy discourse (Ferrari, 2012; Council of the European Union, 2018). This pattern is consistent with frameworks such as DigCompOrg, which frame digital responsibility as an organisational concern embedded in governance structures and institutional culture (Kampylis et al., 2015).

Teaching and Learning Practices represent an area in which leadership-related digital competences intersect with pedagogical conditions. Existing research suggests that digital transformation in education is closely linked to leadership practices that support pedagogical innovation, personalised learning, and inclusive approaches (Redecker, 2017). In this context, school principals contribute by shaping organisational conditions that enable learner-centred pedagogies, rather than by direct instructional involvement. The integration of competences related to collaboration and creativity reflects a broader shift toward understanding digital technologies as resources for knowledge construction and social learning (Freitas Vieira, 2023).

The area of Infrastructure and Digital Resources, while often perceived as a predominantly technical domain, revealed strong connections to strategic planning and equity. Ensuring adequate infrastructure is not solely a logistical responsibility but a prerequisite for inclusive, flexible, and sustainable learning environments (Ifenthaler & Egloffstein, 2020). The findings suggest that digital leadership requires a strategic understanding of how infrastructural decisions shape pedagogical opportunities, organisational resilience, and access to learning, particularly in contexts marked by digital inequalities (Kampylis et al., 2015).

Competences related to Assessment and Evaluation are characterised by a focus on learning analytics, evidence-informed decision-making, and reflective practices within school improvement processes. While data-driven approaches align with accountability-oriented frameworks, the literature also highlights challenges related to data interpretation, literacy, and ethical use (Redecker, 2017). In this respect, leadership-related digital competences are associated with the capacity to mediate between evaluative demands and formative uses of data, avoiding reductive or technocratic approaches to assessment (Ferrari, 2012).

The area of Communication, Collaboration and Engagement reflects changes in the communicative structures of schools within digitally mediated environments. The aggregation of competences related to knowledge exchange suggests that digital technologies are consistently associated with professional interaction, stakeholder engagement, and information sharing across frameworks (Kampylis et al., 2015). This interpretation aligns with research emphasising the role of digital platforms in supporting collaboration, distributed leadership, and organisational transparency within educational institutions.

Finally, the area of Empowerment and Citizenship addresses the normative dimension of digital leadership. By prioritising inclusion, media literacy, and civic engagement, the meta-framework situates school principals as agents of democratic education in digital societies (Council of the European Union, 2018; Redecker, 2017). This area reinforces the idea that digital transformation is not value-neutral but deeply embedded in social, ethical, and political considerations, requiring leadership practices that promote equity, critical reflection, and active participation in digitally mediated public life.

## 5. Conclusions

This study set out to develop a meta-framework of digital competences for school principals in compulsory education by systematically integrating existing frameworks and empirical literature. Unlike existing models, the proposed meta-framework explicitly integrates pedagogical, organisational, ethical, and civic dimensions of digital leadership, offering a more holistic representation of school principals' professional demands in digitally mediated educational systems. In doing so, it addressed a need for conceptual consolidation in educational research, where leadership-focused digital competence models remain fragmented and underdeveloped.

While DigCompEdu and DigCompOrg provide well-established references for educators and educational organisations, respectively, the proposed meta-framework addresses a different analytical level by focusing explicitly on the professional role of school principals in compulsory education. DigCompEdu conceptualises leadership as an advanced stage of teachers' digital competence development, mainly oriented toward pedagogical practices. In contrast, the present meta-framework frames digital leadership as an organisational responsibility that includes governance, strategic planning, infrastructure management, professional development, and ethical accountability. Similarly, although DigCompOrg addresses digital transformation at the organisational level, it does not articulate a competence profile tailored to school principals as institutional leaders. By integrating and consolidating competences across multiple frameworks, the proposed meta-framework offers a structured and leadership-specific reference that complements, rather than duplicates, existing models.

The resulting meta-framework offers a coherent and comprehensive reference that captures the complexity of digital leadership across eight interrelated competence areas. By synthesising 170 competences into 40 consolidated statements, the framework balances conceptual depth with practical usability, making it relevant for research, policy development, and professional training.

From a theoretical perspective, the study contributes to the conceptual clarification of digital leadership by positioning it as an integrative practice that spans organisational strategy, pedagogy,

ethics, and citizenship. Methodologically, it demonstrates the value of reflexive thematic analysis for framework synthesis and theory-building in educational research.

Practically, the meta-framework may inform the design of professional development programmes, self-assessment tools, and policy guidelines aimed at strengthening school leadership capacity in digital contexts. It also provides a foundation for empirical validation through future studies, such as Delphi panels or large-scale surveys assessing principals' digital competence profiles.

The study is not without limitations. The reliance on selected databases and published frameworks may have excluded relevant models from other regions or grey literature. Additionally, the interpretative nature of thematic analysis entails a degree of subjectivity, despite systematic procedures.

Future research should focus on validating and contextualising the meta-framework across different educational systems, as well as exploring its relationship with school outcomes, teacher practices, and student learning experiences. As digital transformation continues to evolve, the role of school principals as digitally competent leaders will remain central to shaping equitable, innovative, and resilient education systems.

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## Conflict of interest

The authors declare no conflict of interest.

## Author contribution

All authors contributed equally to the development of this study and the manuscript, each accounting for 25% of the overall authorship. Their contributions included the study conceptualisation,

methodological design, data analysis, interpretation of findings, manuscript writing, critical revision, and final approval of the submitted version.



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