

Digital Competence in Quebec's Teacher-Education Programs: Toward a Critical Perspective

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Abstract

Digital competence, beyond core content knowledge, is a key skill for many teachers in this day and age, and several frameworks for this have been proposed internationally. In Canada, some provinces and territories are currently implementing rules and guidelines regarding the digital competencies of teachers. However, only Quebec has an actual one that is linked to teachers, with specific dimensions integrating critical knowledge and attitudes. This interpretive study examines Quebec's teacher reference and digital-competency frameworks by exploring their integration into teacher-education programs. Two qualitative data-collection methods, namely, semi-structured interviews and document analysis, were used in this study. The sample included seven university professors from the education departments at different Quebec universities and 34 descriptions of digital technologies courses in Quebec's teacher-education programs. The main results indicate that digital competence is included in at least one course in teacher-education programs, and that instrumental elements are prioritized over critical and ethical digital dimensions. The findings also highlight professors' awareness of the importance of further developing these less prominent dimensions. The challenges associated with this integration are acknowledged, and the need for future research to develop pedagogical strategies that promote the acquisition of these competencies is emphasized.

Introduction

In today's societies, digital competency plays a key role in teacher education. Defined as a "notion of situated multiple integrated skills and practices (conceptual, attitudinal, procedural, and ethical) that empower people (individuals and groups) to participate and communicate efficiently in society" (Marín & Castañeda, 2022, p. 5), "digital competence" has evolved into a more comprehensive and complex understanding in recent years. Thus, teachers not only need foundational skills but also strategies and mindsets that enable them to confidently design their classes using digital tools to support student learning in effective and relevant ways (Falloon, 2020), while also considering their specific contexts. Teachers should also guide students in the responsible and safe use of digital tools (Roy et al., 2020). In this sense, teacher education is fundamental to the development of digitally competent teachers (Howard et al., 2021; Lindfors et al., 2021; Nowak, 2019; Ottestad et al., 2014; Uerz et al., 2018).

Teacher-education programs are typically informed by teacher-reference frameworks, which are policy documents defining the minimum standards of professional attributes that all educators teaching within a given educational system are expected to possess, including developing digital competency (Villar-Onrubia et al., 2022). Some Canadian examples are the Ontario College of Teachers' standards of practice or Alberta's Teaching Quality Standard. In addition, some international digital-competency frameworks have been introduced that detail the dimensions that teachers should develop (e.g., International Society for Technology in Education (ISTE) standards in the United States or the Digital Competence Framework for Educators (DigCompEdu) in Europe).

This study examines the specific case of digital competency in the province of Quebec. When this investigation was conducted, Quebec was the only Canadian province that had elaborated on a digital-competency framework that included teachers (OECD, 2023a). Furthermore, its reference structure for the professional aptitudes of teachers emphasizes the value of critical and digital citizenship elements within the conceptualization and dimensions of digital competence (Collin, 2021). Therefore, this outline differs from other teacher-reference contexts worldwide (Villar-Onrubia et al., 2022).

Literature Review

Digital competence, teacher-digital competency, and critical digital literacies (CDL)

Over the last two decades, the understanding of digital competency has evolved from a traditional, instrumental, and pragmatic approach, based primarily on developing technical skills, to more complex conceptions (Marín & Castañeda, 2022). To date, there is no singular, monolithic concept of digital literacy, but rather multiple literacies that reflect the interconnection of digital competency within the current learning context (Marín & Castañeda, 2022). However, going beyond instrumentalist and determinist conceptions of digital technologies (Bourgeois & Ntebutse, 2020; Collin & Brotcorne, 2019; Miralles-Martínez et al., 2019; OECD, 2023b), and resolving the individualist and universalist understanding of digital competence (Manca et al., 2021) remain subjects of research and practice in the field of education.

The current conception of digital competency addresses CDL, regarding how citizens can engage critically, ethically, and responsibly with electronic technologies (Pangrazio, 2016; Pangrazio & Sefton-Green, 2021; Pötzsch, 2019). Such a perspective considers media as technical objects that are socially constructed and oriented by varying uses, and therefore lack neutrality

(Bourgeois & Ntebutse, 2020; Feenberg, 2003). While there is no universal definition of critical digital literacy, the literature reveals the breadth of the concept (Pangrazio, 2016), and its key skills, such as critical thinking, problem-solving, and creativity, which are needed in the digital age (Van Laar et al., 2020), and are often considered as part of this definition.

Teachers' digital competency entails the same level of complexity as this skill and incorporates pedagogical tasks to help younger generations. Closely related to this, the Technological Pedagogical Content Knowledge (TPACK) framework outlines how subject matter and pedagogy form the foundation for the effective integration of these proficiencies into classrooms, thus providing an approach to the knowledge that educators need to effectively perform such integration (Mishra & Koehler, 2006). The Synthesis of Qualitative Data (SQD) model addresses strategies to prepare preservice teachers to integrate technology into education (e.g., teacher educators as role models or scaffolding authentic technological experiences) and the conditions that are necessary at the institutional level (e.g., technology planning and leadership) (Tondeur et al., 2012). Teachers are uniquely positioned to empower younger generations in their responsible, critical, and ethical engagement with electronic media (Castañeda & Villar-Onrubia, 2023; Gouseti et al., 2021; Marín et al., 2021). However, to achieve this task, teacher education must include the development of preservice teachers' CDL, which empowers them to analytically engage with digital learning critically, thus promoting social justice and addressing inequities in education (Coker, 2020).

Different teacher digital-competency frameworks have been developed internationally and can be used by teacher-education programs to develop these skills in preservice teachers, along with CDL. For instance, the United Nations Educational, Scientific and Cultural Organization (UNESCO) Information and Communications Technology (ICT) Competency Framework for Teachers (UNESCO, 2018) is a global guideline that describes six areas: 1) understanding ICT in educational policy, 2) curriculum and assessment, 3) pedagogy, 4) application of digital skills, 5) organization and administration, and 6) teachers' professional learning. In the context of the United States, the ISTE Standards for Educators (ISTE, 2021) defines seven criteria of the educator as 2.1 Learner, 2.2 Leader, 2.3, Citizen, 2.4 Collaborator, 2.5 Designer, 2.6 Facilitator, and 2.7 Analyst. In the European context, the DigCompEdu (European Commission. Joint Research Centre, 2017) describes six skill areas: 1) professional engagement, 2) digital resources, 3) digital competencies for teaching and learning, 4) digital competencies to enhance assessment, 5) empowering learners, and 6) specific pedagogical competencies related to facilitating learners' digital competency. This broad, general framework is commonly critiqued due to its autonomous and universalist understanding of this notion, along with the lack of consideration of its situated nature and a proactive stance on its development (Marín & Castañeda, 2022). In addition, CDLs are not typically clearly highlighted or explicitly stated in those frameworks; in fact, the ethical approaches to digital competency are considered the next step in updating their frameworks, as well as the one for educators (Marín & Castañeda, 2022).

From another standpoint, the role of teacher educators should be considered. In this sense, sociocultural learning theories can inform how preservice teachers' digital competencies and CDL should be scaffolded. For instance, based on Vygotsky's concept of the zone of proximal development (ZPD), the zone of proximal teacher development (ZPTD) "denotes the distance between what teaching [sic] candidates can do on their own without assistance and a proximal level [that] they might attain through strategically mediated assistance from more capable others" (Warford, 2011, p. 253). As adults, preservice teachers have prior-learning experiences. Therefore, a reversal of the first two stages from the original ZPD process for children is needed in this case (teacher-assistance, then self-assistance) (Warford, 2011). In this way, preservice teachers should

primarily begin with their own reflections on prior experiences and beliefs about teaching and learning (with the mediation of the teacher educator). Then, self-assistance (modelling, direct teaching) is promoted, emphasizing the importance of choice (Lempert Shepel, 1995). On the other hand, Gee's theory of distributed knowledge underpins the idea that "when people learn with human and technological resources, such individuals extend their knowledge and social connections" (Ajayi, 2009, p. 89). Therefore, learning to teach "requires a new way of learning by pre-service teachers [...] and teacher educators[, in order] to use technology to engage pre-service teachers in learning," as well as to support preservice teachers' knowledge construction through active participation in dialogue with their peers (Ajayi, 2009, p. 89; Schellens et al., 2005).

Although teacher education has not traditionally emphasized preparing and supporting future instructors' CDL (Trust et al., 2023), there is some evidence in this direction. For instance, Stewart (2020) developed the Open Page Project in her digital technologies class at the University of Windsor, where her students (preservice teachers) critically evaluated various educational technology platforms and presented them to their classmates and in-service teachers. A similar experience was presented by Castañeda and Villar-Onrubia (2023) involving preservice teachers in a Spanish university, where students critically evaluated technology use to inform professional decisions that enhanced their pedagogical and educational environments. In addition, the CDL framework proposed by Gouseti et al. (2021) for in-service teachers in schools, along with its eight dimensions, should be highlighted: technology use, data literacy, information literacy, digital knowledge creation, digital communication and collaboration, digital well-being and safety, digital citizenship, and digital teaching and learning.

State-of-the-art in Canada

As education is provincially governed in Canada, the patchwork of initiatives and programs across different Canadian regions and sectors reflects the diversity in how digital competencies are dealt with across the country. Examples include British Columbia's Digital Literacy Framework, the Alberta Digital Literacy Program, and the Ontario Transferable Skills Curriculum (Digital Literacy). The inconsistency between provincial frameworks has created notable disparities in education and outcomes across Canada. A 2015 report from Media Smarts highlighted "considerable variance between provinces and territories in terms of digital literacy policies[,] and [sic] implementation programs[,] and schedules" (Hoechsmann & DeWaard, 2015, p. 2). While British Columbia and Quebec have established comprehensive frameworks, Manitoba, New Brunswick, and Nova Scotia have more recently made commitments to teach computer science at the elementary level. However, their constructions are less developed (CSPC, 2015). Ontario has focused on inquiry-based learning and problem-solving in early education, with computer-science courses beginning in Grade 10, allocating 20% of the technology-and-learning fund to teacher professional development (CSPC, 2015). As McLean and Rowsell (2020) assert, "provincial perspectives on digital literacies can vary greatly—with some of the strongest, multimodal pedagogies (in our view) in [the] Prairie [sic, prairie] provinces and Eastern [sic, eastern] Canada—based on Indigenous pedagogies in the Prairie [sic, prairie] provinces and early-childhood methods of inquiry" (p. 179). These provincial variations have resulted in measurable differences in digital readiness, which are linked to age, education, and geographic location (Statistics Canada, 2020). Furthermore, educational institutions vary widely in their curriculum integration of digital literacy and professional training for teachers across provinces and territories.

A few Canadian locations have established rules and guidelines for developing digital competencies among teachers (OECD, 2023a; UNESCO, 2023). For instance, in Alberta's

professional-practice standards for teachers, an explicit reference is made under the heading, “Demonstrating a Professional Body of Knowledge” that outlines indicators related to digital technology: “incorporate digital technology and resources, as appropriate, to build student capacity for: acquiring, applying, and creating new knowledge; communicating and collaborating with others; critical thinking; and accessing, interpreting and evaluating information from diverse sources.” (Alberta Education, 2020, p. 3). Alberta’s Digital Literacy Program emphasizes foundational and intermediate digital skills through self-guided modules that focus on core competencies, adopting a more instrumental approach to foster functional skills and technological proficiency across K-12 education, with limited attention to critical or ethical dimensions. Similarly to Alberta’s professional-practice standards for teachers, in New Brunswick, they highlight the connection to digital literacy for teachers: “know and understand student-centred pedagogies and how to integrate current and ICT to meet the learning needs of 21st-century students in an inclusive education[al] setting.” (Government of New Brunswick, n.d.).

Although linked to students, British Columbia (BC) has implemented its digital-literacy framework, making it one of the few provinces and territories with such a construction, along with Quebec. This basis defines digital literacy as an individual’s interest, attitude, and ability to use digital technologies for different purposes, focused on six characteristics: (1) research and information literacy; (2) critical thinking, problem solving and decision making; (3) creativity and innovation; (4) digital citizenship; (5) communication and collaboration; and (6) technological operations and concepts (Government of British Columbia, 2022). This province’s digital-literacy framework explicitly addresses various aspects of electronic citizenship and CDL, including internet safety, privacy and security, cyberbullying, self-image and identity, as well as creative credit and copyright. Additionally, BC incorporates an understanding of the legal and ethical implications of technological use and fosters a balanced attitude towards it with an awareness of ICT’s societal roles.

The digital-competency framework was developed in Quebec (Quebec Ministry of Education, 2019) for teachers and students of all levels. It not only supports the assessment of digital competency levels, but also provides a foundation for the development of Quebec’s educational programs and workforce, which are tailored to meet the evolving electronic literacy situated needs of teachers and students in Quebec. This structure integrates critical thinking and ethical considerations into its teacher- education programs (part of CDL), explicitly addressing the societal impacts of digital technologies and promoting reflective practices.

These comprehensive elements of BC’s digital-literacy framework and Quebec’s digital-competency framework align with global standards, such as ISTE’s, but stand out for their detailed focus on fostering responsible online behaviour and ethical engagement. In addition, both frameworks stand out among Canadian provinces for their emphasis on CDL and ethical citizenship, which are less pronounced in other regional constructions.

Context

Quebec’s educational system

The province of Quebec, located in eastern Canada, is the largest in the country in terms of area and the second largest in terms of population. Quebec holds a special place in the Canadian landscape, characterized by its distinct culture, use of French as its official language, and rich history. Over the years, Quebec has undergone significant political and social changes that have impacted its educational system and digital strategy. Schooling in this province differs from that

in other Canadian provinces because it is managed by the provincial government, rather than by local authorities. This centralized approach allows for a more uniform policy implementation across the province. In Quebec, the Ministry of Education oversees the K-11 educational system, which includes elementary and secondary schools. The ministry sets the curriculum, standards, and policies, while local school boards are responsible for administering the institutions within their jurisdictions.

Regarding higher education, universities and colleges across Canada, including Quebec, are generally autonomous institutions that receive funding from provincial governments. However, the level of provincial oversight and involvement can vary. The province of Quebec has 18 universities across its territory, all of which are public institutions. Of these, three are English-language universities, and the rest use French as their language of instruction. The latter is entirely based on a distance-education model. Out of the 18 universities, 13 offer some teacher-education program, either for preschool and primary education and/or secondary education (bachelor's degree, 12 universities) or a professional master's degree in preschool and primary education and/or secondary education (eight universities). Both study programs lead to professional accreditation as a teacher in the context of compulsory education. In response to the problems involving the recruitment and retention of teachers, these master's degrees are also offered in Quebec, which allows existing, non-legally qualified teachers and preservice teachers to specialize in particular teaching areas, or to qualify for teaching by completing their initial training, respectively.

The Reference Framework for Professional Competencies for Teachers, which was initially published in French in 2020 (and then in English in 2021) by the Ministry of Education of the Government of Quebec, is the main framework for teacher-education programs in Quebec. This new reference structure, an updated version of the 2001 iteration, was developed to reflect the current reality and needs of educational institutions and teachers in the province of Quebec. It specifies the 13 core teacher-professional competencies that teachers at non-university educational levels must develop to carry out their profession and lead to student learning, education, and success (Quebec Ministry of Education, 2021). The cross-curricular *Competency 12. Mobilize digital technologies* details, in its scope, that it “goes beyond the technical skills needed to use digital tools for pedagogical purposes in the classroom. Teachers must be aware of the impact of these changes on the nature and value of learning” (p. 78) and highlights, as key elements, certain abilities, such as “exercises ethical citizenship in the digital age,” or “develops critical thinking about the use of digital technology” (p. 79). These components coincide with the dimensions that appear in the digital-competency framework, described in the next section.

Digital competencies in Quebec's reference frameworks

The Digital Action Plan for Education and Higher Education, implemented by the Quebec government, aims to develop and integrate ICTs into teaching practices to foster innovation, academic success, and lifelong learning (Quebec Ministry of Education and Higher Education, 2018). The Digital Competency Framework (Quebec Ministry of Education, 2019) for all educational levels is part of this digital action plan. This framework emphasizes the responsibility of teachers and schools for digital education, considering electronic learning a tool, as well as a form of literacy and social practice, which also involves learners and non-teaching professionals. In this context, digital competence is defined as “a set of skills necessary to the confident, critical and creative use of digital technologies to achieve objectives about learning, work, leisure, and inclusion or participation in society” (Quebec Ministry of Education, 2019, p. 7), thus emphasizing

the importance of digital citizenship. Based on over 70 existing frameworks worldwide, Quebec has a distinct, innovative nature compared to its counterparts in other countries due to its holistic understanding of these proficiencies.

This framework comprises 12 strongly interrelated digital competency dimensions, including two central dimensions and 10 other dimensions that are articulated around them (Figure 1). Each dimension includes elements and concrete examples from various learning and teaching contexts and is further divided into elements, resulting in three levels of digital competencies.

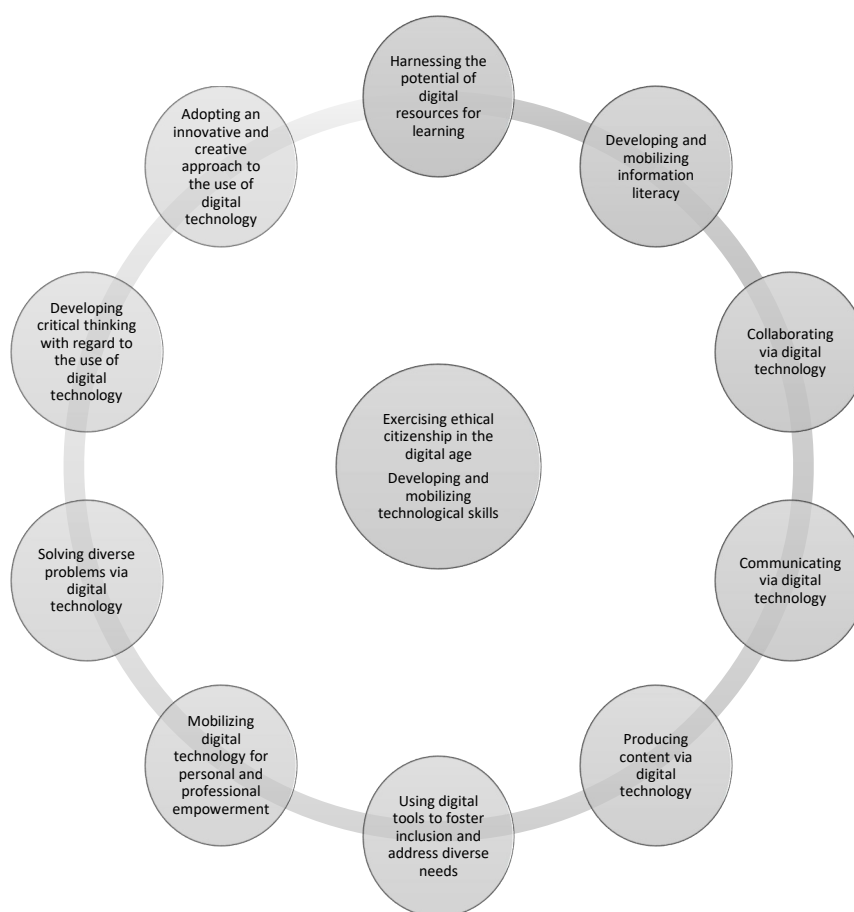


Figure 1: Digital competence dimensions in the Quebec Digital Competency Framework.

Most of Quebec's teacher-education programs include, in their study plans, a course or module (usually compulsory) that specifically addresses teachers' digital competencies. At the same time, considering that these skills are cross-curricular aptitudes in the reference framework, they are expected to be included transversally in other courses in the study programs. Thus, the Quebec Digital Competency Framework is applied in Quebec's teacher-education programs through dedicated courses and the transversal application of these skills across the curriculum.

Materials and Methods

Digital competencies in Quebec's reference frameworks

This study's objective is to explore the integration of digital competencies into teacher-education programs at Quebec universities, with an emphasis on CDL and digital citizenship.

Therefore, the following research questions (RQs) were posed:

- RQ1: How is the Quebec teacher-reference framework being operationalized, in terms of digital competencies, in teacher-education programs offered at Quebec universities?
- RQ2: How are CDL and digital citizenship considered in the development of digital competencies in teacher-education programs offered at Quebec universities?

These questions targeted the presence and practical application of these abilities, offering insights into how these skills can be improved.

Study design

The study follows an interpretive approach, aiming to understand better how digital competency is integrated into teacher-education programs in the Canadian province of Quebec. Considering the importance of subjective experience, individual meaning, and contextual details for comprehending teacher digital competence within its socio-cultural framework and from a proactive perspective on its development (Marín & Castañeda, 2022), interpretivist methods, such as interviews and document analysis, were selected. Two qualitative data collection methods (semi-structured interviews and document analysis) were used in parallel to triangulate the data and obtain a broader view and insights into the two research questions, based partially on common characteristics (dimensions of digital competence) (See Figure 2). Data collection was conducted between August and September 2022.

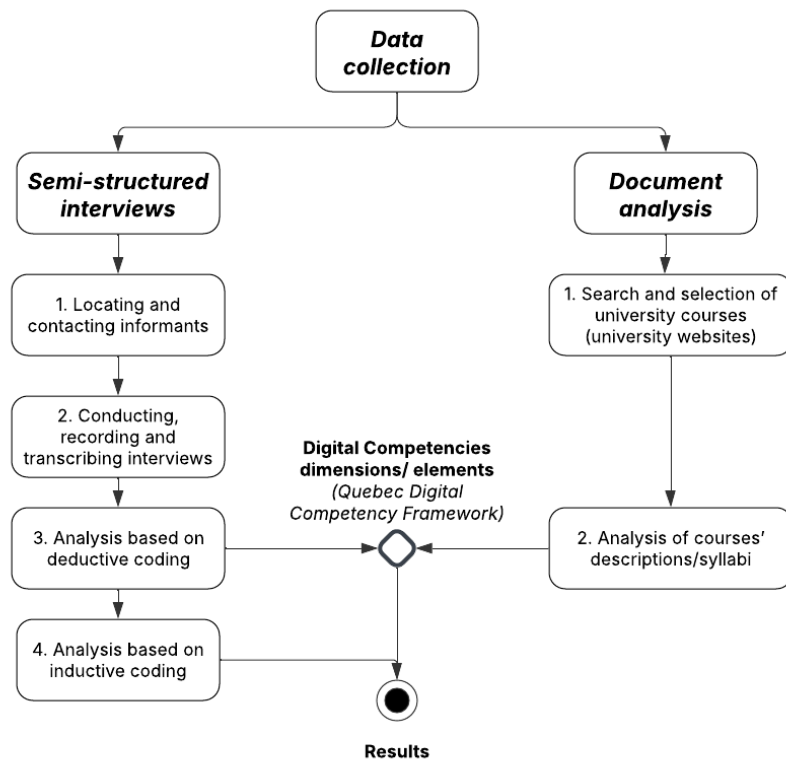


Figure 2: Study design flowchart.

Semi-structured interviews are exploratory, and are often used in social sciences usually following a protocol or guide design in advance. The continuous conversations between the first author (based outside of Canada) and the second author of this study (an education professor in Quebec) were key in ensuring access to the setting, locating informants, and grasping the nuances of the interviewees' language and culture. Ethical approval was obtained from the University of Lleida's data protection officer. In this study, the ethical research guidelines were followed, which included the voluntary nature of participation in the study, ensuring the confidentiality and anonymity of the obtained data, providing the option to interrupt participation without providing reasons or facing penalties, and using the data solely for the development of scientific publications. The interviews, which lasted one hour each, were recorded with the participants' informed consent. Due to the first author's limited language proficiency in French, all interviews were conducted in English, except for one, which a specific interviewee requested. This particular interview required the support of the second author for interpretation and translation.

Document analysis involved searching for courses that explicitly included terms related to digital technologies, ICT, media, or similar topics in their titles within each Quebec university webpage and among the offered teacher-education programs. Only the ones that led to professional accreditation as a teacher in preschool, primary, or secondary education (compulsory education) were considered and analyzed in this study. As mentioned, all the programs searched included bachelor's and professional master's degrees.

Sample and participants

In the interviews, instructors from the education departments of Quebec universities with teacher-education programs were contacted. As part of the inclusion criteria, we included instructors who had some teaching experience related to educational technology or distance education (at least one course taught in the last year). The final, intentional sample depended on the authors' ability to access and reach; the sample did not represent all the universities with teacher-education programs in Quebec, nor all the teacher educators involved in courses related to digital competency within those programs. Eighteen professors from seven universities in Quebec were invited. The final sample consisted of seven professors (3 females and 4 males, all tenured, except for one) from three universities who agreed to participate in the interviews. To ensure confidentiality and anonymity, their real names were replaced with pseudonyms. Apart from having teaching experience related to the field, five out of the seven educators were directly involved in teaching digital-technology courses in teacher-education programs. All of them were familiar with the Quebec Digital Competency Framework.

For the document analysis, all courses across Quebec universities that focused on digital competencies in their teacher education programs were considered. The search was conducted by accessing university websites and their teacher-education programs. A total of 34 courses were identified and included in the analysis.

Instruments

Semi-structured interviews were conducted following an agenda that included five main questions addressing the topic of this study. These served to guide each interview, ensuring consistency and flexibility across all of them. From the beginning and throughout the questions, the participants' experiences and perspectives on how digital competency was integrated into Quebec universities' teacher-education programs were reflected in the answers. The concrete interview questions were as follows:

- (1) What is your vision for the development of digital competencies in teacher education?
- (2) Which elements of digital competence do you consider to be more emphasized in teacher-education programs? Which elements are less emphasized? Do they coincide with what you think should be given more (or less) attention? Is there something that you would like to add?
- (3) What do you consider essential elements, in terms of CDL and digital citizenship, for teachers?
- (4) Which areas do you focus on more in your course/module(s)? How do you do it? (only for instructors teaching a digital-technology course)
- (5) How is digital competency being developed, and how can it be further amplified in the university training for teachers?

These questions were posed orally in-person and online and the participants' answers were recorded on Microsoft Teams and later automatically transcribed and manually revised by the first author.

For the document analysis, a spreadsheet was created in which basic information about the courses and their correspondence to the Quebec Digital Competency Framework elements were collected. The fields used as columns included: a) course, b) study program(s), c) university, d) program block to which the course belonged, e) number of credits, f) whether or not it was compulsory, g) year of studies of the course, h) digital competency dimensions referred to, i) whether CDL and digital citizenship were addressed and j) degree of course information (1: only

a description comprising a couple of lines, 2: includes a longer description and/or objectives/competencies or contents and 3: the full syllabus is available). These headings provided a comprehensive basis for analyzing the courses and their alignment with the Quebec Digital Competency Framework.

Data analysis

The first author utilized the software MAXQDA 2022 to conduct a content analysis of the data collected from the interviews. First, a deductive coding approach was employed to analyze the data based on the digital competency dimensions/elements outlined in the Quebec Digital Competency Framework. Next, inductive coding of the interview data was carried out to identify further the codes considered relevant to addressing the research questions. Finally, both authors discussed the final coding schema to ensure its consistency. The latter can be found in Appendix 1.

In the document analysis, course descriptions/syllabi found on the university websites were used to relate to the dimensions of digital competency. Two (2) of the courses had complete syllabi; 11 included lengthy course descriptions, objectives, competencies, and/or contents, and the rest of the courses (21) only had descriptions comprising a few lines. This shows that the availability and depth of information regarding digital competency integration in course materials varied significantly across the university's offerings.

Results

In this section, the results are presented by answering each of the RQs above, considering both data sources (interviews and document analysis). First section -on RQ1- covers how digital competence is operationalized in teacher-education programs offered at Quebec universities, whereas second section -on RQ2- addresses how CDL and digital citizenship are considered within digital competencies in those programs. The results describe the findings based on the data in the two sections, which are discussed later.

Digital competence in teacher education programs (RQ1)

Out of the 34 courses on digital technologies that were identified in teacher-education programs at Quebec universities, 25 were included in bachelor's degree programs (14 only for preschool and primary education; four for preschool, primary, and secondary education; and seven only for secondary education) and nine in master's degree programs (one for preschool and primary education and eight for secondary education). All universities with teacher-education programs offered training related to digital competencies; however, these courses were not always available in all of them. The analysis of the courses revealed that all dimensions of this component were present, albeit at varying levels (Table 1).

Table 1: Ranking of digital competency dimensions, based on their presence in the course descriptions (N=34).

Dimensions from Quebec's Digital Competency Framework	Frequency	Percentage
Digital resources for learning	31	91.2%
Technological skills	25	73.5%

Critical thinking	18	52.9%
Ethical citizenship	10	29.4%
Content production	9	26.5%
Communication	8	23.5%
Personal and professional empowerment	6	17.6%
Inclusion and diverse needs	6	17.6%
Information literacy	5	14.7%
Collaboration	4	11.8%
Problem-solving	2	5.9%
Innovation and creativity	2	5.9%

Note: Each course could refer to more than one dimension.

Harnessing the potential of digital resources for learning, developing, and mobilizing technological skills were two of the most frequently present digital-competency elements, with 91.2% and 73.5% of the courses including those dimensions in their descriptions, respectively. Both are reflected in the following course descriptions:

This course provides an introduction to theoretical and practical knowledge regarding the use of computers in elementary[-]school classrooms. Assignments are designed to provide students with hands-on experience[s] with the computer. (Course2, Bachelor's degree, Early Childhood and Elementary Education)

Pedagogical use of courseware and common software (word processing, e-mail, Internet, databases, spreadsheets). [sic] Impact of new technologies on the school. [sic] Advantages and limitations of ICT in teaching and learning. [sic] (Course31, Bachelor's degree, Secondary Education, original in French)

The prevalence of digital resource utilization and technological skill development within course descriptions highlights their significance in contemporary educational practices, as evidenced by the examples provided.

Other dimensions, such as *adopting an innovative and creative approach to the use of digital technology* or *solving diverse problems via digital technology*, were barely present (in two courses, 5.9% each):

Develop skills to design a scenario for the pedagogical integration of ICT in an educational situation. To deepen one's reflection on the integration of ICT in teaching, learning and management of educational situations, in a context of educational innovation. [sic] (Course19 on Innovation and Creativity, Master's degree, Preschool and Primary Education, original in French)

Topics include social interaction and equity, problem-solving skills, software evaluation, interactive technologies, and curriculum planning. (Course2 on Problem-solving, Bachelor's degree, Early Childhood and Elementary Education)

While some courses touched upon innovative uses of digital technology, the broader integration of such tools, particularly in fostering creativity and problem-solving skills within educational contexts, remains an area with significant room for development.

These findings from the content analysis partially coincided with what the interviewees stated about which digital competency elements were more emphasized in the teacher-education programs in Quebec universities. These are generally the more instrumental ones, such as technological skills, digital resources for learning, information literacy, collaboration, and communication, or content production. This idea was reflected in some interviewees' comments:

If you do some training course for the teacher about how to use technology, you probably have a lot of development of skills [to teach] about, for example, “develops and mobilizes technological skills, harnesses the potential of digital resources for learning, develops and mobilizes information literacy, and produces content via digital technology”... The other things, it's more global and questionable... (Joel)

The aspect of digital competence [that is] most developed is the basic one: communicating with digital technology and producing content. We ask future teachers to do a PowerPoint, to do an animation, but it's focused on products, communication, ... (Vanessa)

These statements highlight a tendency in Quebec universities' teacher-education programs to prioritize instrumental digital competencies, often at the expense of other, potentially more nuanced, aspects of digital competence.

This is the case for *innovation, creativity, and critical thinking*, which are the less emphasized elements of digital competence in the teacher-education programs analyzed. The same four professors referred to this little consideration to both digital-competency elements:

When we approach the more complex competencies, like critical thinking, [or an] innovative approach... it's not what we see in different programs. [These are] only the base. (Vanessa)

[The dimension that states,] “Adopts an innovative and creative approach to the use of digital technology” It's [sic] not nearly present enough. I would say that it's present in certain classes about science, teaching science[,] and[/]or in my technological class[,] because I talk about creative labs, the makers' movement and stuff like that. So, there are some classes where we specifically talk about how we can use technology to be more creative[,] or to help people who want to create or innovate. [...] It's punctual. We do talk about it, but I think we can do a lot better. (Sebastian, on Innovation and creativity)

[...] Everything ethical, ethical citizenship, is not worked on by the teachers. In my course, they just want to learn the tools; they come with the expectations of the technological ability. (John, on critical thinking, original in French)

These findings highlight a significant gap in teacher-education programs regarding the cultivation of innovation, creativity, and critical thinking skills, in relation to digital competence. They suggest a need for a more comprehensive approach that integrates these crucial elements to better prepare teachers for the evolving demands of the profession.

Most of the interviewees stated that all the dimensions were important and interrelated, but that developing and mobilizing technological skills served as the basis of teachers' digital competencies. One of the participants stated:

Surely, technological skills are also important because they are embedded. If you don't have any technological skills, you will not be able to be a good citizen in a digital era[,] because you don't know how you use an application or how to program [...]. (David)

"Develops and mobilizes technological skills." [...], of course, it's important, because if they don't have the skills, they will not be able to have critical thinking, and they will not be able to use it to improve learning and teaching. So, for sure, it's a kind of basis on which they have to build their competencies. (Monica)

As these interviewees suggest, the development and mobilization of technological skills is perceived as a foundational element for teachers' digital competencies, enabling critical thinking and effective integration of technology in education, as well as more complex elements of the competence.

Ways of Integration Based on content analysis, the courses on digital technologies for future teachers were typically included in the pedagogical foundation block of teacher-education programs, carrying three credits.¹ In three cases, these courses were part of specializations in secondary education (one in French and two in mathematics). In the few cases where more than one course was offered during the program (3 from different universities), each course offered just one credit. There were also some exceptions (5 programs), in which the course earned a student two credits, or a program had one compulsory course and some other optional courses (three credits). One university and program offered five credits for digital technologies courses. Furthermore, digital competency training was usually compulsory; however, in eight cases, the courses were optional, typically offered in master's degree programs (4 cases). The interviewees provided further explanations about how digital competency was integrated into the teacher-education curriculum (Figure 3).

¹ In the context of Quebec higher education, one university course usually corresponds to three credits and one credit represents approximately 45 hours of work (including individual study, presence in a class, lab, workshop, internship, etc.).

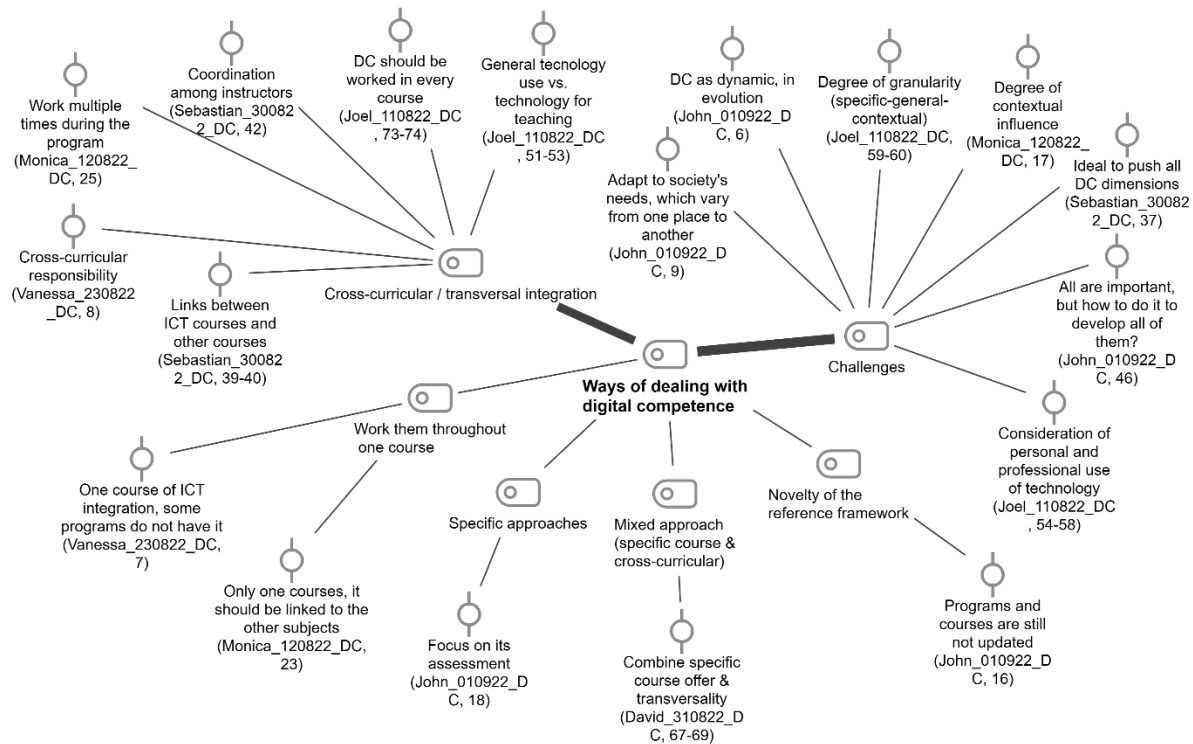


Figure 3: Ways of dealing with digital competency.

Note. Different codes can be identified from the main category, with each including subcodes that are linked to the interviewees' quotes. A stronger line between the category and code involved a higher frequency in the interviewees' answers. This note also applies to Figure 4.

Typically, one media-technologies course addressed digital competence per program, although this was poorly connected to other courses within it. However, the ideal scenario was to reach a cross-curricular/transversal integration across the program, but retaining a specific course:

Normally in teacher training, they have only one course in which they think about the technology[,] but in the competence framework[,] it is transversal. It has to be used in all [of] the courses. So, to be able to take this into account really [...], it should be in all the programs for the initial training of the teachers, I think. [...] But in one course that is not linked with the other things, I don't think we can work on this quite well. (Monica)

This suggests that a single, isolated course on digital competence is insufficient for effective integration, and a cross-curricular approach is necessary to fully equip future teachers with the skills they need.

In addition, one of the interviewees stated that, having reached this cross-curricular vision, presenting sequential progress in the different technological courses to scaffold preservice teachers in their digital-competence training would be beneficial:

There's a link between the ICT courses and the other courses, for example, in the first year. The first year, at the end of the month, I'm gonna [sic] train them to use

Google Drive to collaborate. The week right after, they're gonna [sic] have to use it in one, or, [sic] this year, in two of the other courses, [in order] to produce something, so they're producing and we're producing both in the ICT course and other courses, but there's a link. We try to keep them. [...] So it's in both classes and it's also in practice training [...]. (Sebastian)

Hence, the cross-curricular approach to digital competence training needs to be planned carefully considering the whole study program, making effective and sequential connections across different courses and study years, so that it supports preservice teachers' digital competence development.

The interviewees also acknowledged major challenges involved in integrating digital competencies into teacher-education programs, such as their contextual and dynamic nature, the cross-curricular responsibilities, and the role of teacher-educators. Concerning the latter, issues of these instructors lack of technological abilities were noted by some of the participants. One of whom stated, "There are difficulties (regarding transversality), [...] teachers don't all have the same level of digital competency from the document" (John). He further commented that there were doubts about the technological prowess of those delivering the material, by stating, "Sometimes he [the teacher educator] doesn't know nothing [sic] about the use of technology. However, in spite of this drawback, the student-teachers still have to "do it" and "manage." (Joel). This highlighted the need of coordination between teacher educators, as one of the interviewees indicated:

It has to be the responsibility of all teachers[,] but these professors, some of them—maybe a lot of them—don't [sic] have [sic] developed this competency. It's difficult for them to build some exercise about this competency[,] when they have to develop other competencies [...] but if every course touches this aspect, maybe we can develop more [components about] this key element, and if we coordinate the different courses to develop these elements, maybe we can put the more basic one on [sic] the start of the program and the complex one at the end. (Vanessa)

Therefore, on the one hand, the cross-curricular and sequential perspective of digital competencies in teacher-education programs – introducing basic digital skills early on and more advanced skills subsequently-, and their contextual variability, needs to be considered. On the other hand, attention should be paid to the educators' role in the development of preservice teachers' digital competencies. There is a need for interdisciplinary collaboration, improved coordination among teacher-educators, and further development of educators' digital skills in order to overcome barriers to effective cross-curricular and sequential implementation.

CDL and digital citizenship in teacher-education programs (RQ2)

Most of the courses included descriptions that connected them to CDL and digital citizenship (22 out of 34; 64.7%), particularly critical thinking (52.9%). The digital-competency elements of critical thinking, ethical citizenship, and, to some extent, information literacy, were especially considered in RQ2. On several occasions, all or two appear together in the course descriptions, objectives/competencies, or contents.

In the case of critical thinking, its presence across the courses is much higher than that of the other critical components. In terms of frequency, developing critical thinking regarding the use

of digital technology is the third element listed in Table 1. Some examples are reflected in the following descriptions of the courses' objectives or contents (originally in French). After those examples, practices mentioned by the interviewees about the need to work on critical thinking, regarding the use of digital technology, are shown:

[...] Develop a critical eye on the contributions and limitations of technological tools and be able to target their didactic potential. Reflect on the means to be deployed to promote the appropriation of technological tools by students. (Course15, along with Ethical citizenship, Bachelor's degree, Preschool and Primary education, and Secondary education)

Foundations of a sociocritical approach to digital education. Teachers' and learners' relationship to the digital environment. Opportunities, issues and challenges related to digital education. Digital inequalities. Digital and technical postures. Digital citizenship and ethical issues. [...] (Course21, along with Ethical citizenship, Master's degree, Secondary education)

In our course [...] we emphasize this specific complex skill more than the use of technology [...]. We ask the student to appropriate the competency[,] and after we present them [with] some case and [...] some article to vote For [sic] or Against [sic] the technology, to make them do a reflection about the technology [sic]. We ask them to look at the two sides of this technology in the situation. (Vanessa)

They have to work on a controversy, technological controversy[,] and in a wiki at the time—it's very important—and in teams to collaborate, and they have to produce a text about the controversy and to present this in class. So, it's how I did the exam. (David)

The emphasis on critical thinking about digital technologies over ethical citizenship and information literacy suggests that teacher-education programs should intentionally integrate scaffolded, practice-based activities (e.g., debates, wikis, case analysis) to balance analytical critique with ethical citizenship and information literacy development.

Ethical citizenship was considered in 29.4% of the courses, and it usually referred to the types of licenses, netiquette, and societal issues (originally in French):

Think critically and with nuance about the true benefits and limitations of ICT to support teaching and learning, as well as the issues at stake for society. (Course8, along with Critical Thinking, Bachelor's degree, Preschool and Primary Education)

[...] They (future teachers) will also become familiar with reference management tools. They will develop good [sic] information search strategies on the Internet and master a wide variety of tools and knowledge bases. They will become familiar with copyright, open-source software and netiquette. (Course24, along with Information literacy, Bachelor's degree, Secondary education)

There were also some practical examples presented by the interviewees of how ethical citizenship is worked with preservice teachers, as indicated by:

We don't have a course especially on this. [sic] But [sic] in the course [that] we are developing... they always have a [sic] exercise to do. So[,] they have to plan how to integrate the technology[,] and, in parallel, they have a reflective journal to complete and to share with their colleagues, because we want them to be able to share and to think about what they are doing[,] and to justify how they feel about the integration of the technology and about the society, and the implications that are behind. So[,] if they use technology and they ask the student to give information in one system, for example[,] it has implications[,] because you ask them to give personal information. [...]. (Monica)

In the last years when I taught at university X with future teachers, I start[ed] with a movie, 10 minutes, to show what can be technology, what is technology[,] if we ask [the] question, and they are transformed by this video and they start the discussion. So[,] I start the course with that[,] so during a [sic] 15 weeks[,] they have this in mind [...]. And this video show[s] that technology can have a great impact on us. [...] So[,] I changed their way of seeing technology at the first course, [...], and I think that it's [a] good start for the student and [for their experiences] after this. (David)

All in all, ethical citizenship appears scarcely and in a limited form —typically framed around licenses and netiquette-, but there is potential in how interviewees worked this digital-competency element. More deliberately embed sustained, reflective and experiential activities, such as the ones posed by the interviewees (reflective journals, case discussions, media prompts) are needed to move beyond rules and cultivate preservice teachers' critical understanding of the societal and privacy implications of technology use.

Regarding information literacy, only 14.7% of the courses referred to it to some extent, as shown below. Additionally, one of the interviewees emphasized its importance.

[...] Selection, processing[,] and analysis of information [that is] available on computer networks in the context of the teaching profession. [...] Critical look at the integration of ICT in the classroom. (Course14, along with Critical Thinking, Bachelor's degree, Preschool, Primary and Secondary education, original in French)

I think that a key point is information literacy, because we know that there is so much information coming from everywhere[,] and it is very important that they know how to analyze it, choose which one is reliable, which is... That seems to me to be the most important point. (Beatrice)

Only few courses explicitly addressed this digital-competency element, yet it is identified as a critical gap by one of the interviewees. There is a need that teacher-education programs integrate sustained, practice-based instruction in source evaluation, critical appraisal and

information synthesis across the curriculum to prepare preservice teachers to navigate abundant, unreliable digital information.

Regarding CDL and digital citizenship, the interviewees identified specific, related digital competency dimensions, ethical topics, and challenges for their implementation (Figure 4), which are detailed as follows.

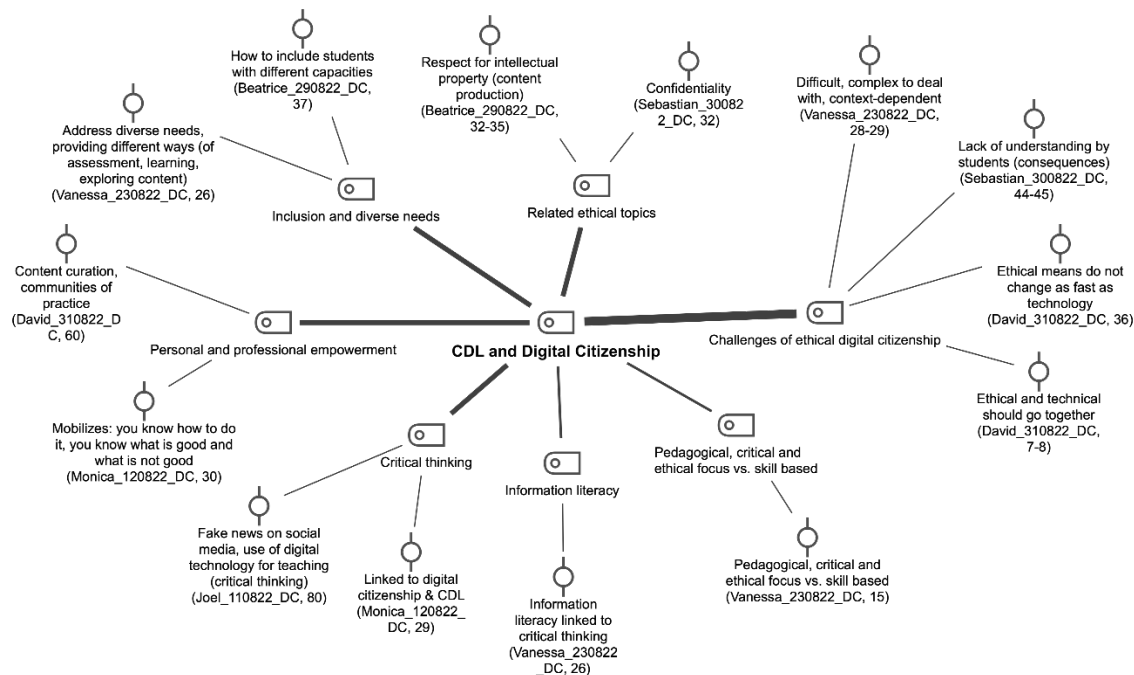


Figure 4: Critical digital literacies (CDL) and digital citizenship.

The professors made connections between CDL and digital citizenship, as well as other dimensions, such as inclusion and diverse needs (n=2), information literacy (n=1), critical thinking (n=2), and personal and professional empowerment (n=2). Some examples are provided below.

In the way that he/she (the student) has to be critical, but it's linked to the first one, [information literacy] it's important. [Also,] the use of technology to help students, address diverse needs to be more inclusive, thinking differently with the technology, but also without the technology. (Vanessa)

You have to be critical thinking about, for example, the people that [sic] take news on Facebook and doesn't [sic] take care. The perspective on that is for some, "I find it on the web, [so] it's OK. How many times we see that about the news, the fake (ones) and the use of digital technology[,] and for teaching too. (Joel)

Overall, while professors connected CDL and digital citizenship to inclusion, information literacy, critical thinking, and personal and professional empowerment, these links are uneven and often incidental. Their statements suggest that teacher-education programs should more explicitly align curricula and create learning activities that strengthen and operationalize these cross-cutting connections for inclusive, critical, and empowered digital practice.

Two interviewees related CDL and digital citizenship to specific ethical topics, such as the respect for intellectual property in content production and confidentiality. “They need to know how to do it (produce content) respecting ethics, which image can be shared, etc.” (Beatrice)

They say things online that they shouldn't say. [sic] And [sic] there's always one student that [sic] will talk about it, that will name a student during their [sic] practice training or... It's all... little something, they don't realize that it's linked to an ethical problem, [sic] they don't realize that technology can take that message[,] and, you know, keep it live for years and years[,] or, [sic] all [of] the messages can go all around the world in 2 [sic] minutes. So, you have to learn and be more critical and more... I don't know. I think it's normal, but as a teacher, it's something really, really important[,] because parents and kids are looking up on social media for their teachers[,] and, [sic] what they see is what they're gonna [sic] believe that you are. So, something that we keep working on, year after year. (Sebastian)

Although only a few interviewees explicitly connected CDL and digital citizenship to ethical issues - intellectual property, confidentiality-, the interviewees' quotes show a pressing need for sustained, practice-based ethics education—case analyses, reflection on digital reputation, and clear professional guidelines—to ensure preservice teachers both understand and can act on these risks.

There are some important perceived challenges regarding CDL and digital citizenship that some interviewees felt should be included appropriately in teacher-education programs. Concretely, there was a lack of understanding of their importance among pre- and in-service teachers, along with several complex issues in dealing with them, due to their context-dependent nature:

Specifically, about being an ethical citizen in 2022, I think that, in general, people don't understand the impact of technology on their daily lives. [...] They don't understand the consequences, how it impacts their life on the positive side, and how it could impact [it] on the negative side. They don't realize the importance of the skills and abilities that they are developing. [...] You need critical thinking to be a good citizen; otherwise, you're gonna [sic] make poor choices. (Sebastian)

I'm not sure [that] it's the most difficult, but it's a complex one. [sic} Because [sic] we aim for something personal for the student, really personal, also for the teacher, and we have a social context. [...] We see a lot of ethical issues in social contexts and media, and when we try to focus on this issue, the responses sometimes are a little bit brutal. The people don't want to be taught how to be ethical, how to be a good person, [or how to be] a correct person. It's why I think this one may[,] maybe[, might] be difficult to develop as a teacher and in our teaching for learning. (Vanessa)

Another interviewee pointed out the improvements in the new program in this respect:

[...] I know that in our new program, it's an aspect, but for now I would say... in many [...] it's something completely apart. So, the new program has this opportunity to speak about it [...]. The technical (aspect) is very important, but we must know at the start what it means to use it. (David)

All together, interviewees highlighted a widespread underestimation of CDL and digital citizenship, compounded by context-dependent complexity and resistance to overt ethics instruction. These aspects may be dealt with the new program by embedding contextualized, reflective, and practice-based ethics and critical-thinking experiences across courses to build deeper preservice teachers' understanding of digital technologies and digital agency.

Discussion

International teacher digital-competency frameworks were noted to be deficient in their explicit approaches to CDL, as well as in acknowledging the situated nature of digital competence and a proactive standpoint on its development (Marín & Castañeda, 2022). In this sense, and based on this analysis, Quebec's teacher-education programs focus on situated digital competency dimensions that emphasize the instrumental side of technology, albeit with some promising prospects for further development in the critical and ethical dimensions. Elements that referred to digital resources for learning and technological skills were mostly standard across the courses, which are components frequently reflected in other frameworks (European Commission, Joint Research Centre, 2017; ISTE, 2021; UNESCO, 2018). This finding could be interpreted in terms of the more instrumental and pragmatic view of the teachers' role, regarding digital technology in education and their teaching of digital competencies, as opposed to more sociocultural and critical approaches to such skills (Bourgeois & Nebutse, 2020; Collin & Brotcorne, 2019; Marín & Castañeda, 2022). This is in line with other Canadian digital-competency frameworks (e.g., for K-12 students, Alberta's Digital Literacy Program; Alberta Education, 2020), but specifically opposed to the BC Digital Literacy Framework, which addresses a wide range of digital citizenship and CDL elements by incorporating an understanding of the legal and ethical implications of technology use. However, this agenda is linked to students (Government of British Columbia, 2022). Other digital-competency dimensions, more closely related to CDL (e.g., innovation and creativity, inclusion of diverse needs) (Van Laar et al., 2020), were identified as significantly complex and challenging to address. The same finding has been reported in other contexts (e.g., Castañeda et al., 2022; Miralles-Martínez et al., 2019; Ottestad et al., 2014).

Digital competence is considered a transversal skill and/or an interdisciplinary one. However, the difficulties of applying it mean that usually just one course (or more than one in the best scenario) is typically offered in an entire teacher-education-program curriculum. This problem has also been pointed out in the literature. For instance, Lindfors et al. (2021) argue that preservice teachers "need more than standalone courses on digital technologies" and that teacher education "should focus on questions of teaching and learning and integrating them with technology throughout the entire curriculum" (p. 395). Ottestad et al. (2014) report that most teacher-education programs in Norway lack a comprehensive approach to developing digital-competency skills, similar to the situation in Canada (OECD, 2023a; UNESCO, 2023). In a study by Nowak (2019) in Poland, the author highlighted that, despite the greater emphasis on the critical and reflective use of digital competencies, there are still insufficient hours of classes in teacher-training programs to support students in this use. Howard et al. (2021) refer to developing an integrated

approach to digital-competency training as a “complex problem,” suggesting different teaching strategies with multiple and nonlinear relationships among them.

In these digital-technology courses, which are integrated into teacher-education programs, the pedagogical (and professional) use of such media is typically addressed. These kinds of uses differ significantly from personal use, and there is no direct transfer from personal to professional, pedagogical, or educational use by students/preservice teachers (Kozyreva & Collin, 2016; Sancho Gil et al., 2015). As in previous research in Norway by Tømte (2015), in the current study, some professors reflected on the difficulties faced by preservice teachers, as they sought to increase awareness of how to use digital tools in their teaching practice, beyond personal use. There is a specific need for practical training, as well as addressing the methodological aspects of the teacher's digital competencies (Gisbert-Cervera et al., 2022), and considering prior experiences and beliefs about teaching and learning with digital technologies (Warford, 2011). This situation calls for continued work in teacher-education programs, considering the TPACK framework, which emphasizes the teachers' technological, pedagogical, and content knowledge to enable them to effectively integrate digital technologies into the classroom (Mishra & Koehler, 2006), as well as teacher educators using technology to engage preservice teachers in learning (Ajayi, 2009).

At the same time, teacher educators play a key role in supporting the development of preservice teachers' digital competencies and serving as role models (Amhag et al., 2019; Uerz et al., 2018). In the present study, various participants highlighted this role and the need for improvement in the development of teacher educators' pedagogical digital competence. Specifically, to know about responsible uses of digital technology in the classroom and develop technology competencies to guide preservice teachers, while at the same time, working on their misbeliefs about students being digital natives or residents (Adnan et al., 2024; Prendes et al., 2017; Warford, 2011), was put on the table. The lack of knowledge and skills among teacher educators to teach or model technology integration to preservice teachers, which makes the application of the ZPTD (Warford, 2011) challenging, is a recurring topic in research (Tondeur et al., 2012). These authors present the various proposed solutions suggested in the literature regarding this aspect, including training, support for technology use through workshops, access to consultants, mentorship, and sharing information (e.g., good practices). Similarly, Amhag et al. (2019) addressed the need to provide extensive pedagogical support for digital teaching and to identify the educational surplus value in their teaching contexts. In their review, Uerz et al. (2018) showed that, compared to other teachers' roles, research on “the specific role of teacher educators in the integration of technology in education has not been an important research theme in the last few decades” (p. 21). Lately, a specific focus on educators' digital competencies in the context of higher education has emerged (Tondeur et al., 2023), which may provide some guidance on the media skills an educator at this level requires. This could be developed further to contextualize it for the case of teacher educators.

Other, specific dimensions of digital competence seem to be ill-defined ones, due to their stronger contextual dependence (e.g., innovative and creative approaches, ethical citizenship) than others; emphasizing the importance of considering the situated nature of digital competencies (Marín & Castañeda, 2022) and their connection to CDL (Pangrazio, 2016; Pötzsch, 2019). In addition, an ethical approach, which assumes the lack of neutrality of such media (Feenberg, 2003) and points towards CDL, requires further development. For instance, despite the importance of information literacy, previous research has highlighted the lack of it among Canadian preservice teachers (Karsenti et al., 2014), and the current study found that the digital-competency dimension has been scarcely incorporated into the analyzed courses. In contrast, the findings from Torres-

Hernández and Gallego-Arrufat (2022) revealed, in a systematic review on preservice teachers' digital competency in online security, that there was much more focus in the literature on information literacy, rather than on other issues that are more related to ethical and critical questions, for instance, those connected to digital security.

Still, in the context of CDL and digital citizenship, issues related to social media (e.g. fake news, netiquette) were also mentioned. In this sense, future teachers should also be trained to employ them beyond personal use, develop critical thinking in their use, attend to data privacy issues, and consider good manners of behaving as an ethical digital citizen (Milton et al., 2021). Mirroring some of the results in this study by this article's authors, Milton et al. (2021) reported a lack of preservice teachers' awareness of how to behave online in a professional capacity, and in an exemplary form, as well as the need to prioritize preservice teachers' knowledge of "cyberethics" (including online responsible behaviour, personal and professional facets, privacy issues, respect to copyright) during initial teacher education. In addition, the different ways preservice teachers may position themselves could vary, considering cultural differences (Marín et al., 2023), and these should be reflected on, in addition to their prior-learning experiences in a first phase of self-assistance of the ZPTD (Warford, 2011).

At the same time, previous research in other geographical contexts has shown that the ethical approach is often insufficiently treated within digital competence. For example, in a study on the teaching guides of ICT-in-education courses in university degrees of Early Childhood and Primary Education in Spain (Novella-García & Cloquell-Lozano, 2021), digital competence was found in most of the assessed programs. However, the ethical dimension was scarcely considered (26.1%), a percentage similar to that of ethical citizenship in this paper's study (29.9%), which is also included among CDL. In comparison, half of the analyzed courses in this study focused on critical thinking and emphasized the importance of this dimension within digital competence.

Finally, some interviewees considered inclusion and diverse needs, as well as course descriptions. Its scarce presence aligns with the lack of awareness of the potential of digital tools to address an inclusive teaching and learning among preservice teachers found by Luís and Rodrigues (2024), which calls for a closer integration in teacher education programs. This means that there is a need for a more comprehensive approach to digital inclusive education in teacher education-programs.

Limitations

As mentioned previously, the interview sample did not represent all of the universities in Quebec offering teacher-education programs, nor did it include all the teacher educators of digital-technologies courses applied to education. In the case of the course-content analyses, the courses included were not analyzed in the teacher-education programs that had no direct connection to the application of digital technologies to education. This fact may have led to the loss of valuable information about the cross-curricular application of digital competence beyond digital-technology courses. Altogether, the limited sample size and the exclusion of non-digital technology courses restrict the generalizability and depth of the findings. To strengthen the validity of this study, it would be beneficial to include further teacher educators from more universities in the interview sample and to consider additional methods, such as classroom observations or longitudinal studies.

Conclusion

By exploring the integration of digital competencies in teacher-education programs at Quebec universities, this study contributes to understanding how these skills are developed in education faculties, especially in their critical dimensions. The findings showed that training for digital competency in teacher-education programs is offered by all Quebec universities (according to the analyzed courses) and that considerable awareness exists among education faculty regarding the importance of further developing CDL and digital citizenship. Also, the need for a critical approach to digital competence in teacher-education programs becomes clear, based on its limited coverage (including practices) and interviewees' statements emphasizing CDL elements as relevant for preservice teachers' professional practice, and responds to current challenges in society and the increased complexity of contemporary digital contexts (e.g., power dynamics in the digital world, misinformation and fake news, datafication, empowerment for change) (Kozyreva et al., 2023; Pangrazio, 2016; Prinsloo, 2022). Based on the findings of this study, there is still room for improvement regarding incorporating complex digital-competency dimensions, especially related to CDL, and the transversality of such abilities. This may be related to the fact that the new reference framework was still being deployed at the time of this research.

While it is acknowledged that innovative experiences in the context of CDL in teacher education (e.g., Castañeda & Villar-Onrubia, 2023; Stewart, 2020) have existed before, these are still scarce, as is research on these topics. Hence, the need for future work, moving forward, by designing, implementing, and evaluating pedagogical strategies that involve the development of CDL in teacher education is reaffirmed. These strategies should go beyond the instrumental view of technologies and challenge the globally dominant discourses regarding digital, technological use in education (McGarr & McDonagh, 2021) by considering techno-ethics in the context of teacher education (including teacher educators) (Krutka et al., 2019). In any case, those strategies should first take into account the ZPTD in a first phase of self-assistance by promoting preservice teachers' reflection on their prior experiences and assumptions on teaching and learning with digital technologies, before more intensive teaching interventions (Warford, 2011) are implemented. In addition, those interventions should consider the teacher educators using technology to engage preservice teachers in learning, and preservice teachers' knowledge construction through active participation in dialogue with their peers (Ajayi, 2009).

A starting point can be provided by looking at examples and strategies documented in the literature. For example, a possible approach is the critical-digital-design practice, which focuses on analyzing both multimodal features of electronic texts and the general architecture of technology, considering systems of power, privilege, and using individuals' beliefs and emotions (Pangrazio, 2016). Another strategy is the one that Moore and Tillberg Webb (2023) called the ethics-in-design method. This process considers the perspectives of teachers (and teacher educators) as learning designers. It promotes the following key ideas: ethics as a reflective practice, the need for constant interrogation of technology, and a design-based approach (consideration of techno-ethics incorporated into the learning design). In this procedure, the teacher role model and reflection are very much present (Howard et al., 2021). A third technique is considering traditional methods in classic humanities (e.g., film, art, literature) to read, discuss, reflect and re-assess specific issues (e.g., surveillance in George Orwell's novel 1984, state power and anonymity in digital domains in the art installation *Autonomy Cube*), without the need of digital devices (Pötzsch, 2019). Trust et al. (2023) proposed that teachers and teacher educators use heuristics, which are pragmatic methods to problem solving, to support critical and ecological approaches toward educational, technological decision-making, such as rubrics or checklists. The same authors highlighted the figure-ground analysis activity of the *Civics of Technology* project, which supported educators in addressing the background effects of digital technology (Krutka & Heath,

2022). Other documented options include using non-commercial alternatives and embedding and contextualizing political and historical aspects (Pötzsch, 2019). Additionally, drawing on Indigenous teachings (McLean & Rowsell, 2020) would provide guidance on ethical citizenship moving forward, which could be applicable to previous strategies. This action should consider the OCAP (Ownership, Control, Access, and Possession) principles articulated by the First Nations Information Governance Centre and the Quebec First Nations Information Governance Framework, which uphold the First Nations people's right to own, control, access, and possess their information and data, emphasizing their self-determination.

An example applied in the context of teacher professional development, which may also be applied in teacher-education university programs, is the use of techno-ethical audits to encourage teachers' reflection on the social, commercial, environmental and pedagogical issues involved in the use of technology in education (Gonzalez-Mingot & Marín, 2024). Through action research, and based on the techno-ethical considerations from Krutka et al. (2019), the authors created and implemented a techno-ethical audit tool to assess the electronic tools used in education, based on four categories (social, commercial, environmental, and pedagogical) in an in-service teachers' professional development workshop. Another example, in the context of an English BA at a U.S. university, involved undergraduates developing tactics for responding to personal ethical concerns related to data privacy and online identity protection (Castañeda et al., 2021). A third example, conducted in a visual and material rhetorics course in the United States, focused on cultivating critical infrastructure literacies by having students notice and document the digital infrastructure on their university campus, as well as conduct research and map the data center locations of their most frequently used digital platforms (Edwards, 2021). All these strategies present the potential for cross-curricular integration, which can also be observed in the various application contexts. It is also important to study the impact of these strategies on teachers' classroom practices.

Some specific solutions regarding curriculum development in teacher-education programs that incorporate digital competency dimensions and CDL are also considered. For instance, ways to verify and challenge preservice teachers' prior experiences and beliefs about teaching and learning with digital technologies can be achieved by having them reflect upon them (Warford, 2011). Another practical recommendation is to combine theory with authentic, subject-specific experiences using digital technologies and incorporate scaffolding and modelling practices (Tondeur et al., 2012; Warford, 2011) across different courses, rather than in just one course.

This study is particularly significant globally, given the limited qualitative research on CDL, in the context of teacher-education programs and the emphasis on the nature of digital abilities in Quebec's Digital Competency Framework. Concerning future research directions, it would be worthwhile to conduct this same study again in the midterm future, (1) to see the evolution of teacher-education programs with the complete deployment of the new reference framework and (2) to examine more closely the role of teacher educators in the development of teaching digital competencies by preservice teachers. Additionally, research methods could consider the preservice teachers' perspectives on integrating digital competencies and CDL into their teacher-education programs. Finally, studying and comparing how these skills are integrated into digital-technologies courses in teacher-education programs in other Canadian provinces and territories could provide a comprehensive view of the topic and point towards recommendations applicable across the country.

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