Review Article

Digital citizenship in primary education: A systematic literature review describing how it is implemented

Ania Tadlaoui-Brahmi [a,b,*], Kostanca Çuko [a], Lionel Alvarez [a,c]

[a] *University of Teacher Education, Fribourg, Switzerland*
[b] *University of Geneva, Switzerland*
[c] *University of Fribourg, Switzerland*

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ABSTRACT

Digital citizenship (DC) has been introduced to the curriculum at Swiss primary schools, a fact that underscores the importance digital skills have for citizens of the future. Already prior to this development, an increasing number of scholarly publications on the concept appeared. In this project, a systematic literature review was conducted to identify how DC has been operationalized in teaching practices to date. The findings reveal that DC is often used as an umbrella term for technology-related learning tasks that nevertheless fail to actively engage students in practicing DC in a critical manner. In addition, older students are often asked to develop DC in project-based learning outside the school setting. While interdisciplinary approaches to DC have been proposed, disciplines such as philosophy or ecology—apparently necessary to work on citizenship—are not considered. Finally, digital tools/environments are never questioned and always imposed; as such, a critical approach to DC is not explicitly developed in the classroom. This literature review discusses the practical implications of the current state of research.

1. Introduction

Over the past two decades, studies on technology in K-12 education have emphasized the importance of including digital citizenship (DC) in the school curriculum (Chen et al., 2021; Hollandsworth et al., 2017; Martin et al., 2020; Romero-Hall & Li, 2020). This development is congruent with numerous studies concluding the need to promote DC skills in students (Choi, 2016; Ribble, 2015) that do justice to the complexities of their socio-technical environments (Alvarez & Payn, 2021). To put it bluntly, although students learn how to use digital tools, school curricula have only just begun to address educating students in the critical and responsible use of such tools. Indeed, the increasing digitization of both educational settings and human activities represents an invitation for school systems around the world to take ownership of the challenges surrounding teaching students to engage with cyberspace. With the COVID-19 pandemic, digitization accelerated (Dwivedi et al., 2020; Gabryelczyk, 2020), and IT departments were often tasked with finding quick solutions so that schools could continue their educational mission.

Although the main reason for DC's increase in importance lies in the ubiquitous presence of digital tools in the everyday lives of students and citizens, it above all concerns issues of a social and educational nature. With regard to promoting respectful behavior online (Jones & Mitchell, 2016), psycho-emotional dimensions of personality (Ohler, 2011) and engagement in society (Frau-Meigs et al., 2017), or whether considered as a fundamental skill for mastering an evolving digital world (Ribble, 2015), the question is no longer *if* DC should be embraced by schools, but *how* it should be taught. Moreover, as recommended by Ahlquist (2017), digital education must start early.

1.1. From need to concept

Although the concept of DC is fairly new, it has been present in the scientific literature including in peer-reviewed papers in education reviews (Chen et al., 2021), at least since 2009 (Greenhow et al., 2009; Keengwe & Onchwari, 2009; Saunders, 2009), and first in the late 1990s (Mancini, 1999). According to *Dimension.io*, the number of publications on the topic is rising every year. Consequently, researchers in education sciences have begun using the concept to design educational settings and rethink school curricula (Hollandsworth et al., 2017).

A common definition of DC refers to promoting respectful online behavior and civic engagement (Jones & Mitchell, 2016). Other

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* Corresponding author. University of Teacher Education, Fribourg, Switzerland.
E-mail addresses: ania.tadlaoui@edufr.ch (A. Tadlaoui-Brahmi), kostanca.cuko@edufr.ch (K. Çuko), lionel.alvarez@unifr.ch (L. Alvarez).

definitions describe it as proactive engagement (Hintz et al., 2019) in the virtual world, and the development of the agency, i.e., a capacity to act and to ensure successful integration as citizens in a digital society (Sharpe and Beetham, 2010). In Law et al. (2018), DC is structured into three curricular perspectives: digital competence, information culture, and civic participation and politics. In sum, teaching DC aims to encourage safe and healthy behaviors while also fostering proactive, reflective, and respectful attitudes in online content creation and self-expression (Hui & Campbell, 2018). In addition, some authors also see a need for deepening the understanding of different DC foci (Law et al., 2018). In light of these broad and polysemic definitions, the question arises as to how DC is operationalized in the classroom.

A recent literature review examined how educators in K-12 education perceive technology, documenting their beliefs and practices (Walters et al., 2019). The authors note a discrepancy between what the literature recommends and what is effectively implemented. However, the paper is not a systematic review and does not detail how the content is actually taught. In 2017, the Council of Europe published a literature review about DC, concluding that the concept involves many stakeholders, and that it should be taught early in compulsory education. Nevertheless, the review provides no description of the status quo of DC education. In addition, another recent literature review discerns a lack of empirical studies treating young children and adolescents, with the majority of work focusing on higher education, pre-service teachers, or secondary schooling (Chen et al., 2021). And yet another review concludes that many studies propose scales to measure the level of DC skills (İmer & Kaya, 2020)—although Chen et al. (2021) have criticized the existing scales and point to the need for authoritative instruments to objectively measure DC (Chen et al., 2021)—which clearly contributes to the definition and operationalization of the concept, but again, provides no information about actual teaching practices.

All these findings point to gaps between theoretical recommendations and actual implementation of DC in the classroom as well as a lack of information about how teaching is implemented. As such, the results, as well as a more precise definition of the key concepts above, can help promote reflection on DC operationalization in the classroom.

1.2. From concept to learning experience

DC can be developed through in-school and out-of-school activities (Gleason & von Gillern, 2018). Although not every school provides DC education (Alonso-Ferreiro et al., 2020), it is interesting to observe what implementation measures are adopted when it is offered. Several definitions or operationalizations of DC have been formulated to describe aims, practices, or interventions (Hames et al., 2019).

To begin, Choi (2016) proposes four different approaches to DC education. First, the *ethical approach* indicates a conception of DC as a set of basic skills needed to function in a digital society: it would be unethical to neglect imparting these skills in compulsory education, as this would be equivalent to raising citizens who are incapable of accessing critical digital resources. Second, the *media literacy approach* implies the development of skills to access, judge, and use information critically on the basis of a broad understanding of the media. Third, the *participation/engagement approach* entails that citizens are proactive users who create content to disseminate their opinions, thus contributing to social, cultural, and economic life online. Finally, the fourth approach is *critical resistance*, in which DC choose the platforms for the values they promote and participate in the development of an online environment that is respectful of human rights and sensitive to every user's needs. These four approaches represent a fair description of the learning outcomes and goals that inform how DC could be implemented in the school curriculum.

A second concept that proves fruitful for describing how DC is implemented in the classroom is the nine-element model (Ribble, 2015). This model's popularity and broad scope make it an interesting framework in this analysis. In it, three main domains are structured into three

subdomains each: *respect online* (digital access, digital etiquette, digital law), *educate for online environments* (digital communication, digital literacy, digital commerce), *protect in online environments* (digital rights and responsibilities, digital safety and security, digital health, and wellness).

Another DC framework is DigComp 2.1 (Carretero et al., 2017), whose broad implementation in Europe makes it an important reference. In DigComp 2.1, five areas of digital competence are defined:

- *Information and data literacy:* browsing, searching, filtering, evaluating, and managing data, information, and digital content.
- *Communication and collaboration:* interacting, sharing, engaging in citizenship, collaborating, and communicating through digital technologies.
- *Digital content creation*: developing, integrating, re-elaborating content, copyright and license management, and programming.
- *Safety*: protecting devices, personal data and privacy, health and well-being, and the environment.
- *Problem-solving*: solving technical problems, identifying needs and technological responses, creatively using digital technology, and identifying digital competence gaps.

Finally, an implementation model is also essential for describing what actually occurred in the classrooms observed in the studies. As adherence and quality of implementation are rarely exposed in articles, *exposure* will be used in this review (Reinke et al., 2013; Rojas-Andrade & Bahamondes, 2018; Sanetti & Fallon, 2011).

The understanding and analysis of DC can certainly benefit from the literature on civic education, because the two concepts are so closely related. For instance, the taxonomy of citizenship from Westheimer and Kahne (2004) illustrates how education and politics are intertwined when citizenship development is targeted at school.

- First, *personally responsible citizenship* refers to morals, towards a respect of rights and duties.
- Second, *participatory citizenship*, refers to "good" citizens participating in public life and actively engaging in the community, considering the interests and values of the group.
- Finally, *justice-oriented citizenship* refers to an awareness of the origins of social inequalities, the identification of governance issues, and a form of political engagement to question the hegemonic social order.

This type of model (DQ Institute, 2017) is useful for identifying the different dimensions of DC as a concept, because such models deal with rights, duties, and identity in addition to addressing a variety of individual and collective obligations, thus leading to a broader understanding of DC. These elements can be applied to expand and specify Choi's first, more civic-minded approach, which is already reflected in the categories developed by Ribble (2015): (a2) *digital etiquette* or (c2) *digital safety and security*.

1.3. Aims and research questions

In order to promote a more complete understanding of DC and its implication for schools, the following questions must be addressed:How has DC been implemented and taught at the primary level to date? What learning outcomes do teachers set? And what impact does a study's year of publication, culture/country where DC is practiced, and student age have? By inquiring into how DC is realized in daily practices and specific classroom interventions, this study aims to contribute to operationalizing the theoretical concept.

2. Material and methods

2.1. Systematic review methodology

In our work, we adhered to the Cochrane Collaboration definition of systematic literature review (Green et al., 2015):

"A systematic review attempts to collate all empirical evidence that fits pre-specified eligibility criteria in order to answer a specific research question. It uses explicit, systematic methods that are selected with a view to minimizing bias, thus providing more reliable findings from which conclusions can be drawn and decisions made" (section 1.2.2).

In conducting the literature review, we followed a predefined procedure proposed by Newman and Gough (2020) that defines the individual steps: formulation of the research questions, selection of studies according to inclusion/exclusion criteria, coding strategy, in-depth evaluation, and synthesis. Our specific focus in each step is detailed in the following sections.

2.1.1. Search procedures

A systematic review of articles published between 2009 and 2021 in peer-reviewed journals was performed using the following computer databases: APA PsychINFO, ERIC, Education Source, EBSCOhost and Dimensions.io. The exact terms to search abstracts were "digital citizenship," "primary," and "implementation".

2.1.2. Eligibility criteria

To answer the research questions, the following criteria for studies were applied:

1. Reporting a real implementation of DC teaching.
2. Concerning primary education.
3. Written in English, French, or German.
4. Published in peer-reviewed journals.
5. Completed after 2009.

The following kinds of studies were excluded:

1. Theoretical studies.
2. Investigations at the secondary or tertiary education level.

3. Articles written in a language other than English, French, or German.

2.1.3. Search and screening process

As seen in Fig. 1, the initial search yielded 334 studies. After removing duplicates, a total of 288 studies remained. After analyzing the titles and abstracts, 41 were extracted; this process was undertaken by two researchers. After reading all the articles, 27 purely theoretical studies were removed. As an end result, 14 studies were included in the review.

2.1.4. Coding and data extraction

To conduct the literature extraction, the *validated 9-step* systematic review process defined by Newman and Gough (2020) was rigorously followed: *Research question* and *conceptual framework* are stated. *Selection criteria* and *search strategy* are identified (see Tables 1 and 2). *Study selection* (see Fig. 1), and *coding strategy* (see Table 3) are determined. Each study is listed according to the identified DC models (see section 1.1). Because this synthesis is interested in describing implementation practices, not research quality, the *assessment of the quality* of each study is briefly discussed in section *2.1.5*; for this reason, the data assessment process was not evaluated. Finally, the findings are reported, with the *results*, the *discussion*, and the conclusion.

2.1.5. Intercoder agreement

For the coding scheme and intercoder agreement, triple coding was applied to define the analysis criteria as follows: (1) first, a single researcher defined the analysis categories on the basis of the identified DC models; (2) the extracted articles were then studied by two other researchers; (3) the first researcher reviewed the three analyses to verify the coding categories and come up with a final proposition. This process ensured intercoder agreement.

2.2. Models of digital citizenship a tool for coding educational devices

The models of DC were applied as a template to categorize the approaches and goals targeted in the educational interventions. Choi's model (2016) clarifies the targeted outcomes of the educational actions by proposing four educational approaches, making it possible to analyze the aim of DC education. Then, Ribble's nine learning dimensions (2015) enable the identification of which skills are needed to function in society. In addition, the areas of competence defined by Carretero et al.
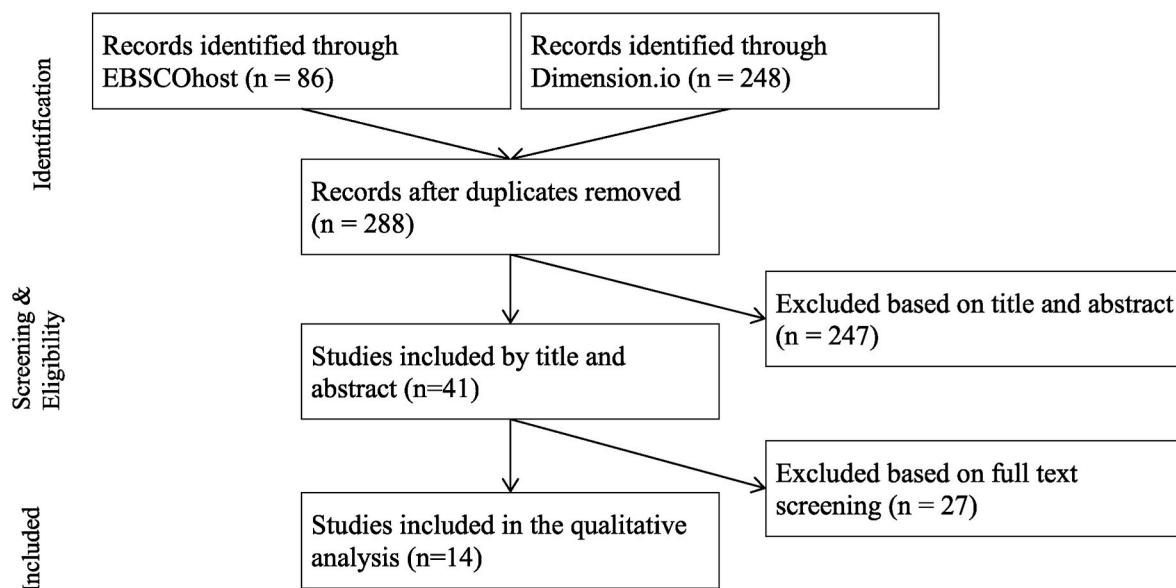

Fig. 1. PRISMA flow diagram of literature extraction.
Digital Citizenship in Primary Education: A Systematic Literature Review Describing How It Is Implemented.

Table 1

Search strategy for the literature extraction.

Keywords	Database	Search options
Digital citizenship + Primary + implementation	1. APA PsychINFO 2. ERIC 3. Education Source via EBSCOhost	• Apply related words • Search within the full text of the articles • Apply equivalent subjects • Peer-reviewed journals since 2009
"Digital citizenship" + "Primary" + "implementation"	Dimensions.io	• Articles only • Articles since 2009

Table 2

Selection criteria.

Inclusion criteria	Exclusion criteria
Real implementation of DC teaching	Theoretical studies
Primary education	Secondary & Tertiary education
Article in English, French, or German	Other languages than English, French, or German

(2017) are used as a framework to supplement Ribble because they offer a more pragmatic view to fit the particular technical and historical demands of the 21st century in relation to digital skills (Higgins, 2014). However, when coding the educational interventions, it proved difficult to separate approaches, dimensions, and areas of competence because they are so closely related. For this reason, we conducted a cross-sectional analysis of the pedagogical interventions by identifying how the models were or were not mobilized. Domains are combined and sometimes intersected:

- Choi (2016): (1) *ethics*, (2) *media literacy*, (3) *participation/engagement*, and (4) *critical resistance.*
- Ribble (2015): (a1) *digital access*, (a2) *digital etiquette*, (a3) *digital law*, (b1) *digital communication*, (b2) *digital literacy*, (b3) *digital commerce*, (c1) *digital rights and responsibilities*, (c2) *digital safety and security*, and (c3) *digital health and wellness*, where (a) is *respect*, (b) is *educate*, and (c) is *protect.*
- Carretero et al. (2017): (A) *information and data literacy*, (B) *communication and collaboration*, (C) *digital content creation*, (D) *safety*, and (E) *problem solving.*

The transversal procedure used is described in the systematic review of Siddiq et al. (2016).

3. Results

This section presents an initial overview of the studies. To answer the research questions, the implementation of DC in the selected studies is then explained and analyzed using the coding system based on the theoretical background presented above.

In the screening and selection process, it was observed that the vast majority of studies is concerned with how DC is taught to future teachers at universities, with some of them targeting the high school level. Only very few focus on investigating DC education at the primary school level. Furthermore, actual implementation measures in the classroom are rarely documented. As a general statement, surveys of large samples of students exist, as do stakeholders' opinions of the concept and theoretical analyses.

The 14 studies selected for the review are presented in Table 3, which provides details on the authors, publication dates, DC definitions, stated learning goals, exposure/dose of intervention, possible interdisciplinary aspects, digital environments/tools used, and other aspects. The identification of the DC approach (Choi, 2016) is based on the following criteria: whether students only access or use digital tools, level (1) was selected; whether students access information and analyze it, level (2)

was added; whether content is created and distributed outside of school, then level (3) was included. Level (4) requires that students analyze what digital tool or environment to use according to their societal values.

3.1. General observations of how digital citizenship is taught

The literature overview highlights the multidimensional quality of DC as well as the fact that only a singular aspect is operationalized in the individual studies. For instance, in Hill (2015), DC education encompassed best online practices and information literacy developed through after-school activities such as using MinecraftEDU. For Dindler et al. (2020), the key idea was empowering students through digital project design in various tools and technologies. In Tapingkae et al. (2020), the focus was on safe everyday habits when using computer and communication technologies in a digital game-based learning environment.

3.2. Implementation and learning tasks/goals of digital citizenship

On the basis of the selected articles and practices described, two main rationales for DC implementation can be identified: a vision of personal growth, and a rather utilitarian perspective for technology-enhanced learning.

The first concerns the notion of learning a use of technology that is responsible and thoughtful; this focus is closely related to (a2) *digital etiquette* or (c2) *digital safety and security* (Ribble, 2015), and it involves encouraging students to adopt safe daily online behaviors for a respectful use of digital environments and tools. Theses teaching practices are sometimes embedded in a more reflective stance or in personal growth. For instance, Dindler et al. (2020) aimed at enabling informed decisions about the role of technology in the students' everyday lives by providing them with the means to actively engage in building their future. These elements are also observed in Becker and Bishop (2016), where the social network Twitter is used as a means to forge critical thinking skills in digital communication. For Felt et al. (2012), the development of social and cultural skills in digital environments is designed to foster a sense of civic responsibility and the development of collective intelligence.

In line with the perspective of safe behavior and personal growth, Aesaert et al. (2014) focused on a rational and appropriate use of technology to assess student digital competences. Similarly, digital technology can be considered as a means for fostering ethical behaviors and critical thinking online (Chou et al., 2012), as an environment in which individuals can reflect on their own digital experience (Tapingkae et al., 2020), as an opportunity to promote metacognitive functioning (Gutierrez de Blume et al., 2016), or as a way to enable collaboration between older and younger students and to develop best practices for information literacy (Hill, 2015). In these studies, the use of digital technology is therefore not viewed as an end in itself, but rather a means to encourage the development of citizenship skills, whether digital or traditional.

The second common use of DC corresponds to a more utilitarian rationale. Although the definitions of DC in these studies are contrasted, the goal generally appears to be enhancing students' learning or motivation through digital technologies; this aim is founded in the premise

Table 3

Overview of the included studies with relevant information for the analysis and discussion.

Author, year Country Student age	Country Student age	N	DC definition	Stated learning goals	Implement. exposure	Interdisciplinary	Digital environments or tools	Approach (Choi, 2016)	Topics (Ribble, 2015)	Dimensions (Carretero et al., 2017)
Aesaert et al. (2014)	Belgium 12.06	560 students	Digital information processing and communication	Digital information processing	NA	NA	Web pages built on Flex framework, PHP & MySQL	(1), (2)	(a2), (b2)	(A)
Ball and Skrzypek (2019)	USA 9-11	38 students	Online safety & the use of tablet	Increasing student and family engagement in school	8 1-h sessions	NA	Tablet and a free 4-month broadband access at home	(1)	(a1), (c2)	(B), (D)
Becker and Bishop (2016)	USA 12-14	150 students	Use social networks in a responsible and structured manner	Learning and reflecting on Twitter as a learning tool in science	80 min per week during science class	Science	Twitter	(1), (2), (3)	(a2), (b1), (c3)	(A), (B), (C)
Chou et al. (2012)	USA 14-15	120 students	Content privacy and ethical behaviors online	Learning geography with iPads	Several teaching periods over 4 months	Geography	iPads	(1), (2)	(a2), (b2), (c1)	(A), (E)
Dindler et al. (2020)	Denmark 11-15	NA	Make connections between students' digital projects and community. Empower students through digital project design	Describing how literacy could be developed through constructive and critical digital design processes	NA	Design, computational thinking	Digital tools and technologies (no precision)	(1), (2), (3)	(a2), (b1), (b2), (c1)	(C), (E)
Dooley et al. (2016)	USA 9-12	~200 students	Engage children as digital participants through classroom instruction	Produce digital content	Several teaching periods over a year	Math, Science	Digital cameras, media lab with computers, and WeVideo	(1), (2), (3)	(b1), (c3)	(B), (C)
Downes et al. (2016)	USA 5-12	241 students	NA	Engage in a project for school improvement in technology-rich settings	Various projects (n = 6) (length not stated)	Various projects: interdisciplinary thanks to project-based learning	Various projects: Web-based videos, iPad, smart phones and iPod, Twitter	(1), (2)	(a1), (b1)	(A), (B), (C)
Felt et al. (2012)	USA 15	8 students	Respect the impact of one's actions beyond the self on the larger collective.	Various. Implementing a digital culture in the context of a pilot after-school program.	After-school program, 15 instructional weeks, every Friday	interdisciplinary thanks to project-based learning	Various digital tools and technologies including Apple MobileMe, Vuvox, iPod touch, web, MSPaint,	(1), (2), (3)	(a2), (b1), (b2), (c1)	(A), (B), (C), (E)
Gutierrez de Blume et al. (2016)	USA 8-10	28 students	A vital skill that leads to participation of youth in the creation of media and content	Improve metacognitive skills, as well as problem-solving and reasoning ability.	After-school program, 10 1-h sessions	interdisciplinary thanks to project-based learning	iPods, MS PowerPoint, Windows MovieMaker Google Drive	(1), (2), (3)	(a2), (b1), (b2), (c1)	(C), (D)
Hill (2015)	USA 9-10	8 students	Best practices online and information literacy	Embedding information literacy skills in the elementary school library.	Instruction by librarians & after-school Minecraft club during several months	no	Mac computers and MinecraftEDU	(1), (2)	(a2), (b2)	(A), (C)
Meabon Bartow (2014)	USA 12-18	5 classes	A participatory culture without barriers to civic engagement and creative expression	Teaching with social media	Various projects: Several teaching periods	Various projects: Social studies, English, Science, Religion …	Various projects: Desktop computers, Moodle, Edmodo, Wiki, Blog, Google Docs	(1), (2)	(a1), (b1)	(B), (C)
Stork (2018)	USA 6-18	26 teachers	NA	Enhance learning experiences	Various projects: Several teaching periods over 3 years	Various projects: Math, Science, English, language art, English as second language, physical science, health, education courses, social sciences	Various projects included in a wide BYOD initiative: tablet, smartphones, laptops, computer lab, kindles, QR codes, Google Translate/Doc, Mimeo, LiveScribe, Apple TV, Kahoot, Pinterest,	(1), (2), (3)	(a1), (b1), (b2), (c3)	(A), (B), (C), (E)

Table 3 (*continued*)

Author, year	Country Student age	N	DC definition	Stated learning goals	Implement. exposure	Interdisciplinary	Digital environments or tools	Approach (Choi, 2016)	Topics (Ribble, 2015)	Dimensions (Carretero et al., 2017)
Tapingkae et al. (2020)	Thailand 12-14	60 students	Safe daily life habits while using computer and communication technologies	Guiding students to make decisions and to monitor their learning during the gaming process	160-min session spread over 4 days	NA	MSOffice, Adobe Photoshop, Quizlet, Padlet, Powtoon … Digital game-based learning environment	(1), (2)	(a2), (b2), (c1), (c2)	(B), (D), (E)
Taranto et al. (2011)	USA 11-13	2 classes	Modeling appropriate use online	Delivering content and providing opportunities students to interact online	Several teaching periods over 1 year	English	Wiki	(1), (2), (3)	(a1), (b1), (c3)	(A), (B)

Note. Choi (2016) approach is identified by the authors: (1) ethic, (2) media literacy, (3) participation/engagement, and (4) critical resistance. Ribble (2015) topics are identified by the authors: (a1) Digital access, (a2) Digital etiquette, (a3) Digital law, (b1) Digital communication, (b2) Digital literacy, (b3) Digital commerce, (c1) Digital rights and responsibilities, (c2) Digital safety and security, and (c3) Digital health and wellness, where (a) is Respect, (b) is Educate, and (c) is Protect. Carretero et al. (2017) dimensions are identified by the authors: (A) Information and data literacy, (B) Communication and collaboration, (C) Digital content creation, (D) Safety, and (E) Problem solving.

that a contemporary digital citizen should be able to learn via digital tools/environments. Thus, in particular the dimensions of (B) *communication and collaboration* and (C) *digital content creation* are targeted. In addition, DC education is often integrated within disciplines like English, mathematics, or science, where technology is used to foster learning through project-based learning or integrative learning tasks. Thus, half the studies selected integrate an interdisciplinary approach. For instance, Meabon Bartow (2014) sees the use of technology as the reason for higher motivation for diverse school subjects. Chou et al. (2012) observes that the use of tablets in geography class for four months coincided with a phase in which student motivation increased. Felt et al. (2012) and Gutierrez de Blume et al. (2016) present the implementation of DC in the context of project-based tasks where learning in every subject could be considered. Meabon Bartow (2014) examines various school projects that link DC with social studies, English, or religion class. Hill (2015) suggests an interdisciplinary design with subjects like mathematics, coding, or design. This latter discipline especially is also strongly associated with DC in Dindler et al. (2020). Becker and Bishop (2016) describe the integration of Twitter in 80-min science lessons as a new way to learn and talk about science. Tapingkae et al. (2020) compare two approaches to develop DC in science education during four 40-min classes. Stork (2018) describes how K-12 teachers use digital technologies in their subjects to enhance student learning. Similarly, the integration of digital technology seems to encourage the creation of digital content (Dooley et al., 2016), which allows for collaborative action research and learning communities (Downes et al., 2016), promotes content delivery and interaction opportunities (Taranto et al., 2011), or plays a role in the level of family engagement (Ball and Skrzypek, 2019). In these analyses, DC is partially a prerequisite and not specified as a learning outcome, and its purpose is to improve student motivation, open schools to communities, or enable content creation.

3.3. Approaches of digital citizenship

Safety and best practices online—in Choi (2016), an *ethical* approach—represent the most common aim of DC identified in these studies; indeed, it is found in nearly all of them. While some studies clearly identified ethical behavior as a learning goal (Ball & Skrzypek, 2019; Hill, 2015; Tapingkae et al., 2020), all observed that correct use was an indirect result of using digital technologies. Media literacy—Choi's (2016) second approach—is also sometimes explicitly targeted (Aesaert et al., 2014; Hill, 2015), but this aspect is usually part of the students' daily activities (Downes et al., 2016; Gutierrez de Blume et al., 2016; Meabon Bartow, 2014; Stork, 2018). Participation and engagement—Choi's (2016) third approach—is rarely realized; in Taranto et al. (2011), Felt, et al. (2012), Gutierrez de Blume et al. (2016), and Dindler et al. (2020), this approach is explicit due to the project-based pedagogical method in which students are invited to create content and share it. Finally, critical resistance—Choi's (2016) fourth approach—was not identified in any of the studies: the choice of digital tools/learning environments was never associated with values, intentions, or critical stances.

3.4. Differences between year of publication

When comparing studies according to the year of publication, the technologies used in the DC implementations will obviously differ. Some applications implemented in earlier studies no longer exist, for instance MobileMe or Vuvox (Felt et al., 2012). Other tools that have survived the passage of time, like wikis or blogs (Taranto et al., 2011), are not explicitly investigated in later studies. In the most recent studies (Dindler et al., 2020; Stork, 2018), a variety of digital solutions are sometimes privileged over a unique digital tool, as was the earlier tendency (Chou et al., 2012; Hill, 2015). While the focus on software or hardware seems unrelated to the year of publication, in general; however, it is

clear that technology trends most certainly impact the choices made by researchers and school practitioners: yesterday wikis, today Twitter.

3.5. Cultural and national differences

The articles mainly illustrate practices in the United States. This fact is certainly related to cultural and economic aspects, but it is also due to the process used for the literature extraction. Of the non-US studies, one article describes a project in Thailand that focuses on gaming (Tapingkae et al., 2020), another describes developments in a region of Belgium with regard to digital information processing (Aesaert et al., 2014), and yet another describes a Danish project about design and computing (Dindler et al., 2020). Every study outside the US implemented a diversity of digital tools/environments.

3.6. Age differences in students

An analysis of student age is complicated by the fact that the majority of studies covers a large age ranges—up to 13 years (from 6 to 18) in Stork (2018). It seems that younger students are more often invited to learn technical skills and digital access (e.g., Ball & Skrzypek, 2019), and that they are also included in civic engagement and societal participation (e.g., Gutierrez de Blume et al., 2016). The articles under investigation focus principally on the development of digital literacy skills.

By contrast, older students seem to be more often engaged in digital tasks (e.g., Meabon Bartow, 2014) in which content creation and dissemination (e.g., Felt et al., 2012) as well as digital problem-solving (e.g., Chou et al., 2012) are essential. From this perspective, the definitions of DC in these studies concern the development of safe, responsible, and structured daily online habits (Becker and Bishop, 2016; Chou et al., 2012; Tapingkae et al., 2020), as well as participation in digital community projects, civic engagement (Dindler et al., 2020; Felt et al., 2012; Meabon Bartow, 2014), and the respect of one's rights and duties (Downes et al., 2016; Dooley et al., 2016; Gutierrez de Blume et al., 2016). However, this proposed distinction requires careful analysis, as these observations are based on only a few studies that are not very distinct in terms of student age.

4. Discussion

This review is a systematic extraction and analysis of studies documenting how DC is implemented. The range of studies emphasizes the extent to which this subject has been investigated over the past 15 years. In general, a wide variety of classroom practices was observed, a condition that mirrors the diverse understandings of the concept that currently exist as well as the lack of coherent operationalization measures.

4.1. Summary of findings

It became apparent that DC is often used as an umbrella concept to justify projects. For instance, when Minecraft is implemented for media literacy purposes, DC educational practices are put forward without, however, providing a clear aim other than references to a framework of popular competences.

Another finding is that a technological trend or the year of publication is likely an influencing factor on choices made by the researchers and people responsible for implementing DC at schools. Wiki as a tool is no longer explicitly investigated, whereas Twitter and other digital instruments and environments are. These trends may be traced back to factors such as novelty, economic and cultural contexts, political agendas, or even the race for innovative publishing.

Then, the complexity of formulating a definition of DC seems partially related to student age. The older students are, the more often they are enrolled in digital projects, whereas younger students primarily learn digital literacy skills. However, most studies cover a large age

range, thereby complicating the capacity to create clear age-based categories in relation to the digital tools and teaching approaches used. Moreover, it remains difficult to understand how objectives are selected, or to establish coherency between how DC is defined and what is actually done in the classroom.

In particular, two main definitions of DC are identified. First, a vision of personal growth that encourages students to adopt safe habits online and a second perspective, more utilitarian, that aims to enhance student learning through the use of technology. This second aim provides an explanation for why a majority of studies adopt interdisciplinary approaches.

Indeed, interdisciplinary projects are the most common, most likely because they offer a more integrative learning experience (McDonald & Czerniak, 1994). In such projects, students work on DC skills in authentic settings, enabling them to develop more proactive and contextually adapted reflective skills.

None of the studies reviewed considered the most ambitious DC approach (Choi, 2016) named *critical resistance*. Because there is a lack of serious ethical reflection in these DC implementations, students are not invited to question how they engage with digital tools and environments. As such, environmental issues, governance concerns, opportunities of free open-source solutions, or societal implications of digital choices are never explicitly addressed. Asking students about the necessity, or otherwise, of using digital technologies could have been an entry point (Guay, 2011, pp. 60–63). Contextualizing when which digital environments or tools are chosen could have been a second step. This finding represents a clear invitation to school administrations and teachers to seriously consider the digital tools/environments that are promoted in their schools, the consequences of their digital choices and, more globally, the place of the individual in a fully digital world. When investigating how schools integrate technology into students' learning experiences, OECD (2015) illustrated that there is a clear correlation between use of technology and the availability of digital tools/environments, but that this use is also related to the wider context shaped by teachers and curricular policies. These digital choices are certainly embedded in political and pedagogical digital trends, which perhaps explains the omission of the more philosophical aspects of DC. Moreover, these findings could also be explained by the fact that the literature extraction process targeted the primary school level, where pupils do not yet study philosophy, ethics, or other school subjects that could more easily encompass the dimension of critical resistance.

4.2. Limitations of the study

There are several limitations that should be considered with the study findings. The orientation of this work and the keywords chosen are subjective by nature and thus have inherent limitations. Moreover, the criteria excluded literature in languages other than English, German, and French, and despite paying particular attention to reducing subjectivity, researcher subjectivity has obviously influenced the results. For this reason, a generalization of the findings for all school contexts is not viable.

To begin, cultural differences are present at the international level, but they are also the object of heterogeneity within school structures. It would therefore be wise to investigate the cultural capital of parents. In their literature review, Tan et al. (2019) observed that "the relationship between cultural capital and student achievement was stronger for objectified and institutionalized forms and for parental expectations than for other variables" (p. 11). By extrapolating this statement, it is possible to ask whether and to what extent cultural differences are related to the assessment of DC skills.

The systematic review conducted by Siddiq et al. (2016) revealed that most assessments concern the students' digital information search, retrieval, and technical skills; however, other aspects of information and communications technology (ICT) literacy are not evaluated to the same extent. It is therefore necessary to develop ways to measure these other

aspects of ICT literacy, for instance, problem-solving with ICT, digital communications, and online collaboration (Silva, 2009).

Furthermore, because the extraction process for this review focused on documentation of pedagogical interventions and descriptions of how DC is implemented in the classroom, no critical literature on DC was examined. Some researchers propose introducing a significant shift in pedagogical practices—a transformation of DC learning standards—through teacher education. In this perspective, Choi and Cristol (2021) offer a deeper understanding of the non-neutral concept of DC embedded in intersectional relationships. By applying conceptions of participatory democracy to the notion of DC, the authors rethink institutional power structures and systemic oppression in order to promote a more democratic educational process for marginalized students. Moreover, research on secondary education aims at developing inclusive, equitable, and multi-contextual teaching approaches to promote equal opportunity for the most vulnerable youth. This pedagogical method develops skills such as autonomy, critical thinking, ethics, safety, and free expression (MINDtheGaps, 2021).

In addition to reducing the asymmetrical relationship between users and technologies, Richardson and Milovidov (2019) suggest an inclusive approach based on information, tools, and best practices to support the development of these more empowering skills. Some authors (Heath & Marcovitz, 2019), see the absence of such issues in the current understanding of DC as being related to the fact that DC as a notion lacks a historical character (e.g., as relates to gender/cultural bias). This decontextualization is believed to be a contributing factor in excluding invisible social groups from participating in civic life by perpetuating the values and habits of the dominant group. Because they believe a socially relevant definition of DC is currently lacking, these authors argue for more critical and inclusive perspectives with a focus on social justice.

Other research—interested in opening a critical pathway to understand DC—explores a perspective of "radical digital citizenship" and studies its implications in education. The material inequalities between the Global North and Global South, and men and women constitute the main problematic of the project, Emejulu and McGregor (2019) assert the necessity to seize these socially acute questions that remain absent in school curricula. Within this framework, these authors point to the need to adopt a politically informed, critical, and ethical understanding for an egalitarian us of technologies.

4.3. Practical implications

The digital world is growing ever more complex. In this context, recent studies are particularly interesting, as they identify an urgent need to develop DC in students through the school curriculum. Indeed, DC has been introduced in educational settings and thus framed as an essential life skill for citizens of the future.

Despite the various limitations identified above, this literature review provides an overview of how DC is implemented at schools and can thus help to inform teachers and researchers about the current state of DC practices at schools. Over the course of this study, it became apparent that how DC is taught depends greatly on the specific context, and that the DC skills of students vary according to school level (primary/secondary school) or country of implementation (US, Thailand, Northern Europe); the publication date of a study (more or less recent) is another factor. This literature review therefore makes a relevant contribution to operationalizing the concept as well as to identifying the skills teachers or students need, the degree of knowledge according to student age or subject, and the informed design of digital school tools/environments.

When interdisciplinary approaches are implemented, DC education seems to be linked with certain subjects only. As a result, the question arises as to whether integrating DC learning tasks in subjects such as philosophy, ethics, or ecology would be a vital resource for helping students develop critical thinking skills and resistance vis-à-vis technology.

A further possibility is for students to learn DC as a subject in its own right, which would particularly address the fourth approach of Choi (2016). Such educational settings could give rise to pedagogical practices and digital developments with a social-justice orientation by promoting especially inclusive approaches.

In many countries, recent curricula name DC as a main goal. Researchers, educators, and policymakers are now expressing interest in theorizing and applying the concept of DC (Castells, 1996). Consequently, current education policy calls for research that will help formalize a process for developing and disseminating pedagogical interventions to support the recent addition of DC to the curricula. This literature review aimed to document DC implementation in diverse cultural contexts, disciplines, and age range, and to make suggestions on possible ways to encourage the development of skills that are vital for citizens of the future.

5. Geolocation information

Declaration of competing interest

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Ania Tadlaoui-Brahmi is a research associate at the Research Centre on Teaching and Learning with Digital Technology (CRE/ATE) at the University for Teacher Education (UTE) Fribourg; she is also working on her PhD. Gender studies and digital citizenship are her main research interests.

Kostanca Çuko is a professor at UTE Fribourg and a research associate at CRE/ATE. Her research focuses on digital citizenship as well as the integration and thoughtful use of digital technology in education as a teaching, regulatory and self-regulatory tool.

Alvarez Lionel is head of CRE/ATE, professor at UTE Fribourg. His main research interests include technology-enhanced learning, technology, and universal design for learning, and digital citizenship.