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REVIEW

Conceptualizing Digital Awareness: Introducing a Definition via a Scoping Review of Digital Literacy and Digital Citizenship

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ABSTRACT

Individuals need to be sufficiently digitally literate to (success)fully participate in our society due to the increased mediation and redefinition by digital technologies. Full participation in contemporary society requires an individual to be digitally aware. Serving as both a precursor and a successor, digital awareness will become increasingly prevalent in education. However, no clear definition has been derived in scholarship yet, contributing to ambiguity in society and education. Grounded in a scoping review of empirical research in the last nine years, 112 articles were included. By separating scholarship on digital literacy, digital citizenship and a combination of the aforementioned, this review displayed different foci on indications for awareness (e.g., a future link, its potential, and a comparison of, for example, the use of digital technologies). The current review conceptualizes digital awareness as an precursor and successor of digital literacy and citizenship—resulting in a conceptualization of digital awareness as "the degree to which an individual is able to critically recognize and reflect upon the declarative, structural, procedural, and conditional knowledge and understanding which are necessary to identify the necessities, opportunities, risks and consequences of the use of (future) digital technologies in and across an individual's public, work, and private lives". Conceptualizing digital awareness informs education (and policy) by contributing to conceptual coherence—as a precursor and successor of digital literacy and digital citizenship—and by directing learning objectives related to digital awareness, literacy and citizenship to allow individuals to become digitally literate for (success)full participation in society and education.

Keywords: Digital Awareness; Digital Literacy; Digital Literacies; Digital Citizenship; Lifelong Learning

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1. Introduction

Individuals increasingly use digital technologies for a range of purposes related to their public, work and private lives, and consume a broad range of digital information [1]. To be able to participate in the current society, they are required to be sufficiently digital literate [2]. However, not every individual or student is able to reach this goal due to, for example, a lack of access to social and/or digital (re)sources, a lack of engagement, motivation or difficulties to work with digital technologies [2]. With increased digital mediation as well as the impact and fast-paced developments of digital technologies in education, the question arises whether it is sufficient to describe students as being digital literate only in terms of acquiring skills or competencies [3], or in terms of being socially and/or digitally included [2].

Combined with a lifelong learning imperative for both educational purposes and full participation in the current society, questions arise whether once a student has gained digital awareness, followed by the status of being (somewhat) digital literate or being a digital citizen, and whether that is the final level for (full and successful) participation in education and society. A lifelong learning imperative detains such a final status and views digital literacy and citizenship as processes [4]. This process-oriented view requires continuous personal development and resilience to what the education requires from students. The definition of this concept needs to align with the dynamic or process-oriented nature of digital literacy and digital citizenship. By means of a scoping review of empirical research, a definition of digital awareness will be derived. In the following sections, digital literacy and digital citizenship will be discussed, including an elaboration of their conceptualization while acknowledging conceptual shortcomings in the field. This is followed by addressing two clusters for digital literacy and citizenship (i.e., capitals and individual characteristics). Eventually, an evaluation is presented whether and to what extent existing literature allows for a definition of digital awareness and, finally, a definition of digital awareness is proposed—in line with the current lifelong learning imperative.

Digital Literacy and Citizenship

Throughout the years, researchers have designed and adapted existing definitions of digital literacy as an attempt to capture its essence [1, 5, 6], to make the definition and framework more inclusive to cover multiple contexts [7, 8]. For example, to tailor a definition to specific educational contexts, such as in primary education [9], secondary education [10], or higher education [11, 12], or to give direction to future research [6]. Initially, digital literacy was referred to as a multimedia literacy, including many forms of information (e.g., written or spoken texts, images, or sounds) [13]. A more general definition was provided by Gilster [5], who defined digital literacy as "the ability to understand and use information in multiple formats from a wide range of sources when it is presented via computers…". This definition—that does not refer to necessary skills, competencies, or attitudes to make sense of working with digital technologies—moves beyond views of digital literacy merely as a collection and accumulation of technical skills. Moreover, more recent research emphasizes "a plurality of terms associated with digital literacy" [14]. Whereas some researchers might label the change from digital literacy to digital literacies as fashionable [15], the plural form is frequently used in scientific research [6, 8, 16, 17]. Although several researchers believe digital literacy is learned in more informal ways [5, 18], Eshet-Alkalai describes it as a "survival skill in the digital era" [19]. This description is largely derived from the context of formal education and, therefore, highlighting the role of educational institutions to sufficiently prepare students for full participation in our society. Consequently, with formal education being the main facilitator of (success)full participation in our society, explicitly describing knowledge, skills, competencies, and/or attitudes is necessary. As a result, this will allow curricula to be responsive to these requirements.

Despite the plethora of research conducted on digital literacy and the different disciplinary backgrounds this is rooted in, has resulted in a lack of consensus about digital literacy frameworks, with variations in width, detail, and position of digital literacy to other literacies [11, 20]. Within this plethora of research, digital literacy and digital citizenship are interlinked: they can encompass similar activities and acts. However, it is essential to distinguish the concepts to avoid conceptual confusion [21]. Whereas digital literacy can be ascribed as more specific, e.g., in terms of knowledge, skills, competencies, and attitudes, digital citizenship can be defined as "the self-creation and self-assertion of citizens as active participants in society through digital acts" [22]. It

appeals to different levels of society (e.g., individual, societal, and global level) and describes "the centrality of digital infrastructure in contemporary social interactions, the implications for people's identities and forms of belonging, and the active self-creation of citizenship in digital environments"[22]. A frequently used framework of digital citizenship lists three overarching goals (i.e., respect, educate, and protect) and nine elements[23], applicable to public (citizenship, education), work, and private lives. Whereas digital literacy can be directly linked to learning objectives, the goal of "(full) participation in society" can be—in particular for young(er) students—perceived as dormant. The increased mediation by digital technologies, for example by emailing, blogging, collaborating, coding, and tweeting, allows individuals to perform, enact, and create their role on the different levels of society[22]. Younger students will do this—in most cases—under parental and/or teacher supervision until they get older. While performing, enacting, and creating roles in society outside educational hours, individuals—such as (young) students—might encounter both positive and negative aspects of and in the use of digital technologies, on account of digital technologies providing both opportunities and challenges.

The current scoping review explores whether and to what degree the concept of digital awareness is present in existing literature on digital literacy and digital citizenship. The main research aim can therefore be captured into two main research questions:

RQ1: To what degree does existing research about digital literacy and digital citizenship provide conceptual aspects for digital awareness, consisting of mentioning (digital) awareness with its subjective orientation (i.e., positive or negative), terms related to awareness, and how dynamic (i.e., applicability and transferability to other contexts) the concept is?

RQ2: What conceptualization of digital awareness, based on aspects in existing literature about digital literacy and digital citizenship, can be derived?

2. Materials and Methods

The sample consists of peer-reviewed English scientific articles, published in the last nine years (November 2015 until June 2024). The research was updated in July 2024 (extending the timeframe until June 2024). Given the rapid development of digital technologies, changes in their use in everyday life and growing policy interest and educational practices in digital literacy and citizenship, this is a relevant timeframe. To guarantee that research from relevant disciplines was included, articles were obtained from the search databases ERIC, SocINDEX, Communication & Mass Media Complete, and Library, Information Science & Technology Abstracts (LISTA). The search string used was designed to include as many relevant articles as possible: ('digital' OR 'digitalization') AND ('aware*' OR 'resilien*' OR 'liter*' OR 'illiterate' OR 'citizen*'). Referring to part 1 and part 2 respectively of this search string, part 2 had to occur near part 1 (i.e., five words). This search string was used in a preliminary search to examine how many hits each search engine provided. The goal of this preliminary search was twofold: (a) to determine whether relevant literature would be included in the current review, and (b) to select a suitable manageable time frame (e.g., five or ten years). It turned out that a time frame of five year resulted in a representative sample of relevant articles albeit the update of our research extended this timeframe with four more years of research.

In order to be included in the current systematic review, articles had to meet one of the following criteria:

1. Studies involving general and special needs education and/or work-related practices;
2. Studies involving social media platform use (e.g., TikTok or Instagram);
3. Quantitative outcomes obtained from human on individual or group level, including validation of specific instruments;
4. Manuscripts explicitly mentioning (a) digital literacy, (b) digital citizenship, or (c) a combination of digital literacy and citizenship.

The following exclusion criteria were used to narrow the scope:

1. Studies primarily focused on user experience or (game) design with a digital device or technology (e.g., to test if a specific mobile application matches its purpose or computational models);
2. Studies primarily focused on awareness measured with or by a digital device, technology, and/or company (e.g., tracking awareness of breast cancer by means of

a mobile application, or tracking [health] devices in general) or training (e.g., navigation training);
3. Studies focused on using digital devices for (research of) illegal practices (e.g., stalking and/or sexual assault), offensive language, and/or addiction;
4. Studies reporting on technological forecasting, remote sensing, and/or migration (e.g., of historical, geographical, and/or architectural phenomena; e.g., historical trackways in forests or mobility);
5. Studies reporting on outcomes from medical (physiological) imaging, material or development for engineering or supply chain developments, and/or imaging related to architectural purposes;
6. Studies focused on (analysis of) digital art, music, films/movies, and/or literature (e.g., translations and/or archival research/practices);
7. Studies focused on and/or including celebrities;
8. Reviews (systematic or literature reviews, meta-analyses, frameworks, [re]conceptualizations, protocols);
9. Grey literature (dissertations, theses, books or book chapters, conference papers) or editorials.

In total, the initial search provided 1359 hits and during the first phase all abstracts were scanned for the inclusion of the word 'digital' in combination with terms related to (il)literacy, awareness, resilience, or citizen(ship), by either specifically mentioning the term, with a similar description, or placed within five words after 'digital'. Removing the duplicates from the sample and applying the in- and exclusion criteria to the remaining articles resulted in 65 articles that were included in the coding process. The updated research yielded an additional 452 hits. With a similar procedure, we derived seven articles to be included.

After systematically searching scientific literature and updating this accordingly, the emphasis on the concept of digital awareness appeared more crucial after the COVID-19 pandemic [24]. Therefore, a secondary literature search was conducted—after the updated search—with only the search term "digital awareness" alongside the in- and exclusion criteria. This search covered the complete timespan: 2015 until 2024. This secondary search yielded 39 hits and we derived nine articles, in which three were included.

To ensure methodological quality of this review, the Assessment of Multiple Systematic Reviews (AMSTAR) was used [25]. This tool provides an overall judgment whether required elements of a (systematic) review were included and emphasizes which methodological decisions could have been implemented better. The AMSTAR was administered throughout the process to provide input for the discussion of main findings and the study's limitations. In addition, in the update of this research, the PRISMA checklist for updated (systematic) reviews was used alongside the flowchart for updated reviews (see **Appendix A Figure A1**).

Coding of Variables

The coding scheme was developed beforehand to determine variables that matched the research questions. These variables covered two main categories. First, methodological and study characteristics (e.g., age, research setting, and sample), related to the research design of the included studies. Second, potential aspects of (digital) awareness (e.g., explicitly mentioning [digital] awareness, creation, critical, future link, potential, and comparison). These aspects should explicitly mention the terms 'awareness' and/or 'digital awareness', terms often related to awareness such as 'critical' and a future link, and whether the concept of digital literacy and citizenship is described as a dynamic rather than static concept. In addition, inductive open coding was used to further refine the categories of aspects of digital awareness.

The articles were coded dichotomously (i.e., yes or no) according to whether the term 'digital literacy' (or 'digital literacies') and/or 'digital citizenship' was mentioned. This creates three main bodies of scholarship: one focused on digital literacy, one focused on digital citizenship, and one with a combination of the two aforementioned concepts (themes A, B, and C respectively). This distinction was considered relevant in the current review because digital awareness subsumes a different position in articles focused on digital literacy than in articles focused on digital citizenship. A fourth theme (theme D) was created with the search term 'digital awareness'.

In addition, results will be presented on both article-, study-, and case-level. Methodological and study characteristics will be displayed on article-level, whereas the variables of the three themes will be presented on case-level. Each article can report on multiple studies or experiments with more than one digital literacy or citizenship measure necessitates presenting the results on case-level. The 112 included articles report on 117 studies and 128 cases.

3. Results

3.1. Methodological and Study Characteristics

The sample contained studies from a broad range of different countries, reflecting the international nature of digital literacy and citizenship, and the scope of research. For 32 out of 112 articles the country or origin of the participants was explicitly mentioned in the article (28.3%). The remaining 81 articles did not display this country- or origin-specificity (71.7%). For the majority of the articles, it was unclear in which language the measures were implemented (see **Table 1**). The identified languages comprised Bengali and French (amongst others), each pertaining to 0.9% of the total number of articles. One article (0.9%) used both Chinese and English materials.

Table 1. Frequencies and Percentages of Language, Education, and Educational Level.

Characteristic	Frequency	Percentage(%)
Language		
English	34	30.1%
Turkish	6	5.3%
Spanish	2	1.8%
Unclear	61	53.9%
Education		
General education	67	59.3%
General work	10	8.8%
Special needs education	1	0.9%
Other	10	8.8%
Combination	25	22.1%
Educational level		
Higher education	46	40.7%
High school	3	2.7%
Middle school	3	2.7%
Primary school	6	5.3%
Combination	15	13.3%
Other	2	1.8%
Universal/all ages	33	29.2%
Unclear	5	4.4%

The setting in which the studies were conducted is displayed in **Figure 1**. For example, in the category that combines settings, the work by Wang and Xing included both teens and parents as participants [26]. Van de Oudeweetering and Voogt examined the family environment and digital literacy and the education of critical citizens—therefore, covering public, and private lives [27]. Three articles were listed as other (2.7%; e.g., "older adults" without further specification) [28].

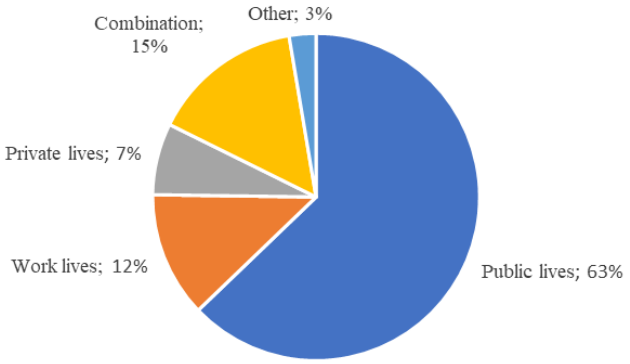


Figure 1. Distribution of Studies in Setting.

When it comes to the target group of the studies, we see a clear focus on students and education (see **Table 1**). The articles reported on a target group labelled as other (7.7%). For example, Altinay et al. studied disabled citizens to explore the role of social media tools in creating accessible tourism [29].

In terms of educational level, most articles could be assigned to belonging to higher education (see **Table 1**). In fifteen articles the participants could be assigned to a combination of educational levels (13.3%). More specifically, in the studies conducted by Kim and Choi [30], participants were aged 11 to 15 years and 11 and 14 years for the pilot and the main study respectively. Both studies included participants with ages stemming from middle and high school. The label other was assigned to an article with education from the private sector [31].

Finally, an age-range was mentioned in 35 articles (31.0%). More specifically, Altinay et al. mention five sequential age-ranges and cover an overarching age range of 18 until 64 years old [29]. In 54 articles the age of the participants was unclear (47.8%). Eight articles displayed the age of the participant by, for example, mentioning the grade level, or with general categories. Fourteen articles mentioned the average age of the participants (12.4%). The average age of the participants in the current sample—based on four articles—was 30.38 years (SD = 12.60; min. 12.60; max. 49.00).

3.2. Indications for Digital Awareness

Table 2 lists number of articles pertaining to digital literacy, digital citizenship, and a combination of the aforementioned. While all 65 articles presented indications for

digital awareness, only one explicitly mentioned the concept while none of the studies presented a definition. Kim and Choi listed digital awareness as part of the ethics for digital environments in the SAFE framework for digital citizenship scale of youth [30]; however, the article which focused on both digital literacy and citizenship does not elaborate on this awareness.

Table 2. Themes with Corresponding Frequencies and Percentages for Included Articles.

Theme	Frequency(%)	Frequency Studies(Cases)
Digital literacy	95 (61.6%)	98 (105)
Digital citizenship	19 (26.0%)	27 (31)
Digital literacy and digital citizenship	13 (12.3%)	12 (12)

3.2.1. Digital Literacy

Although the concept of digital awareness was not specifically mentioned, 51 out of 88 cases mentioned 'awareness' as such (58.0%). In twelve cases (13.5%), this awareness was related to something positive, such as gaining knowledge or increasing specific experiences or "…by interacting with their colleagues who are competent in this" [31]. Nine cases mentioned negative aspects (10.2%), related to cyberbullying and privacy-related matters [32, 33]. Both positive and negative aspects of awareness have been mentioned in 31 cases (35.2%). For example, Clark and Simpson referred to the "increased awareness of the rapidly approaching need for employment" [34], highlighting both job opportunities and hinting towards potential knowledge and/or understanding gaps to fill in these jobs. **Table 3** displays how many cases mentioned the following related aspects of awareness (listed from most to least): critical, creation, potential and future link, and a comparison [35–43]. In addition, the majority of the cases described in the articles (n_{cases} = 26; 29.5%) allowed the concept of digital literacy as something continuously open for improvement and change, meaning that the concept can be considered dynamic. For example, Powers et al. report on the dynamic nature of digital literacy by explicitly mentioned that digital literacy is constantly evolving—emphasizing the dynamic nature of the concept [35]. Two cases were labelled as being static (2.3%), meaning that the article did not explicitly mention whether digital literacy is continuously open for improvement and/or change. For the remaining 60 cases, the dynamicity of the concept was unclear (68.2%), as a result of the concept of digital literacy remaining undefined and/or unconceptualized.

Table 3. Aspects, Frequency, and Examples Theme A: Digital Literacy [35–43].

Theme	Aspect	Frequency* (n_{cases})	Percentage	Examples
A	Critical	71	80.7%	"…foster critical thinking…" [36].
				"…a critical vision of the technological environment…" [36].
				"…while demonstrating a critical awareness of the designs, algorithmic processes and datasets that constitute these platforms [37].
	Creation	70	79.5%	"…to create, share, and understand meaning and knowledge in a digital environment…" [38].
				"…texts or visuals created with digital tools…" [39].
				"…the students created narratives on topics such as paleontology, forces, genetics, Pythagoras' theorem and cell structures" [40].
				"…including using AI to create vocabulary games for learning new English words, seeking real-time grammar feedback from AI to enhance English grammar proficiency, and engaging in topic-specific conversations…" [37].
	Potential	58	65.9%	"…the potential to transform teaching and learning" [35].
				"…chatbots have demonstrated remark able potential in accomplishing natural-language tasks…" [37].

Table 3. *Cont.*

Theme	Aspect	Frequency* (n_{cases})	Percentage	Examples
A	Future link	50	65.9%	"…may influence their future competencies and skills…"[41].
				"…lifelong learning in the future workplace…"[41].
				"…in a way that safeguards environmental, social and economic wellbeing, both in the present and for future generations"[42].
	Comparison	21	23.9%	"Visual mode results were higher with addition of non-digital elements as compared with pure digital images only"[43].
				"…influence their future competencies and skills"[41].

Note. * One case could mention one or more aspects.

3.2.2. Digital Citizenship

Sixteen out of 24 cases mentioned 'awareness' (66.7%). Of these cases, one was predominantly positive and only two focused on predominantly negative consequences[44, 45]. As Styron et al. exemplified: "Awareness levels of teacher and principal preparation students to identify acts of cyberbullying, perceived awareness of and preparedness for incidences of cyberbullying…"[45]. Eleven cases reported on both positive and negative aspects of awareness (45.8%). For example,[46] explicitly mentioned that students may lack digital citizenship qualities (negative aspect) such as "the ability to use technology safely, responsibly, critically, productively, and civically" (positive aspects). In addition, Altinay et al. argued: "Education for the awareness and applications will become strategic actions to remove barriers of disabled"[29]. For ten cases the subjective orientation was unclear (41.7%).

Table 4 displays the aspects often related to awareness (listed from most to least)[45–51]. The majority of the cases described in the articles (ncases = 6; 25.0%) allowed the concept of digital literacy to be dynamic, as exemplified by the following texts: "…to enhance the concept of digital citizenship" and "…to increase instilling digital citizenship values…"[52]. Six cases were labeled as static. Twelve cases were labelled as unclear without indications of dynamicity (50.0%).

Table 4. Aspects, Frequency, and Examples Theme B: Digital Citizenship[45–51].

Theme	Aspect	Frequency* (n_{cases})	Percentage	Examples
B	Creation	16	66.7%	"…the current digital technology that is used and what will be applied in future…"[47].
				"More students reported that they knew how to create an online survey after the workshop"[48].
	Future link	15	62.5%	"…browses questions and solutions created by peers…"[49].
	Critical	14	41.7%	"…to exercise critical thinking toward information…"[48].
				"…stressed the critical importance of good organisation and instructional design…"[50].
				"…Such a digital citizen is more likely to possess critical literacy…"[51].
	Potential	13	54.2%	"The full potential of LMSs can be realised through the alignment of online activities…"[49].
				"…to assess the familiarity, potential harm and frequency of each type of cyberbullying,…"[45].
				"…when Internet users became potential contributors of information…"[46].
	Comparison	10	41.7%	"…compare international with US students' levels of digital citizenship"[47].
				"When asked to compare their use of computers and cell phones regarding internet access,…"[48].

Note. * One case could mention one or more aspects.

3.2.3. Digital Literacy and Digital Citizenship

All thirteen cases mentioned 'awareness'. Ten out of thirteen cases reported on both positive and negative aspects of awareness (76.9%), as exemplified by the following text from Kim and Choi: "local/global awareness" extended with "…citizenship awareness in the digital age to provide effective education and to facilitate culturally appropriate behavior online"[30]. One case (11.1%) primarily reported on negative consequences: "…safe and responsible online interactions should be discussed with teens…"[53]. In addition, the authors stated on page 10: "…the lack of awareness about what was being taught…". Two cases were labelled as predominantly positive, stemming from the work by Karunanayaka and Weerakoon[54].

Table 5 displays how many cases mention the following aspects (listed from most to least): future link, critical and potential, creation, and comparison[26, 30, 31, 53, 55–57]. Five out of thirteen cases described in the articles allowed the concept of digital literacy as something open for improvement, meaning that the concept is dynamic (38.5%). As exemplified by Van de Oudeweetering and Voogt[27], by placing emphasis on fostering competencies. Two cases could be labelled as being static (15.4%)[26, 30]. For the remaining six cases it was unclear how dynamic the concept was (46.2%).

Table 5. Aspects, Frequency, and Examples Theme C: Digital Literacy and Digital Citizenship[26, 30, 31, 53, 55–57].

Theme	Aspect	Frequency* (n_{cases})	Percentage	Examples
C	Future link	11	84.6%	"…to help them self-regulate learning processes in future learning situations…"[55].
				"…students may adapt their capstone ePortfolio into a professional ePortfolio for future uses"[55].
				"…to use these new skills on digital media projects in the future"[55].
	Critical	10	76.9%	"…apply critical thinking skills…"[55].
				"…can critically review content from disparate general education classes…"[55].
				"…critical reflection…".
				"…to observe the entire education system in a critical way…"[56].
	Potential	10	76.9%	"…have the potential for guiding future model development and to further influence positive social change by supporting parents and educators to promote online safety and digital citizenship development"[26].
				"…to prevent potential dangers faced by youth…"[30].
				"…amidst increasing concerns about cyberbullying and the potential for hacking…"[53].
	Creation	9	69.2%	"…to create multi-modal representations such as digital art and images, video, audio, and websites…"[57].
				"…create communities in a different way from the older generation that was born and grown in the industrial world"[31].
	Comparison	5	38.5%	"…described their science teacher using technology a lot compared to only about 8% of students reporting they used it a lot"[57].
				"…reflective capstone ePortfolio as compared to a professional presentation ePortfolio"[55].

Note. * One case could mention one or more aspects.

3.2.4. Digital Awareness

Three articles explicitly mentioned the term "digital awareness"[58–60]. Two articles did not provide a definition of the concept[58, 60], whereas Chen et al. conceptualized digital awareness as the importance of different aspects, such as the use of Internet for a range of activities[59]. The authors referred to the "penetration of digital awareness". A future link and comparison were mentioned in two cases,

whereas critical and potential were mentioned in one case (due to the low numbers of articles (cases), no percentages will be reported on). Chen et al. referred to positive aspects of digital awareness[59], such as the crucial role of the Internet for different activities alongside the trust that individuals need to put in strangers. In a similar vein, Mack et al. refer to "enhancement purposes", highlighting the positive effect of the use of Internet for a variety of activities[58]. Last, Serdarušić et al. emphasize both the positive and negative aspects of digital awareness by discussing "the perceived risks and barriers associated with the adopting Fintech solutions"[60].

3.3. Comparison Aspects Between Themes

The comparison of aspects listed in **Tables 1**, **2**, and **3** and in-text for themes A, B, C, and D respectively is display in **Table 6**. Comparing these aspects yield information about potential prioritization or commonality—indicated by how often these are mentioned—of those aspects within that context. In turns, this prioritization or commonality can be used for theoretical and practical implications of digital awareness.

Table 6. Ranked from Most to Least Mentioned Aspects for Themes A, B, C, and D.

Theme			
A **Digital Literacy**	**B** **Digital Citizenship**	**C** **Digital Literacy/Citizenship**	**D** **Digital Awareness**
Critical	Creation	Future link	Future link/comparison
Creation	Future link	Critical/potential	Potential/critical
Potential	Critical	Creation	
Future link	Potential	Comparison	
Comparison	Comparison		

Note. The slash between aspects means that the frequency is the same.

4. Discussion

The included empirical studies from 2015–2024 provided sufficient information to deriving a definition of digital awareness, both as a precursor and successor of digital literacy and citizenship. The duality of that awareness might cause conceptual challenges; however, these challenges can be picked up by future research. Two requirements can be derived for this definition, pertaining to the methodological and study characteristics. First, the sample included research stemming from international contexts. Notably, most studies were conducted in a non-Western context and were partly replicating previous research in a different setting. It shows that no part of the world remains untouched by digitalization. The take-home message from these differences and similarities is that digital literacy and digital citizenship have situational aspects as well as general, perhaps even transferable, aspects. This emphasizes the necessity of deriving a definition of digital awareness, that includes domain- and situation-specific as well as generalizable components. Second, the majority of the research included participants from a large emphasis from general education, meaning two things: (a) teaching digital literacy and citizenship to students provide the main context for research[4, 11, 61], and (b) digital literacy and citizenship are teachable concepts. Also, at the intersect of digital literacy and digital citizenship—as separate concepts—the combination is resembling individuals' daily life as is nested in many areas[1, 15].

RQ1 covers the degree to which existing research provides potential aspects of digital awareness. Digital awareness was mentioned explicitly once, in items in the SAFE framework digital citizenship scale of youth related to the ethics of digital environments: "Students should be aware of the order of others in the online digital environment and should obey the order"[30]. This item insufficiently informs about what is meant with that. The majority of the articles reported on awareness in general with a dominant focus on both positive and/or negative aspects. This is preferred to allow for a complete rendering of anything digital related. Moreover, it allows students to develop a sense of ethical digital behaviour[9, 10].

The different themes—digital literacy, digital citizenship and a combination of both—have different foci in research, as corroborated by Yang et al.[62]. Without reiterating the results, this means that for each of these themes can prioritize different aspects. Again, this stresses the applicability of

the definition in various contexts and, as a result, a process-oriented view by capturing these differing prioritizations. Yet indications for the dynamic nature of the concepts were varied. The dynamicity within the themes varied between 50 to 80% of the cases. As a result, a lifelong learning imperative seems more prominent, or possible, in certain themes (e.g., digital literacy as compared to digital citizenship).

With ample mentioning of digital literacy and citizenship as dynamic concepts, there are opportunities for including digital awareness in definitions and frameworks related to these concepts. Several potential aspects of digital awareness, serving as input for its definition, were present in the sample, such as mentioning both positive and negative aspects (e.g., consequences or knowledge) of engaging in digital technologies, involving critical thinking and/or a critical evaluation, and comparing consequences and knowledge (amongst other aspects). The concept of digital awareness appends digital literacy and/or digital citizenship due to (a) their dynamic nature, (b) the increased mediation of digital technologies in the current society, and (c) a lifelong learning imperative [1].

RQ2 focuses on establishing a conceptualization of digital awareness. No definition was provided in the three cases that mentioned digital awareness. A definition focused on one tool or platform remains too simplistic [21]. As a result, digital awareness needs to include more than a single platform and/or tool. The association of 'awareness' with terms such as critical, potential, and comparison may imply that it is a higher order skill [63]. With a distinction between awareness as a precursor and successor. The depth with which the aspects will be implemented might differ. Before mastering functional skills, such as identifying, accessing and evaluating digital resources, constructing new knowledge, creating media expressions, and/or privately and publicly communicating with others [64], a basic level of awareness is required. Furthermore, awareness being conceptualized as dynamic in the current sample indicates that digital awareness should be conceptualized as a process rather than a product. This fits a lifelong learning imperative [1, 4]: digital awareness develops continuously throughout a student's life and should be applicable in a variety of contexts.

The majority of the research included both positive and negative aspects of awareness. A faulty assumption is that awareness is associated with or directed towards negative aspects, such as harmful consequences (e.g., mentioned with digital safety) [22], yet research including illegal practices was excluded. A concept becomes better established when both the positive and negative aspects are addressed. The potential of digital technologies in terms of creation, comparison, future links, and critical aspects requires more emphasis in future research. Whereas the negative aspects of digital technologies are crucial to protect students throughout their learning process and in the current society, the positive aspects further develop the student and create possibilities in terms of gaining knowledge, skills, and/or competencies.

Despite the absence of a sufficient description of definition of 'digital awareness' in the current sample, it has been proposed previously by Verma et al. to generally convey the "ability to work with digital devices and environments for research, communication, entertainment, etc." [65]. In the methodology of the article, the authors specify digital awareness as being "about different types of electronic gadgets (digital gadgets) being used by the students, their favorite gadget for communication, entertainment, Internet, and SM access" [65]. Two arguments are proposed for why a (re)conceptualization is necessary. First, the definition is imprecise and does not provide sufficient detail to be used in a meaningful way. More specifically, the question arises how 'ability' or 'is used' are operationalized. This raises the question if an individual is digital aware when they are able to use a mobile phone for a range of purposes. Raising this question evokes a plethora of follow-up questions, such as questions about the frequency of use and purpose. Furthermore, this leads to a second argument: the term can hardly be distinguished from other definitions of digital literacy (or from being digital literate). For example, the definition of Martin focuses on the "ability of individuals to appropriately use digital tools and facilities" [64], and Gilster mentions "the ability to understand and use information in multiple formats from a wide range of sources when it is presented via computers" [5]. In contrary to the definition of Martin [64], who includes an individual's awareness of appropriately using digital technologies as well as "facilities to identify, access, manage, integrate, evaluate, analyze and synthesize digital resources, construct new knowledge, create media expressions, and communicate with others". This definition shows the dynamicity of digital awareness as a concept, but also shows its complexity (i.e., broadness and depth), as indicated by the use of verbs. As a result, the current definition of digital awareness should display

dynamicity and capture the complexity of the topic at hand both as a precursor and successor—as previously emphasized.

4.1. Towards a Definition of Digital Awareness

The lack of consensus in defining and conceptualizing digital literacy and, to a lesser extent digital citizenship, resulted in a broad range of interdisciplinary studies and approaches [7, 8]. Despite that this variety resembles a realistic representation of the quantitative interdisciplinary research conducted in this area between 2015 and 2024 [4], the lack of consensus about clear definitions of digital literacy and citizenship obstructs research, policy and interventions. The absence of a complete (i.e., dynamic and complex) definition of digital awareness in the sample displays the necessity for more conceptual coherence, starting with indications for digital awareness found in sample. Digital awareness is—similar to digital literacy being perceived as being broader than separate literacies—more than a collection of awareness about aspects of digital technologies. It bridges economic, cultural, personal, political, and social aspects of behaviors, activities, attitudes, values, and beliefs involved in digital technologies. In addition, whether or not someone is digital aware is binary; however, once they are, the quality of the awareness is relevant. The latter can differ between (groups of) students. Moreover, digital awareness is a process, meaning that it is continuously developing, following the mediation of digital technologies in education and daily lives. As a result, the definition for digital awareness is:

the degree to which an individual—or students—is able to critically recognize and reflect upon the declarative, structural, procedural, and conditional knowledge and understanding which are necessary to identify the necessities, opportunities, risks and consequences of the use of (future) digital technologies in and across one's public, work, and private lives.

4.2. Crucial Considerations for the Definition

For a student—or individual in general—to become digital aware the individual needs to have sufficient knowledge (i.e., the functional skills must be covered). The functional skills can be conceptualized in different types of knowledge and understanding [64]. Tapping into different types of knowledge, declarative knowledge is viewed as static and refers to specific knowledge about a topic and answers a what-question [66]. For example, laptops have an 'on' button and need to be recharged when the battery is empty. Transferring this declarative knowledge to new digital technologies, an individual might look for a button to turn the device on despite not knowing how to operate it. Structural knowledge refers to an understanding of how bits of declarative knowledge fit together in a meaningful way and can be viewed as a collection of what-questions [67]. Procedural knowledge is dynamic and refers to knowledge and understanding of how to implement strategies based on an individual's skills and abilities. Conditional knowledge refers to knowledge and understanding about when to implement strategies based on an individual's skills and abilities [66, 67]. It provides an answer to a when-question, but also contributes to a why-question. In the simplified example used previously, an individual needs to be aware that the laptop needs to be charged when it does not turn on anymore or when the percentage exceeds a certain threshold (i.e., answering the why-question).

The level of declarative, structural, procedural, and conditional knowledge and understanding an individual has, can differ per digital technology. The interplay with age becomes relevant. It can be directed towards unique characteristics of hardware, software, and/or connection components, but also refers to their interactions within and between them and other relevant factors. Moreover, digital awareness relies heavily on an individual's intra- and interpersonal characteristics [54, 68]. As a result, similar to digital literacies, the quality of digital awareness might vary according to life circumstances and experiences but also across different field of expertise, educational levels, and generations.

The concept of digital awareness still needs further development. The proposed conceptualization can offer a starting point for this. Future research could focus on including the concept of digital awareness in the theoretical framework of (empirical) studies and further developing indicators, such as individual characteristics and contextual aspects (i.e., situation-specific aspects). This also means that (empirical) studies need to include both theoretical and practical implications, such as in and for education. The conceptualization of digital awareness is not set in stone with this review, as the rapidly changing digital world requires flexibility of actors and aspects involved. A limitation of this review is that it only included quantitative research. Other types of research, such as qualitative research, grey literature, and reviews, may also contain useful aspects of digital awareness to further refine the conceptualization. Theo-

retical research often misses a practical component, which is crucial for education. This offers an excellent starting point for new research. Future research should focus on developing a more unified definition and framework of digital literacy and digital citizenship instead of adding new ones to the existing repository of research to avoid conceptual confusion and ambiguity. In particular, the plethora of literacies—aside digital literacy—does not serve a purpose anymore; by adding more literacies meaning will be lost.

That being said, future research can tap into age-related aspects of digital awareness. Because digital technologies are now part of society and education, older students display variations of digital awareness than younger students, who are brought up with other or more advanced digital technologies. Furthermore, digital awareness seems mostly present in older individuals/students, or at least in individuals/students that have mastered functional digital skills; however, that calls upon research about digital awareness in early educational levels, such as primary and secondary education. The challenges lie in further developing the concept of digital awareness in such a way that it is generalizable across different settings, yet with sufficient detail to be useful in research and practice. These age-related aspects of digital awareness might be crucial for policy and interventions. Special attention has to be paid to AI due to its increased popularity and/or use[69, 70]. Last, digital technologies also offer gamification to prepare individuals for various aspects of society and education[71]. Therefore, it would be relevant to examine how gamification can use to affect digital awareness.

5. Conclusions

The definition for digital awareness is as follows: the degree to which an individual—or students—is able to critically recognize and reflect upon the declarative, structural, procedural, and conditional knowledge and understanding which are necessary to identify the necessities, opportunities, risks and consequences of the use of (future) digital technologies in and across one's public, work, and private lives. This definition pertains to various types of knowledge alongside functional skills such as critical thinking and reflecting. By addressing both advantages and disadvantages the definition provides a more realistic rendering of the use of digital technologies in different areas of individuals lives.

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Data Availability Statement

The data can be made available by contacting the first author.

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Conflicts of Interest

The author declares no conflict of interest.

Appendix A

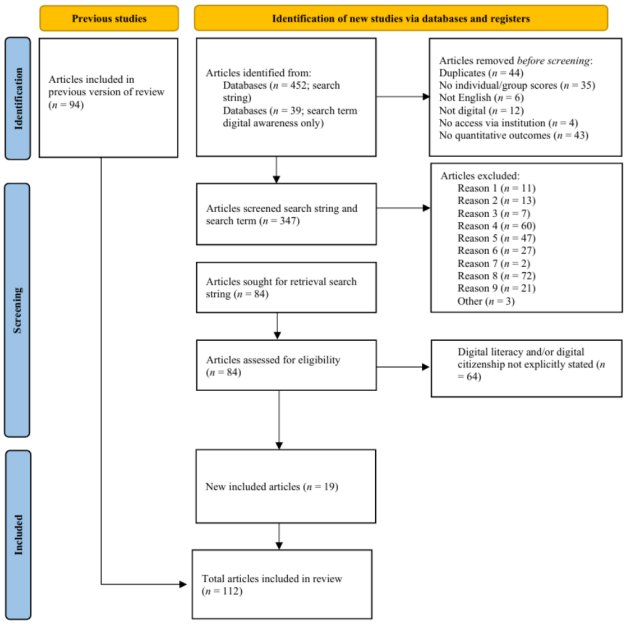


Figure A1. PRISMA 2020 Flow Diagram for Updated Reviews[72].

References

[1] Jaeger, P.T., Bertot, J.C., Thompson, K.M., et al., 2012. The intersection of public policy and public access: Digital divides, digital literacy, digital inclusion, and public libraries. Public Library Quarterly. 31(1), 1–20. DOI: https://doi.org/10.1080/01616846.2012.654728

[2] Helsper, E.J., 2021. The digital disconnect: The causes and consequences of digital inequalities. Sage Publications: London, UK.

[3] Littlejohn, A., Beetham, H., McGill, L., 2012. Learning at the digital frontier: A review of digital literacies in theory and practice. Journal of Computer Assisted Learning. 28(6), 547–556. DOI: https://doi.org/10.1111/j.1365-2729.2011.00474.x

[4] Martínez-Bravo, M.C., Sádaba-Chalezquer, C., Serrano-Puche, J., 2020. Fifty years of digital literacy studies: A meta-research for interdisciplinary and conceptual convergence. Profesional de la información. 29(4), e290428. DOI: https://doi.org/10.3145/epi.2020.jul.28

[5] Gilster, P., 1997. Digital literacy. Wiley: New York, USA.

[6] Nichols, T.P., Stornaiuolo, A., 2019. Assembling "digital literacies": Contingent pasts, possible futures. Media and Communication. 7(2), 14–24. DOI: https://doi.org/10.17645/mac.v7i2.1946

[7] Wilson, C., Grizzle, A., Tuazon, R., et al., 2011. Media and information literacy: Curriculum for teachers. UNESCO Publishing: Paris, France. Available from: https://unesdoc.unesco.org/ark:/48223/pf0000192971?posInSet=8&queryId=28c42b34-5f6e-4a02-9258-8e2fb2d5f4f1 (cited 5 July 2025).

[8] Law, N.W.Y., Woo, D.J., De la Torre, J., et al., 2018. A global framework of reference on digital literacy skills for indicator 4.4.2. UNESCO Institute for Statistics: Montreal, Quebec, Canada. Available from: https://unesdoc.unesco.org/ark:/48223/pf0000265403?posInSet=1&queryId=0e0a5c7b-496d-443d-bbd2-039bed2a5179 (cited 5 July 2025).

[9] Vélez, A.P., Zuazua, I.I., 2017. Digital literacy and cyberconvivencia in primary education. Procedia - Social and Behavioural Sciences. 237(2), 110–117. DOI: https://doi.org/10.1016/j.sbspro.2017.02.050

[10] Hatlevik, O.E., Christophersen, K.A., 2013. Digital competence at the beginning of upper secondary school: Identifying factors explaining digital inclusion. Computers & Education. 63, 240–247. DOI: https://doi.org/10.1016/j.compedu.2012.11.015

[11] Miller, A., 2012. On paper, in person, and online: A multiliteracies framework for university teaching. Journal of Academic Language & Learning. 9(2), A19–A31.

[12] Holm, P., 2025. Impact of digital literacy on academic achievement: Evidence from an online anatomy and physiology course. E-Learning and Digital Media. 22(2), 139–155.

[13] Lanham, R.A., 1995. Digital literacy. Scientific American. 273(3), 198–199.

[14] Audrin, C., Audrin, B., 2022. Key factors in digital literacy in learning and education: A systematic literature review using text mining. Education and Information Technologies. 27(6), 7395–7419.

[15] Buckingham, D., 2006. Defining digital literacy: What do young people need to know about digital media? Nordic Journal of Digital Literacy. 1(4), 263–277.

[16] New London Group, 1996. A pedagogy of multiliteracies: Designing social futures. Harvard Educational Review. 66(1), 60–93. DOI: https://doi.org/10.17763/haer.66.1.17370n67v22j160u

[17] Pahl, K.H., Rowsell, J., 2010. Artifactual critical literacy: A new perspective for literacy education. Berkeley Review of Education. 2(2), 129–151.

[18] Martin, A., 2006a. Literacies for the digital age. In: Martin, A., Madigan, D. (eds.). Digital literacies for learning. Facet Publishing: London, UK. pp. 3–25.

[19] Eshet-Alkalai, Y., 2004. Digital literacy: A conceptual framework for survival skills in the digital era. Journal of Educational Multimedia and Hypermedia. 13(1), 93–106.

[20] Fieldhouse, M., Nicholas, D., 2008. Digital literacy as information savvy: The road to information literacy. In: Lankshear, C., Knobel, M. (eds.). Digital literacies: Concepts, policies and practices. Peter Lang Publishing: New York, USA. pp. 47–72.

[21] Jones, L.M., Mitchell, K.J., 2016. Defining and measuring youth digital citizenship. New Media & Society. 18(9), 2063–2079. DOI: https://doi.org/10.1177/1461444815577797

[22] Hintz, A., Dencik, L., Wahl-Jorgensen, K., 2019. Citizenship in a digital age. In: Hintz, A., Dencik, L., Wahl-Jorgensen, K. (eds.). Digital citizenship in a datafied society. Polity Press: Cambridge, UK. pp. 20–42.

[23] Ribble, M., 2007. The nine elements of digital citizenship. In: Ribble, M. (ed.). Digital citizenship in schools. International Society for Technology in Education: Eugene, OR, USA. pp. 23–56.

[24] Polyakova, V., Streltsova, S., Iudin, I., et al., 2024. Irreversible effects? How the digitalization of daily practices has changed after the COVID-19 pandemic. Technology in Society. 76, 102447.

[25] Shea, B.J., Grimshaw, J.M., Wells, G.A., et al., 2007. Development of AMSTAR: A measurement tool to assess the methodological quality of systematic reviews. BMC Medical Research Methodology. 7(1), 10–17. DOI: https://doi.org/10.1186/1471-2288-7-10

[26] Wang, X., Xing, W., 2018. Exploring the influence of parental involvement and socioeconomic status on teen digital citizenship: A path modeling approach. Educational Technology & Society. 21(1), 186–199.

[27] Van de Oudeweetering, K., Voogt, J., 2018. Teachers'

conceptualization and enactment of twenty-first century competences: Exploring dimensions for new curricula. The Curriculum Journal. 29(1), 116–133. DOI: https://doi.org/10.1080/09585176.2017.1369136

[28] Scheurs, K., Quan-Haase, A., Martin, K., 2017. Problematizing the digital literacy paradox in the context of older adults' ICT use: Aging, media discourse, and self-determination. Canadian Journal of Communication. 42(2), 359–377. DOI: https://doi.org/10.22230/cjc.2017v42n2a3130

[29] Altinay, Z., Saner, T., Bahceleri, N.M., et al., 2016. The role of social media tools: Accessible tourism for disable citizens. Educational Technology & Society. 19(1), 89–99.

[30] Kim, M., Choi, D., 2018. Development of youth digital citizenship scale and implication for educational setting. Educational Technology & Society. 21(1), 155–171.

[31] Hamutoglu, N.B., Gemikoakli, O., De Raffaele, C., et al., 2010. Comparative cross-cultural study in digital literacy. Eurasion Journal of Educational Research. 20(88), 121–148.

[32] Altun, D., 2019. Investigating pre-service early childhood education teachers' technological pedagogical content knowledge (TPACK) competencies regarding digital literacy skills and their technology, attitude and usage. Journal of Educational and Learning. 8(1), 249–263.

[33] Feola, E.I., 2016. Digital literacy and new technological perspectives. Universal Journal of Educational Research. 4(9), 2174–2180.

[34] Clark, T., Simpson, S., 2020. Using a student-staff partnership to map, understand, and develop the digital curriculum. International Journal of Teaching and Learning in Higher Education. 32(1), 138–148.

[35] Powers, J.R., Musgrove, A.T., Nichols, B.H., 2020. Teachers bridging the digital divide in rural schools with 1:1 computing. The Rural Educator. 14(1), 61–76.

[36] Valdés, R.T.V., Soriano, A.S., Álvarez, C.L., 2018. Resignification of educational e-innovation to enhance opportunities for graduate employability in the context of new university degrees. Journal of New Approaches in Educational Research. 7(1), 70–78. DOI: https://doi.org/10.7821/naer.2018.1.263

[37] Liu, G.L., Darvin, R., Ma, C., 2024. Exploring AI-mediated informal digital learning of English (AI-IDLE): A mixed method investigation of Chinese EFL learners' AI adoption and experiences. Computer Assisted Language Learning. 1–29. DOI: https://doi.org/10.1080/09588221.2024.2310288

[38] Baterna, H.B., Mina, T.D.G., Rogayan, D.V., Jr., 2020. Digital literacy of STEM senior high school students: Basis for enhancement program. International Journal of Technology in Education. 3(2), 105–117.

[39] Özden, M., 2018. Digital literacy perceptions of the students in the department of computer technologies teaching and Turkish language teaching. International Journal of Progressive Education. 14(4), 26–36.

[40] Paige, K., Bently, B., Dobson, S., 2016. Slowmation: An innovative twenty-first Century teaching and learning tool for science and mathematics pre-service teachers. Australian Journal of Teacher Education. 41(2), 1–15.

[41] Šorgo, A., Bartol, T., Dolničar, D., et al., 2017. Attributes of digital natives as predictors of information literacy in higher education. British Journal of Educational Technology. 48(3), 749–767. DOI: https://doi.org/10.1111/bjet.12451

[42] Filho, W.L., Price, E., Wall, T., et al., 2021. COVID-19: The impact of global crisis on sustainable development teaching. Environment, Development and Sustainability. 23, 11257–11278.

[43] Starčič, A.I., Cotic, M., Solomonides, I., et al., 2016. Engaging preservice primary and preprimary school teachers in digital storytelling for the teaching and learning of mathematics. British Journal of Educational Technology. 47(1), 29–50. DOI: https://doi.org/10.1111/bjet.12253

[44] Hollandsworth, R., Donovan, J., Welch, M., 2017. Digital citizenship: You can't go home again. TechTrends. 61(6), 524–530.

[45] Styron, R.A., Bonner, J.L., Styron, J.L., et al., 2016. Are teacher and principal candidates prepared to address student cyberbullying? The Journal of At-risk Issues. 19(1), 20–28.

[46] Takavarasha, S., Chilliers, L., Chinyamurdindi, W., 2018. Navigating the unbeaten track from digital literacy to digital citizenship: A case of university students in South Africa's Eastern Cape province. Reading & Writing. 9(1), 1–15.

[47] Alqahtani, A., Alqahtani, F., Alqurashi, M., 2017. The extent of comprehension and knowledge with respect to digital citizenship among Middle Eastern and US students at UNC. Journal of Education and Practice. 8(9), 96–102.

[48] Eckert, S., Metzger-Riftkin, J., Nurmis, J., 2018. Teaching girls online skills: Results of the Wikid Grrls Intervention. Journal of Media Literacy Education. 10(3), 20–42.

[49] Cheng, G., Chau, J., 2016. Exploring the relationships between learning styles, online participation, learning achievement and course satisfaction: An empirical study of a blended learning course. British Journal of Educational Technology. 47(2), 257–278.

[50] Howard, J.M., Scot, A., 2017. Any time, any place, flexible: Technology-enhanced language learning in a teacher education programme. Australian Journal of Teacher Education. 42(6), 51–68.

[51] Nordin, M.S., Ahmad, T.B.T., Zubairi, A.M., et al., 2016. Psychometric properties of a digital citizenship questionnaire. International Educational Studies. 9(3),

71–80. DOI: https://doi.org/10.5539/ies.v9n3p71

[52] Alharbi, W.O., Alturki, K.I., 2018. Social media contribution to the promotion of digital citizenship among female students at Imam Mohammed bin Saud Islamic University in Riyadh. English Language Teaching. 11(1), 80–92. DOI: https://doi.org/10.5539/elt.v11n1p80

[53] Phillips, A.L., Lee, V.R., 2019. Whose responsibility is it? A statewide survey of school librarians on responsibilities and resources for teaching digital citizenship. School Library Research. 22, 1–20.

[54] Karunanayaka, S.P., Weerakoon, W.M.S., 2020. Fostering digital education among teachers and learners in Sri Lankan school. Journal of Learning and Development. 7(1), 61–77.

[55] Morreale, C., Van Zile-Tamsen, C., Emerson, C.A., et al., 2017. Thinking skills by design: Using a capstone ePortfolio to promote reflection, critical thinking, and curriculum integration. International Journal of ePortfolio. 7(1), 13–28.

[56] Seifert, T., 2017. Pedagogy 2.0 in pre-service teacher education. Journal of Educational Technology. 14(3), 15–31.

[57] Hughes, J.E., Read, M.F., 2018. Student experiences of technology integration in school subjects: A comparison across four middle schools. Middle Grades Review. 4(1), 1–31.

[58] Mack, E.A., Marie-Pierre, L., Redican, K., 2017. Entrepreneurs' use of internet and social media applications. Telecommunications Policy. 41(2), 120–139.

[59] Chen, Z., Cui, R., Tang, C., et al., 2024. Can digital literacy improve individuals incomes and narrow the income gap? Technological Forecasting & Social Change. 203, 123332.

[60] Serdarušić, H., Pancić, M., Zavišić, Ž., 2023. Green finance and fintech adoption services among Croation online users: How digital transformation and digital awareness increase banking sustainability. Economics. 12(3), 54–72.

[61] Gillen, J., Marsh, J., Bus, J., et al., 2018. Digital Literacy and young children: Towards better understandings of the benefits and challenges of digital technologies in homes and early years settings. Policy briefing of DigiLitEY COST Action IS1410 and the Digital Childhoods SIG of the European Early Childhood Research Association. 31st August 2018. Available from: https://e-space.mmu.ac.uk/624237/1/Gillen_Arnott_PB_2018_Digital_Literacy_and_Young_Children_Towards_Better_Understandings_of_the_Benefits.pdf (cited 5 July 2025).

[62] Yang, F., Yao, R., Ren, Y., et al., 2025. Harmony in diversity: Digital literacy research in a multidisciplinary landscape. Computers & Education. 230, 105265. DOI: https://doi.org/10.1016/j.compedu.2025.105265

[63] Conklin, W., 2012. Higher-order thinking skills to develop 21st century learners. Shell Education: Huntington Beach, CA, USA.

[64] Martin, A., 2006b. A European framework for digital literacy. Nordic Journal of Digital Literacy. 1(2), 151–161.

[65] Verma, A., Jha, M., Mitra, M., 2016. Digital awareness and Internet usage by school students. Journal of Psychosocial Research. 11(2), 259–270.

[66] Hooper, S., Hokanson, B., 2000. The changing face of knowledge. Social Education. 64(1), 28–31.

[67] Egbert, J., 2017. Supporting student content learning. In: Egbert, J. (ed.). Methods of education technology: Principles, practice, and tools. Pressbooks: Montreal, Quebec, Canada. pp. 28–49.

[68] Seemann, K., 2003. Basic principles in holistic technology education. Journal of Technology Education. 14(2), 28–39.

[69] Baskara, F.R., 2025. Conceptualizing digital literacy for the AI Era: A framework for preparing students in an AI-driven world. Data and Metadata. 4, 530. DOI: https://doi.org/10.56294/dm2025530

[70] Ciampa, K., Wolfe, Z.M., Bronstein, B., 2023. ChatGPT in education: Transforming digital literacy practices. Journal of Adolescent & Adult Literacy. 67(3), 186–195.

[71] Liu, J.W., Shadiev, R., Coa, M., 2025. Effects of digital citizenship educational game on teenagers' learning achievements, motivation, cognitive load, and behavioral patterns. Education and Information Technologies. 1–54. DOI: https://doi.org/10.1007/s10639-025-13399-7

[72] Page, M.J., McKenzie, J.E., Bossuyt, P.M., et al., 2021. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. British Medical Journal. 372(71). DOI: http://dx.doi.org/10.1136/bmj.n71