

Fifty years of digital literacy studies: A meta-research for interdisciplinary and conceptual convergence

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Abstract

The following research has as its starting point the previous existence of different approaches to the study of digital literacy, which reflect a specialisation by area of study as well as connections and complementarity between them. The paper analyses research from the last 50 years through 11 key terms associated with the study of this subject. The article seeks to understand the contribution of each term for an integrated conceptualisation of digital literacy. From the data science approach, the methodology used is based on a systematized review of the literature and a network analysis using *Gephi*. The study analyses 16,753 articles from *WoS* and 5,809 from *Scopus*, between the period of 1968 to 2017. The results present the input to each key term studied as a map of keywords and a conceptual framework in different levels of analysis; in these, we show digital literacy as a central term that connects and integrates the others, and we define it as a process that integrates all the perspectives. The conclusions emphasise the comprehensive sense of digital literacy and its social condition, as well as the transversality to human life. This research aims to understand the relationships that exist between the different areas and contribute to the debate from a meta-theoretical level, validating meta-research for this interdisciplinary purpose.

Keywords

Digital literacy; Media literacy; Information literacy; New literacies; Digital divide; Lifelong learning; 21st century skills; Critical literacy; Learning motivations; Curriculum; Digital culture; Network analysis; Meta-research; Data science.

1. Introduction

Digital literacy or digital competence (i.e. information literacy, ICT skills, technological literacy) is part of the competencies for lifelong learning. Voogt and Pareja-Roblin (2012) highlight that, in the different proposals for competence frameworks, emphasis is placed on the 'digital' as the central competence and as the axis for strengthening other competences.

The concept 'digital literacy' integrates digital skills and 21st century skills. It was introduced in 1998 by Gilster (**Van-Laar et al.**, 2017), and is considered as the ability that allows users to perform intuitively in digital environments to easily and effectively access the wide range of knowledge embedded in those environments. It is also considered more than a technical skill involving the use of software and digital devices, as it also includes a cognitive and socio-emotional dimension to problem solving in the digital environment (**Eshet-Alkalai**, 2004; **Martín**, 2006; **Ilomäki**; **Kantosalo**; **Lakkala**, 2011). Digital literacy enables the development of skills for the safe and critical use of ICT, learning, personal growth and participation in society (*European Commission*, 2007; **Ala-Mutka**; **Punie**; **Redecker**, 2013; **Vuorikari et al.**, 2016).

The concept of digital literacy is not standardised, as the scope is broad and has been researched from different fields. The most common approaches so far have been those of media studies, educational studies, computer science, information science and librarianship (**Ilomäki et al.**, 2016). Due to this, the understanding of this competence can be diverse.

Several terms have been identified by researchers to refer to digital literacy: information literacy, digital competence, digital skills, new literacies, multiliteracies, media literacy, e-literacy, internet literacy, ICT Skills, ICT Competence, ICT Literacy, meta-literacy, computer literacy, computer skills, e-competence, e-skills, and technology literacy (**Martín**, 2006; **Bawden**, 2008; **Gillen**; **Barton**, 2010; **Mackey**; **Jacobson**, 2010; **Ilomäki**; **Kantosalo**; **Lakkala**, 2011; **Ferrari**, 2012; **Aesaert et al.**, 2013; **Gallardo-Echanique et al.** 2015; **Van-Laar et al.**, 2017; **Siddiq**; **Gochyyev**; **Wilson**, 2017).

In part, the different denominations of digital literacy respond to the interests and scope of each era. It emerged at the end of the twentieth century with the spread of ICT, so in the early eighties of the last century the term mainly referred to computer literacy, focusing on the handling of software and hardware (**Naval et al.**, 2016).

The critical approach of this competence has been growing in the various research perspectives, especially in concepts such as digital literacy, information literacy and media literacy (**Buckingham**, 2003; **Aguaded**; **Marín-Gutiérrez**; **Caldeiro-Pedreira**, 2018; **Redecker**; **Punie**, 2019). The approach to educational technology and media literacy studies not only highlight this critical dimension, but also provides an emotional perspective which, in addition to the so-called critical thinking, refers to a "critical attitude" (**Ferrés**; **Masanet**; **Mateus**, 2018)

Finally, it is important to highlight that digital literacy

"has been one of those key concepts whose relevancy and weight as a key element for a digital citizenship have shifted from being recommended to essential" (**Pérez-Escoda**; **García-Ruiz**; **Aguaded**, 2019).

As these researchers point out, this competence has become a training requirement for different international bodies such as the *European Commission*, *Unesco*, and *OECD*.

The various concepts have been defined by different authors (Table 1). Some of these have a greater focus on certain competences, and therefore the potential to complement each other, while other terms are more comprehensive.

Table 1. Definition of the key terms studied.

Key term	Publication	Autor
Information literacy	Information literacy - A core competency	Burnhein (1992)
New literacies	New literacies: A dual-level theory of the changing nature of literacy	Leu et al. (2017)
Digital literacy	What is digital competence?	Ilomäki ; Kantosalo ; Lakkala (2011)
Digital skills	A new direction?: Digital literacy, student participation and curriculum reform in Norway	Erstad (2006)
Media literacy	Alfabetización mediática y nuevo humanismo	Pérez-Tornero ; Varis (2012)
Technology literacy	Standards for technological literacy: Contents for the study of technology	<i>International Technology Education Association (ITEA)</i> (2007)
Digital competence	DigComp: A Framework for developing and understanding digital competence in Europe	Ferrari (2013)
ICT skills	Terminology of European education and training policy	<i>European Centre for the Development of Vocational Training (Cedefop)</i> (2014)
ICT competence	A basic model of integration of ICT by teachers: competence and use.	Suárez-Rodríguez et al. (2018)
Multiliteracies	Multiliteracies: Literacy learning and the design of social futures	Cope ; Kalantzis (1999)
ICT literacy	Digital literacies for learning. London: Facet Publishing.	Madigan ; Martin (2006)

Source: Based on a literary review of scientific publications.

The commonalities of the definitions of these key terms is the user's appropriation and understanding of the technology. Each study perspective supports an integrated concept, and after analysing the relationships between terms at different scales, the results demonstrate the approach of each concept in terms of the subjects researched, which can be visualised in a large network where these relationships converge.

The main interest of this study is to identify the conceptual contributions of each key term studied, in order to develop an integrated conceptual framework. Starting from the premise of the existence of diverse approaches to the study of the subject, whereby derivables first reflect a dispersion and specialisation by area of study, and which in spite of this, are connected or complementary, we begin with the research question (RQ1): What is the contribution of each term for an integrated conceptualisation of digital literacy? Three secondary questions are derived from this: (RQ1a) What is the structure of the data visualisation that connects the key terms investigated?, (RQ1b) What is the relationship between the different key terms that address the study of digital literacy?, (RQ1c) What are the most important secondary keywords linked to each key term analysed?

“The main interest of this study is to identify the conceptual contributions of each key term to develop an integrated conceptual framework of digital literacy”

The results of the investigation are presented in four sections. The first, second, and third show the findings around the three secondary research questions mentioned in the previous paragraph. This display of the results allows to observe the methodological process and the systematisation of the information, finally leading the reader to the fourth section where the main question of the study is answered. This allows us to conclude that the term “digital literacy” has an important social focus and that it is an integrating concept.

This meta-research from a data science perspective constitutes the first study using a network analysis methodology to shape a conceptual relationship of digital literacy as a set of competences for lifelong learning.

2. Materials and methods

This meta-research pursues an interdisciplinary approach in order to integrate the different areas of study that have investigated digital literacy over the last 50 years.

“Meta-research involves taking a panoramic view of science (...) This emphasis on the larger picture is typical of many meta-research investigations” (Ioannidis *et al.*, 2015).

“This meta-research constitutes the first study using a network analysis methodology to shape a conceptual relationship of digital literacy as a key competence for lifelong learning”

The meta-analysis starts from a systematic review of metadata (keywords) from 25,562 academic articles, which in turn generate 73,523 connection data, processed with a network analysis.

The 11 keywords for meta-analysis were selected from the following process:

- 1) A first and exploratory literature review in high-impact academic articles was conducted, as shown in the introduction
- 2) Second and mainly, eight terms present in the international competency frameworks were selected (in order to delimit the keywords that arose in the previous literature review):

- Information literacy: *Unesco, European Commission, Partnership for 21st Century Learning (P21)*
- Digital literacy: *European Commission, National Educational Technology Standards (NETS)*
- Media literacy: *Unesco, European Commission, P21*
- Technology literacy: *NETS, P21, National Assessment of Educational Progress (NAEP)*
- Digital competence: *European Commission*
- ICT skills: *NAEP*
- ICT competence: *European Commission, Unesco*
- ICT literacy: *P21*

- 3) Finally, based on the high visibility of terms in the network analysis, three terms were added: multiliteracies, new literacies and digital skills.

The selection of keywords was not intended to be exhaustive and that the analysis could be completed with the inclusion of other terms that are also widely used in this area.

2.1. Systematized literature review

For the analysis of different perspectives of research about digital literacy, a systematic approach (Booth; Papaioannou; Sutton, 2012) was chosen to synthesize academic literature. This method helps to collect, identify, select and analyse data in an appropriate and reliable manner (Van-Laar *et al.*, 2017).

For this study, we explore academic scientific databases that contain the terms related to digital literacy, and we then complete the process with a network analysis.

This research has its foundations in *Web of Science (WoS)* and *Scopus* metadata extracted from 11 selected terms related to digital literacy, which in the context of this research are called ‘key terms’. As for the keywords of each scientific article connected to these ‘key terms’, we use the concept of ‘secondary keywords’.

In the context of this document, the term ‘digital literacy’ will be used to refer to the group of key terms that, depending on the area of study, have a different denomination (Table 1).

2.1.1. Search terms and selection criteria

In order to carry out the study, the following criteria were considered for the systematic review of the literature, prior to the analysis of networks:

- 1) Period of analysis: the research contains the metadata from articles from 1968, the year when the first results appeared, to 2017, the year when the data was extracted.
- 2) Key terms: From the preliminary bibliographic review, 11 key terms focused on the study of digital literacy were selected.
- 3) Scientific data bases: Metadata was obtained from the academic production of *WoS* and *Scopus*.
- 4) Category: The category of results listed as ‘academic journals’ were selected because they were considered the most significant contributions in the scientific field, as well as those of greater volume, and therefore, more representative in the academic production.

2.1.2. Network analysis: Data collection and preparation

Network analysis has often been used to assess links between entities in a network (Grandjean, 2016). It consists of representing a graph with two elements: a set of nodes and a set of lines (De-Nooy; Mrvar; Batagelj, 2005).

In this case, the nodes are formed from the secondary keywords extracted from the scientific articles containing the key terms studied. The lines of the network connect the various keywords to each other and the greater the number of relationships the larger the node is displayed. The analysis of networks was carried out with the free software *Gephi*, and the algorithm ‘modularity class’ was applied. This allowed for the understanding of the structure of relations, since the algorithm groups keywords with similar characteristics, meaning it concentrates other keywords that generate subnets according to their relations.

Network analysis has been applied on two scales. The first for the entire extracted database (key terms + secondary terms); and the second applied to a subset of the network formed solely by the key terms of the study.

In the hypothetical example in Figure 1, each keyword represented by the letter ‘K’ is part of a modularity, which is differentiated by colour. This type of visualisation of information allows us to determine the density that is greater or lesser, and the closeness of relationships. In turn, this method allows us to analyse the information both quantitatively (co-occurrence of the number of links between keywords which generates a greater weight to the linked nodes) and qualitatively (role of the keyword and its situation in the network).

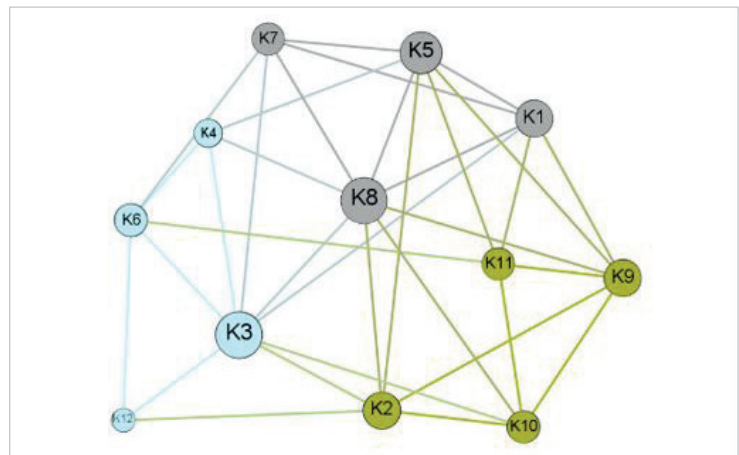


Figure 1. Network analysis methodology implemented. Source: Based on random data in *Gephi*.

The scientific production over time of each of the terms associated with digital literacy research adds up to 52,903 results in the *WoS* and *Scopus* databases. A total of 23,866 *WoS* and 9,608 *Scopus* scientific articles were extracted with the selected key terms, of which 16,753 and 5,809 were finally analysed (Table 2), respectively, from a purging of the database.

Table 2. Search results of scientific production with analysed keywords. (Excel)

Key terms	WoS Total results	WoS academic articles	WoS academic articles analyzed	Scopus total results	Scopus academic articles	Scopus academic articles analyzed	WoS & Scopus academic articles analyzed
Information literacy	9.974	7.217	6.236	6.590	4.352	2.243	8.479
New literacies	6.063	4.401	2.905	800	613	362	3.267
Digital literacy	2.698	1.672	1.541	1.636	961	801	2.342
Digital skills	4.887	2.584	1.950	1.042	466	246	2.196
Media literacy	3.347	2.448	1.302	1.472	1.057	808	2.110
Technology literacy	4.758	2.938	996	2.045	1.093	648	1.644
Digital competence	1.291	637	603	638	441	148	751
ICT skills	2.425	932	519	374	165	124	643
ICT competence	1.029	413	283	207	128	107	390
Multiliteracies	278	221	210	185	147	163	373
ICT literacy	833	403	208	331	185	159	367
Total	37.583	23.866	16.753	15.320	9.608	5.809	22.562

Period of search: 1968-2017

Source: Information extracted from *Scopus* and *WoS*.

In order to apply the analysis of networks, data reprocessing was previously carried out, which involved three phases:

- Data cleaning: In this process, key terms and secondary keywords were homogenised (for example, terms such as: ICT with Information and Communication Technologies; e-books with eBooks; 21st century skills with XXI century skills, etc). Categories that are not compatible with the study area were also discarded, and duplicate articles in both databases were eliminated.
- Data structuration: From the database, a co-word analysis was carried out applying a relational unpivot table - which shows the existing relations between each and every one of the keywords, thus generating 73,783 relations between the keywords.
- Data analysis and synthesis: The *Gephi* tool was used for network analysis and data visualisation as synthesis process for data interpretation.

It should be specified that what gives more significance to a term in the network is not only the number of times it appears, but the number of relationships that this term generates. Therefore, the fact that a term has been researched for a longer time, and as a result, has greater scientific production (greater contribution of keywords to this study), does not mean that it will be the most relevant term, since network analysis considers other algorithms to define that level of importance in the network.

The data obtained contains almost 100% of the scientific articles within the selected areas produced from 1968 to 2017. It can be considered that approximately 10% of the articles in the scientific databases did not contain secondary keywords or presented data export errors.

3. Findings

3.1. Mapping the structure of research about digital literacy

The analysis shows us two structures of relationships; the first, solid, and the second, dispersed. On the one hand, there is the conformation of three main consolidated groups that link to each other (Figure 2), highlighted with yellow circles; and, on the other hand, a dispersed structure of nodes characterised by a lesser integration, indicated with a black circle.

In Figure 2, in which the key terms studied are displayed, we can observe a structure formed by 16 modules (several imperceptible), in which 8 of these have more than 150 nodes, and therefore, have greater relevance within the network. This Figure also highlights 3 key terms in red that have greater visibility and importance within the network.

From this first level of analysis, the term that stands out the most is “information literacy”, together with the secondary keywords “assessment” and “academic libraries” which are areas less related to this research. This reflects the fact that this key term covers broader topics and that it is not only linked to the area of digital literacy, but mainly to professionals in librarianship and information sciences.

The second most visible key term on the network is “digital literacy”, surrounded by the secondary keywords “literacy”, “education”, “internet”, “ict”, and “technology”; terms more focused on the area of this study. In addition, it is centrally related to the term “digital divide”, which is a very important node within the entire network, as we will see later.

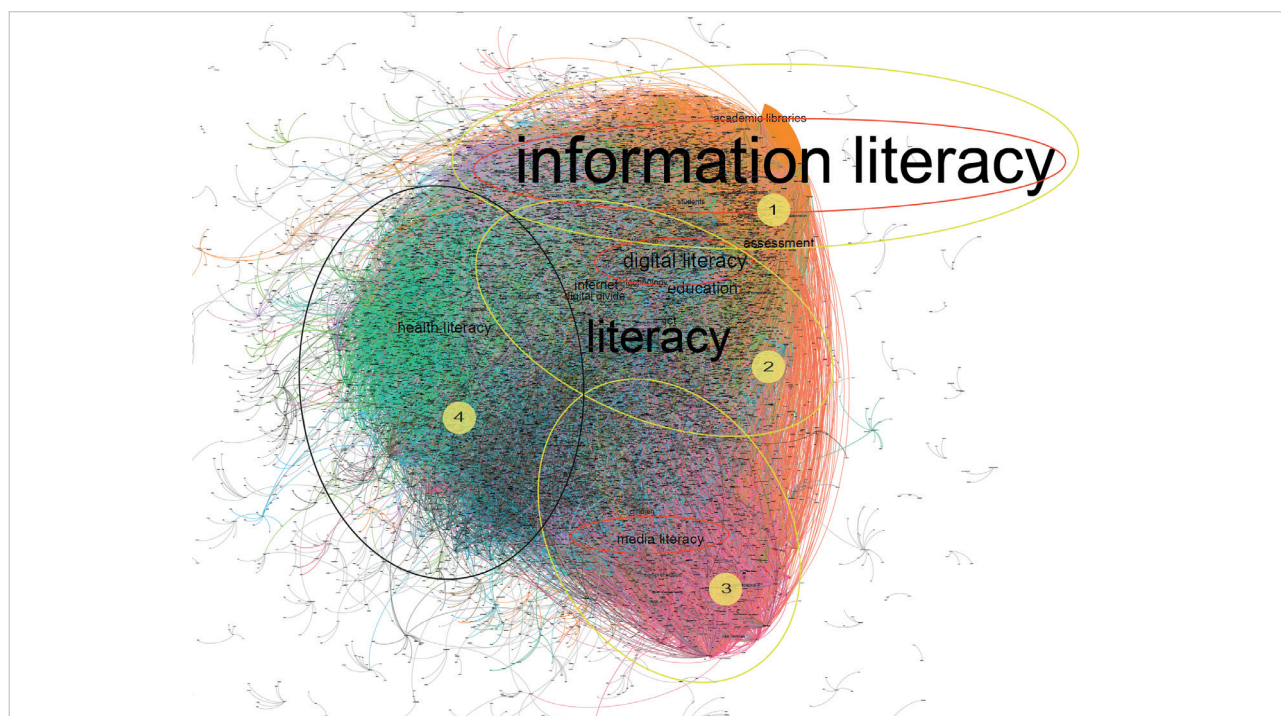


Figure 2. Mapping digital literacy research: key terms structure. Source: Based on data extracted from *WoS* and *Scopus*, analysed in *Gephi*.

On the other hand, media studies also have an important role within the network, which is reflected in the key term that stands out in the third level as “media literacy”. This term explores a wide field that goes beyond digital education and encompasses the critical consumption of media in general (On and Off), and is further manifested in the relation with other terms such as “media”, “comprehension” and “new literacies.” It also highlights the keywords from the groups “adolescents” and “children”, in which these studies are oriented. In this context, it is important to highlight the relationship of new literacies focused on the youngest.

In the scattered area (black circle, area 4), the studies from the health area stand out with the secondary keyword “health literacy,” which is related to “communication,” and to the central area where the term “digital literacy” is found, therefore referring to a social approach to health linked to ICT. This keyword is not part of the selected terms; however, it has an important visibility and a great relation with the central theme, which is an interesting finding. In this dispersed area, secondary keywords such as “literacy”, “technology”, “skills”, “knowledge”, “adolescence”, “scientific literacy”, “information” “attitudes” can also be observed, which are transversal terms to the study of the topic and form a connecting area between different modularities (groups of terms).

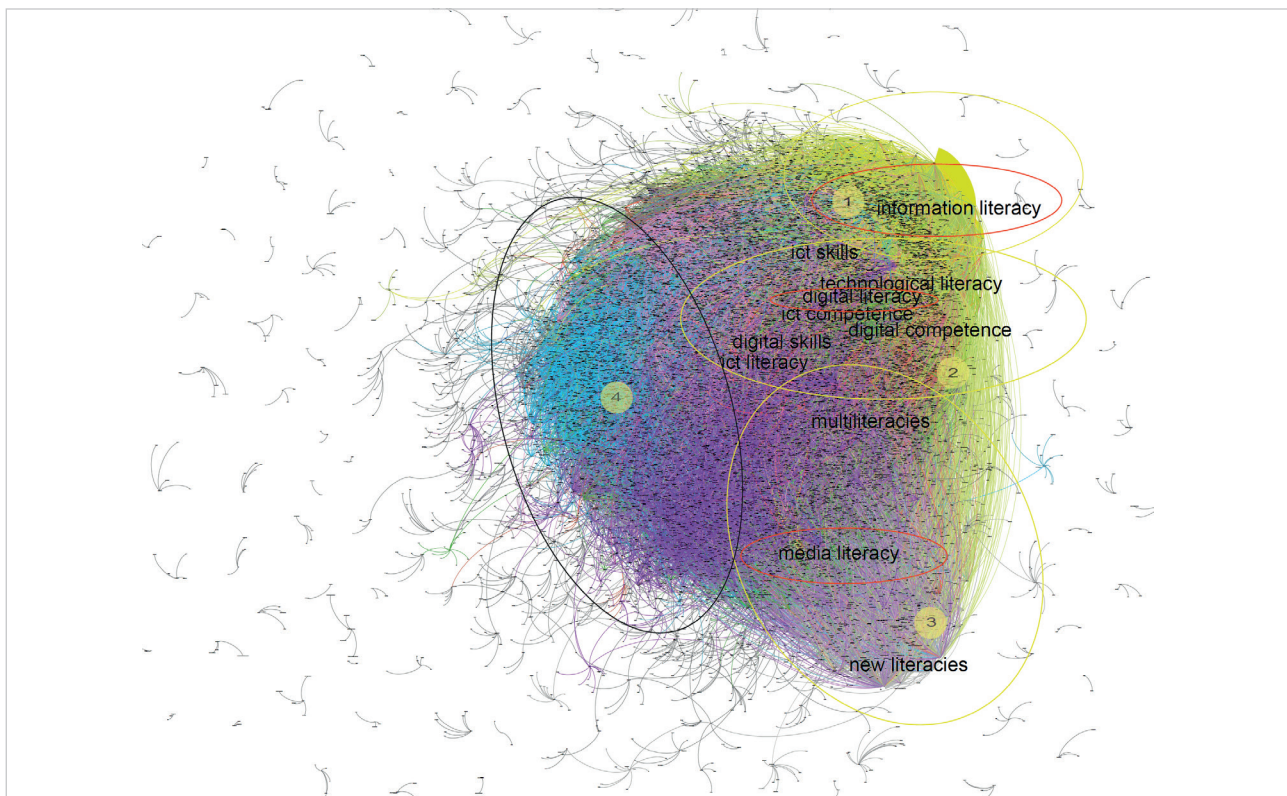


Figure 3. Mapping digital literacy research: Localisation of the key terms studied.

Source: Based on data extracted from *WoS* and *Scopus*, analysed in *Gephi*.

While Figure 2 shows the network with the size of the nodes according to the importance they have in the network; Figure 3 shows the location of all the key terms within the conformed network.

This display allows us to see the structure of stronger and weaker relationships between key terms. This can be attributed to the “modularity class” tool used in network analysis, which determines the set of nodes that are most related to each other and gathers, in this case, the most related terms. The remarkable discovery in this analysis was finding cases where the key terms shared the same modularity (set of similar characteristics), showing a closer relationship. We can also see the opposite case, showing key terms less related to each other.

Table 3 shows the 8 largest modularities, which make up 70% of the entire network (out of a total of 16 modularities), and whereby the 20 most connected terms in each modularity are identified. The key terms highlighted in **green** and their location in each modularity have been highlighted in the table.

The modularity “B” has the most key terms clustered (4 of 11): “digital literacy”, “digital skills”, “technological literacy” and “ict skills” form a single group. Secondly, with 3 key terms clustered, we find the modularity “A”: “digital competence”, “ict competence” and “ict literacy”; while the Modularity “C” contains 2 key terms in its group; “new literacies” and “multiliteracies.” Therefore, 9 of the 11 key terms are concentrated in 3 modularities.

Moreover, the “D” and “E” modularities contain a studied key term, “information literacy” and “media literacy” respectively, and they do not share modularity with any other studied term. This allows us to understand that although these terms deal with the main focus of this research, they cover many other topics and are more specialised in their area.

Table 3. Modularities and clustered key terms.

Key terms grouped by modularity							
Modularity A	Modularity B	Modularity C	Modularity D	Modularity E	Modularity F	Modularity G	Modularity H
1) digital competence 2) teacher education 3) design 4) teachers 5) computer-mediated communication 6) ict competence 7) performance 8) model 9) elementary education 10) media in education 11) creativity 12) ict literacy 13) perceptions 14) applications in subject areas 15) digital game-based learning 16) gender differences 17) secondary education 18) computer use 19) teaching/learning strategies 20) teacher training	1) digital literacy 2) digital divide 3) internet 4) ict 5) social media 6) computer literacy 7) gender 8) collaborative learning 9) competences 10) web 2.0 11) digital skills 12) computers 13) web 14) online 15) identity 16) community 17) access 18) information and communication technology 19) internet use 20) digital inequality (35) technological literacy (77) ict skills	1) adolescence 2) digital 3) comprehension 4) new literacies 5) multiliteracies 6) writing 7) early adolescence 8) critical literacy 9) childhood 10) motivation 11) case study 12) university students 13) visual literacy 14) strategies 15) information and communication technologies 16) content literacy 17) action research 18) digital/media literacies 19) policy 20) engagement	1) information literacy 2) academic libraries 3) assessment 4) students 5) higher education 6) collaboration 7) critical thinking 8) library instruction 9) e-learning 10) learning 11) digital libraries 12) academic literacy 13) libraries 14) active learning 15) evaluation 16) 21st century skills 17) distance education 18) digital natives 19) information retrieval 20) blended learning	1) media literacy 2) education 3) media 4) adolescents 5) media education 6) curriculum 7) pedagogy 8) citizenship 9) youth 10) competence 11) videogames 12) media competence 13) critical media literacy 14) television 15) advertising 16) schools 17) civic engagement 18) agency 19) mass media 20) audiences	1) literacy 2) technology 3) children 4) skills 5) reading 6) instruction 7) multimodality 8) language 9) digital media 10) classroom 11) school 12) professional development 13) early literacy 14) phonological awareness 15) digital storytelling 16) emergent literacy 17) achievement 18) vocabulary 19) dyslexia 20) culture	1) health literacy 2) information 3) communication 4) information-seeking 5) consumer health information 6) self-efficacy 7) behavior 8) impact 9) numeracy 10) readability 11) information seeking behaviour 12) care 13) cancer 14) patient education 15) adults 16) health communication 17) health 18) health information 19) outcomes 20) financial literacy	1) knowledge 2) attitudes 3) scientific literacy 4) science 5) science education 6) credibility 7) beliefs 8) socioscientific issues 9) discourse 10) framework 11) science communication 12) argumentation 13) inquiry 14) trust 15) science literacy 16) media and science 17) biology 18) chemistry 19) reasoning 20) Wikipedia

Source: Based on data extracted from *WoS* and *Scopus*, analysed in *Gephi*.

The modularity with the most association of key terms researched (modularity B) is the one that corresponds to the key terms “digital literacy,” “digital skills,” “ICT literacy” and “technological literacy.” It is the fourth modularity in size, with 12,963 keywords associated in this group.

Also, the 3 remaining modularities (F, G and H) are modularities that are located in the dispersed area of the network structure, appearing as a connecting area with themes and literacies that enrich the results. For example, health literacy, science literacy, financial literacy, etc.

This first level of analysis provides the structure of the visualisation of data, as well as relations and nodes with greater significance, where the key term digital literacy is shown as a more integrating term and focused.

3.2. ‘Digital literacy’ an integrated and connected concept

In the first section of the results, we analyse the relationship of the key terms in the large set as well as the relationship structure with other secondary keywords. Furthermore, the key terms are analysed in relation to themselves and their relevance within the network as a whole.

Therefore, this section focuses on the subnet formed by the key terms; this level change in the analysis shows the number of relationships between these terms. A co-occurrence matrix is used in which the set of key terms is listed horizontally and vertically (Table 4). The last two rows of the table present the total relations corresponding to each term and the percentage.

The inter-relations between the terms analysed are concentrated. Two key terms, “digital literacy” and “media literacy,” generate more than half of these relations (52%), and if the next three terms “information literacy,” “digital competence” and “new literacies” are considered in terms of importance, 85% of generated relations are achieved.

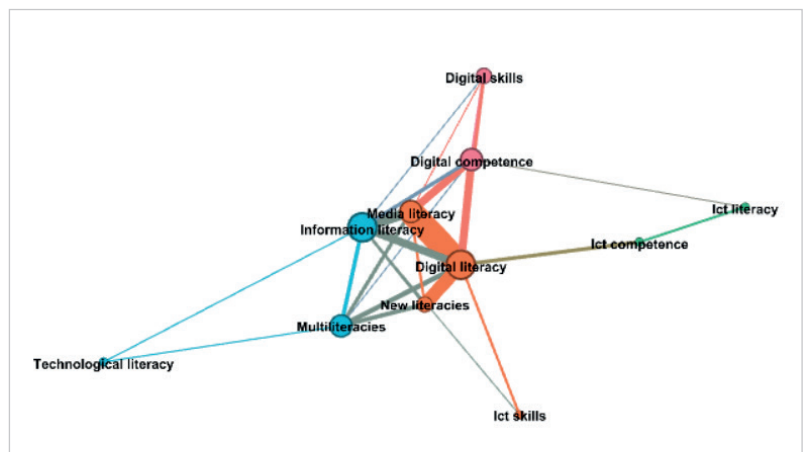


Figure 4. Subnetwork of key terms. Source: Based on data extracted in *WoS* and *Scopus*, analysed in *Gephi*.

Table 4. Co-occurrence matrix of key terms studied.

Key terms	Technology literacy	ICT literacy	ICT skills	ICT competence	Digital skills	Multi-literacies	New literacies	Digital competence	Information literacy	Media literacy	Digital literacy
Technology literacy	x	0	0	0	0	1	0	0	1	0	0
ICT literacy	0	x	0	3	0	0	0	1	0	0	0
ICT skills	0	0	x	0	0	0	0	0	1	0	3
ICT competence	0	3	0	x	0	0	0	0	0	0	5
Digital skills	0	0	0	0	x	0	0	5	1	1	4
Multiliteracies	1	0	0	0	0	x	6	1	5	5	7
New literacies	0	0	0	0	0	6	x	0	4	3	21
Digital competence	0	1	0	0	5	1	0	x	5	12	12
Information literacy	1	0	1	0	1	5	4	5	x	16	12
Media literacy	0	0	0	0	1	5	3	12	16	x	40
Digital literacy	0	0	3	5	4	7	21	12	12	40	x
Total relationships	2	4	4	8	11	25	34	36	45	77	104
% of relationships	1%	1%	1%	2%	3%	7%	10%	10%	13%	22%	30%

Source: Based on data extracted from *WoS* and *Scopus*, analysed in *Gephi*.

“Digital literacy” is the term that generates the greatest connectivity (Figure 4), as it establishes relations with eight of the ten key terms, which is reflected in the highest value (11.9) of ‘betweenness centrality.’ In this sub-network, this indicator shows the degree of interconnection that the node allows within the network. In other words, “digital literacy” is characterised by a high number of relationships, as well as by its role as a central link between the different key terms of the subnet.

On the other hand, the five least related terms (digital skills, ict competence, ict skills, ict literacy and technological literacy) do not reach even 10% of the relationships between them.

3.3. The social condition of digital literacy

The first two result sections cover first, the structure of the network as a whole, and the interrelation of the key terms studied in that aggregate. In this section we analyse the secondary keywords or descriptors associated to each one of the 11 key terms, this will allow us to see their thematic contribution to the overall relation.

Table 5 presents the key terms and their relevance in the network in relation to themselves and the secondary keywords. The degree is the number of nodes (contained keywords) and the weighted degree is the number of relations (connections that form the nodes or keywords). Each relationship characterises the study approach of each key term.

In table 6, we observe the ranking of the 50 most connected words in the whole network. The table shows the most important keywords, and where the key terms are. Their position within this ranking is highlighted in **green**. This set of data represents an extended definition, which will be considered in the final section of the results, in a comprehensive approach that aims to collect the different perspectives.

Table 5. Key terms. Ranking of relations.

Keyword	Modularity class	Degree	Weighted degree
information literacy	D	1,537	3,538
digital literacy	B	804	1,790
media literacy	C	643	1,302
new literacies	E	257	573
digital competence	A	262	506
multiliteracies	E	245	350
ict competence	A	127	197
digital skills	B	122	192
ict literacy	A	89	131
technological literacy	B	66	87
ict skills	B	29	42

Source: Based on data extracted from *WoS* and *Scopus*, analysed in *Gephi*.

Table 7, meanwhile, contains the first 20 words most related to each of the key terms. Here we highlight the term “digital literacy” in yellow, which is shown to be more connected with the other terms with greater repetition and relevance (position), as it is in the first positions of the blocks of keywords and modularities. The other key terms and their repetitions are highlighted in blue. Also highlighted in green we find the secondary keyword with the greatest repetition (“digital divide”) associated with the key terms.

From this third level of analysis, the most important research topics associated with each key term stand out. The block of terms of modularity “A” is more focused on the pedagogical area of digital literacy, related to teachers and ICT; and block “B”, to the different competences (especially basic: technique, communication, information, media, collaboration), as well as the learning environments and results of the students.

Block “C”, from a critical literacy approach, is oriented to the connection with different realities, intercultural communication, gender, culture, finance; that is to say, diverse contexts of life connected with technology.

Furthermore, the blocks with modularity D and E also include competencies, which although are basic or linear (information, communication and media), their approach is more transversal with the development of critical thinking and the construction of digital citizenship.

Finally, the results of this section highlight two terms: “digital literacy” and “digital divide”. The first integrates all the concepts; the second deepens the social condition of technology, an approach sometimes lost by the technical perspective. This network of keywords allows us to outline the integrated framework, which will be described in the following section.

3.4. Convergence: towards an integrated conceptual framework

In the previous sections, all key terms are framed in the inclusive term “digital literacy”. First, because it is the most targeted term, and secondly, because it is the most central and connected of the other 10 terms studied.

This section proposes an integrated conceptual framework that considers different elements: actors, strategies, competencies, and ecosystems, which are outlined in a table that integrates the different levels of analysis of the results.

Table 8 therefore, is the extract of the approach of each key term, in which there are four levels of results: 1) The 5 keywords most related to the modularity, 2) The 5 secondary keywords most related to each key term, 3) The description of the approach of each key term and 4) The description of the approach from the modularity.

It is important to mention that secondary keywords have been highlighted in the analysis. These give value to the different perspectives of studies and have been integrated conceptually by their importance and weight in the network. Both the key terms and the secondary keywords of greater frequency have been indicated and differentiated by colour in Table 8.

This integrated perspective sees digital literacy as more than the sum of competencies. Rather, it looks at it as a process for subtracting the digital divide, starting with the analysis and exploration of literacies, curricular planning and design, and then reaching the user-subject who is endowed with these diverse competencies specialising in multiple areas and approaches such as; social, technical, critical. From this process perspective, there are different actors and stages.

Table 6. Ranking of keywords most connected within the network.

Top keywords conected in the network			
1	information literacy	26	skills
2	literacy	27	social media
3	digital literacy	28	adolescents
4	media literacy	29	multiliteracies
5	academic libraries	30	computer literacy
6	adolescence	31	critical thinking
7	digital divide	32	media education
8	assessment	33	gender
9	health literacy	34	curriculum
10	internet	35	library instruction
11	education	36	reading
12	ict	37	instruction
13	digital	38	e-learning
14	technology	39	writing
15	comprehension	40	attitudes
16	children	41	information-seeking
17	students	42	pedagogy
18	new literacies	43	teacher education
19	information	44	scientific literacy
20	communication	45	early adolescence
21	digital competence	46	design
22	higher education	47	learning
23	collaboration	48	multimodality
24	knowledge	49	language
25	media	50	science

Source: Based on data extracted from WoS and Scopus, analysed in Gephi.

Table 7. Secondary keywords associated to key terms.

Keyword	Digital competence	ICT competence	ICT literacy	Digital skills	Digital literacy	ICT skills	Technological literacy	New literacies	Multiliteracies	Information literacy	Media literacy	
Modularity Class	A											
	(1) ict (2) higher education (3) digital literacy (4) media literacy (5) digital divide (6) media competence; (7) teacher; (8) assessment; (9) teacher education; (10) training; (11) academic literacy; (12) archeology; (13) basic competences; (14) social networks; (15) education; (16) indicators; (17) information literacy; (18) perceptions; (19) secondary; (20) digital skills	(1) primary education (2) cognitive differences and learning (3) digital literacy (4) ict engagement (5) students (6) teachers; (7) primary-education; (8) digital learning; (9) material; (10) basic skills; (11) elementary education; (12) multilevel; (13) ict interest; (14) ict literacy; (15) ict self-concept; (16) social exposure to ict; (17) secondary education; (18) teacher integration; (19) technology; (20) gender	(1) digital divide (2) digital curriculum (3) ict motivation (4) ict competence (5) computer literacy (6) design; (7) ict self-efficacy; (8) ict self-regulation; (9) social networking; (10) 21st century skills; (11) social network; (12) bridging digital divide; (13) computer-assisted language learning; (14) factorial invariance; (15) gate-keeping; (16) complex problem solving; (17) convergent validity; (18) assistive technology; (19) gender differences; (20) collaborative learning	(1) digital divide (2) digital competence (3) academic achievement (4) digital literacy (5) biblioredes (6) computer literacy; (7) digital inequality; (8) internet; (9) digital activity; (10) children; (11) curriculum; (12) audiences; (13) digital exclusion; (14) information; (15) digital career literacy; (16) beginner; (17) adult learning; (18) collaborative work; (19) computer-based testing; (20) advertising	1) media literacy 2) information literacy 3) ict 4) digital divide 5) internet (6) new literacies; (7) multimodality; (8) adolescence (9) technology; (10) digital; (11) critical literacy; (12) learning; (13) literacy; (14) media education; (15) education; (16) identity; (17) computer literacy; (18) literacies; (19) assessment; (20) information	(1) 21st century skills (2) digital literacy (3) digital divide (4) community of practice (5) team leadership skills (6) dynamic adaptability; (7) e-competences; (8) foreign language teaching; (9) science; (10) education; (11) information technology and communication; (12) prisoner; (13) engineering; (14) college; (15) training needs assessment; (16) causal relationship model; (17) instrument development; (19) information literacy; (20) computer literacy	(1) computer literacy (2) digital divide (3) elementary competences (4) basic competences (5) digital media programming; (6) computer and communication technology literacy; (8) community; (9) science; (10) technology integration; (11) digital rhetoric; (12) political and new media; (13) academic health sciences libraries; (14) academic libraries; (15) distance learning; (16) hbcc freshmen; (17) distance education; (18) enterprise resource planning; (19) curriculum design; (20) information literacy	(1) adolescence (2) digital literacy (3) digital literacy (4) early adolescence (5) assessment (6) literacy; (7) comprehension; (8) childhood; (9) children's literature; (10) university students; (11) media; (12) critical literacy; (13) multiliteracies; (14) competences; (15) children's everyday literacy lives; (15) children's everyday literacy lives; (16) content literacy; (17) multimodality (18) action research; (19) design; (20) gamification	(1) multimodality (2) literacy (3) digital literacy (4) design (5) new literacies (6) information literacy; (7) media literacy; (8) competences; (9) dive deep; (10) critical literacy; (11) social semiotics; (12) children's everyday literacy lives; (13) ethnography; (14) children's literature; (15) gender; (16) intercultural communication; (17) adolescence; (18) constructionism; (19) financial education; (20) language policy and planning	(1) digital citizenship (2) asia (3) bandwagon effect (4) library instruction (5) affective embodied agent (6) cultural practices; (7) faculty-librarian; (8) collaboration; (9) students; (10) demographic; (11) factors; (12) digital natives; (13) university libraries; (14) business librarians; (14) information skills; (16) information-seeking; (17) learning; (18) libraries; (19) libraries; (20) instruction;	E (1) media literacy (2) education (3) media (4) adolescents (5) media education (6) comprehension; (7) media; (8) adolescence; (9) critical thinking; (10) digital competence; (11) gender; (12) media competence; (13) adolescents (14) assessment; (15) advertising; (16) content literacy; (18) digital divide; (19) pedagogy; (20) television	
Keywords associated	B											

Source: Based on data extracted from WoS and Scopus, analysed in Gephi.

Table 8. Integrated conceptual framework of the key terms studied.

	Digital competence	ICT competence	ICT literacy	Digital skills	Digital literacy	ICT skills	Technological literacy	New literacies	Multiliteracies	Information literacy	Media literacy
Modularity class & related keywords	Modularity Class A digital competence, teacher education, design, teachers, computer-mediated communication	Modularity Class B digital literacy, digital divide, internet, ict, social media	Modularity Class C adolescence, digital comprehension, new literacies, multiliteracies	Modularity Class D information literacy, academic libraries, assessment, students, higher education	Modularity Class E digital literacy, digital literacy, media education, children, information literacy	Modularity Class C adolescence, digital comprehension, new literacies, multiliteracies	Modularity Class D information literacy, academic libraries, assessment, students, higher education	Modularity Class E digital literacy, digital literacy, media education, children, information literacy	Modularity Class C adolescence, digital comprehension, new literacies, multiliteracies	Modularity Class D information literacy, academic libraries, assessment, students, higher education	Modularity Class E digital literacy, digital literacy, media education, children, information literacy
Keyword related to key terms	ict, higher education, digital literacy, media literacy, digital divide	primary education, cognitive differences and learning, digital literacy, ict engagement, students	digital divide, digital curriculum, ict motivation, ict competence, computer literacy	digital divide, digital competence, academic achievement, digital literacy, biblioreads	media literacy, information literacy, ict, digital divide, internet	21st century skills, digital literacy, digital divide, community of practice, team leadership skills	computer literacy, digital divide, elementary, basic competences, digital media	adolescence, digital literacy, early adolescence, assessment	multimodality, literacy, digital literacy, design, new literacies	digital citizenship, asia, bandwagon effect, library instruction, affective, embodied agent	media literacy, education, media, adolescents, media education
Description of key terms	Associated with ICT in secondary education, students and competence assessment, with emphasis on curriculum, teachers and their training. Focus on media competence, information and technological skills in the context of web2.0	Associated with education in the context of primary education and basic skills, teacher pedagogy, learning levels and strategies. Focus on digital competence, ICT. Emphasis on social exposure to technology and inclusion.	Associated with the social use of technology and an inclusive perspective of it, the design of the digital curriculum and teaching-learning methodologies. Focus on ICT competence, with a technical approach (problem solving), in the context of 21st century competencies.	Associated with the social perspective of internet use, academic performance, and social projects. Focused on digital, technical and strategic use of the computer. It includes not only the context of formal education, but also the inclusion of more vulnerable groups such as children and older adults.	Associated with ICT education, use of the internet as a medium, within the social framework of gaps in access to technology. It integrates diverse competences with technical and critical approaches, the ICT competence in general as well as in the context of new literacies in relation to technology, and in the framework of formal and non-formal education.	Associated with ICT as a competence for lifelong learning. The development of social-cultural behaviours and skills, adaptation to learning environments, instruments and needs. Focus on diverse digital competencies such as: technical, information, ICT.	Associated with the inclusion of the technical/functional perspective of problem-solving technology, its basic competences and distance education. Focus on programming skills, information, communication, new media, science and learning technology as a means for innovation and experimentation.	Associated with studies of different age groups: childhood, pre-adolescence, adolescence, university students and the evaluation of competences in the digital environment. Focus on critical thinking, competence in the digital ecosystem, media, content and new perspectives of digital literacy.	Associated with the design of new modularities, trends and forms of learning in the digital environment, as well as public policies. Focus on critical literacy skills (information, media, communication) and knowledge on diverse/global issues such as: finance, foreign language, foreign media, content and new perspectives of digital literacy.	Associated with the management of libraries and information in general, with emphasis on digital information in the academic and citizen spheres. Focus on the competence of the search for information, media competence, scientific competence, in the context of digital citizenship and use of data and resources.	Associated with the critical consumption of media and content, the understanding of the information ecosystem, and the media education curriculum. Emphasis on research in childhood and adolescence. Focus on critical thinking skills within the social framework of the digital divide.
Description of Modularity Component	Component focused on curriculum design, teachers, pedagogical implementation, strategies, levels, ecosystems and evaluation, within the framework of different ICT competencies.	Component focused on instructor role: perspective of curriculum design, teachers, pedagogical implementation, strategies, levels, ecosystems and evaluation, within the framework of different ICT competencies.	Component focused on the learning role: skills and aptitudes in front of technical focus, focused on user needs to bridge the digital divide under the umbrella of 21st century skills. The following skills are integrated: media, information, problem solving (programming), communication, information and new literacies in relation to technology, culture and society, in formal and non-formal education environments.	Component focused on the learning role: skills and aptitudes in front of technical focus, focused on user needs to bridge the digital divide under the umbrella of 21st century skills. The following skills are integrated: media, information, problem solving (programming), communication, information and new literacies in relation to technology, culture and society, in formal and non-formal education environments.	Component focused on the learning role: skills and aptitudes in front of technical focus, focused on user needs to bridge the digital divide under the umbrella of 21st century skills. The following skills are integrated: media, information, problem solving (programming), communication, information and new literacies in relation to technology, culture and society, in formal and non-formal education environments.	Component focused on the learning role: skills and aptitudes in front of technical focus, focused on user needs to bridge the digital divide under the umbrella of 21st century skills. The following skills are integrated: media, information, problem solving (programming), communication, information and new literacies in relation to technology, culture and society, in formal and non-formal education environments.	Component focused on the learning role: skills and aptitudes in front of technical focus, focused on user needs to bridge the digital divide under the umbrella of 21st century skills. The following skills are integrated: media, information, problem solving (programming), communication, information and new literacies in relation to technology, culture and society, in formal and non-formal education environments.	Component focused on the learning role: skills and aptitudes in front of technical focus, focused on user needs to bridge the digital divide under the umbrella of 21st century skills. The following skills are integrated: media, information, problem solving (programming), communication, information and new literacies in relation to technology, culture and society, in formal and non-formal education environments.	Component focused on the learning role: skills and aptitudes in front of technical focus, focused on user needs to bridge the digital divide under the umbrella of 21st century skills. The following skills are integrated: media, information, problem solving (programming), communication, information and new literacies in relation to technology, culture and society, in formal and non-formal education environments.	Component focused on the learning role: skills and aptitudes in front of technical focus, focused on user needs to bridge the digital divide under the umbrella of 21st century skills. The following skills are integrated: media, information, problem solving (programming), communication, information and new literacies in relation to technology, culture and society, in formal and non-formal education environments.	Component focused on the learning role: skills and aptitudes in front of technical focus, focused on user needs to bridge the digital divide under the umbrella of 21st century skills. The following skills are integrated: media, information, problem solving (programming), communication, information and new literacies in relation to technology, culture and society, in formal and non-formal education environments.

Source: Based on data extracted from WoS and Scopus, analysed in Gephi.

Moreover, this vision does not only focus on the “what?” of competence, that is, “what am I going to teach?” (curriculum), but also on the “how?” (strategies, pedagogies, ecosystems) and the “why?” or “what for?” associated with learning objectives and needs, and specifically, with the reduction of the digital divide.

This systematisation of information leads us to propose a more comprehensive definition:

Digital literacy encompasses two perspectives: the first, focusing on skills-competencies for the use of technology at the personal, professional and citizen level; the second, on teaching-learning and its strategies, both in the context of lifelong learning and 21st century competencies. It also integrates two actors in different roles: 1) instructor/executor and 2) user-learner.

From the first perspective, digital literacy implies the development of competencies for the effective, critical, strategic, social, technical, creative and healthy management of technology (ICT) in different environments (formal-informal); the participation in the digital ecosystem and the appropriation of different innovations. On the other hand, the second perspective focuses on curriculum design, planning, implementation, and evaluation of competencies. Both visions aim at digital inclusion and to break down the digital divide.

“ Digital literacy encompasses two perspectives: the first, focusing on skills-competencies for the use of technology at the personal, professional and citizen level; the second, on teaching-learning and its strategies for digital literacy ”

This proposal of definition, integrating the different approaches, is the result of a dialogue between different areas of knowledge, of an analysis of meeting points, and the association of the contributions of each specialty. From this point of view, digital literacy is a process with different actors, within the social framework of digital inclusion

4. Discussion

As it is observed throughout this research, digital literacy encompasses a diversity of subjects, which in turn explains the different perspectives that enrich the study. Viewing the subject from an integral perspective can refocus research, as well as limit it in its components.

Beyond an unifying term, it is key to orient the comprehensive perspective to the contribution that each term can make to the concept of digital literacy and how each one contributes, within its field of specialisation, with a sum of essentials that develop a macro concept that connects with the competencies of the 21st century skills.

It is important to emphasize that the breadth of the subject, in turn, requires an interdisciplinary vision, which could be methodologically enriched with a Delphi method for the interpretation and discussion of results.

In terms of research on the subject, within the framework of lifelong learning, digital literacy has been framed in studies in specific populations such as childhood and adolescence, giving less focus to other target groups. Therefore, it is vital to visualise digital literacy, not only within the framework of formal education, but also to strengthen research on the subject in informal education (*Scolari et al.*), citizenship and vulnerable groups.

The most crucial finding to the study of digital literacy is to situate the subject within the social framework of ‘digital divide’, an approach that seeks social inclusion, equity and access to knowledge, which is extremely important in the information and knowledge society (*Van-Deursen; Van-Dijk, 2014; Martínez-Bravo; Sádaba-Chalezquer; Serrano-Puche, 2018*), and can sometimes be lost in a solely technical and instrumental view of technology, surpassed in the concept of ‘digital literacy’ (*Ilomäki; Kantosalo; Lakkala, 2011*). Disconnecting the user’s learning needs and motivations can result in making the digital divide more complex.

Other study perspectives have also turned out to be interesting findings, such as the one in the field of health with the approach of “health literacy” (*Van-Deursen, 2012*) or the vision of digital literacy from the professional and scientific approaches (*Leahy; Wilson, 2014*). Seeing digital literacy from a cross-cutting approach to human life is a pending challenge.

As for the methodology applied, it is limited to the precision with which authors identify their articles with keywords. In addition, secondary keywords associated with scientific production do not always determine the entire content of the contribution. Also, when working with such a dense database, some factors could go unnoticed.

It is also important to point out that throughout the research process and data processing we identified other terms of interest that have been left out of the analysis such as: computer literacy, e-literacy, internet literacy, among others, which should be considered in future studies.

“ The most crucial finding to the study of digital literacy is to situate the subject within the social framework of ‘digital divide’, an approach that seeks social inclusion, equity and access to knowledge ”

5. Conclusion

The research on the digital literacy context yielded abundant information, which posed a challenge to data interpretation. In the midst of density, the methodology allowed the organisation of results for meta-analysis, from which the following conclusions can be highlighted.

Methodologically, this meta-research and the network analysis made it possible to achieve the objective of identifying the relationships, themes and focus of the different terms associated with research about digital literacy. Also, the methodology allowed for the understanding of other unforeseen findings that gave value to the study, localising the important position of some terms such as: digital divide, health literacy, critical literacy, scientific literacy, among others.

The study identified the key term “digital literacy” as a common and integrating axis that encompasses the diverse perspectives. In addition, this integration made it possible to define digital literacy with two perspectives. The first focused on skills-competences for the use of technology; the second, on teaching-learning and its strategies. This double perspective allowed us to define “digital literacy” not only as the sum of a number of competences, but as a process that goes from design and implementation to the evaluation of competencies, where several features are involved.

With respect to the central position of the secondary keyword “digital divide” in the network, it highlights the integral sense of digital literacy, since it places in a social framework. This places the person at the centre and his or her social inclusion in the opportunities offered by technology, a focus which is sometimes overshadowed by instrumental vision and in basic, less critical, global and transversal competencies. In this context, it is important to remark the transversality of digital literacy to human life and the importance of connecting it with learning needs and motivations. Ultimately, digital literacy is substantive to lifelong learning.

Meta-research is an interdisciplinary approach that favours the interdisciplinary nature, and data science offer new schemes to investigate. This study reflects dialogical points between sciences, which show the possibility of interdisciplinary approaches to a social phenomenon in a more comprehensive way connecting, in this case, the technological vision with the social challenges.

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