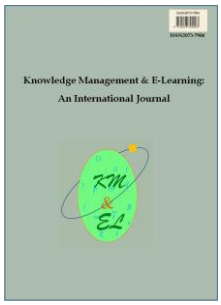
*Knowledge Management & E-Learning, Vol.16, No.3. Sep 2024*

# A digital competence framework for learners (DCFL): A conceptual framework for digital literacy

**Basel Hammoda**
Tallinn University of Technology, Tallinn, Estonia
**Samuel Foli**
The Society for Inclusive and Collaborative Entrepreneurship, Stuttgart, Germany




**Knowledge Management & E-Learning: An International Journal (KM&EL)**
ISSN 2073-7904

**Recommended citation:**
Hammoda, B., & Foli, S. (2024). A digital competence framework for learners (DCFL): A conceptual framework for digital literacy. *Knowledge Management & E-Learning*, *16*(3), 477–500. https://doi.org/10.34105/j.kmel.2024.16.022

*Knowledge Management & E-Learning, 16(3), 477–500*

# A digital competence framework for learners (DCFL): A conceptual framework for digital literacy

Basel Hammoda*

Department of Business Administration
Tallinn University of Technology, Tallinn, Estonia
E-mail: basel.hammoda@taltech.ee

Samuel Foli

The Society for Inclusive and Collaborative Entrepreneurship,
Stuttgart, Germany
E-mail: folisamuel11@gmail.com

*Corresponding author

**Abstract:** Digital technologies are the main driver of the future economy, with technology jobs and those requiring digital skills on the rise. In educational settings, there is an accelerated propagation of digital learning environments, which was amplified by the online shift following COVID-19. To equip learners with the necessary digital skills, there ought to be a purpose-built framework that can be used as a reference point. Although in recent years there were multiple attempts to develop digital literacy frameworks such as DigComp by the European Commission and the Digital Literacy Global Framework (DLGF) by UNESCO, with several other frameworks built on top of them, there is a lack of frameworks devised specifically for learners and students. This paper proposes a conceptual digital literacy framework for learners, building mainly on DigComp 2.0 and the DLGF. We use an integrative review methodology of six main empirical frameworks, developed in recent years with educational applications, to achieve our aim. We added new competencies specific to mobile learning environments and career-related digital endeavors by learners. In addition, we further tailored the competences related to device and software operations to both personal computers and mobile devices. The proposed framework in this paper expounds on DigComp and DLGF by adding several competences which are deemed essential for learners in today's digital world. The framework can be used by educational institutes, policymakers, as well as learners to assess their digital skills and devise strategies for capacity building.

**Keywords:** Digital literacy; Digital competence; Digital skill; Framework; Education

**Biographical notes**: Basel Hammoda is a Lecturer and PhD candidate in Entrepreneurship at the Department of Business Administration, Tallinn University of Technology (Taltech) in Estonia. His research focuses on innovative approaches to entrepreneurial learning and its intersection with the wider entrepreneurship and management fields. He has several publications in the field of entrepreneurship, digital technology, and education and is the editor of the Routledge book: "Contemporary Entrepreneurship: Global Perspectives and Cases".

Samuel Foli, a PhD candidate, serves as a Research Associate at the Society for Inclusive and Collaborative Entrepreneurship (S4ICE) in Stuttgart, Germany. He has published in several internationally recognised peer-reviewed journals such as Journal of Knowledge Management, Technology in Society and Management Review Quarterly. His research interests include knowledge (risk) management, business sustainability, supply chain risk management, and statistical/mathematical modelling.

## 1. Introduction

Digital literacy is perceived as a vital element in today's learning environment (Khan et al., 2022; Polizzi, 2020) and a requirement for improved student performance (Tohara et al., 2021). Thus, it became an essential policy agenda for many countries; whether developed or on their path of development (Law et al., 2018; Salas-Pilco, 2013). Digital literacy brings forth enormous benefits not only to individuals but also to the institutions and the society at large. It has the potential to support the development of educational institutions as learning organizations, and provide ground for dialogue, collaboration, and reflection in professional communities of practice (Caena & Redecker, 2019).

The definition of digital literacy remains inconclusive and there are several other terms that are used interchangeably across the literature to indicate the same notion (Falloon, 2020; Park et al., 2020; Stopar & Bartol, 2019), such as '*information literacy*' (Tewell, 2015; Zurkowski 1974), '*computer literacy'* (Epperson, 2010; Tsai & Hebert, 2002), '*internet literacy*' (Bauer & Ahooei, 2018; Harrison & Alvermann, 2018), and 'media literacy' (Christ & Potter 1998; Potter, 2018). For the purpose of this research, we anchor on the definition provided by Law et al. (2018):

> *"Digital literacy is the ability to access, manage, understand, integrate, communicate, evaluate and create information safely and appropriately through digital technologies for employment, decent jobs and entrepreneurship. It includes competences that are variously referred to as computer literacy, ICT literacy, information literacy and media literacy."*

Many scholars share a similar view that digital literacy goes beyond the know-how of digital tools. The ability for an individual to apply his/her skills and competences to comprehend and make meaningful deductions from digital content is also essentially important. The mere fact that digital technology evolves (Hammoda, 2024a; Tang & Chaw, 2016) emphasizes the need to have an up-to-date digital literacy framework that would reflect all available information and new changes that might have transpired over time, especially with the recent massive shift to online education triggered by the COVID-19 pandemic (Hammoda et al., 2023). Although much research has been conducted on areas of digital competence and digital literacy over the past years, there is still a lack of their specific identification within an educational context (Zhao et al., 2021), especially on the learners' side (Khan et al., 2022). Pettersson (2018) also found that most extant research focuses on teachers (e.g., Borthwick & Hansen, 2017; Caena & Redecker, 2019; Falloon, 2020; Savage, 2015; Záhorec et al., 2019).

This paper aims to develop a conceptual digital competence framework specialized for learners, using an integrative literature review methodology. The proposed framework mainly relies in its building blocks on the Digital Competence Framework for Citizens

(DigComp 2.0) by Van den Brande et al. (2016) and UNESCO's 2018 global framework; Digital Literacy Global Framework (DLGF) by Law et al. (2018). The latter initially reviewed frameworks from 47 countries, then directly mapped a selected nine frameworks, including both national and enterprise digital competence frameworks, against DigComp 2.0: The European Digital Competence Framework for Citizens (Van den Brande et al., 2016) as a reference point.

We developed the following questions to guide our research after a preliminary literature review on digital competence frameworks:

***RQ1:*** What is the state of the art with regard to widely recognized digital competence/literacy frameworks?

***RQ2:*** What are the missing competences in those frameworks within a learner/student context in the digital era and how they can be addressed?

The paper is structured as follows. In the next section, we review and analyse extant literature on digital competences and the previous attempts at constructing digital literacy frameworks, with a special focus on the DigComp series of publications by the European Commission and UNESCO's Digital Literacy Global Framework. Then, we present the proposed Digital Competence Framework for Learners (DCFL), which highlights competence areas and individual competences with its descriptions. Afterwards, we discuss the proposed framework and contrast it with the two main frameworks we used as building blocks and benchmarks: DigComp 2.0 and UNESCO's Digital Literacy Global Framework. Lastly, we conclude by explaining the possible implications and opportunities that this framework presents as it helps advance academic discourse in this field, supports the mobilization of digital literacy initiatives within educational contexts, and provides guidance to policymakers. We identify the limitations of this paper, being of a conceptual nature, and set the future direction for research that can build on our work.

## 2. Literature review

### *2.1. Digital competence*

#### *2.1.1. Origin and definitions*

Digital literacy, which is often used interchangeably with digital competence (DC) (Madsen et al., 2018), especially in a European context (Ferrari, 2012; Krumsvik, 2008), was introduced by Gilster (1997). DC is one of the eight key skills for life-long learning identified by the European Union (2006). It refers to the skills and abilities needed by a person to learn and perform in a digitally empowered society (Ilomäki et al., 2016; Jones-Kavalier & Flannigan, 2021) and extends even beyond the technical skills (Bawden, 2008), to include attitudes as well (Janssen et al., 2013).

Discussions about digital literacy/digital competence have reached new heights in recent years (Gallardo-Echenique et al., 2015), and were further accelerated by the COVID-19 pandemic and its huge impact on the education industry (Zhao et al., 2021), as it increased attention to the urgent need for digital skills development in this sector (Iansiti & Richards, 2020).

### *2.1.2. Digital competence in education literature*

Although much research has been conducted on areas of digital competence and digital literacy over the past years, there is still a lack of their specific identification within an educational context (Zhao et al., 2021), especially on the learners' side, with most literature focusing on teachers (Pettersson, 2018). Since the DigComp 2.0 publication (Van den Brande et al., 2016), there have been scarce attempts to build on it by devising a digital literacy framework for students/ learners (e.g., Kampylis et al., 2017; Guitert et al., 2021). Most studies discussing the digital competences of students dealt with a certain level of education only (e.g., Aesaert et al., 2015; Generalitat de Catalunya, 2017); preceded the DigComp era (e.g., Calvani et al., 2008; Norwegian Directorate for Education and Training, 2012; Welsh Government, 2008); were mainly of empirical nature (e.g., Guzmán-Simón et al., 2017; Shariman et al., 2012) which mostly relied on questionnaires (Zhao et al., 2021); reviewed extant literature (e.g., Nowak, 2019; Zhao et al., 2021); or discussed it as a subset of digital competences in teachers (e.g., Caena & Redecker, 2019; Guillén-Gámez & Mayorga-Fernández, 2020; Svensson & Baelo, 2015). Thus, research needs to focus on producing more frameworks that address current gaps (Zhao et al., 2021), and propose new approaches for assessing and enhancing digital competence in educational contexts in general (Pettersson, 2018), and students in specific.

### *2.1.3. Digital competence in education institutes*

Digital transformation has changed and complicated education institutes (EI) operations (Hatlevik & Christophersen, 2013; Murawski & Bick, 2017; Zaphiris & Ioannou, 2018), with many EI modifying pedagogies and methods to adapt to the new digital reality (Hammoda, 2023, 2024b). Although students are regarded as digital natives, a significant number only have a basic digital skills level (Bennett et al., 2008; Cabezas González & Casillas Martín, 2017; Petit et al., 2024; Zhao et al., 2021). Thus, there is an increasing urgency to improve the digital skills of learners (Bond et al., 2018), in order to graduate digitally knowledgeable citizens to engage in society (Aesaert et al., 2013; Somerville et al., 2007) and perform in the technology intense workplaces of the future (Ancarani & Di Mauro, 2018; Janssen et al., 2013). Moreover, recent use cases have emerged that necessitate advancing students' digital skills beyond basic knowledge. For example, students and their future selves as workers are faced with situations where they must deal with cyber threats and identity theft, which requires advanced technical and non-technical skills and knowledge (Falloon, 2020; Formosa et al., 2021; Palermiti et al., 2017), which was highlighted under competence area 4: Safety 4.1 Protecting devices in DigComp 2.1 (Carretero et al., 2017). They are also expected to manage their digital profiles prudently and apply circumspect judgment on online information utilisation and dissemination (Labrecque et al., 2011; Van Dijck, 2013).

In response, education institutes are asked to develop both teachers' and students' digital competences (Zhao et al., 2021). However, it is argued that single actors need to take control of improving their own digital skills as well (Pettersson, 2018). There are several individual factors that were found to affect digital competence among students which need to be considered by the different EI and actors such as gender, with men found to have a higher perception of their abilities (García-Peñalvo et al., 2021), and readiness and previous digital work experience or training (Kim et al., 2019; Romero-Tena et al., 2020).

### *2.1.4. Digital competence importance*

Digital competence has become essential for people worldwide (Castells, 2010) and it is closely connected to sustainable development (Poore, 2011; Pradhan et al., 2014; Sharma & Mokhtar, 2006), as it enables the participation of different stakeholders in society to leverage knowledge for economic progress (Hilbert, 2011; Poore, 2011). It also has a key role in improving people's ability to leverage available information, collaborate and interact with others and participate in public life (Gallardo-Echenique et al., 2015; Zhong, 2011). In addition, most organizations these days require a decent level of digital skills (Ancarani & Di Mauro, 2018; Gallardo-Echenique et al., 2015).

Most importantly though, multiple studies have shown a clear positive association between university students' digital competence and their performance, academic engagement, involvement in student activities and collaboration on project and group-based assignments (He & Li, 2019; He & Zhu, 2017; He et al., 2018; Kim et al., 2019).

## *2.2. Digital competence frameworks relevant to the learner/student context*

In this part, we review and analyze the six main digital competence frameworks that are included in our integrative review. Table 1 compares these frameworks based on the competence areas, number of competences, target audience, year of publication, affiliated organizations and geographical coverage.

### *2.2.1. tDigComp 2.0*

Van den Brande et al. (2016) drafted the Digital Competence Framework for Citizens (DigComp 2.0) based on the prior framework (DigComp 1.0), that was originally proposed by Petit et al. in 2024. Although the motivation to 'improve citizens' digital competence, to help policymakers formulate policies that support digital competence building, and to plan education and training initiatives to improve the digital competence of specific target groups (Petit et al., 2024), that fueled the buildup of the previous framework was not annulled in that of DigComp 2.0 development. However, DigComp 2.0 intended to advance it by contextualizing and incorporating the concept of digitalization which over the last decade has been regarded as an innovative tool for sustainable economic growth (Myovella et al., 2020). To develop DigComp 2.0, Van den Brande et al. (2016) engaged multiple stakeholders of high expertise, such as national authorities, relevant interest groups, and others.

The architecture of DigComp 2.0 shows two phases; one of the phases depicts the conceptual reference model located at the inner core of the structure, while the other phase is the covering layer called the real framework. It is also noted that there are two dimensions for each phase: Phase 1 represents the competence areas and the competences; Phase 2 accommodates all three proficiency levels, and the description of the knowledge, skills and attitudes pertaining to each competence. It should be noted that despite DigComp 2.0's contributions, its limited and narrow proficiency levels are a major setback (Carretero et al., 2017).

**Table 1**
Comparison of digital competence frameworks relevant to the learner/student context

| | DigComp 2.0 | DLGF | DigCompEDU | DigComp 2.1 | DCFS | COBADI ® |
|---|---|---|---|---|---|---|
| Competence areas | | | | | | |
| Information and data literacy | ✓ | ✓ | | ✓ | ✓ | ✓ |
| Communication and collaboration | ✓ | ✓ | | ✓ | ✓ | ✓ |
| Digital content creation | ✓ | ✓ | | ✓ | ✓ | ✓ |
| Safety | ✓ | ✓ | | ✓ | | |
| Problem-solving | ✓ | ✓ | | ✓ | ✓ | |
| Professional engagement | | | ✓ | | | |
| Digital resources | | | ✓ | | | |
| Teaching and learning | | | ✓ | | | |
| Assessment | | | ✓ | | | |
| Empowering learners | | | ✓ | | | |
| Facilitating learners' digital competence | | | ✓ | | | |
| Devices and software operations | | ✓ | | | | |
| Career-related competences | | ✓ | | | | |
| Digital citizenship | | | | | ✓ | |
| Number of competence areas | 5 | 7 | 6 | 5 | 5 | 3 |
| Number of individual competences | 21 | 26 | 22 | 21 | 12 | 22 |
| Intended audience/use cases | All citizens | All citizens; focus on youth. | School and university students; CPD; teacher-centric | All citizens; employment and learning use cases provided | School students (10y – 16y) | University students |
| Year published | 2016 | 2018 | 2017 | 2017 | 2020 | 2020 |
| Affiliated organization | European Commission | UNESCO | European Commission | European Commission | Higher educational institute | Higher educational institutes |
| Geographical merit | Europe | Global | Europe | Europe | Europe | Europe |

*Note.* Compiled by authors based on their analysis of Carretero et al. (2017), Guitert et al. (2021), Law et al. (2018), López-Meneses et al. (2020), Redecker (2017), and Van den Brande et al. (2016)

### *2.2.2. DLGF (UNESCO's digital literacy global framework)*

Law et al. (2018) produced a similar framework called the Digital Literacy Global Framework (DLGF), where they synthesized 47 frameworks from several geographical regions including Asia, the European Union, high-income countries outside the European Union, Latin America, the Middle East and North Africa, and Sub-Saharan Africa. In conjunction, they reviewed enterprise frameworks mainly from the ICT industry. Aside from that, they supported the results obtained from the mapping stage, with concrete data gathered through experts' consultations and deliberations while using DigComp 2.0 as a reference point. DLGF primarily aims at enhancing digital literacy among all citizens, with much focus on youth. In addition, it serves as a bedrock for the Sustainable Development Goal (SDGs) 4.4 and 8.6, which stress on the provision of digital literacy skills for the youth to help promote employment, education and training (United Nations, n.d.).

With reference to the DLGF, 7 competence areas were developed against the 5 and 6 competence areas of DigComp 2.0 and DigComp 2.1 respectively. DLGF extended

DigComp 2.0 by adding two additional competence areas. The first addition is the competence area "*0. Devices and software operations*", which identifies the necessary skills needed to operate digital hardware, tools, applications and information needed to use digital devices and related software. It has two further individual competences: "*0.1 Physical operations of digital devices*" and "*0.2 Software operations in digital devices*". The second additional competence area that DLGF introduced is "*6. Career-related competences*", which covers relevant digital skills pertinent to each professional specialization or industry; those that are considered necessary to work and advance your career in a certain field. This competence area also provided two additional individual competences: "*6.1 Operating specialized digital technologies for a particular field*" and "*6.2 Interpreting and manipulating data, information and digital content for a particular field*". In addition, UNESCO's DLGF introduced a fifth individual competence under competence area "*5. Problem-solving*", which is "*5.5 Computational thinking*" provided the following description for it: "*To process a computable problem into sequential and logical steps as a solution for human and computer systems*".

Competence areas "*1. Information and data literacy*", "*2. Communication and collaboration*", "*3. Digital content creation*", "*4. Safety*", and most of competence area "*5. Problem-solving*" remained the same as listed on DigComp 2.0 without the introduction of additional individual competences (except for competence area "*5. Problem-solving*") or making any changes to the descriptions provided against the main competence areas or the individual competences (Law et al., 2018).

### *2.2.3. DigCompEDU*

The project, carried out by Redecker (2017), developed the European Framework for the Digital Competence of Educators (DigCompEdu) which was primarily designed for educational institutes to support teachers' practices and continuous professional development (CPD). The objective of DigCompEdu is to provide a digital pedagogical competence framework for teachers which would have a ripple effect on the quality of both online and on-site teaching-learning experiences. Apart from its emphasis on teachers, it also intends to support the growth and development of learning organizations in EU countries. DigCompEdu leveraged extended consultations with experts and practitioners, coupled with thorough analysis and synthesis of existing frameworks gathered from sub-national, national, and international levels.

The structure of the DigCompEdu framework consists of three overall areas: "*Educators' professional competences*", "*Educators' pedagogic competences*", and "*Learners' competences*". These 3 main areas cover six distinctive sub-areas commonly referred to as competence areas: "*Professional engagement*", "*Digital resources*", "*Teaching and learning*", "*Assessment*", "*Empowering learners*", and "*Facilitating learners' digital competence*". It is observed from the framework that each of the aforementioned competence areas is assessed using a 6-pointer proficiency level drawn from the Common European Framework of Reference for Languages (CEFR) (Redecker, 2017). A major drawback of the DigCompEdu framework though, is that it is generally recognized to be more teacher-centric, with little emphasis on the learner.

### *2.2.4. DigComp 2.1*

Notwithstanding the efforts made earlier to continuously update and improve digital competence frameworks, they still faced a challenge with the development of learning and teaching materials in more complex ecosystems. In response to the shortcomings of DigComp 1.0 and DigComp 2.0, Carretero et al. (2017) extended DigComp 2.0 by proposing an additional layer covering the applicability of competences to different purposes; employment and learning to be specific. They also added 5 extra proficiency levels, to sum up to 8 in total. The framework was then called DigComp 2.1. The developmental phases of DigComp 2.1 were also supported by a series of stakeholders' consultations with the objective of expanding it and making it more comprehensive. It is however recommended as a suitable benchmark for institutes to improvise on when assessing competences of citizens for the purposes of job promotion or career guidance.

### *2.2.5. Digital competence framework for students (DCFS)*

Guitert et al. (2021) noticed the scarcity of frameworks developed for primary and secondary school students. Hence, they devised the Digital Competence Framework for Students (DCFS) for 10-16-year-olds, based primarily on DigComp 2.0, while reviewing other frameworks from seven European countries and inputs from 100+ teachers and experts. They identified five main competence areas: "*Citizenship*", "*Communication and collaboration*", "*Information seeking and management*", "*Content creation*", and "*Problem solving*". They then assigned 12 sub competences and 35 performance (assessment) criteria among them. A major limitation of DCFS's broader application in educational settings is that it focuses on secondary school students only, which makes its ability to address the needs and competencies of tertiary students questionable.

### *2.2.6. University students' basic digital competences 2.0 (COBADI®)*

López-Meneses et al. (2020) designed the COBADI® (University Students' Basic Digital Competences 2.0) framework/ questionnaire, which they tested among students of three European universities. They relied on the first three competence areas in DigComp 2.1 in developing it. COBADI® included three competence areas (blocks) with 22 items underneath them as follows: 1) individual competence to use technology tools (10 items); 2) digital competence in searching for, and treatment of information (8 items); and 3) ICT use as a virtual and social communication tool in the university context (4 items). Although the results of the assessment showed a crucial need to develop digital skills among university students to improve their professional and academic performance through better utilization of available digital tools, the framework was based only on a quantitative study without qualitative inputs or adequate literature review.

In conclusion, the aforementioned frameworks have not spared effort in identifying competencies needed for individuals to comprehend and utilize digital tools and artefacts across a multitude of daily settings. DigComp 2.0 is intended as a seminal framework that other scholars and policymakers can use to build on more specific utility frameworks. DLGF advanced DigComp 2.0 by adding two main competence areas. One is related to the usage of digital devices which are shaping human-machine interaction, and the other is career-oriented as a practical application of the developed digital skills. DigComp 2.1 and DigComp Edu built on DigComp 2.0 by adding specific proficiency/assessment levels for employability and learning and providing a more nuanced educator digital competence

archetype respectively. DCFS while using DigComp 2.0 as a starting point, reconfigured it to suit the 10-16-year-old students' levels with COBADI developing an assessment model for the university students' digital skills, using part of the DigComp 2.1 framework.

## 3. Method

We followed an integrative review methodology (Torraco, 2016) to inspect extant literature and critique existing digital competence/ literacy frameworks. This was coupled with the author's own views. As Snyder (2019) states: "*A literature review is an excellent way of synthesizing research findings to show evidence on a meta-level and to uncover areas in which more research is needed, which is a critical component of creating theoretical frameworks and building conceptual models.*"

Although integrative reviews are not as well organized as other types of literature reviews as there are no set criteria to follow (Torraco, 2005), if done properly they can add remarkable value to both academia and practice by introducing new conceptual frameworks (MacInnis, 2011). Integrative reviews are forward-looking in nature focusing on advancing existing models and theories rather than simply reviewing and discussing previous literature. Hence, they are deemed suitable for the purpose of this paper.

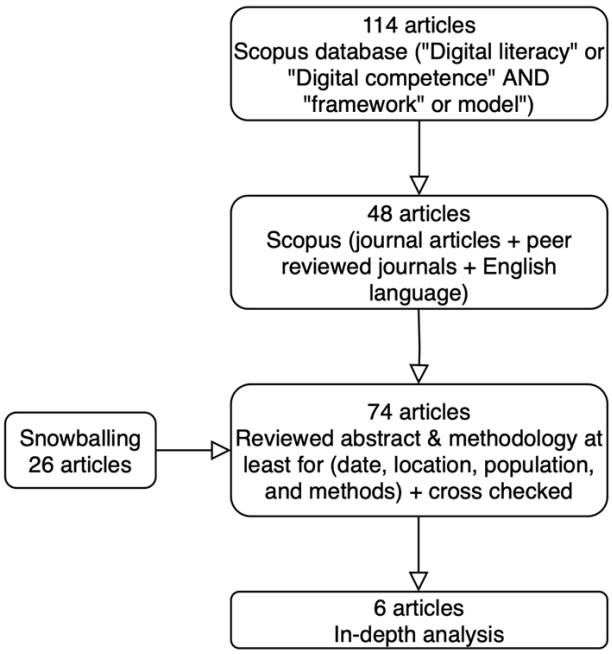



**Fig. 1.** Literature review steps

As shown in Fig. 1, we searched for relevant literature on the Scopus database as it has the largest selection of academic journals (Thelwall, 2018; Waltman, 2016). We used a combination of keywords "*digital competence*" or "*digital literacy*" and "*framework*" or "*model*" to search in the title and abstract. The first hit generated 114 articles, which were initially filtered to 48 articles by keeping only journal articles that were written in the English language and published in peer-reviewed journals. The authors had prior

knowledge of the DigComp series and DLGF frameworks. Thus, we used a snowballing method as well to find relevant articles cited in them, that were not included in our database search results. A total of 26 articles were identified by the snowballing method and added to the list, to make it into 74 articles. For all 74 articles, we went through the abstracts and the methodology sections, at least, to exclude non-relevant papers. The inclusion criteria were empirical papers, incorporated Delphi expert methodology (Linstone & Turoff, 1975), developed a framework, published after DigComp and of a global or regional merit. Four articles remained after applying our selection criteria: Carretero et al. (2017); Guitert et al. (2021); López-Meneses et al. (2020); and Redecker (2017). They were added to DigComp 2.0 (Van den Brande et al., 2016) and DLGF (Law et al., 2018). The six articles and the frameworks included within each were investigated in depth, mainly focusing on the context, competence areas, individual competences, descriptions, use cases, applications and limitations.

## 4. Digital competence framework for learners (DCFL)

In Table 2, we present the proposed digital competence framework for learners (DCFL), based on the analysis and synthesis of reviewed frameworks and the author's own views. The framework includes main competence areas with subsequent individual competences and the description of each. The parts that have been adjusted, synthesized or developed for the specific purpose of this framework are highlighted.

**Table 2**
The proposed competence areas, competences and their descriptions for the Digital Competence Framework for Learners (DCFL)

| Competence areas and competences | Origin | Description |
|---|---|---|
| 0. Devices and software operations | | • To identify and use hardware tools and technologies.<br>• To identify data, information and digital content needed to operate software tools and technologies. |
| 0.1 Physical operations of PCs and Laptops<br>0.2 Software operations in PCs and Laptops | Adjusted from DLGF and supported by literature (e.g., Cooper, 2007; Grimes & Warschauer, 2008; Moos & Azevedo, 2009; Nusir et al., 2013) | • To identify and use the functions and features of PC and laptop tools and technologies.<br>• To know and understand the data, information and/or digital content that are needed to operate software tools and technologies. |
| 0.3 Physical operations of mobile devices<br>0.4 Software operations in mobile devices | Adjusted from DLGF and derived from the literature (e.g., Drigas et al., 2015; European Commission, 2020; Gikas & Grant, 2013; Martin & Martin, 2015; Woodcock et al., 2012) | • To identify and use the functions and features of mobile tools and technologies.<br>• To know and understand the data, information and/or digital content that are needed to operate software tools and technologies. |
| 1. Information and data literacy | | • To articulate information needs, to locate and retrieve digital data, information and content.<br>• To judge the relevance of the source and its content.<br>• To store, manage and organize digital data, information and content. |
| 1.1 Browsing, searching and filtering data, information and digital content | DigComp 2.0 | • To articulate information needs, to search for data, information and content in digital environments, to access them and to navigate between them.<br>• To create and update personal search strategies. |
| 1.2 Evaluating data, information and digital content | DigComp 2.0 | • To analyze, compare and critically evaluate the credibility and reliability of sources of data, information and digital content. |

| | | |
|---|---|---|
| | | • To analyze, interpret and critically evaluate the data, information and digital content. |
| 1.3 Managing data, information and digital content | DigComp 2.0 | • To organize, store and retrieve data, information and content in digital environments.<br>• To organize and process them in a structured environment. |
| 2. Communication and collaboration | | • To interact, communicate and collaborate through digital technologies while being aware of cultural and generational diversity.<br>• To participate in society through public and private digital services and participatory citizenship.<br>• To manage one's digital identity and reputation. |
| 2.1 Interacting through digital technologies | DigComp 2.0 | • To interact through a variety of digital technologies and to understand appropriate digital communication means for a given context. |
| 2.2 Sharing through digital technologies | DigComp 2.0 | • To share data, information and digital content with others through appropriate digital technologies.<br>• To act as an intermediary, to know about referencing and attribution practices. |
| 2.3 Engaging in citizenship through digital technologies | DigComp 2.0 | • To participate in society through the use of public and private digital services.<br>• To seek opportunities for self-empowerment and for participatory citizenship through appropriate digital technologies. |
| 2.4 Collaborating through digital technologies | DigComp 2.0 | • To use digital tools and technologies for collaborative processes and co-construction and co-creation of resources and knowledge. |
| 2.5 Netiquette | DigComp 2.0 | • To be aware of behavioral norms and know-how while using digital technologies and interacting in digital environments.<br>• To adapt communication strategies to the specific audience and to be aware of cultural and generational diversity in digital environments. |
| 2.6 Managing digital identity | DigComp 2.0 | • To create and manage one or multiple digital identities, to be able to protect one's own reputation, and to deal with the data that one produces through several digital tools, environments and services. |
| 3. Digital content creation | | • To create and edit digital content.<br>• To improve and integrate information and content into an existing body of knowledge while understanding how copyright and licenses are to be applied.<br>• To know how to give understandable instructions for a computer system. |
| 3.1 Developing digital content | DigComp 2.0 | • To create and edit digital content in different formats, to express oneself through digital means. |
| 3.2 Integrating and re-elaborating digital content | DigComp 2.0 | • To modify, refine, improve and integrate information and content into an existing body of knowledge to create new, original and relevant content and knowledge. |
| 3.3 Copyright and licenses | DigComp 2.0 | • To understand how copyright and licenses apply to data, information and digital content. |
| 3.4 Programming | DigComp 2.0 | • To plan and develop a sequence of understandable instructions for a computing system to solve a given problem or perform a specific task. |
| 4. Safety | | • To protect devices, content, personal data and privacy in digital environments. To protect physical and psychological health, and |

| | | |
|---|---|---|
| | | to be aware of digital technologies for social well-being and social inclusion.<br>• To be aware of the environmental impact of digital technologies and their use. |
| 4.1 Protecting devices | DigComp 2.0 | • To protect devices and digital content, and to understand risks and threats in digital environments.<br>• To know about safety and security measures and to have due regard to reliability and privacy. |
| 4.2 Protecting personal data and privacy | DigComp 2.0 | • To protect personal data and privacy in digital environments.<br>• To understand how to use and share personally identifiable information while being able to protect oneself and others from damage.<br>• To understand that digital services use a "*Privacy policy*" to inform how personal data is used. |
| 4.3 Protecting health and well-being | DigComp 2.0 | • To be able to avoid health risks and threats to physical and psychological well-being while using digital technologies.<br>• To be able to protect oneself and others from possible dangers in digital environments (e.g., cyberbullying).<br>• To be aware of digital technologies for social well-being and social inclusion. |
| 4.4 Protecting the environment | DigComp 2.0 | • To be aware of the environmental impact of digital technologies and their use. |
| 5. Problem-solving | | • To identify needs and problems and to resolve conceptual problems and problem situations in digital environments.<br>• To use digital tools to innovate processes and products.<br>• To keep up to date with the digital evolution. |
| 5.1 Solving technical problems | DigComp 2.0 | • To identify technical problems when operating devices and using digital environments, and to solve them (from troubleshooting to solving more complex problems). |
| 5.2 Identifying needs and technological responses | DigComp 2.0 | • To assess needs and to identify, evaluate, select and use digital tools and possible technological responses to solve them.<br>• To adjust and customize digital environments to personal needs (e.g., accessibility). |
| 5.3 Creatively using digital technologies | DigComp 2.0 | • To use digital tools and technologies to create knowledge and to innovate processes and products.<br>• To engage individually and collectively in cognitive processing to understand and resolve conceptual problems and problem situations in digital environments. |
| 5.4 Identifying digital competence gaps | DigComp 2.0 | • To understand where one's own digital competence needs to be improved or updated.<br>• To be able to support others with their digital competence development.<br>• To seek opportunities for self-development and to keep up to date with the digital evolution. |
| 5.5 Computational thinking | DLGF | • To process a computable problem into sequential and logical steps as a solution for human and computer systems. |
| 6. Career-related competences | | • To operate specialized digital technologies and to understand, analyze and evaluate specialised data, information and digital content for a particular field. |
| 6.1 Operating specialized digital technologies for a particular field | DLGF | • To identify and use specialized digital tools and technologies for a particular field. |
| 6.2 Interpreting and manipulating data, information and digital content for a particular field | DLGF | • To understand, analyze and evaluate specialised data, information and digital content for a particular field within a digital environment. |

| | | |
|---|---|---|
| 6.3 Creating and editing career-related profiles | Derived from literature (e.g., Florenthal, 2015; Hinchliffe & Jolly, 2011; Jackson, 2017; Van Dijck, 2013). | • To understand the components of a curriculum vitae and how to present skills, knowledge and experience in a professional, concise and easy-to-understand way. |
| 6.4 Browsing, searching, filtering and evaluating career opportunities | Synthesized from DigComp 2.1 - Competency 1.1: Example of use 01: Employment Scenario: Job Seeking Process | • To identify and use career-related portals, advertising jobs and projects in for a particular field |

## 5. Discussion

The digital revolution has transformed the way people access information and learn (Caena & Redecker, 2019; Ogbodoakum et al., 2022), especially young people who are more connected than ever (Schleicher, 2019). However, this was not matched by enough endeavors from researchers to devise a digital literacy framework specifically targeted at learners, even after the release of the EU-wide DigComp 2.0 framework in recent years (Van den Brande et al., 2016). The framework proposed through this study addresses this gap and draws inspiration from DigComp 2.1, an evolved version of DigComp 2.0 (Carretero et al., 2017), and the Digital Literacy Global Framework (DLGF). This developed framework, titled Digital Competence Framework for Learners (DCFL) (see Table 2 above), not only presents an upgraded framework but also presents a tailor-made framework specifically designed for learners.

The proposed Digital Competence Framework for Learners (DCFL) maintains all the fundamental competence areas outlined in the DLGF (Law et al., 2018). Nevertheless, a more detailed examination of the competencies within each core area of our framework reveals specific modifications. Notably, within the "*Devices and software operations*" competence area, four competences have been adjusted. These include physical operations of PCs and laptops, software operations in PCs and laptops, physical operations of mobile devices, and software operations in mobile devices. Unlike the DLGF, which covers digital devices in general (Law et al., 2018), our framework focuses exclusively on PCs, laptops, and mobile devices.

The use of computers and laptops offers numerous advantages to learners (Cooper, 2007; Grimes & Warschauer, 2008; Moos & Azevedo, 2009). One notable advantage is the development of competences in navigating the web, which allows students to access online libraries, research papers, educational websites, and digital resources (Shopova, 2014; Ukwoma et al., 2016). This access to a vast amount of information greatly facilitates self-directed learning, empowers students to gather relevant data, and improves their understanding of various subjects (Bayrak, 2022; Rana et al., 2016; Zhu et al., 2020). In addition to accessing information, laptops and PCs can also enable students to engage in collaborative activities and communication with peers, teachers, and experts globally (Caballé et al., 2010). Online platforms like collaborative document editors and video conferencing tools serve as valuable resources for group projects, discussions, and knowledge-sharing (Kumaraswamy & Chitale, 2012). The development of competences in online collaboration and communication not only enhances students' teamwork skills but also broadens their perspectives through meaningful interactions. Furthermore, the availability of various software applications on PCs and laptops allows students to create multimedia presentations, design graphics, produce videos, and develop interactive projects (Nusir et al., 2013). These competences foster innovative thinking and also enable

students to effectively showcase their knowledge and express themselves, ultimately enhancing their overall learning experience.

In a similar manner, the acquisition of skills and competences in using mobile devices is crucial for learners. As mobile devices are becoming increasingly powerful and technologically sophisticated (Aazam et al., 2021), learning with them requires that learners acquire a certain level of competency in utilizing these devices (Lim et al., 2019). In fact, the European Commission (2020) emphasizes the importance of acquiring skills in social media and mobile use as part of the Digital Competence and New Skills Agenda. One of the primary advantages of mobile devices is their portability, enabling students to access information anytime and anywhere (Chen et al., 2008). This accessibility empowers students to engage in autonomous learning, expand their knowledge beyond the boundaries of the classroom, and stay up to date with current information relevant to their studies. Additionally, mobile devices, particularly smartphones, provide students with a rich multimedia learning environment (Drigas et al., 2015). Equipped with built-in cameras, audio recorders, and video capabilities, smartphones offer opportunities for students to engage in hands-on learning experiences (Martin & Martin, 2015). By developing competences in capturing images, recording audio, and shooting videos, students can document experiments, create visual presentations, and capture real-world examples that support their learning. This interactive and engaging approach enhances their comprehension and retention of knowledge. Furthermore, smartphones provide a wide range of educational resources and applications that cater to a variety of learning styles and subjects (Woodcock et al., 2012). Students will be able to access interactive tutorials, digital textbooks, language learning tools, and academic resources tailored to meet their specific needs by developing competences in identifying and utilizing educational apps. These applications provide personalized learning experiences, reinforce concepts, and offer opportunities for practice and self-assessment.

Employability competences were separately highlighted in DLGF in comparison to DigComp 2.0 through the addition of a separate competence area "*Career-related competences*" (Law et al., 2018). We find this competence is very important to the end goal of digital literacy capacity-building programs among learners, i.e., improving their job market readiness and employability potential (Ancarani & Di Mauro, 2018; Gallardo-Echenique et al., 2015; Khan et al., 2022). As an extension of this competence area, we introduced two additional individual competencies. The first aspect is "*Creating and editing career-related profiles*," which focuses on understanding the components of a curriculum vitae (CV) and effectively presenting skills, knowledge, and experience in a professional and concise manner, including in online environments and professional communities (Florenthal, 2015; Van Dijck, 2013). Students can also present themselves in a manner that aligns with professional expectations and industry standards by carefully curating their profiles in terms of language, tone, and formatting (Hinchliffe & Jolly, 2011; Jackson, 2017). Furthermore, regularly updating and adapting their profiles to reflect new skills, certifications, or experiences showcases their ability to learn and adapt to changing workplace dynamics, demonstrating their employability.

The second aspect is "*Browsing, searching, filtering, and evaluating career opportunities*," which highlights the ability to identify and utilize career-related portals that advertise jobs and projects specific to a particular field. This competence aims at developing an essential skill that career-seeking graduates need to master and thus complements the existing employability competences described in the DLGF, namely "*Operating specialized digital technologies for a particular field*" and "*Interpreting and*

*manipulating data, information, and digital content for a particular field*", forming a comprehensive set of skill package that would allow them to find and excel in their chosen career paths. Through job portals, career websites, professional networking platforms, and industry-specific resources, students can explore a wide range of options. This exposure helps students understand the demands of the job market, and gain insights into the skills and qualifications sought by employers (Ala-Mutka, 2011; Jackson & Wilton, 2016). By actively engaging in professional communities, joining relevant groups, and connecting with industry professionals, students can leverage the power of networking and ultimately enhance their employability (Florenthal, 2015; Van Dijck, 2013).

### *5.1. Implications*

This framework is among the few available frameworks discussing digital literacy within a learner context, and as the first to utilize inputs from both DigComp 2.0 (Van den Brande et al., 2016) and UNESCO's Digital Literacy Global Framework (DLGF) (Law et al., 2018) and build on them. The proposed framework presents opportunities for advancing academic research in the field of digital competences/digital literacy and their mobilization, as an area that begs further scholarly attention (Falloon, 2020; Madsen et al., 2018). It adds a comprehensive and updated model that caters for the changes induced by COVID-19 (Zhao et al., 2021), to the short list of digital competence frameworks targeted at learners (Pettersson, 2018).

On national and regional levels, it can be used as a guide to policymakers and regulators in areas of education, employment, and industry. It can contribute to defining policies and standards for learners' digital competence assessment and development, whether through the educational institute or by themselves (Caena & Redecker, 2019), as it has become evident that user buy-in and engagement are essential for the success of digital literacy programs (Kampylis et al., 2017). From an economic development angle, having digitally skilled graduates is becoming a critical success factor of today's technology-reliant businesses and organizations (Ancarani & Di Mauro, 2018; Janssen et al., 2013). Educational institutes have recently started recognizing this urgent need (Bond et al., 2018) and are prioritizing the development of digital skills among their students (Aesaert et al., 2013; Somerville et al., 2007), in order to graduate digitally capable manpower. Thus, this framework supports and contributes towards digital literacy development initiatives at education institutes and within life-long learning environments, which can enhance the innovation ability (Caena & Redecker, 2019) of societies' future workforce and entrepreneurs.

### *5.2. Limitations*

To develop the proposed framework, we conducted a thorough literature review of digital competence/literacy frameworks, including but not limited to the DigComp series of frameworks and UNESCO's Digital Literacy Global Framework. However, we understand that the reviewed literature is non-exhaustive as there is potentially an infinite number of digital competence frameworks, whether in published literature where we searched or those published by governments and industry in non-academic portals. Our proposed framework is a conceptual one, based primarily on synthesizing and integrating the reviewed literature with additional modifications and inputs supported by the literature. It will need to be further refined and validated through experts' feedback and learners' surveys, which we

intend to perform as the next step. In addition, variations in technology implementation across educational institutes and other organizations, imply that the proposed digital competence framework for learners (DCFL) will need to be tailored to match its intended purpose of use in different settings.

### *5.3. Future research*

Building on this conceptual paper, further work needs to be done to improve and validate the proposed framework by following an iterative process of expert and stakeholders' consultations with item revision (Janssen et al., 2013). We intend to request and draft elaborations on examples of use for each competence as these are deemed beneficial for bringing the topic to life and improving its comprehension and application by the learner and educator (Brown, 1982; Carretero et al., 2017). We plan to include lecturers, recruiters, digital transformation experts, educational consultants, instructional designers and student representatives in our consultations. In addition, an assessment matrix for each of the seven competence areas needs to be developed that can be readily applied and utilized by the different stakeholders (Littlejohn et al., 2012): learners, educational institutions, industry and policy planners.

## 6. Conclusion

This study followed an integrative approach to reviewing digital literacy frameworks to advance our understanding of this increasingly important field of study and to propose an updated framework that is specifically relevant to new generations of learners who are naturally digitally savvy (Schleicher, 2019). We started our search with 114 articles on Scopus and ended up reviewing 6 articles (frameworks) in depth. The resultant proposed framework builds mainly on DigComp 2.0 (Van den Brande et al., 2016) and DLGF (Law et al., 2018) and adds to 170 competences that we argue are relevant to the modern learning and professional environments. These competences address specifically the usage of mobile devices and software, including cloud-based computing, which became the main interface for machine-human interaction, in addition to competences related to managing their profiles in digital environments and searching for jobs using online portals.

## Author Statement

The authors declare that there is no conflict of interest.

## ORCID

*Basel Hammoda* https://orcid.org/0000-0001-7595-4835

*Samuel Foli* https://orcid.org/0000-0003-2938-7344

## References

Aazam, M., Zeadally, S., & Flushing, E. F. (2021). Task offloading in edge computing for machine learning-based smart healthcare. *Computer Networks, 191*: 108019.

https://doi.org/10.1016/j.comnet.2021.108019
Aesaert, K., Van Braak, J., Van Nijlen, D., & Vanderlinde, R. (2015). Primary school pupils' ICT competences: Extensive model and scale development. *Computers & Education, 81*, 326–344. https://doi.org/10.1016/j.compedu.2014.10.021
Aesaert, K., Vanderlinde, R., Tondeur, J., & Van Braak, J. (2013). The content of educational technology curricula: A cross-curricular state of the art. *Educational Technology Research and Development, 61*(1), 131–151. https://doi.org/10.1007/s11423-012-9279-9
Ala-Mutka, K. (2011). *Mapping digital competence: Towards a conceptual understanding*. Institute for Prospective Technological Studies, Joint Research Centre, European Commission. Retrieved from https://www.academia.edu/42521335/Mapping_Digital_Competence_Towards_a_Conceptual_Understanding
Ancarani, A., & Di Mauro, C. (2018). Successful digital transformations need a focus on the individual. In F. Schupp & H. Wöhner (Eds.), *Digitalisierung im Einkauf* (pp. 11–26). Springer.
Bauer, A. T., & Ahooei, E. M. (2018). Rearticulating internet literacy. *Journal of Cyberspace Studies, 2*(1), 29–53. https://doi.org/10.22059/jcss.2018.245833.1012
Bawden, D. (2008). Origins and concepts of digital literacy. In C. Lankshear & M. Knobel (Eds.), *Digital Literacies: Concepts, Policies and Practices* (pp. 17–32). Peter Lang.
Bayrak, F. (2022). Associations between university students' online learning preferences, readiness, and satisfaction. *Knowledge Management & E-Learning, 14*(2), 186–201. https://doi.org/10.34105/j.kmel.2022.14.011
Bennett, S., Maton, K., & Kervin, L. (2008). The 'digital natives' debate: A critical review of the evidence. *British Journal of Educational Technology, 39*(5), 775–786. https://doi.org/10.1111/j.1467-8535.2007.00793.x
Bond, M., Marín, V. I., Dolch, C., Bedenlier, S., & Zawacki-Richter, O. (2018). Digital transformation in German higher education: student and teacher perceptions and usage of digital media. *International Journal of Educational Technology in Higher Education, 15*: 48. https://doi.org/10.1186/s41239-018-0130-1
Borthwick, A. C., & Hansen, R. (2017). Digital literacy in teacher education: Are teacher educators competent? *Journal of Digital Learning in Teacher Education, 33*(2), 46–48. https://doi.org/10.1080/21532974.2017.1291249
Brown, D. E. (1992). Using examples and analogies to remediate misconceptions in physics: Factors influencing conceptual change. *Journal of Research in Science Teaching, 29*(1), 17–34. https://doi.org/10.1002/tea.3660290104
Caballé, S., Xhafa, F., & Barolli, L. (2010). Using mobile devices to support online collaborative learning. *Mobile Information Systems, 6*(1), 27–47. https://doi.org/10.1155/2010/935169
Cabezas González, M., & Casillas Martín, S. (2017). ¿Son los futuros educadores sociales residentes digitales? *Revista Electrónica de Investigación Educativa, 19*(4), 61–72. https://doi.org/10.24320/redie.2017.19.4.1369
Caena, F., & Redecker, C. (2019). Aligning teacher competence frameworks to 21st century challenges: The case for the European Digital Competence Framework for Educators (DIGCOMPEDU). *European Journal of Education, 54*(3), 356–369. https://doi.org/10.1111/ejed.12345
Calvani, A., Cartelli, A., Fini, A., & Ranieri, M. (2008). Models and instruments for assessing digital competence at school. *Journal of E-learning and Knowledge Society, 4*(3), 183–193.

Carretero, S., Vuorikari, R., & Punie, Y. (2017). *DigComp 2.1: The digital competence framework for citizens with eight proficiency levels and examples of use*. Joint Research Centre (European Commission). Retrieved from https://data.europa.eu/doi/10.2760/38842

Castells, M. (2010). *The rise of the network society* (2nd ed.). Wiley-Blackwell.

Chen, G. D., Chang, C. K., & Wang, C. Y. (2008). Ubiquitous learning website: Scaffold learners by mobile devices with information-aware techniques. *Computers & Education, 50*(1), 77–90. https://doi.org/10.1016/j.compedu.2006.03.004

Christ, W. G., & Potter, W. J. (1998). Media literacy, media education, and the academy. *Journal of Communication, 48*(1), 5–15. https://doi.org/10.1111/j.1460-2466.1998.tb02733.x

Cooper, B. (2007). Central issues in the use of computer-based materials for high volume entrepreneurship education. *Active Learning in Higher Education, 8*(3), 201–217. https://doi.org/10.1177/1469787407081887

Drigas, A., Kokkalia, G., & Lytras, M. D. (2015). Mobile and multimedia learning in preschool education. *Journal of Mobile Multimedia, 11*(1/2), 119–133.

Epperson, A. (2010). Computer literacy revisited: A comprehensive investigation of computer literacy. *ACM Inroads, 1*(2), 30–33. https://doi.org/10.1145/1805724.1805736

European Commission. (2020). *European skills agenda for sustainable competitiveness, social fairness and resilience*. European Commission. Retrieved from https://ec.europa.eu/migrant-integration/library-document/european-skills-agenda-sustainable-competitiveness-social-fairness-and-resilience_en

European Union. (2006). *Recommendation of the European Parliament and of the Council of 18 December 2006 on key competences for lifelong learning*. Publications Office of the European Union. Retrieved from http://op.europa.eu/en/publication-detail/-/publication/0259ec35-9594-4648-b5a4-fb2b23218096/language-en

Falloon, G. (2020). From digital literacy to digital competence: The teacher digital competency (TDC) framework. *Educational Technology Research and Development, 68*, 2449–2472. https://doi.org/10.1007/s11423-020-09767-4

Ferrari, A. (2012). *Digital competence in practice – An analysis of frameworks*. Publications Office of the European Union. Retrieved from https://data.europa.eu/doi/10.2791/82116

Florenthal, B. (2015). Applying uses and gratifications theory to students' LinkedIn usage. *Young Consumers, 16*(1), 17–35. https://doi.org/10.1108/yc-12-2013-00416

Formosa, P., Wilson, M., & Richards, D. (2021). A principlist framework for cybersecurity ethics. *Computers & Security, 109*: 102382. https://doi.org/10.1016/j.cose.2021.102382

Gallardo-Echenique, E. E., De Oliveira, J. M., Marqués-Molias, L., Esteve-Mon, F., Wang, Y., & Baker, R. (2015). Digital competence in the knowledge society. *MERLOT Journal of Online Learning and Teaching, 11*(1), 1–16.

García-Peñalvo, F. J., Corell, A., Abella-García, V., & Grande-de-Prado, M. (2021). Recommendations for mandatory online assessment in higher education during the COVID-19 pandemic. In D. Burgos, A. Tlili and A. Tabacco (Eds.), *Radical Solutions for Education in a Crisis Context* (pp. 85–98). Springer. https://doi.org/10.1007/978-981-15-7869-4_6

Generalitat de Catalunya. (2017). *Competències bàsiques de l'àmbit digital. Identificació i desplegament a l'educació secundària obligatòria*. Departament d'Ensenyament. Retrieved from https://educacio.gencat.cat/web/.content/home/departament/publicacions/colleccions/c

ompetencies-basiques/eso/ambit-digital.pdf
Gikas, J., & Grant, M. M. (2013). Mobile computing devices in higher education: Student perspectives on learning with cellphones, smartphones & social media. *The Internet and Higher Education, 19*, 18–26. https://doi.org/10.1016/j.iheduc.2013.06.002
Gilster, P. (1997). *Digital literacy*. Wiley Computer Publication.
Grimes, D., & Warschauer, M. (2008). Learning with laptops: A multi-method case study. *Journal of Educational Computing Research, 38*(3), 305–332. https://doi.org/10.2190/EC.38.3.d
Guillén-Gámez, F. D., & Mayorga-Fernández, M. (2020). Quantitative-comparative research on digital competence in students, graduates and professors of faculty education: An analysis with ANOVA. *Education and Information Technologies, 25*(5), 4157–4174. https://doi.org/10.1007/s10639-020-10160-0
Guitert, M., Romeu, T., & Baztán, P. (2021). The digital competence framework for primary and secondary schools in Europe. *European Journal of Education, 56*(1), 133–149. https://doi.org/10.1111/ejed.12430
Guzmán-Simón, F., García-Jiménez, E., & López-Cobo, I. (2017). Undergraduate students' perspectives on digital competence and academic literacy in a Spanish University. *Computers in Human Behavior, 74*, 196–204. https://doi.org/10.1016/j.chb.2017.04.040
Hammoda, B. (2023). Digital technology in entrepreneurship education: An overview of the status quo. In S. Durst & A. Pevkur (Eds.), *Digital Transformation for Entrepreneurship* (pp. 71–93). World Scientific. https://doi.org/10.1142/9789811270178_0006
Hammoda, B. (2024a). ChatGPT for founding teams: An entrepreneurial pedagogical innovation. *International Journal of Technology in Education, 7*(1), 154–173. https://doi.org/10.46328/ijte.530
Hammoda, B. (2024b). The impact of educational technologies on entrepreneurial competencies: A systematic review of empirical evidence. *Knowledge Management & E-Learning, 16*(2), 309–333. https://doi.org/10.34105/j.kmel.2024.16.015
Hammoda, B., Ellyton, M., Foli, S., Mallarge, J., Durst, S., & Rothenberger, S. (2023). Reference framework for inclusive digital education – A project report. In M., Pietrzykowski, S. Cardinali, & K. Mühlmann (Eds.), *Fostering Digital Skills and Competencies in Higher Education* (pp. 150–197). Bogucki Wydawnictwo Naukowe.
Harrison, C., & Alvermann, D. E. (2018). Critical internet literacy: What is it, and how should we teach it? *Journal of Adolescent & Adult Literacy, 61*(4), 461–464.
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. https://doi.org/10.1016/j.compedu.2012.11.015
He, T., & Li, S. (2019). A comparative study of digital informal learning: The effects of digital competence and technology expectancy. *British Journal of Educational Technology, 50*(4), 1744–1758. https://doi.org/10.1111/bjet.12778
He, T., & Zhu, C. (2017). Digital informal learning among Chinese university students: the effects of digital competence and personal factors. *International Journal of Educational Technology in Higher Education, 14*: 44. https://doi.org/10.1186/s41239-017-0082-x
He, T., Zhu, C., & Questier, F. (2018). Predicting digital informal learning: An empirical study among Chinese University students. *Asia Pacific Education Review, 19*, 79–90. https://doi.org/10.1007/s12564-018-9517-x
Hilbert, M. (2011). The end justifies the definition: The manifold outlooks on the digital divide and their practical usefulness for policy-making. *Telecommunications Policy,*

*35*(8), 715–736. https://doi.org/10.1016/j.telpol.2011.06.012

Hinchliffe, G. W., & Jolly, A. (2011). Graduate identity and employability. *British Educational Research Journal, 37*(4), 563–584. https://doi.org/10.1080/01411926.2010.482200

Iansiti, M., & Richards, G. (2020, March 26). *Coronavirus is widening the corporate digital divide*. Harvard Business Review. Retrieved from https://hbr.org/2020/03/coronavirus-is-widening-the-corporate-digital-divide

Ilomäki, L., Paavola, S., Lakkala, M., & Kantosalo, A. (2016). Digital competence – An emergent boundary concept for policy and educational research. *Education and Information Technologies, 21*, 655–679. https://doi.org/10.1007/s10639-014-9346-4

Jackson, D. (2017). Developing pre-professional identity in undergraduates through work-integrated learning. *Higher Education, 74*, 833–853. https://doi.org/10.1007/s10734-016-0080-2

Jackson, D., & Wilton, N. (2016). Developing career management competencies among undergraduates and the role of work-integrated learning. *Teaching in Higher Education, 21*(3), 266–286. https://doi.org/10.1080/13562517.2015.1136281

Janssen, J., Stoyanov, S., Ferrari, A., Punie, Y., Pannekeet, K., & Sloep, P. (2013). Experts' views on digital competence: Commonalities and differences. *Computers & Education, 68*, 473–481. https://doi.org/10.1016/j.compedu.2013.06.008

Jones-Kavalier, B., & Flannigan, S. (2006). *Connecting the digital dots: Literacy of the 21st century*. EDUCAUSE Review. Retrieved from https://er.educause.edu/articles/2006/4/connecting-the-digital-dots-literacy-of-the-21st-century

Kampylis, P., Bacigalupo, M., Punie, Y., Redecker, C. Langer, L., Rasmussen, M., Conrads, J., Winters, N., & Geniet, A. (2017). *Digital education policies in Europe and beyond – Key design principles for more effective policies*. Publications Office of the European Union. Retrieved from https://data.europa.eu/doi/10.2760/462941

Khan, N., Sarwar, A., Chen, T. B., & Khan, S. (2022). Connecting digital literacy in higher education to the 21st Century workforce. *Knowledge Management & E-Learning, 14*(1), 46–61. https://doi.org/10.34105/j.kmel.2022.14.004

Kim, H. J., Hong, A. J., & Song, H. D. (2019). The roles of academic engagement and digital readiness in students' achievements in university e-learning environments. *International Journal of Educational Technology in Higher Education, 16*: 21. https://doi.org/10.1186/s41239-019-0152-3

Krumsvik, R. J. (2008). Situated learning and teachers' digital competence. *Education and Information Technologies, 13*, 279–290. https://doi.org/10.1007/s10639-008-9069-5

Kumaraswamy, K. S. N., & Chitale, C. M. (2012). Collaborative knowledge sharing strategy to enhance organizational learning. *Journal of Management Development, 31*(3), 308–322. https://doi.org/10.1108/02621711211208934

Labrecque, L. I., Markos, E., & Milne, G. R. (2011). Online personal branding: Processes, challenges, and implications. *Journal of Interactive Marketing, 25*(1), 37–50. https://doi.org/10.1016/j.intmar.2010.09.002

Law, N., Woo, D., & Wong, G. (2018). *A global framework of reference on digital literacy skills for indicator 4.4.2*. UNESCO. Retrieved from http://uis.unesco.org/sites/default/files/documents/ip51-global-framework-reference-digital-literacy-skills-2018-en.pdf

Lim, G., Shelley, A., & Heo, D. (2019). The regulation of learning and co-creation of new knowledge in mobile learning. *Knowledge Management & E-Learning, 11*(4), 449–484. https://doi.org/10.34105/j.kmel.2019.11.024

Linstone, H. A., & Turoff, M. (1975). *The Delphi method: Techniques and applications*.

Addison-Wesley.
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. https://doi.org/10.1111/j.1365-2729.2011.00474.x
López-Meneses, E., Sirignano, F. M., Vázquez-Cano, E., & Ramírez-Hurtado, J. M. (2020). University students' digital competence in three areas of the DigCom 2.1 model: A comparative study at three European universities. *Australasian Journal of Educational Technology, 36*(3), 69–88. https://doi.org/10.14742/ajet.5583
MacInnis, D. J. (2011). A framework for conceptual contributions in marketing. *Journal of Marketing, 75*(4), 136–154. https://doi.org/10.1509/jmkg.75.4.136
Madsen, S. S., Thorvaldsen, S., & Archard, S. (2018). Teacher educators' perceptions of working with digital technologies. *Nordic Journal of Digital Literacy, 13*(3), 177–196. https://doi.org/10.18261/issn.1891-943x-2018-03-04
Martin, N. A., & Martin, R. (2015). Would you watch it? Creating effective and engaging video tutorials. *Journal of Library & Information Services in Distance Learning, 9*(1/2), 40–56. https://doi.org/10.1080/1533290X.2014.946345
Moos, D. C., & Azevedo, R. (2009). Learning with computer-based learning environments: A literature review of computer self-efficacy. *Review of Educational Research, 79*(2), 576–600. https://doi.org/10.3102/0034654308326083
Murawski, M., & Bick, M. (2017). Digital competences of the workforce – A research topic? *Business Process Management Journal, 23*(3), 721–734. https://doi.org/10.1108/BPMJ-06-2016-0126
Myovella, G., Karacuka, M., & Haucap, J. (2020). Digitalization and economic growth: A comparative analysis of Sub-Saharan Africa and OECD economies. *Telecommunications Policy, 44*(2): 101856. https://doi.org/10.1016/j.telpol.2019.101856
Norwegian Directorate for Education and Training. (2012). *Framework for basic skills*. Norwegian Ministry of Education and Research. Retrieved from https://www.udir.no/contentassets/fd2d6bfbf2364e1c98b73e030119bd38/framework_for_basic_skills.pdf
Nowak, B. M. (2019). The development of digital competence of students of teacher training studies – Polish cases. *International Journal of Higher Education, 8*(6), 262–266. https://doi.org/10.5430/ijhe.v8n6p262
Nusir, S., Alsmadi, I., Al-Kabi, M., & Sharadgah, F. (2013). Studying the impact of using multimedia interactive programs on children's ability to learn basic math skills. *E-learning and Digital Media, 10*(3), 305–319. https://doi.org/10.2304/elea.2013.10.3.305
Ogbodoakum, N., Ayub, A. F. M., & Abiddin, N. Z. (2022). The influence of individual and organizational factors on readiness to accept online learning among higher education lecturers in Nigeria. *Knowledge Management & E-Learning, 14*(3), 304–328. https://doi.org/10.34105/j.kmel.2022.14.017
Palermiti, A. L., Servidio, R., Bartolo, M. G., & Costabile, A. (2017). Cyberbullying and self-esteem: An Italian study. *Computers in Human Behavior, 69*, 136–141. https://doi.org/10.1016/j.chb.2016.12.026
Park, H., Kim, H. S., & Park, H. W. (2020). A scientometric study of digital literacy, ICT literacy, information literacy, and media literacy. *Journal of Data and Information Science, 6*(2), 116–138. https://doi.org/10.2478/jdis-2021-0001
Petit, A., Wala, Z., Ciucci, M., & Martinello B. (2024). *Digital agenda for Europe*. European Parliament. Retrieved from

https://www.europarl.europa.eu/factsheets/en/sheet/64/digital-agenda-for-europe

Pettersson, F. (2018). On the issues of digital competence in educational contexts – A review of literature. *Education and Information Technologies, 23*(3), 1005–1021. https://doi.org/10.1007/s10639-017-9649-3

Polizzi, G. (2020). Digital literacy and the national curriculum for England: Learning from how the experts engage with and evaluate online content. *Computers & Education, 152*: 103859. https://doi.org/10.1016/j.compedu.2020.103859

Poore, M. (2011). Digital literacy: Human flourishing and collective intelligence in a knowledge society. *Literacy learning: The Middle Years, 19*(2), 20–26. Retrieved from https://search.informit.org/doi/10.3316/aeipt.187377

Potter, W. J. (2018). *Media literacy*. Sage Publications.

Pradhan, R. P., Arvin, M. B., Norman, N. R., & Bele, S. K. (2014). Economic growth and the development of telecommunications infrastructure in the G-20 countries: A panel-VAR approach. *Telecommunications Policy, 38*(7), 634–649. https://doi.org/10.1016/j.telpol.2014.03.001

Rana, S., Ardichvili, A., & Polesello, D. (2016). Promoting self-directed learning in a learning organization: Tools and practices. *European Journal of Training and Development, 40*(7), 470–489. https://doi.org/10.1108/EJTD-10-2015-0076

Redecker, C., & Punie, Y. (2017). *European framework for the digital competence of educators: DigCompEdu*. Publications Office of the European Union. https://doi.org/10.2760/159770

Romero-Tena, R., Barragán-Sánchez, R., Llorente-Cejudo, C., & Palacios-Rodríguez, A. (2020). The challenge of initial training for early childhood teachers. A cross sectional study of their digital competences. *Sustainability, 12*(11): 4782. https://doi.org/10.3390/su12114782

Salas-Pilco, S. Z. (2013). Evolution of the framework for 21st century competencies. *Knowledge Management & E-Learning, 5*(1), 10–24. https://doi.org/10.34105/j.kmel.2013.05.002b

Savage, M. (2015). *Digital literacy for primary teachers*. Critical Publishing.

Schleicher, A. (2019). *Helping our youngest to learn and grow: Policies for early learning*. OECD Publishing.

Shariman, T. P. N. T., Razak, N. A., & Noor, N. F. M. (2012). Digital literacy competence for academic needs: An analysis of Malaysian students in three universities. *Procedia – Social and Behavioral Sciences, 69*, 1489–1496. https://doi.org/10.1016/j.sbspro.2012.12.090

Sharma, R., & Mokhtar, I. A. (2006). Bridging the digital divide in Asia: Challenges and solutions. *International Journal of Technology, Knowledge & Society, 1*(3), 15–30. https://doi.org/10.18848/1832-3669/CGP/v01i03/55886

Shopova, T. (2014). Digital literacy of students and its improvement at the university. *Journal on Efficiency and Responsibility in Education and Science, 7*(2), 26–32. https://doi.org/10.7160/eriesj.2014.070201

Snyder, H. (2019). Literature review as a research methodology: An overview and guidelines. *Journal of Business Research, 104*, 333–339. https://doi.org/10.1016/j.jbusres.2019.07.039

Somerville, M. M., Lampert, L. D., Dabbour, K. S., Harlan, S., & Schader, B. (2007). Toward large scale assessment of information and communication technology literacy: Implementation considerations for the ETS ICT literacy instrument. *Reference Services Review, 35*(1), 8–20. https://doi.org/10.1108/00907320710729337

Stopar, K., & Bartol, T. (2019). Digital competences, computer skills and information literacy in secondary education: Mapping and visualization of trends and concepts.

*Scientometrics, 118*, 479–498. https://doi.org/10.1007/s11192-018-2990-5
Svensson, M., & Baelo, R. (2015). Teacher students' perceptions of their digital competence. *Procedia – Social and Behavioral Sciences, 180*, 1527–1534. https://doi.org/10.1016/j.sbspro.2015.02.302
Tang, C. M., & Chaw, L. Y. (2016). Digital literacy: A prerequisite for effective learning in a blended learning environment? *Electronic Journal of E-learning, 14*(1), 54–65.
Tewell, E. (2015). A decade of critical information literacy: A review of the literature. *Communications in Information Literacy, 9*(1), 24–43. https://doi.org/10.15760/comminfolit.2015.9.1.174
Thelwall, M. (2018). Dimensions: A competitor to Scopus and the Web of Science? *Journal of Informetrics, 12*(2), 430–435. https://doi.org/10.1016/j.joi.2018.03.006
Tohara1, A. J. T., Shuhidan, S. M., Bahry, F. D. S., & bin Nordin, M. N. (2021). Exploring digital literacy strategies for students with special educational needs in the Digital Age. *Turkish Journal of Computer and Mathematics Education, 12*(9), 3345–3358. https://doi.org/10.17762/turcomat.v12i9.5741
Torraco, R. J. (2005). Writing integrative literature reviews: Guidelines and examples. *Human Resource Development Review, 4*(3), 356–367. https://doi.org/10.1177/1534484305278283
Torraco, R. J. (2016). Writing integrative literature reviews: Using the past and present to explore the future. *Human Resource Development Review, 15*(4), 404–428. https://doi.org/10.1177/1534484316671606
Tsai, N., & Hebert, T. E. (2002). Measurement of a college computer literacy course. In M. Dadashzadeh, A. Saber, & S. Saber (Eds.), *Information Technology Education in the New Millennium* (pp. 49–53). IGI Global.
Ukwoma, S. C., Iwundu, N. E., & Iwundu, I. E. (2016). Digital literacy skills possessed by students of UNN, implications for effective learning and performance: A study of the MTN Universities Connect Library. *New Library World, 117*(11/12), 702–720. https://doi.org/10.1108/NLW-08-2016-0061
United Nations. (n.d.). *The 17 goals | Sustainable development*. United Nations. Retrieved from https://sdgs.un.org/goals
Van den Brande, L., Carretero, S., Vuorikari, R., & Punie, Y. (2016). *DigComp 2.0: The digital competence framework for citizens*. Publications Office of the European Union. Retrieved from https://data.europa.eu/doi/10.2791/11517
Van Dijck, J. (2013). 'You have one identity': Performing the self on Facebook and LinkedIn. *Media, Culture & Society, 35*(2), 199–215. https://doi.org/10.1177/0163443712468605
Waltman, L. (2016). A review of the literature on citation impact indicators. *Journal of Informetrics, 10*(2), 365–391. https://doi.org/10.1016/j.joi.2016.02.007
Welsh Government. (2008). *Digital competence framework*. Welsh Government. Retrieved from https://hwb.gov.wales/curriculum-for-wales/cross-curricular-skills-frameworks/digital-competence-framework
Woodcock, B., Middleton, A., & Nortcliffe, A. (2012). Considering the Smartphone Learner: an investigation into student interest in the use of personal technology to enhance their learning. *Student Engagement and Experience Journal, 1*(1), 1–15.
Záhorec, J., Hašková, A., & Munk, M. (2019). Teachers' professional digital literacy skills and their upgrade. *European Journal of Contemporary Education, 8*(2), 378–393. https://doi.org/10.13187/ejced.2019.2.378
Zaphiris, P., & Ioannou, A. (2018, July). Learning and collaboration technologies. Design, development and technological innovation. In *Proceedings of the 5th International*

*Conference on Learning and Collaboration Technologies (LCT 2018) (Vol. 1)*.

Zhao, Y., Llorente, A. M. P., & Gómez, M. C. S. (2021). Digital competence in higher education research: A systematic literature review. *Computers & Education, 168*: 104212. https://doi.org/10.1016/j.compedu.2021.104212

Zhong, Z. J. (2011). From access to usage: The divide of self-reported digital skills among adolescents. *Computers & Education*, *56*(3), 736–746. https://doi.org/10.1016/j.compedu.2010.10.016

Zhu, M., Bonk, C. J., & Doo, M. Y. (2020). Self-directed learning in MOOCs: Exploring the relationships among motivation, self-monitoring, and self-management. *Educational Technology Research and Development, 68*, 2073–2093. https://doi.org/10.1007/s11423-020-09747-8

Zurkowski, P. G. (1974). *The information service environment relationships and priorities*. National Commission on Libraries and Information Science. Retrieved from https://files.eric.ed.gov/fulltext/ED100391.pdf