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# Discovering the synergies among information literacy and mobile learning in higher education

*Explorando las sinergias entre la alfabetización informacional y el aprendizaje móvil en la enseñanza superior*

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## Resumen

Esta investigación pretende explorar las sinergias y relaciones entre los dominios de la alfabetización informacional y el aprendizaje móvil en entornos de Educación Superior. El método se basa en una revisión bibliográfica narrativa de los artículos disponibles en inglés (2006-2022) y una selección de los más relevantes mediante análisis de contenido cualitativo, para descubrir los temas principales y sus relaciones. Los resultados confirman que la alfabetización informacional y el m-learning son ámbitos cercanos e interrelacionados. Las tecnologías móviles y las bibliotecas académicas desempeñan un papel intermediario en esas relaciones. Con el apoyo de las tecnologías móviles, la integración progresiva de la alfabetización informacional y el aprendizaje móvil puede llevar a la biblioteca académica a experimentar y canalizar un servicio mejorado. El mayor reto consiste en adaptar los conceptos y comportamientos informativos y pedagógicos a una tecnología que evoluciona sin cesar pero que, en cualquier caso, debe apuntar a las necesidades individuales y comunitarias. La biblioteca académica es una entidad fundamental para canalizar el progreso de la alfabetización informacional y el aprendizaje móvil.

**Palabras clave:** Alfabetización informacional. Aprendizaje electrónico. Aprendizaje móvil. Tecnologías móviles. Bibliotecas académicas. Servicios orientados al usuario.

## 1. Introduction

Concerning the topic of learning in Higher Education (HE), two domains should deserve special attention, information literacy (IL) and mobile learning (ML). The earliest conceptualizations of IL, related to a series of standards to attain (ACRL, 2000; SCONUL, 1999), have evolved into a cluster of groundbreaking IL perspectives (ACRL, 2015; SCONUL, 2011; CILIP, 2018), and the phenomenon of ML continues to have an increasing role in learning environments (Crompton and Burke, 2018). The evident pervasiveness of mobile devices among young people in leisure and communication activities (Taylor and Silver, 2019) evolved to include academic learning

## Abstract

This research aims at exploring the synergies and relationships between information literacy and mobile learning domains in Higher Education environments. The method is based on a narrative literature review of available articles in English (2006-2022) and one selection of the most relevant items using qualitative content analysis, to discover the main topics and their relationships. Results confirm that information literacy and m-learning are close and interrelated domains. Mobile technologies and academic libraries perform an intermediating role in those relationships. With the support of mobile technologies, the progressive integration of information literacy and mobile learning may lead the academic library to experience and channel an enhanced service. The greatest challenge consists in adapting the concepts and behaviors informational and pedagogical to a technology that evolves relentlessly but, in any event, ought to point to individual and community needs. The academic library is a pivotal entity in channeling the progress of IL and mobile learning.

**Keywords:** Information literacy. E-learning. Mobile learning. Mobile technologies. Academic libraries. User-oriented services.

tasks, even more in the Covid-19 circumstances (Turnbull et al., 2021). New research fronts based on the learning affordances allowed by mobile devices are opening up. Given that both domains (IL and ML) are involved in teaching and learning processes, more deep knowledge of the literature simultaneously addressing them is advisable.

This work has the general objective of exploring the main characteristics, synergies, and connections between the domains of IL and ML in the HE framework. We are aware of the continuous growth of ML in teaching and learning, as well as the impact of IL concepts and abilities in today's digital environments. Since universities are undergoing a continuous process of digital adaptation, they need to improve their levels of

information literacy, defining new patterns and synergies that encourage specific IL contributions in the digital learning spaces, -especially in the new mobile learning contexts. The goal is to identify these relationships, unveiling the elements involved, the major emerging issues, and the future lines of research. Any progress of the university in the knowledge society requires the knowledge and mastery of informational and digital literacies of its members, significantly when mobile technologies affect personal, academic, and professional life. We intend that a thorough and objective content analysis of the most recent literature on IL and ML in HE environments will allow us to answer the following research questions:

- RQ1. What are the main challenges of the recent literature on information literacy and academic libraries in higher education?
- RQ2. What are the most significant contributions of mobile learning and mobile technologies in those environments?
- RQ3. What are the synergies and relationships between the domains of information literacy and mobile learning?

Consequently, the main academic trends should merge.

## 2. State of the art

Once coined the term information literacy (Zurkowski, 1974), the first impulse of this emerging domain consisted of a series of specific standards elaborated by relevant library associations that conceived IL as the set of requirements for the information-literate person to be met (SCONUL, 1999; ACRL, 2000). It was a series of essential competencies for survival in the information society, an idea of IL lately seconded by the declarations of Prague (2003) and Alexandria (2005). Later, starting from this competency perspective of IL, it has evolved towards a more academic and theoretical picture, emerging different re-conceptualizations. Among them, the Seven Pillars (SCONUL, 2011) or the Framework (ACRL, 2015) models stand out. Since IL relates and overlaps with other literacies and areas of knowledge, it is no longer an independent concept (CILIP, 2018). These last approaches, affecting the theory and practice of IL, aim to respond to the growing complexity of information and its scenarios. In this way, the IL concept has expanded its dimensions and functions, overcoming traditional borders and assuming the presence of other increasingly influential literacies (media, visual, digital, and data...) (Onyan-cha, 2020; Chen et al., 2021). Some bibliometric studies have addressed the evolution of IL

scientific production, offering a systematic view of its thematic and new trends (Nazim y Ahmad, 2007; Aharony, 2010; Pinto, et al., 2020, 2015, 2019; Kolle, 2017; Uribe Alhuay, 2017; Bapte, 2020)

Recently, Hicks et al. (2022) addressed the conceptual influence and appropriation of information literacy in other disciplinary landscapes. Li et al. (2021) highlighted the stability of learning and education topics within information literacy research since it is a complex and evolutionary domain with significant effects on teaching and learning (Pinto et al., 2020; Pinto, 2022). The most effective way to educate individuals on information literacy is through the education system. In this sense, one of the emerging trends in current education systems is mobile learning, a concept in an embryonic process that bases on the mobility of information and people. Although its theoretical and practical consolidation is yet to come, there are many investigations around. Born as an extension of e-learning, m-learning has evolved into a different frame (Parson et al., 2007; Vavoula and Sharples, 2009; Koole, 2009; Dennen and Hao, 2014; Hsu and Ching, 2015; Parsazadeh et al., 2018). M-learning has also been approached from a theoretical point of view as a domain with its identity (Traxler, 2009; Pachler et al., 2010; Kearney et al., 2012; Ko et al., 2015; Al-Said, 2020; Al-Rahmi, 2021). In this evolutionary line, the phenomenon of mobile information literacy emerges in the literature (Walsh, 2012; Havelka, 2013; Ng, 2013; Bergdahl, 2020; Blau et al., 2020; Matula, 2020; Moya and Camacho, 2020; Hidayat, 2022).

## 3. Methods

Along the search process, on peer-reviewed articles in English sharing information literacy (IL) and mobile learning (ML) topics in HE environments, within the 2006-2022 period, we resorted to five international databases (ERIC, LISA, LISTA, Scopus, and WOS). The strategy consisted of some queries, which covered the intersection of terms related to the concepts of information literacy ("information literac\*", "metaliterac\*", "digital literac\*", "information competenc\*\*", "mobile literac\*"), mobile learning ("ubiquitous learning", "learning smartphone", "online learning", "e-learning") and higher education. We used the title, abstract, and keywords/descriptors fields of the databases. This way we imported into the Mendeley reference manager, and normalized, a set of 684 items which, after duplicate removal, went down to 505. For the selection of the records that would be part of the final sample, these steps were followed: first, their titles and abstracts we read, discarding (386 items) those not relevant for

this research and included 122. Second, the full text of the remaining 122 items was read, discarding 43 and leaving 79. An Excel template allowed recording some items with relevant tags such as authorship, affiliation, title, journal, year, country, type of study, abstract, keywords, thematic field, and relevant contents. After considering the relevance of these indicators for the research questions, the research team selected for analysis a total of 79 articles, which were read in depth, analyzing their content based on the aforementioned questions. In these tasks of selection and conceptual refinement intervened the authors of this work

The articles to review were from academics (48), librarians (24), and both (7), and consisted of case studies (46), theoretical research (18), and literature reviews (15). The countries with the highest participation: are the USA (36), the UK (14), Australia (6), Canada (3), Germany (3), and Spain (3). The most frequently recurring journals: Reference Services Review (6), Electronic Library (4), International Journal of Mobile and Blended Learning (4), Education and Information Technologies (4), Journal of Academic Librarianship (4), College and Research Libraries (3), Computers and Education (3) and International Journal of Emerging Technologies in Learning (3).

## 4. Findings

The categorized and synthesized findings from the content analysis procedures allowed opportune answers to the three research questions on reframing information literacy and academic libraries (1), contributions of mobile learning and mobile technologies (2), and synergies of information literacy and mobile learning (3). In this way, the main topics and lines of research may be inferred.

### 4.1. Reframing information literacy and academic libraries

Through the literature analyzed, we have observed how the conceptual framework of IL in the framework of HE has experienced a significant leap from approaches based on a set of competencies to those based on a series of concepts. In this sense, the role of metaliteracy has been key to this transition. We have also found publications that address the role of libraries as promoters and trainers in IL. The use of mobile technologies also has a significant presence in the literature on m-learning. At the beginning of the period analyzed, Lloyd (2006) was aware that IL should broaden its horizon, until then focused on the acquisition of competencies, and explore other modalities

and situations. In this same line, Ward (2006) advocated a new view of IL for lifelong meaning. In a collaborative effort between academics and librarians to enable students richer experience of IL, Diekema et al. (2011) advocated for a more situated experience of information literacy. Other relevant concepts started to incorporate into IL, such as those related to reflection and self-knowledge (Markless, 2009). All these approaches tended to expand the functions and benefits of IL, a concept that in any case ought to be reconsidered in light of the most recent socio-technological advances (Blau et al., 2020; Moya and Camacho, 2020)

#### 4.1.1. Information literacy as a threshold concepts framework

Significant changes in IL conceptions have emerged in the last decade. The evolution started with the introduction of the meta literacy concept, “an overarching, self-referential, comprehensive framework that informs other literacy types” (Mackey and Jacobson, 2011,70). Meta literacy intended a renewed vision of IL as a global skill set in which students, as information consumers and creators, could successfully participate in collaborative spaces. Meta literacy requires not only behavioral and cognitive engagements but also affective and critical engagements with the information ecosystem. It also broadens the scope of traditional IL skills to include collaborative production and information sharing in participatory digital environments, in which formal and informal learning are recognized.

One of the most significant steps in reframing IL was the ACRL’s Framework, which is grounded in six frames or threshold concepts on authority, information creation and value, research, scholarship, and searching (ACRL, 2015). The mainstreaming of these new well-embedded components and their precise formulation can be game-changing for the future of IL as an academic discipline. The Framework affects both the theory and the practice of IL, since “under the overarching theme of meta literacy, introduce information literacy concepts and allow various methods of implementation” (Loftis and Wormser, 2016, 244). The Information Literacy Group spoke along the same lines, stating that IL is not a stand-alone concept, relates to information in all its forms, relates and overlaps with other literacies, and aligns with other areas of knowledge and understanding (CILIP, 2018). But the temporary closeness of these new re-conceptualizations does not allow immediate and practical results. It is still early to evaluate these new approaches, yet there is consensus that these new approaches represent a milestone in the

evolution of IL (Pinto, 2022). In any case, most of the literature addressing IL-related topics does so in convergence with other neighboring domains (Goodsett, 2020). Hence, IL is an evolving conceptual framework highly conditioned by the growing complexity of information systems and environments (Cochrane et al., 2022).

#### 4.1.2. Information literacy and academic libraries

Libraries align with the University's educational goals to support students in their information literacy process. Some of the publications reviewed relate to the role of IL within academic libraries. A Delphi study by Saunders (2009) contended that a holistic approach is more effective than the current competency-based IL conceptions. Using a case study, Kammerlocher et al. (2011) suggested low-cost solutions that can provide libraries with an important IL presence within the university learning landscape using locally managed learning object repositories. Exploring the variations in the use of technology in the classroom by students and faculty is a relevant issue since it could lead to pedagogical innovations that librarians would be able to apply. In this regard, Vander Meer, Perez-Stable, and Sachs (2012) tackled faculty perceptions about library research instruction. In the same vein, Becker et al. (2013) consider that the digital transformation of the academic library has led to a change at all levels, including media, the role of librarians and the attitude of the teaching staff. The development of accessible apps contributes to a greater awareness of the importance of academic libraries and the possibilities it offers. Gunton (2022) and Obinyan and Ikechukwu (2022) underscore the relevance of the adaptation to new technologies by librarians. At the same time, the authors consider that the training of librarians turns into a priority for the academic community. Its formative contribution is linked to ethics and, therefore, to the detection and reduction of dishonest behaviors.

#### 4.1.3. Information literacy and mobile technologies

Some reviewed papers relate to IL and mobile technologies. In this regard, Kleinveldt and Zulu (2007) launched the IL tablet project, including topic analysis, library catalogs, information sources, evaluation, databases, referencing, and plagiarism. Using a literature review, Farkas (2012) pointed to the need for significant changes in the conceptualization of IL, including its incorporation into the most current technologies, since it is a critical component of pedagogy 2.0. Johnston and Marsh (2014) used a case study to explore how technological tools have increasingly

influenced the delivery of information literacy curricula, also verifying the success of library staff and the use of mobile apps. As for the predictive power of some attributes of digital natives, Sorgo et al., (2017) concluded that mastery of technologies does not warrant proficiency in IL. This perspective is also underlined by Antee (2021), who also considers that there is a link between social level, digital and mobile skills and the acquisition and development of IL.

#### 4.2. Contributions of mobile learning and mobile technologies

In the context of this research, the field with the largest number of publications was mobile learning, including the impact of mobile technology on learning experiences.

##### 4.2.1. E-learning, the starting point of mobile learning

Compared to traditional models e-learning, and the greater facilities provided by information technology, is a rich and flexible way of addressing student instruction. The specific literature on e-learning is quite heterogeneous and includes, among others, academic, psychological, and practitioner perspectives.

Publications on e-learning are chiefly carried out from an academic perspective, preferably through case studies. Aware of its richness and flexibility, Andone et al. (2007) performed a qualitative analysis of e-learning environments including digital literacy, Internet use, mobile phone use, learning attitudes, visual use, and IT expectations. In this same line, Stagg and Kimmins (2012) focused on virtual learning spaces, emphasizing the social scope of these tools better suited to the new socio-technological environments. Buchanan, Sainter and Saunders (2013) examined the factors associated with the use of learning technologies by higher education faculty, among them Internet self-efficacy, structural factors, and perceived usefulness. In summary, the acceptance of new technologies by teachers is an essential e-learning requirement, since the little attention paid to the crucial role of teachers in online settings results in a moderate acceptance of the technologies. Once examined the main reasons why many academics harbor doubts about using the technologies, Guri-Rosenblit (2018, 97) concluded that e-teaching is "an essential prerequisite for achieving efficient and fruitful e-learning in higher education, particularly at the undergraduate level." In this regard, the emergence of Covid-19 has exerted a crucial influence on e-learning among teachers

(Dattatraya and Passad, 2020; Dubey and Kumar, 2021; Miles et al., 2021).

From a psychological point of view, Prior et al. (2016) highlighted the importance of students' online learning behavior. More specifically, they referred to self-efficacy and the positive results it generates. As Dattatraya and Prasad (2020) point out, students are experiencing a significant change in their attitudes, due to the use of ICT. The use of mobile has improved both social relations and processes of teaching and learning (Martzoukou et al., 2020).

From a practitioner's perspective, publications center on the use of tutorial products, virtual learning environments (VLE), and learning management systems (LMS) for IL teaching and learning. The presence of Learning 2.0 was a significant step forward in e-learning and socializing (Corrall and Keates 2011; Mestre et al. 2011; Farkas 2012). Likewise, tagging is an essential practice to organize and identify relevant topics in online learning environments (Dennen, Bagdy, and Cates, 2018).

#### 4.2.2. *M-learning, the latest progress of e-learning*

In its earliest days the m-learning domain, which appeared to be a simple extension of e-learning, attracted a growing interest among academics. Most publications reviewed are about m-learning frameworks and theories, and to a lesser extent case studies. Parsons, Ryu, and Cranshaw (2007) suggested a conceptual framework for m-learning applications designed from four perspectives: generic mobile environment, learning contexts, learning experiences, and learning objectives. For them, the m-learning's most promising feature was allowing collaborative activities. Aware of its complex nature, Vavoula and Sharples (2009, p. 65) devised m-learning as a social, rather than technical, phenomenon of people on the move. They recommended a framework consisting of six challenges for m-learning evaluation: learning within and across contexts; learning processes and outcomes; ethical guidelines for mobile contexts; usability of the mobile technology; seeing the bigger picture; and understanding the attributes of in/formality. Stressing the relevance of contexts, this m-learning framework suggested an evaluation at three levels: micro, meso, and macro. The FRAME model proposed by Koole (2009, 38) recognized three aspects of m-learning: device, learner, and social. She argued that m-learning experiences were embedded within a context of information, and were capable of contributing significantly to the improvement of the tasks related to the handling of information, that is to say, of IL skills and

competencies. Despite its obvious interest, this model, firmly anchored in theory, should be developed and sanctioned from practice.

Traxler (2009) self-limited to the idea of learning in a mobile age. Mobile devices, and their technologies and systems, reconfigure the relationships between spaces -public, private, and virtual-, redefine discourse and conversation, and create communities. Considering the profound change caused by m-learning, it is difficult to guess how far this process will go. Pachler, Cook, and Bachmair (2010) proposed a model for the appropriation of mobile cultural resources for learning lenses. Key aspects of the model are situatedness of learning, user/learner-generated content and context, collaborative knowledge building, conversational threads, and reflexive context awareness. Kearney et al. (2012, p. 14406) viewed m-learning from a socio-cultural and pedagogical perspective. Although it is widely described as the process of learning mediated by a mobile device, it must be conceptualized from the perspective of learners' experiences rather than the affordances of the technology tools. The organization of time-space is an essential part of its nature. A suitable m-learning pedagogy has three constructs: *authenticity* highlights opportunities for contextualized, participatory, situated learning; *collaboration* captures the conversational, connected aspects of m-learning; and *personalization* has strong implications for ownership, agency, and autonomous learning.

Since instructor-led m-learning remains a less-researched area, Dennen and Hao (2014) suggested an intentionally mobile pedagogy, the M-COPE framework for m-learning in higher education. Its five critical key elements were mobile affordances, conditions, outcomes, pedagogy, and ethics. A literature review by Hsu and Ching (2015) addressed the existing models and frameworks for designing m-learning experiences and environments. The learning experiences afforded by mobile technologies were organized into five categories: context-aware learning, seamless and ubiquitous learning, game-based learning, mobile computer-supported collaborated learning, and mobile social learning.

To delve into the identity of m-learning, a case study by Ko et al. (2015, p. 569) introduced its usage among LIS students. They referred to mobile devices and their peculiarities (closeness to the users, unrestricted Internet connectivity capabilities) since these unique features draw attention to the potential of m-learning to transform the educational landscape. Parsazadeh, Ali, and Rezaei (2018) developed a framework for a cooperative and interactive m-learning application (CIMLA). This proposal included a series of

online information evaluation skills and m-learning application usability attributes, among which timeliness stood out as perhaps the most important. Results showed that the application was significantly more effective than traditional learning. From a similar perspective, Cochrane et al. (2022) emphasized that there is a process of transformation toward technology-based teaching. The use of resources that make possible the transition to hybrid, online or mobile education has been enhanced after the pandemic crisis (Nokou, 2021). As Frolova et al. (2021) point out, this crisis contributed to transform the practice of higher education in the conditions of transition to these new methodologies. Online training has become an alternative to the face-to-face format of classes (Rahmah, 2022).

From the literature reviewed, it appears that m-learning is something more than just a simple extension of e-learning because significant differences emerge, thereby making it a quite different way of learning. E-learning contributes to acquire and develop critical thinking and abilities to learn, communicate, work as a team, and create information as well (Apriliyanti, 2022). Mobile devices have the distinct property of ubiquity, making m-learning possible across almost all contexts, in contrast with desktop computers that are usually restricted to classrooms, seminars, computer desks, and offices. M-learning is also fully open to augmented reality, and the virtualization of real spaces, with the potential to transform every space into a learning space in the different dimensions implied by the aforementioned authors.

#### 4.2.3. *Mobile learning and academic libraries*

Particularly significant is the relationship between the academic library and m-learning, which preferably center on three areas: the academic library and the culture of learning, the role of librarians, and the future of the AL.

From the academic perspective, a theoretical analysis by Rezaei Sharifabadi (2006, p. 391) evaluated the significant advances that e-learning represents if compared with previous systems since it “knows no time zones and location and distance are not an issue.” Although digital libraries have the potential to offer unprecedented resources to support e-learning, there is a lack of awareness of how best to integrate these resources into the e-learning environment. Conscious of the need for a digital version of the academic library, the author recognizes the lack of awareness regarding its integration into e-learning environments and realizes that the concept of a digital library is assumed in a rather superficial way. The weakness of opinions on what a digital library consists of contrasts with the strength of

the resources that these entities can offer. In any event, the influence of technology on the organization charts and behaviors of the new library environments is evident. Ultimately, the role of academic libraries must experience radical changes.

A literature review by Virkus et al. (2009) allowed for a better understanding of the integration of digital libraries and virtual learning environments (VLE). Based on the idea that LibGuides are themselves learning objects contributing to a larger virtual experience, Hemmig et al. (2012) referred to the virtual experience of the library as a place that brings together electronic resources and services. In this regard, the Bucks Mobile app combines electronic resources and services to create that experience. Also based on student-centered design principles and key learning theories, Baker (2014) addressed the topic of designing LibGuides as instructional tools for critical thinking and effective e-learning (of IL and other subjects). Also, Hufford (2016), using a case study, addressed the relationship between academic libraries and the culture of learning. Given that the library usually adds value to the campus learning culture, all its contributions should be assessed. Yet, it seems that the added value provided by the library to the campus learning culture is often not sufficiently understood. In this regard librarians, as drivers of learning, should be proud of their mission and disseminate it among students.

Concerning the role of librarians, Lavery and Stockley (2006, p. 48) considered that librarians are “ideally suited to participate in new institutional experiments in the design and application of educational technology.” They called for a resource-rich environment, ensuring that IL skills are embedded in it. Its collaboration in online course design and with faculty may provide fertile learning experiences. A qualitative survey on the use of VLE among subject librarians in UK universities carried out by Corral and Keates (2011) proved their important benefits as new tools for learning since they “are both a way of organizing online information and learning resources by subject [...] and a medium for delivering crucial information skills and information literacy tutorials.” It offers a more detailed understanding of the role of these professionals, as well as that of the VLE construct as a tool for channeling library learning, which is a concept still to be explored.

Through a case study on current habits of distance learners in HE regarding information access and mobile device use, Parsons (2010, p. 239) stressed the need for changes in the library status, since it “is becoming less of a physical collection, and this may make it easier for the library to act more as a gateway.” However, she was

cautious regarding the future of mobile devices in library environments since there was no sufficiently strong evidence of the trends of students (Badke, 2020; Gunton, 2022).

#### 4.2.4. Mobile learning and mobile technologies

Mobile technologies, which significantly favor constructivist and collaborative approaches to learning, are pervasive within the literature reviewed. The technological dimension of m-learning is an essential part of its conceptual framework. A case study reported by Motiwalla (2007, p. 593) contended that, while deploying good pedagogical practices to achieve specific learning goals, “the key is to understand the strengths and weakness of a particular technology.” His exploratory study provided a better understanding of the role of mobile technology in higher education, in particular, on the extension of e-learning into wireless/handheld computing devices with the help of an m-learning framework. The parallel evolution of e-learning and mobile technologies allows m-learning to favor, and in turn be favored, by the theories of social constructivism and conversation (Volkovitchkaia, 2020).

Concerned with the 21st-century librarian, a literature review on m-learning performed by Hahn (2008) brought to light its impulse outside the domain of librarianship. Although mobile technology may be regarded as a social science, it has not yet evolved into a robust field in librarianship. Notwithstanding, there is a promising future for embedding this kind of technology in academic environments: “with the assistance of mobile technology, librarians can produce new research methodology for the way we study information search by students and in how faculty create knowledge” (Hahn, 2008, p. 281). A timely literature review allowed Murray (2010) to select seven mobile technology initiatives: Websites, SMS references, MOPACs, mobile collections, eBooks, instruction, and audio/video tours. More than mere trends, they are becoming best practices, and content and recommendations are provided for each of them. Given that users are creating new reasons for seeking information and ways to do it, the case study by Hicks and Sinkinson (2011) depicted the benefits of QR codes as key tools for mobile web services in libraries. The review by Nikou and Economides (2018) focused its attention on a series of mobile-based assessment articles. The most reviewed studies reported a significant positive impact on student learning performance, motivation, and attitudes.

Al Said (2020) emphasized that “the effective integration of mobile technology into educational practices depends on factors related to people, design (content and technology), and institutions

(policies and strategies)”. That is why it turns into a challenge. Moreover, smartphones show some advantages due to their “functionality, interaction, and reaction all working together to improve learners’ motivation” (Al-Rahmi, 2021, 7820). Another review by Turnbull et al. (2021, 6415) identified the most important challenges to this relevant transition to the generalization of mobile technologies: “integrating synchronous and asynchronous tools, overcoming barriers to technology access, improving online competencies for learners and faculty, overcoming academic dishonesty issues in online assessment, and privacy and confidentiality.” In this sense, Daniela (2021, p. 711) described this phenomenon as “smart pedagogy”, which consists of incorporating the diverse technological advances, including mobile devices and their applications “into the learning environments”. In summary, from the literature reviewed, it can be inferred that the role of mobile technology in higher education settings needs to be better assimilated, mainly after the impact of the pandemic crisis.

#### 4.3. Synergies of information literacy and mobile learning

The coexistence of concepts related to IL and mobile learning was a constant in the literature. We could say that both thematic fields provide mutual feedback. Most publications simultaneously addressing these fields were case studies implemented by librarians. In any case, we will distinguish between the synergies of IL and e-learning, the synergies of IL and m-learning, both mediated by the channeling role of academic libraries, and the progress of mobile technologies.

##### 4.3.1. Information literacy and e-learning

Although much literature refers, to a greater or lesser extent, to the relationship between IL and e-learning, some publications explicitly address this issue. A theoretical study by Markless (2009, p. 30) offered a new IL framework for the digital learning environment in HE. Assuming that IL is an enabler of learning, she provided a better understanding of how the principles of learning and the digital environment (especially Web 2.0) inform our conception of IL. Probably, the practice of IL may be one of the activities which call for a conceptual review, including “areas such as critical and creative thinking, structured reflection, active construction of subject knowledge, and academic writing.” The case study by Mestre et al. (2011) focused on learning objects as tools for teaching information literacy online. Through a survey, they verified how librarians use design principles and pedagogical considerations for learning management systems and learning

objects in IL instruction. Mostly concerned with the social dimension of learning, Domínguez-Flores and Wang (2011) explored the effectiveness of online learning communities (OLC), since they are the most effective delivery format in terms of students' acquisition of information skills.

From academia, a critical review of the approaches to define and adapt IL in e-environments conducted by Nazari and Webber (2012, p. 105) focused on IL's place in e-learning. Instead of stretching some components of IL, or appending other literacies to the IL framework, they proposed "a contextual approach for the conceptualization of IL in e-learning which is fully aligned with the origins of IL." In this same line, the case study on the efficiency of e-learning by Kratochvil (2014, p. 322), concluded that "e-learning can be a viable alternative teaching method for information literacy." Results stressed some of the benefits of e-learning, such as overcoming the barriers of textual language predominance. The case study by Loftis and Martinez (2016, p. 254) reported the development of an online tutorial aimed at undergraduates in art and design. Based on the opinions of librarians and faculty, it included resources, strategies, evaluation, ethical use of information, citation, and information literacy, echoing also the six core concepts of the ACRL Framework: "image appropriation is a particularly tricky issue for artists given the proliferation and easy use and manipulation of online images." The Mullins' (2016) case study recognized the pedagogical benefits of a systematic instructional design approach to curriculum development. It was based on the sequential model IDEA (interview, design, embed, assess), a step-by-step curriculum design for integrating IL in academic courses.

#### 4.3.2. Information literacy and M-learning

Publications that explicitly relate IL and m-learning are scarce, given the embryonic state of this domain. The case study by Hanbidge, Tin, and Sanderson (2018, p. 119) is one of the few collaborative initiatives undertaken by academics and librarians. They suggested that IL surpasses the boundaries of academic environments: "learning beyond the world of academia is part of the aim of IL as it promotes critical thinking, increases information competencies, and equips individuals for lifelong learning." With doubts about the actual value of the institutional tools for IL learning, since it is not a learning object but rather a complex activity, they were conscious of the enormous potential of the still untapped m-learning in academic environments (Tylor, 2019).

#### 4.3.3. Channeling role of academic libraries

The academic library is the channel through which IL and m-learning converge. Most of the literature on academic libraries revolves around the problem of their integration into digital and mobile environments and the functional complexity that it entails. Zhang's (2006, p. 295) literature review showed how some libraries "have implemented web-based instruction as an appropriate and beneficial mode to teach students information literacy skills, and to satisfy their needs in using rich and valuable library resources." From a theoretical point of view, Lippincott (2010, p. 206) analyzed the potential of mobile devices in academic libraries, which may lead to new forms of engagement with students learning. Yet recognized that few libraries "are thinking of the potentially dramatic changes that the uptake of devices with sophisticated capabilities may have."

Some case studies have addressed the relationship between academic libraries and mobile technologies. Among academics, there is a general acknowledgment of the need for technological mobilization in libraries. Becker et al. (2013) contended that the presence of a mobile network in libraries constitutes a priority. They developed a library mobile technology survey to create a user-centered mobile presence. The acceptance of this technological mobilization is a recurring issue. Aharony (2013, p. 366) addressed the attitudes of librarians toward mobile services and, more specifically, the extent to which the technology acceptance model (TAM) explains librarians' perceptions of mobile services. She explored whether a series of variables, such as "perceived ease-of-use, usefulness, personal innovativeness, and smartphone usage" may predict librarians' behavioral intention to use m-services.

From academia, Mullins (2017, p. 46) raised a systematic approach to an IL mobile app prototype, a model for libraries seeking to enhance their mobile resources. Since mobile technologies entail significant financial expenses, including the specialized staff, it is difficult for libraries to be permanently aligned with the most advanced educational technology. They must, however, continually keep an eye on the horizon of such technological developments. He posed that "rather than repackaging the status quo into a digital format, we must consistently re-evaluate and transform library resources to align with new information-seeking behaviors and dynamic educational technologies." In a similar vein, Obinyan and Ikechukwu (2022) consider that "e-learning stages offer numerous benefits to students like authority over the content, control over the time spent learning". There has been a great digital and mobile transformation that has increased

during and after the pandemic crisis. Libraries have not been oblivious to this circumstance (Turnbull et al., 2021). That is why librarians must increase their awareness to this new context and develop strategies and resources to achieve this goal.

#### 4. Discussion and conclusions

Concerning RQ1, the conceptual status of IL has experienced a quite significant evolution, as reflected in the literature by academics, librarians, and professional associations. Some topics, on IL landscapes, IL for lifelong meaning, IL learning based on problems, IL perceptions of faculty, digital nativeness as an IL predictor, and meta literacy, stand out in the literature (Lloyd, 2006, p. 396; Ward 2006; Diekema, Holliday and Leary, 2011; Mackey and Jacobson, 2011; Šorgo et al., 2017). Regarding the standards and frameworks from professional associations, IL reframing involves significant conceptual changes (SCONUL, 2011; ACRL, 2015; CILIP, 2018). Likewise, according to the changes in information technology, other specific types of literacy around IL flourished (digital, data, mobile...). As Wang and He (2022) points out. "digital literacy is generally considered as an evolving and dynamic notion". That is why "its conceptualization has been in an expanding state with the advancement of cognitive ability and social practices as well as the evolving new technologies" (p. 53).

We have checked the relationship between academic libraries and IL through a series of specific topics about web instruction to teach IL, the future of IL in the academic library, low-cost solutions for the presence of IL in AL, and faculty perceptions of library instruction (Zhang, 2006; Saunders, 2009; Kammerlocher et al., 2011; Vander Meer, Perez-Stable and Sachs 2012). Likewise, we have tested the relationship between academic libraries and learning through some publications devoted to advances in e-learning in AL, the integration of AL and VLE, the library as a place for e-resources, lib-guides for e-learning, AL and the learning culture, and the future of AL (Lippincott, 2010; Virkus et al., 2009; Parsons, 2010; Hemmig, Johnstone and Montet, 2012; Baker, 2014; Hufford, 2016). Other items, on librarians' attitudes toward mobile services, mobile app prototypes, and mobile devices in AL have enabled us to check the relationship between academic libraries and mobile technologies (Lippincott, 2010; Aharony, 2013; Mullins, 2017). The topics on librarians' IL experience or their use of VLE should be highlighted (Laverty and Stockley, 2006; Corral and Keates, 2011). Based on these findings, the perception is that academic libraries are called upon to experience a dramatic leap

that could place them again at a key position in mobile teaching and learning processes.

Concerning RQ2, on mobile learning contributions, we have been able to verify that items related to mobile learning predominate in the literature. This is comprehensible considering the enormous teaching–learning potentialities for this emerging domain and the ensuing interest among information and pedagogy professionals. E-learning is a fairly consolidated field in academic environments, as can be seen from its many applications, among which VLE and Learning 2.0 stand out above the rest (Andone et al., 2007; Farkas, 2012). Special mention should be made of the relationship of teachers with e-learning (TAM), and e-teaching (Buchanan, Sainter and Saunders, 2013; Daniela et al., 2018; Guri-Rosenblit, 2018; Turnbull et al., 2021). More abundant is the literature on m-learning. Its embryonic status results in a large amount of research that includes theories, frameworks, and case studies. Theories focus on topics about learning in a mobile age, cultural resources for m-learning, and the pedagogical perspective of m-learning (Traxler, 2009; Pachler, Cook and Bachmair, 2010; Kearney et al., 2012). M-learning frameworks focus on m-learning apps, m-learning as a social phenomenon, its integration into IL, mobile pedagogy, m-learning experiences, and cooperative–interactive m-learning (Parsons, Ryu and Cranshaw, 2007; Vavoula and Sharples 2009; Koole 2009; Hsu and Ching 2015; Dennen, Bagdy and Cates 2018; Parsazadeh, Ali, and Rezaei 2018; Al-Rahmi, 2021). In any case, m-learning is a fresh tendency, the social, cultural, and academic consequences of which remain uncertain. M-learning encourages individualism but at the same time socialization, since the convergence of personal and social may favor learning progress. In any case, m-learning is not a simple extension of e-learning.

Concerning the contributions of mobile technologies, we have found publications that relate MT and IL using a technological update of the concept of IL, the impact of web 2.0 tools on IL curricula, and the integration of tablets into IL training (Farkas, 2012; Johnston and Marsh, 2014; Kleinveldt and Zulu, 2016). Others relate to the role of MT in extending e-learning, or the future of MT in academic environments (Motiwalla, 2007; Hahn, 2008). Internet access, which is immediate and popular, and especially the wireless nature of mobile devices, places them at the core of m-learning as the last frontier of informational and learning literacies: ubiquitous learning (Srisuwan and Panjaburee, 2020).

As for RQ3, on the synergies of IL and ML, we have checked the co-occurrence of IL and e-

learning topics from different perspectives such as IL in HE e-learning environments, e-learning objects for teaching IL, e-learning communities for IL acquisition, the place of IL in e-learning, e-learning of IL among art-design students, and integrating IL in academic courses (Markless, 2009; Domínguez-Flores and Wang, 2011; Mestre et al., 2011; Nazari and Webber, 2012; Kratochvil, 2014; Loftis and Wormser, 2016; Mullins, 2016). However, the co-occurrence of IL and m-learning topics within the same publication is not so frequent in the literature. We have found few papers about IL skills in mobile environments (Hanbidge et al., 2018; Rahmi et al., 2022). This circumstance is easily understandable considering the still embryonic state of m-learning.

As conclusion, a research trend may be inferred, that of mobile information literacy, since some examples emerge in the literature. Grounded in the experience of five confident users of mobile devices, a case study offered a preliminary outline of information behavior in a mobile environment. The hypothesis was that “the current dominance of competency-based IL models does not take into account the changing nature of information discovery and use on the move [...] leaving a gap for true IL models that describe how people act in real life” (Walsh 2012, p. 67). Another case study by Havelka (2013) involved a pilot program about mobile information literacy. From a theoretical viewpoint, Ng (2013) introduced a model for the new disciplinary field of m-learning literacy, made up of three dimensions (cognitive abilities, technical, and socio-emotional) and two kinds of attributes -competencies and affections. Likewise, a comprehensive multimodal analysis of a complex academic text suggested a theoretical and critical approach to the concept of mobile literacy, a new topic that should be “characterized by interactivity, autonomy, spontaneity, and creativity when working to make meaning on the move” Barden (2019, p. 28). In any case, definitions of mobile literacy ought to consider the mobility of technology, learners, and learning. Likewise, the need for teachers to be m-learning literate should be highlighted. In recent years, proposals continue to arise in the same direction (Bergdahl, 2020; Blau et al., 2020; Moya and Camacho, 2020; Pinto et al., 2020; Hidayat et al., 2022). The emergence of literature on mobile information literacy is evident, a field in need of further research.

The greatest challenge consists in adapting the concepts and habits (both informational and pedagogical) to a technology that evolves relentlessly but, in any event, ought to be subordinated to individual and community needs. The academic library is a pivotal entity in channeling the

progression in IL and m-learning. In this sense, librarians should embrace an innovative spirit allowing them to be continuously at the forefront of informational, pedagogical, and technological changes.

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