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Information literacy trends in higher education (2006–2019): visualizing the emerging field of mobile information literacy

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Abstract
The thematic evolution of research on Mobile Information Literacy between 2006 and 2019 in the field of Information Literacy, learning and mobile technologies is analysed in an international context. For this purpose, the relevant bibliographic references from five databases (ERIC, LISA, LISTA, Scopus and WOS) were retrieved. To systematize the keywords, high dimensionality is reduced by means of a term-based process. Fields, topics, sub-topics and top terms are defined. The main top-terms and their relationships are analysed applying the fractional counting methodology using VOSViewer software. Fifteen major themes were set, which were grouped into six clusters to identify the main thematic trends during the period under review: IL and e-learning, Mobile devices and competencies, Ethics, Library and e-resources, Educational technology and Technological environment. The convergence of IL and e-learning, the growth of e-literacy, the increasing relationship between mobile devices and information competencies, as well as that of libraries and e-resources, are thus detected. In conclusion, there is evidence of a growing interdisciplinarity in the scientific publications on Mobile Information Literacy, which interrelates the studies of information and digital literacy with e-learning and mobile technologies.

Keywords Information literacy · e-Learning · e-Literacy · Mobile learning · Mobile devices · Mobile information literacy · Research trends · Bibliometric studies · Term-based method · Cluster analysis · Visualization

Introduction

In the world of information science (IS), domain analysis has emerged as a new front of research concerning discourse communities. It represents a shift in the view of knowledge that stress it "social, ecological, and content-oriented nature." (Hjorland and Albrechtsen

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1995: 400). Initially seen as a rather compilatory work, domain analysis is now recognized as a proper method of research: "it is really important to know the most important information sources in one or more domains at a rather detailed level, [since] it has a strong relevance for practical information work" (Hjørland 2002: 425). As a "set of techniques for identifying a specified knowledge base" (Smiraglia 2015: 602), this methodological paradigm enhances the psychological, socio-linguistic, and sociological perspective of science. At the same time, it attempts to establish the basis of the scientific domains employing factors that are external to the users' subjective viewpoint. In any case, domain analysis is a widely recognized and appropriate-to-any-field method of research, regardless of its nature and size.

In the arena of IS, several different approaches to the domain analytic view have emerged. Among them bibliometric studies stand out as one of the most comprehensive attempts, becoming "popular to make bibliometric maps or visualizations of scientific areas based on co-citation analysis." Factors that may "influence the outcome of such a map in a systematic fashion" are next: the databases and documents that form its empirical basis; the citation behaviour of the authors; the easiness/difficulty of the own research process; and author's popularity in the domain (Hjørland 2002, p. 432-3-5). Despite this complexity, there is a strong accord supporting the bibliometric approach, along with the so-called bibliometric visualization, as a means to perform the analysis and visualization of large scientific domains using bibliometric indicators (Vargas Quesada 2005). As stated by Gutierres Castanha and Wolfram (2018: 13), this increasing trend "represents a foundational area of information science."

Within the lively and evolving field of IS, an incipient sub-domain with great possibilities for progress, that of Mobile Information Literacy (MoIL), in the convergence of information literacy (IL) and mobile learning, is emerging. In this regard, the application of domain analysis would be the first step toward MoIL's conceptual framework as an academic domain in higher education (HE). There are no previous studies specifically addressing this emerging field. The overall objective consists of providing a first drawing of the MoIL's uncharted territory. This, in turn, leads to the following specific objectives:

- Identifying the main issues, topics, subtopics, and top terms involved in MoIL's framework, as well as its evolution 2006–2019.
- Detecting main MoIL's research trends
- Visualizing MoIL's specific lines of research and its interrelations

Literature review

Facing the literature review, we suggest two differentiated sets. While the one is about bibliometric and information visualization studies, the other relates to the concepts of IL and mobile learning which are involved in MoIL.

Bibliometric and information visualization studies

Bibliometric studies are particularly relevant in the field of IS and more specifically with regard to IL, given the significant evolution of Digital Literacy and Mobile Information Literacy. Hjørland (2013: 1313) argues: "knowledge organization (KO) and bibliometrics have traditionally been seen as separate subfields of library and information science". In

the last few decades, the organization of information has shown significant interest in the visualization of scientific domains. The different forms of visualization represent a privileged instrument for the analysis and dissemination of information. They would allow the identification of the most relevant bibliometric aspects of the area to be analysed, together with the networks and relations that exist among them: co-citation, co-occurrence and co-authorship (Van Eck and Waltman 2014). A series of different techniques and instruments such as maps, clusters, graphs and diagrams (Yang et al. 2012) can be used to simplify the knowledge (Small 1999). Within the field of IS these structures are crucial. "Traditionally the bibliometric method is being used in librarianship and Information science field to analyse the citation characteristics, content analysis etc., but nowadays it is widely being used for measuring country scientific performance, Institutional research performance, authors impact over a period of time, global and institutional collaboration" (Trivedi 2019: 3).

The three fundamental approaches to visualization are based on distances, graphs and timelines (Van Eck and Waltman 2014). Most of them are used to subsume complex terminological structures into simple units of analysis, interpretation, relationship and hierarchy. In this respect, Hjørland (2000) and Hjørland and Albrechtsen (1995: 400) refer to a relationship paradigm called "domain-analysis", which is based on the analysis of areas or domains of knowledge. Another important aspect of this methodology is its tendency toward objectivity. As stated by Yoon et al. (2010: 803), knowledge maps are "a novel and exceptional technique for enhancing the applicability of bibliometric analysis."

Information visualization and the use of maps are intrinsically linked to bibliometric analysis. Novak et al. (2004: 213) stress that conceptual maps are a "form of visual representation of resulting knowledge structures". Conceptual maps are based on the analysis of co-occurrences of the keywords that represent the cognitive structures of documents (Glänzel 2001). According to O'Donnell et al. (2002: 71–72), knowledge maps are "node-link representations in which ideas are located in nodes and connected to their related ideas through a series of labeled links."

An important but under-addressed problem is the decision regarding which keywords should be retained/considered as objects of analysis. In previous studies, researchers have mainly focused on identifying research topics (for example, research theme clustering and network community discovery) and interpreting the results. Less attention has been paid to the process of selecting appropriate keywords for future analysis. Popular keywords are usually considered important and are selected on the base of frequency or centrality-based network measures, both of which have been proven to choose similar keywords (Choi et al. 2011). Innovative approaches for mapping science via associated bibliometric techniques have been considered in Zhang et al. (2014), who propose a method to clean noisy terms, and Zhang et al. (2017), to derive term-based method to visualize the relationships among scientific topics from the construction of a simulated data streaming function.

One of the first bibliometric studies on the visualization of information (Zhao and Logan 2002) focused on analysing different thematic areas, especially based on the XML language. This work provides clear evidence of the incorporation of technologies and the web for searching for data and the analysis of citations.

Other studies address related periods and similar lines. For instance, Milojević et al. (2011: 1933) conducted both a bibliometric and a scientometric analysis of the words in the titles of papers within the field of LIS (Library and Information Science). These authors established three hierarchical fundamental clusters: Information Literacy, Libraries, and Information Seeking Behaviour.

Of special interest is the analysis of keywords conducted by Chang and Huang (2012), regarding the dominance of LIS over the last three decades, characterized by the

growing rise in multidisciplinarity, with authors and scientific productions that cover a range of disciplines related to LIS: computer science, economics, general science, education and medicine.

Another notable bibliometric analysis focuses on scientific production in LIS over the period from 1978 to 2015, based on the 92,000 references in the LISA database (García Figuerola et al. 2017). The statistical technique of topic modelling and the Latent Dirichlet Allocation (LDA) method was used for this purpose. The quantitative results reveal the existence of nineteen important topics that can be grouped into these four clusters: processes, information technologies, libraries, and applied (specialized) information.

Mishra and Jena (2017: 63) highlight the considerable increase in bibliometric and scientometric studies in recent years, together with their visualization, as it is a useful and systematic methodology with which to "measure scientific progress in many disciplines". However, taking into account both trends and perspectives, we did not find any conceptual studies focused on the analysis of words from two currently significant domains within the LIS framework -IL and its subsidiary Digital Literacy-.

Along the same lines, Pinto et al. (2014) used the scientific production on Information Literacy contained in WOS to analyse the results of IL in several disciplines belonging to both Health and Social Sciences, and highlighted the growth of inter- and multidisciplinarity. Likewise, Pinto (2015) analyses and visualises the international scientific production on the evaluation of IL in higher education, using co-word analysis and its mapping through visualisation techniques.

The study of Shen et al. (2017) focuses on patterns, frequencies and concurrences in the research on information behaviour and information competence over the past three decades in China. The study is of particular interest because, using visualization techniques, it projects the evolution of IL over an extended period, including the moving trends of recent years. However, it does not directly address the intersection between IL and ML in any way.

In the work by Liao et al. (2018), while addressing the visualization technique and the issue of terminological concurrence of keywords and citation frequency, the authors focus on the specific field of medical science, and deal with the relevance of big data.

The analysis carried out by Stopar and Bartol (2019) is based on a mapping of trends in IL and Computer Skills, establishing the relationships between the terms in the impact publications of recent years in the field of secondary education. The authors concluded that there are relationships between the terms. If we consider the journals published in WOS, the order of frequency of terminology would be: WOS, Education and Educational Research, as the main field of study; followed by Computer Science, Information Science and Library Science. In any case, this research does not address Mobile Information Literacy, which is a topic of interest at present.

The research developed by Chen et al. (2019) includes visualization and mapping techniques to express the results of the relationship between education and technology. To do this, the authors focus on a long period of four decades, and use exclusively the journal *Computer and Education*, which is a top publication in the field. Although it handled a large number of articles (almost four thousand), the study adheres to a single, high-impact journal. The results yielded interesting data. Firstly, the incidence of the top terms that converge most frequently: interactive learning environment, teaching/learning strategies, pedagogical aspects, and computer assisted communication. Secondly, after this exhaustive study, the authors propose the need to investigate further the issue of the relationship between information and mobile learning and between IL and the use of technologies.

Mobile information literacy (MoIL)

The other factor to be considered in the literature review is related to the new **Mo**bile **I**nformation **L**iteracy domain (MoIL), which is being subtly introduced into the new information environments. This domain is based above all on the continuous evolution of IL and mobile learning (ML). The convergence of the two domains is a growing reality of which there is an increasing amount of evidence. Thus, Vassilakaki (2014) explains the need to include mobile technology in the university library, due to its advantages and adaptation to the new needs of users. It also underlines its usefulness, accessibility and ubiquity. These elements will become a constant in subsequent literature referring to both mobile education and MoIL. Briz-Ponce et al. (2016) underline all these elements, also contextualizing MobIL as part of the process of new trends in information literacy, closely related to mobile technologies.

Some relevant studies have underscored this convergence, as well as the change of paradigm in IL toward MoIL. In this vein, a research of special interest is the study conducted by Parsazadeh et al. (2018), which shows the confluences between the acquisition of IL and the academic use of mobile devices. This empirical study found that an adjusted application could increase the acquisition of IL, through cooperative work. It would deal, as a central issue, with MoIL, converging also with another aspect of great relevance: the assessment of competencies.

The study of Hamidi and Chavoshi (2018) is of significant interest. In addition to measuring the practical effects of the implementation of mobile technology on university students in technical studies, theoretical implications for its implementation are taken into account. Hence, the acquisition of information skills in an agile and effective way in university students is highlighted. Utility, culture of use, applicability, together with context and personal capabilities, affect an optimal use of the mobile for the acquisition of MoIL.

The study developed by Al-Daihani (2018) which measures the attitudes of undergraduate students towards the use of mobile phones to access and select information, is in a similar vein. This empirical study (focused on social science students) shows competence in the use of mobile technology and its usefulness. However, these skills are high in everyday use for intercommunication, networking and leisure. Therefore, measures should be implemented that help to influence the use of the mobile phone for informational academic purposes. Taking MoIL as a central theme, but from the perspective of university library information professionals, two outstanding studies should be noted. On the one hand, Elahi et al. (2018) underline, after an extensive quantitative study, that ubiquity, immediate access and time availability are an advantage for information access and retrieval. However, the training of students, teachers and information professionals should be improved, and there is good will on the part of all the groups towards MoIL. Academic information search and the development of informational competencies through mobile phones are highlighted, as priority needs. In fact, Mierzecka (2018) emphasises these needs, in her review paper, analysing students' needs of MoIL and the functioning and tools offered by the university academic library. The author determines that the functional changes produced respond to new needs and abilities on the part of the student body. Therefore, in coordination with teachers, libraries should continue to adapt to this context.

One of the most recent studies has been carried out by Kwasitsu and Chiu (2019). In relation to mobile teaching and its confluence with MoIL, the authors conducted an

empirical study on university students. They noted both the unpredictable nature of student attitudes and a decrease in the use of libraries for access to information. The convergence between fields reflects the need to take into account their interconnection, together with the development of guidelines that contribute to coordination and cooperation between fields and agents.

Materials and methods

This research is based essentially on five international databases, of high relevance in the fields of Librarianship, Information Science, Education and Educational Technology: two of which are interdisciplinary, namely Scopus and Web of Science (WOS); two are specialized in the field of IL, namely Library and Information Science Abstracts (LISA) and Library, Information Science and Technology Abstracts (LISTA); and the fifth is specific to the field of Education: Education Resources Information Center (ERIC).

Most of the work carried out on these five databases has dealt with keywords, although the titles and abstracts of papers have also been downloaded, always using documents in English.

The phases involved in this work are the following:

- Selective search in these five international databases and creation of the MoIL database.
- Analysis and normalization of the retrieved references, carried out by experts.
- Selection of the terms included in the analysis: labelling keywords. A categorization was performed to unify keywords, given the high degree of proximity or overlapping among the original terms.
- Statistical analysis, selection and counting of frequencies.
- Visualization of results, including spatial (density) and thematic (clusters) views using VOSViewer software.

Selective search and creation of MoIL database

As stated previously, the search was carried out on a series of international databases—Scopus, WOS, LISA, LISTA and ERIC—as they are relevant and appropriate for the subject of Information Science, and especially in relation to IL, Education, and MoIL. Inclusion and exclusion criteria were defined to formalize the search strategy. The inclusion criteria were: only papers published in peer-reviewed journal, and conference proceedings; papers published between 2006 and November 2019 on the topic defined in the search strategy; only in English. The exclusion criteria used were: general studies on IL, learning and Mobile learning, books and doctoral theses were excluded. Applying these criteria, the following search equation was used:

> TITLE-ABS-KEY (“information literac*”ORmetaliteracyOR”digitalliterac*”OR”in formationcompetenc*” OR”digitalcompetenc*”OR”mobileliterac*”) AND TITLE-ABS-KEY (“online learning”OR “e-Learning” OR “ubiquitouslearning”OR”mobil etelephone”OR”cell* phone”OR”learningsmartphone”OR”mobilelearning”OR”mo bile training”) AND TITLE-ABS-KEY (universit* OR college OR “higher education”) AND PUBYEAR2006-2019

Initially the search returned 561 hits. Duplicates were filtered out and each reference was subjected to the lexical analysis required to normalize the characters (upper/lower case, diacritics) and authorship, as well as to remove empty words. The MoIL database was created with a final documentary corpus of 428 records from the following sources: WOS (6%), ERIC (12%), LISA (26%), LISTA (28%) and SCOPUS (29%). The references included journal papers (83.2%) and conference proceedings (16.8%). "Appendix 1" shows a sample of database.

Analysis and normalization

Each reference in the MoIL database contained the following elements: title, authors, year of publication, publishing house, abstract, descriptors, external links, and document typology. To represent the records of the sample, a total of 3158 keywords, or content indicators, were downloaded. They were introduced into a terminology bank so that they could be analysed and normalized, following the criteria of an interdisciplinary group of experts (faculty and researchers from the areas of Human and Social Sciences). These experts refined the terminological corpus by checking for spelling mistakes, repetitions, synonyms (syntactic, semantic and graphic levels) and thus work with a secure, coherent, and normalized database. The filter also included the revision of ambiguities derived from the use of upper and lower case letters or the presence of hyphens joining characters, to be reviewed at a later stage. As a result, the initial corpus was reduced to 814 keywords.

Selection of fields-terms

The characterization carried out with the terminological corpus was a complex task (Arum and Roksa 2008). In line with Newman and Block (2006) and McCallum (2002), who state that the best way to choose the number of topics is human judgment, the group of experts in different areas of knowledge (specifically: Information Science, Education, Translation, Statistics, and Anthropology) that have developed the present paper worked on the definition of the topics and top-terms, based on an in-depth review of the records in the MoIL database.

The steps followed to standardize keywords are shown in Fig. 1. In order to reduce the high dimensionality of the terms, a term-clumping process was used to group keywords (Zhang et al. 2014). To compare textual units using measures of similarity, neighbouring terms, according to criteria of lexical proximity, synonymy and/or different spelling, were associated to the first, thereby reducing redundancy and heterogeneity until just 11% (90/814) of the keywords were preserved. The keywords with highest prevalence were selected to represent the resulting groups. These were called top terms.

Four levels of depth were distinguished: field, topic, subtopic and top term. In order to identify the principal research topics within the field of *MoIL,* the experts considered these

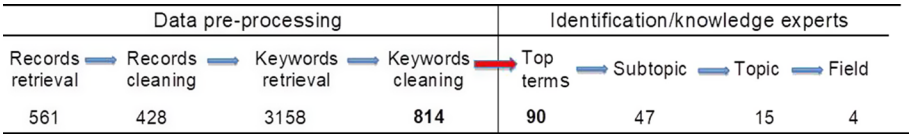

Fig. 1 Processing/categorization sequence

four main fields: *Digital Literacy*, *Information Literacy, Instruments and Methods* and *Teaching–learning process,* and a miscellanea field (M) for terms that were not directly related to the research topic. At a second level, 15 topics, 47 subtopics and 90 top terms were detected, to which the 814 normalized keywords were associated (Fig. 1).

Statistical analysis

The statistical analysis was developed in two approaches: In the first, the terminological corpus was then performed to establish the frequencies of the keywords; the distribution of the terms analysed was obtained, and the time evolution over the period 2006–2019 was studied (Monroy and Diaz 2018).

In the second approach, topic-modelling algorithms consist of statistical techniques for describing the topics and the top terms discussed in the documents, and the subsequent construction of a specific collection of documents. Firstly, a statistical analysis of the keywords in the documents was performed to get an overview of the general structure and, secondly, the density map and the network of co-occurring words are considered in order to detect the main topics discussed, as well as their relationship and evolution over time (Blei 2012).

A word co-occurrence analysis providing a similarity matrix (Hu et al. 2013) was carried out to represent the empirical relationships existing among the keywords from the documentary corpus under study, normalized to 90 top terms. This made it possible to identify, in a two-dimensional space, emerging areas of research and the composition of different scientific domains.

The VOSviewer software package that has been developed for constructing and viewing a bibliometric map was employed. Thus, the top terms can be clustered using the VOS mapping technique and a weighted and parameterized variant of modularity-based clustering (Newman and Girvan 2004), which rely on similar underlying principle (Yan et al. 2012).

As a result, two types of distance-based maps in which the distance between two items/nodes gives an approximate indication of their relatedness (Van Eck and Waltman 2010), are provided:

a. In the density view, the colour of a point in a map is associated to its item density and the size of the label increases with the weight of the item. By default, colours range from blue–green to a yellow scheme: Blue relates to the lowest item density (small number of items in the neighbourhood of a point and low weights of the neighbouring items) and yellow relates to the highest item density (large number of items in the neighbourhood of a point and high weights of the neighbouring items).
b. The network/cluster density view is created using the VOS clustering technique, where the item density of a point in a map is calculated separately for each cluster (Waltman et al. 2010). Then, a two-step process assigns each item to a cluster, considering a weighted average of the colours and the background colour (black or white) of the cluster density view.

Findings

The overall distribution of the keywords in the four fields is shown below (Table 1). The higher incidence of keywords related to the field of the *teaching–learning process* stands out against the lower frequency in *digital literacy* and *instrument and methods*. The

Table 1 Keywords by field

Field	Frequency	Percentage (%)
A. Digital literacy	292	12
B. Information literacy	763	30
C. Instruments and methods	184	7
D. Teaching–learning process	1282	51
Total included	2521	100
M. Miscellanea	637	
Total	3158	

decision was made to discard the *miscellanea* field because it contained keywords that are not directly related to our area of study.

A two-step analysis was performed: First, the incidence at the four levels analysed (field, topic, subtopic, and top term) is provided. Then, fractionalization-based analysis techniques "for normalizing the matrix of co-occurrences" (Eck and Waltman 2009) were used to visualize the specific lines of research and assess the interrelations present in the scientific production analysed.

The topics and subtopics obtained were grouped in the four fields considered (Tables 2, 3, 4, 5). Tables 9, 10, 11 and 12 in the "Appendix 2" show the allocation of the keywords from the initial documentary corpus to the 90 top terms considered.

In the following, we briefly outline the conceptualization of these fifteen main topics:

- *Computer skills* All aspects relating to technologies, program management, Internet access skills within the educational context, computing, training, and counselling are included in this category.
- *e-Literacy* This broad category contains all the elements related to digital literacy, e-literacy and all the means and aspects that are used to access and attain the competencies linked to information literacy.
- *Academic library* The library plays a key role in academic training. Training, instruction, usability, information processing and many other possibilities become key elements of the training process.

Table 2 Topics and subtopics within the field of digital literacy

Field	Topic	Subtopic	*N*
Digital literacy	Computer skills	Computer assisted instruction	53
		Computer skills	13
		Information and communication technology	75
		Total	141
	e-Literacy	Digital literacy	55
		e-Literacy	29
		Online information services	67
		Total	141
	Total		292

Table 3 Topics and subtopics within the field of information literacy

Field	Topic	Subtopic	*N*
Information literacy	Academic library	Librarian	66
		Library instruction	44
		Library services	124
		Library user training	174
		Total	408
	Critical thinking	Critical thinking	16
		Instruction and embedded instruction	17
		Use of e-resources	20
		Total	53
	Information literacy	Information literacy	263
		Lifelong learning	39
		Total	302
		Total	408
	Total		763

Table 4 Topics and subtopics within the field of instruments and methods

Field	Topic	Subtopic	*N*
Instruments and methods	Assessment	Best practices	15
		Educational outcomes	23
		Effectiveness	14
		Perceptions	12
		Student evaluation	36
		Total	100
	Instruments	Methods	30
		Surveys and tests	29
		Total	59
	Quantitative techniques	Statistical analysis	25
		Total	25
	Total		184

- *Critical thinking* This refers to skills and competencies needed to analyse, interpret, and select information from reliable sources, in addition to the rigorous selection of contents.
- *Information literacy* This is the core aspect on which the principles of the need for information, evaluation, use and dissemination as well as the ethical principles derived from the handling of information are based. This includes practice and research, instruction and lifelong learning.

Table 5 Topics and subtopics within the field of teaching–learning

Field	Topic	Subtopic	*N*
Teaching–learning	Blended learning	Learning environment	27
		Multimodal learning	62
		Total	89
	Distance education	Distance learning	113
		Virtual support	19
		Total	132
	Education resources	Open education	41
		Resources	31
		Web 2.0	18
		Total	90
	Faculty	Educational technology	34
		Faculty	58
		Faculty development	68
		Higher education	211
		Teaching–learning methods	54
		Total	425
	Mobile and ubiquitous learning	Mobile communication systems in education	20
		Mobile devices	50
		Mobile learning	39
		Social networks	25
		Total	134
	Online learning	e-Learning	150
		Online instruction	66
		Tutorial programs	18
		Total	234
	Students	Academic skills	40
		Graduates	16
		Learning practices	21
		Teacher–students relationships	15
		Undergraduates	86
		Total	178
	Total		1282

- *Assessment* It is based on the fostering of good practices and ethics, rates results and effectiveness, as well as the capacity for analysis and critical thinking, on the part of both the teacher and the students themselves.
- *Instruments* All the qualitative research methods and instruments, such as surveys, focus groups and case studies, are included here. These instruments provide a basis for educational research.
- *Quantitative techniques* These refer to the assessment instruments of a statistical, quantifiable nature, and under the analytical-positivist, that is, predictionist, paradigm, which is based on a hypothesis that we seek to confirm.

- *Blended learning* This refers to flexible learning, which combines face-to-face learning with online teaching and the resources available on the different platforms or means at students' disposal (multimodal). The methodology that involves the application of blended learning includes teaching through the traditional methods with the use of burgeoning technologies (physical and virtual environments), as well as synchrony and asynchrony.
- *Distance education* This describes training that is carried out in the non-face-to-face way, using resources that make it possible to mark the pace of learning in an autonomous manner, without the need to attend classes or sessions.
- *Educational resources* The instruments and means for attaining competencies and assimilating contents become primordial aspects at all levels of education. Nowadays, many resources are online and the web is the basic way to access them.
- *Faculty* They have a crucial role as guides and facilitators of those processes. Faculty members have to permanently review and update their teaching methodologies in order to adapt to the mobile technology environments.
- *Mobile and ubiquitous learning* This links the current training process in regulated education mainly to learning through mobile devices, given the possibilities they offer regarding direct accessibility, ubiquity, and intercommunication. Likewise, it also contributes to establish a relationship among the different aspects of daily life, such as the use of social and academic networks. The introduction of smartphones into education and the ubiquity deriving there from constitute a growing and unstoppable process.
- *Online learning* It relates to distance learning, mobile learning, and the concept of e-learning. It is based on the use of the Internet as a fundamental element that offers basic resources and means to make teaching and learning processes possible. Online teaching includes all e-learning methodology (online courses, tutorials, open courses, online collaborative work and, in general, web 2.0) and is intimately linked to it, the border between the two being complex. Nevertheless, online learning incorporates a greater number of resources and combines e-learning with other formulas such as blended learning. Although several authors consider that m-learning includes in part the elements and principles of e-learning, as Korucu and Alkan (2011) indicate, "m-learning is a characterized technology and has its own terminology". Thus, and following the authors, "while the terms multimedia, interactive, hyperlinked, media-rich environment are among the terminology of e-learning; terms like spontaneous, intimate, situated, connected, informal, lightweight are among the terminology of m-learning" (p. 1927). In a similar vein, there are recent studies such as those by Rimale et al. (2016) and Kumar et al. (2018), which not only nuance the distinction, but also investigate their respective methodologies and efficiencies.
- *Students* As recipients of the teaching–learning process, students are conceptualized in this case as the group of university students, mainly at the undergraduate stage, whose experiences, practices and competencies will determine the practices to be adopted by teachers, including the modes of relationship and the means employed to implement them.

Analysis by fields and topics

A general analysis of the evolution of the four main fields was performed, based on the number of papers produced each year (Fig. 2). One notable finding is that the number of publications on Digital Literacy, Information Literacy, and the Teaching and Learning

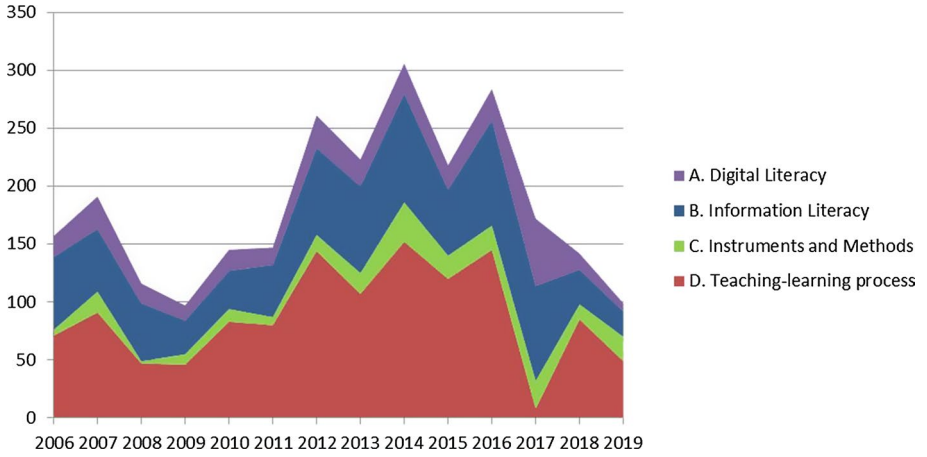

Fig. 2 Time evolution of the trend across fields based on the MoIL database

Process, which increased during the period 2012–2016, has suffered a significant setback from 2016 onwards.

A detailed analysis of the evolution of each of the topics in each field is also provided (Fig. 3). Within the field of *Digital Literacy*, the two topics studied—*e-Literacy and computer skills*—display a parallel incidence. In the field of *Information Literacy*, the topic *Academic library* confirms its importance, showing a notable growth over the whole of the time series studied. The topics in the field *Teaching–Learning Process* appear in the literature displaying a fairly homogeneous behaviour, with the topic *Students* standing out

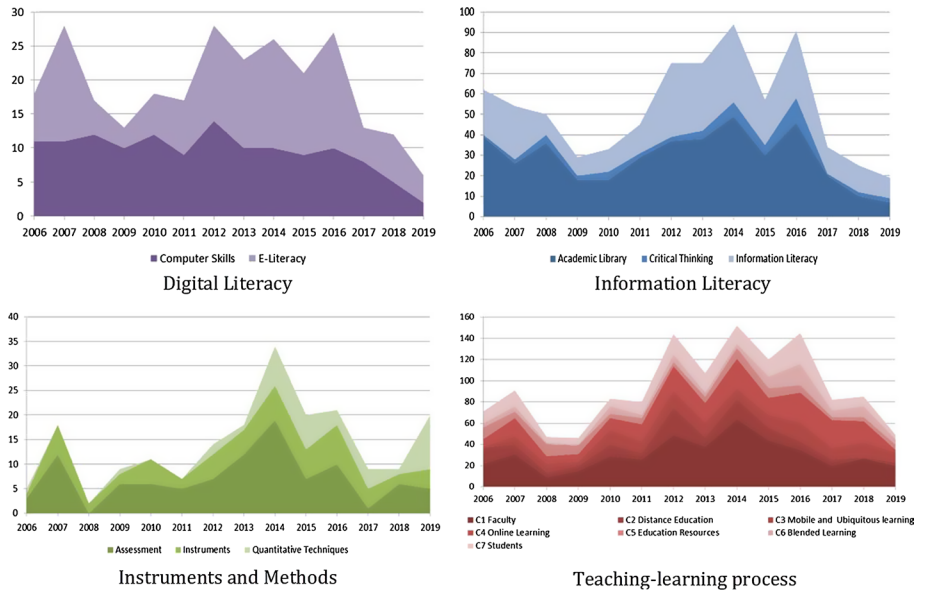

Fig. 3 Cumulative time evolution of topics by field

above the rest. In the field *Instruments and Methods* we find a greater degree of heterogeneity, because the topic *Quantitative techniques* presents a series of marked ups and downs, while that of *Assessment* has a greater weight throughout the entire period. According to the results, we can confirm that during the five-year period 2012–2016 there was a high incidence of publications related to the field of study, in which the topics considered reached historical highs. The change of trend that takes place in 2017 is remarkable in the topics of the fields *Digital Literacy*, *Information Literacy* and *Teaching–Learning Process*, while the topics of the field *Instruments and Methods* have recovered from the fall suffered in 2017 and seem to be focus of interest in recent years.

Analysis by top terms

Tables 9, 10, 11 and 12 in the "Appendix 2" show the detailed classification and the representativeness of the terms extracted from the documents analysed. This allows the most significant frequencies of the previously extracted top terms to be observed. In particular, those with a higher incidence are displayed in descending order (Table 6). In the categorization we have carried out, three top terms related to the MoIL domain can be seen: *mobile learning, mobile devices/smartphones,* and *mobile communication networks,* which are present in 18.45% of the documents analysed.

Essentials of MoIL

Essentials of MoIL refer to the basic topics in this domain, together with their most significant interrelations and groupings. Sixty top terms (66.67%) with the highest levels of co-occurrence were included in the analysis. The map was created using the VOSViewer software package, as it provides a low-dimensional visualization in which top terms are located in such a way that the distance between any pair of top terms reflects their similarity (Van Eck and Waltman 2007). This software identifies the clusters of co-occurring words, thus allowing identification of the main terms and their relationships (Waltman et al. 2010).

Density views of the main top terms are obtained using the association strength normalization method. This technique allows us to display the most trending top terms, as the item density of a point on a map depends on both the number of neighbouring terms and their weights. The colours scheme -called viridis- ranges from blue–green to yellow, where yellow is related to the highest item density and blue denotes the lowest item density. The strength of the terms *information literacy, higher education, academic library* and *distance education* is especially prominent (Fig. 4).

Counting the co-occurrences enables us to obtain a measure of similarity (comparable to a spatial distance), which makes it possible to represent the relationships (conceptual clustering) that exist among the units under study and to identify, among other aspects, emerging areas of research or the composition of fields of science (Ding et al. 2000; Kim et al. 2008; Leydesdorff and Heimeriks 2001).

With the aim of visualizing the interrelationships and therefore the research trends in MoIL, the top terms included in the documentary corpus were used to apply a *fractional counting* methodology. Here, each top term cited in a publication has the same influence in a bibliographic coupling analysis as each publication has the overall weight equal to one and each top-term has a weight of $1/N_i$, being N_i the total number of top terms in the 'i'-publication (Perianes-Rodriguez et al. 2016). For the interpretation of the results, this study is not interested in obtaining small clusters, so minimum cluster size parameter is

Table 6 Top terms with the highest frequency

Top term	*N*	Top term	*N*	Top Term	*N*
Information literacy	204	Surveys	29	Web 2.0	19
Academic library	118	Online courses	27	Curriculum	17
Higher education	89	Online learning environment	27	Digital library	17
Distance education	73	Collaborative work online	26	Digital media	17
Online learning	73	Learning	25	Embedded librarianship	17
Librarians	57	Methods	25	Technological literacy	17
e-learning	56	Social networks	25	Tutorial programs	17
User training	56	Statistical analysis	25	Critical thinking	16
Education	53	Competencies	24	e-journals	16
Information and library science	48	Online information services	24	Faculty	16
Undergraduate students	48	Information literacy instruction	23	Graduate students	16
Computer aided instruction	47	Performance	23	Instructional development	16
ICT	43	Educational technology	22	Library research	16
Mobile learning	*42*	Internet in education	22	Accessibility	15
Distance learning	40	*Mobile devices + smartphones*	*22*	Ethic and quality	15
Digital literacy	39	Assessment	21	Evaluation	15
Online instruction	39	Information literacy—research	21	Information literacy practices	15
Students	38	Learning experiences	21	Informational skills	15
Multimodal methodologies	36	Learning management system	21	Life long learning	15
University and college	36	Library services	20	*Mobile communication networks*	*15*
Postsecondary education	35	Open courses	20	Teacher-student relationships	15
Teaching methods	35	Cognitive style	19	Cognitive skills	14
Library instruction	34	ICT skills	19	ICT in education	14
e-resources	33	Pedagogical innovations	19	Library resources	14
Educational resources	31	Platforms	19	Self-efficacy	14

Italics indicates top terms related to the MoIL domain

specified. Then, clusters that are too small are merged with other clusters (Waltman and Van Eck 2012). The results show the empirical relationships that exist between the original keywords of each document analysed. VOSviewer collects the matrix of co-occurrence of terms, providing a visualization of the research trends.

Each cluster, or thematic grouping, consists of a specific set of top terms that is clearly delimited by its situation within a particular area of the map, which in turn reveals the research trends within the previously delimited MoIL domain (Fig. 5, Table 7). As can be observed, the structure of the map stands out for the notable overlapping of the six thematic groupings that have been discovered.

The six clusters discovered are also understood to represent the clearest research trends. Ranked in order of importance, these trends are the following: IL and e-Learning, Mobile

Fig. 4 Density view showing the strengths of the most frequently used terms

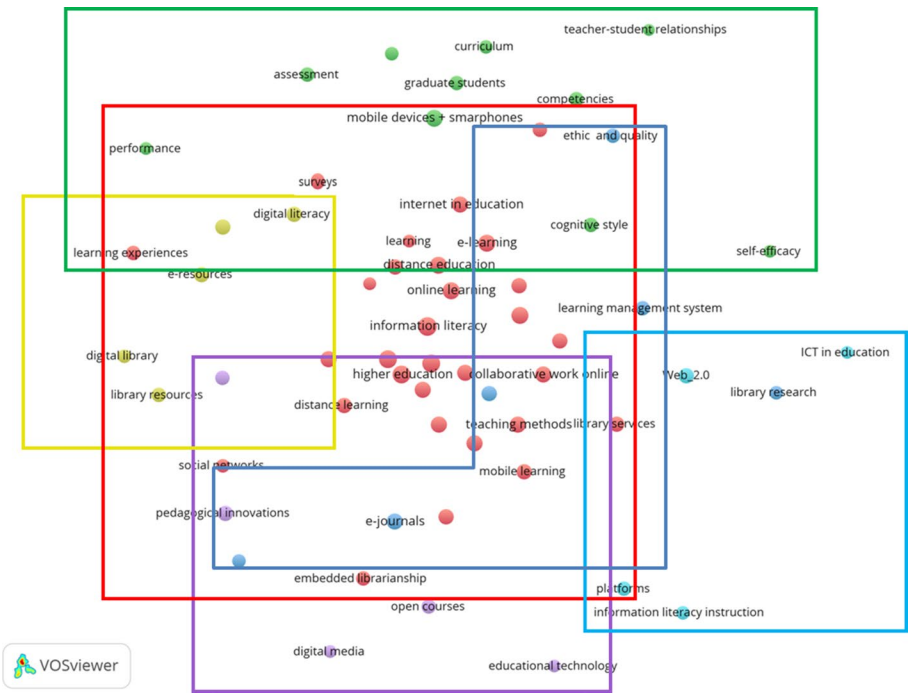

Fig. 5 Cluster view of the MoIL map normalized using the fractional counting method

Table 7 Clusters and top terms of the MoIL framework

Cluster	Top terms
Information literacy and e-learning (30 top terms) Colour	Academic library; collaborative work online; computer assisted instruction; distance education; distance learning; e-learning; education; embedded librarianship; higher education; information and communication technology; information literacy; IL science; internet in education; learning; learning experiences; library instruction; library services; methods; *mobile learning*; multimodal methodologies; online courses; online instruction; online learning; social networks; students; teaching methods; surveys; undergraduate students; university and college; user training
Mobile devices and competencies (10 top terms) Colour	Assessment; cognitive style; competencies; curriculum; graduate students; *mobile communication networks*; *mobile devices and smartphones*; performance; self-efficacy; teacher-students relationships
Ethics (6 top terms) Colour	e-journals; ethic and quality; learning management systems; librarians; library research; online learning environment.
Library and e-resources (5 top terms) Colour	Digital library; digital literacy; e-resources; information literacy-research; library resources
Educational technology (5 top terms) Colour	Digital media; educational technology; open courses; pedagogical innovations; statistical analysis
Technological environment (4 top terms) Colour	ICT in education; IL instruction; platforms; web 2.0

devices and competencies, Ethics, Library and e-resources, Educational technology, and Technological environment.

The classification in large areas makes it possible to trace the evolution of research trends, analysing the incidence (annual occurrence/total occurrence of the term in %) of the main terms that give name to the clusters identified throughout the period 2006–2019. The time series reflects the emerging character of the trends Mobile devices and competencies, Educational technology and Technological environment, and the stability of broader trends such as Information Literacy and e-Learning, which maintain a stable incidence in the analysed time interval (Fig. 6).

Information literacy and e-learning

This is the largest and most important thematic cluster due to its centrality, overall weight, density, and degree of overlapping with the other topics. A large number of its top terms are related to IL, education, and distance and/or virtual learning. The average weight per top term is the most prominent (57.30), with a "% link-strength" of 62.65% (Table 8). Of the thirty words of which it is composed, the terms at the core are, for the most part, of a generic nature: *academic library, information literacy, distance education, distance learning, learning, e-learning, LIS, higher education, online learning, user training*.

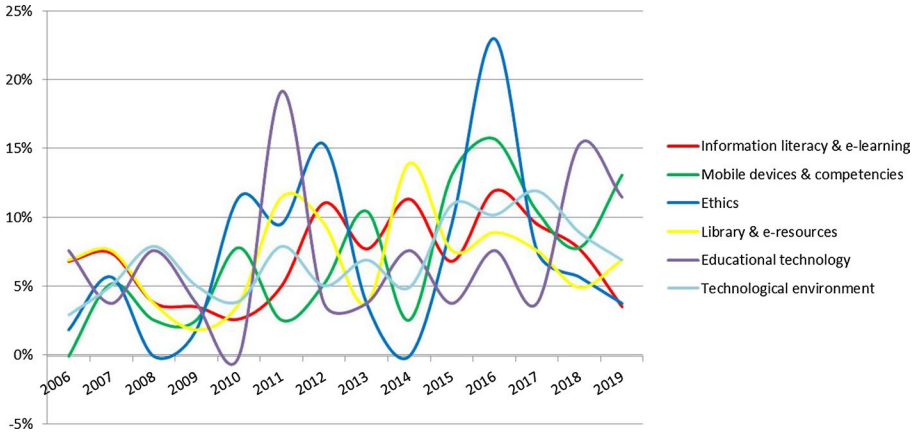

Fig. 6 Temporal evolution of the research trends

Mobile devices and competencies

With ten items, this group is situated in the upper top area of the map. Its link strength (i.e., the strength of the link between the nodes of the keywords) places it as the second largest thematic group of MobIL (Fig. 5, Table 7). The core terms reflect lines of research related to *assessment, competencies, curriculum*, *self-efficacy, performance* and *teacher-students relationships*. This cluster includes two of the three top terms related to the mobile domain: *mobile communication networks*, *mobile devices* and *smartphones*, which may demonstrate its use as a tool to facilitate a paradigm shift in the processes of teaching, learning and evaluation.

Ethics

This thematic group includes six top terms, including e-journals; ethic and quality; learning management systems; librarians; library research; online learning environment. These terms are scattered across the map, intermingled with the other trends (Table 7). The outstanding impact of these terms in 2016 (Fig. 6) highlights the importance of the concepts regarding this group in the context of the MoIL framework.

Library and e-resources

The fourth cluster is situated entirely within the Information literacy and e-Learning cluster. It is therefore a somewhat secondary grouping, consisting of only five terms, among which digital library, digital literacy, library resources and e-resources stand out above the rest. Nevertheless, their items offer a high mean weight per word (mean 41.8, Table 8), showing the importance of the terms of this group within the whole framework of the documentary corpus analysed throughout the period under study (Fig. 6).

Educational technology

This cluster is located at the bottom area of the map (Fig. 5) and involves five terms related to educational and pedagogical approaches that facilitate learning, such as digital media,

Table 8 A comparison of MoIL essentials-research trends

Essentials—research trends	Mean weight	link strength	% link strength (%)
1 Information literacy and e-learning	57.30	2135	62.65
2 Mobile devices and competencies	37.75	339	9.95
3 Ethics	32.50	242	7.10
4 Library and e-resources	41.80	304	8.92
5 Educational technology	36.80	211	6.19
6 Technological environment	23.00	177	5.19
Total		3408	100

educational technology, open courses and pedagogical innovations. These terms present a low mean weight per word (mean 36.8, Table 8), possibly due to the low presence of these terms in the publications at the beginning of the analysed period (Fig. 6).

Technological environment

The last and smallest cluster, given its peripheral profile and low density, is located in the lower left corner of the map (Fig. 5). It is made up of terms such as ICT in education, Platforms and Web 2.0, which are intrinsically related to the technology that transforms the educational experience.

Discussion

There are many possible ways of categorizing and visualizing the diagrams and images that reflect the associations among terms in the collections of documents. The new capabilities and possibilities of the visual system allow for comparisons, pattern recognition, the detection of changes and other cognitive skills (Yee et al. 2003).

The essentials of MoIL

This research, focused on the conceptualization of the MoIL domain based on the literature produced in the period 2006–2019, expands and delves deeper into some of the perspectives previously put forward by González-Valiente (2015), who does not disaggregate the levels, but instead starts out with topics-keywords; Liu et al. (2011), Hu et al. (2013), Zins (2007), who conducted a critical review of the keystones of Information Science; or Pinto (2015), on the subject of Information Literacy Assessment in Higher Education (ILAHE), providing a categorization, methodology and techniques that allow the identification of the main research topics and the coincidences and degree of proximity between them.

The dominant terms that we have identified highlight the relational and multidisciplinary nature of the area under study. As a starting point for the research, the main *fields* of the documentary corpus were defined, namely, *Digital Literacy, Information Literacy*, *Instruments and Methods* and *Teaching–Learning process*. It was discovered that the most prominent topic was the field of *Teaching–Learning process*, followed by that of *Information*

Literacy. Both fields play a key role in the analysis presented in this study. Likewise, given their high frequency, several top terms also stand out, as *Information literacy*, *Academic library*, *e-learning, online learning*, *Distance education*, and *Higher Education*.

The comparison between these fields and starting terms and the results obtained by means of the clusters used to identify trends allows us to discover some specific circumstances of the MoIL domain:

- An absence of borders between the previously defined fields, which reflects the interdisciplinarity that exists, is again seen in the composition of the resulting trends. The fields and trends overlap to a greater or lesser extent, displaying relationships of dependence, continuity, and contiguity (Cheng et al. 2014).
- As regards content, there are certain correspondences between the trends identified and the predetermined fields, although with some nuances. The initial field referring to Instruments and Methods has been diluted among the resulting trends, given the interdisciplinary profile of the MoIL domain.

In short, six essential components—research trends—have been revealed in the MoIL domain: IL and e-learning, Mobile devices and competencies, Ethics, Library and e-resources, Educational technology and Technological environment.

Convergence of information literacy and e-learning

The first and main trend in the MoIL domain is what we have named *Information Literacy and e-learning*, which is very present in the literature reviewed (Burkhardt and Cohen 2012; Havelka and Verbovetskaya 2012; Virkus 2012; Havelka 2013; Chatterjee et al. 2015; Schmidt Hanbidge et al. 2016; Rodrigues et al. 2019).

All these authors highlight the convergence of IL and e-learning, with an especially prominent role played by the latter, as it is a phenomenon that has been the usual common ground in the processes of acquiring information skills in HE environments over the last decade. This trend works in both directions, because the two concepts that it is made up of provide each other with feedback. In fact, the purpose of IL is of course e-learning, and this in turn becomes a medium for IL. As stated by Kratochvil (2014: 322) "e-Learning can be a viable alternative teaching method for information literacy". There are studies in this line, such as Hess (2013); Chang and Chen (2014); Chen, Lee and Hsiao (2018) and Reynolds et al. (2019), which underline that this convergence has become more pronounced in recent years.

Mobile devices and competencies

This is the second most prominent trend in the configuration of MoIL in HE environments. The convergence between informational competencies and mobile devices, which we have called "mobile devices/competencies", emerges as one of the main components of the MoIL domain, reaching its peak in 2016 (Spring 2016; Ntuli and Kyei-Blankson

2016; Chin Roemer and Greer 2016; Marta-Lazo et al. 2016; Harrison 2016). The literature analysed offers many examples of combinations of topics related to both assessment and informational competencies and mobile devices. While some studies focus on assessment (Hung and Zhang 2012; Glassman and Worsham 2017), others focus their attention on the use of mobile technologies (Su and Cheng 2015; Hess 2015; Tang and Chaw 2016). On the other hand, Aharony and Gazit (2019) point out the inherent relationship between self-efficacy IL and the introduction of mobile devices and their appropriate use in higher education.

In what follows, we will focus our attention on the emerging trend of mobile technologies within the framework of education. The three top-terms found, *mobile learning*, *mobile devices + smartphones*, and *mobile communication networks,* show a notable relationship. They all belong to the topic of *mobile and ubiquitous learning*. The top term *mobile learning*, which is clearly present in the literature (in 42 documents) (Walsh 2010; Brabazon 2014; Bosman and Strydom 2016; Mullins 2017), is directly located within the IL and e-Learning cluster. The top terms *mobile devices + smartphones* found in the analysed literature (Havelka 2013; Magunje and Brown 2013; Ko et al. 2015; among others) and *mobile communication networks* (Kvale and Buset 2007; Mansour 2016), which appear respectively 22 and 15 times in the literature, are closely related to other top terms belonging to their own cluster named Mobile devices and Competencies. Research by Chang and Chen (2014), Johnson (2010) and Lawal et al. (2014) echo this terminological convergence.

Ethics

The terms of this trend are intrinsically linked. On-line learning environments, which directly and indirectly influence student learning, are becoming more common as an alternative learning environment in HE (Bilgiç et al. 2016). Likewise, learning management systems are widely used for educational and training purposes in on-line learning environment, since they offer tools that encourage learner-educator, learner-learner and learner-content communication (Psaromiligkos et al. 2011). The development of ethical instruction and research in this field is paramount, since any training process should foster the promotion of ethics and quality (Chen et al. 2007).

Among other examples of this trend in the analysed literature of the MoIL base, one could mention the work of Mestre et al. (2011), which focuses on how *librarians* employ *learning management systems* in user training and *Library research*; Hess (2013), also in line with the Ethics trend, analyses best practices for engaging students from user training provided by *librarians*; Murray et al. (2012) also focuses on *learning management systems* that can provide motivation in user training by librarians, as does Chen et al. (2015), who influence the *online learning environments* in the development of Library research. In all these works, it should be emphasized that the ethical concern for providing quality training underlies.

Library and e-resources

Due to the increasing digitalization of information, libraries are being transformed into digital libraries. Traditional resources are complemented by e-resources, which facilitate and modify the way users use libraries. Thus, the awareness of the importance of digital literacy becomes essential in order to access information and acquire information resources, in the new digital libraries (Kenchakkanavar 2014).

Furthermore, different authors stress the growing availability of electronic resources both in the classroom and in libraries (Dalal and Lackie 2014; Greenlee 2014; Kumar 2016). Tutorials, promotional videos and various electronic resources become the most immediate reality of the teaching–learning processes, especially in the realm of higher education. The generalization of e-resources, an unstoppable and innate reality of today's generations, "offers numerous advantages to students such as convenience, flexibility and access to education" (Bowers and Kumar 2015: 27). This trend is consolidated since 2014, as shown in the studies by Daniel (2015), Albert and Sinkinson (2015), Huang (2015), Mullins (2017), Rodgers and Puterbaugh (2017) and Wissinger et al. (2018). The presence in social networks and the use of these for the dissemination of online resources is a topic of interest presented by Harrison et al. (2017) Not only is it a question of interest to be taken into account in the future, but it also shows how the needs of the student body are moving in this direction. Similarly, recent studies such as Stopar and Bartol (2019) highlight these growing convergences in recent years.

Educational technology and technological environment

Although present to a lesser extent than the previous trends, these are evidently growing in the construction of MoIL in HE. Courtney and Wilhoite-Mathews (2015) note the shift from the traditional forms of literacy to the introduction of technological environments. Qian and Clark (2016), Caldwell (2018), and Pooley et al. (2019) underline these same aspects, with special emphasis on mobile technologies and higher education, proposing gamification and digital environments to increase motivation and purposeful engagement. This confirms the fact that educational technology has taken up a place in literacy, regardless of the medium or device used, although it is clear that these are becoming increasingly dependent on mobile technologies. This fact is confirmed by studies such as Zawacki-Richter and Latchem (2018), who stress that "higher education in particular was adopting these means, both on and off campus" (p. 141).

In sum, these uncovered clusters reflect, as the present research puts forward, the research trends in MoIL, with certain similarities to some of the trends included in the Horizon Report (2018) within the field of Higher Education. The report's insistence on the incorporation of the emerging technologies such as mobile, with its ubiquitous and immediate nature, only reinforces the results obtained here. The convergence between IL and e-Learning shows the necessary incorporation for the acquisition of an optimized learning of technologies, as underlined by the Horizon Report.

Conclusions

In recent years, we have witnessed the growing and unstoppable progression of mobile technologies, especially in HE environments. This work hopes to contribute to the definition of a new informational sub-domain, that of MoIL, which is gradually being introduced in a slow but subtle manner into the information landscape. We are not aware of any similar proposal addressing the issue in this depth.

Bibliometric analysis about the emerging domain of MoIL has provided us not only with its evolution along the 2006–2019 stage but also a sketch of its future conceptual framework. Besides, the main research trends have been uncovered. Graphic visualization of the specific research lines in the domain is also provided. Concerning possible MoIL contents, we have uncovered six thematic clusters, which should be basic components of its future conceptual framework: IL and e-learning, Mobile devices and competencies, Ethics, Library and e-resources, Educational technology, and Technological environment. At the same time, these components represent the research trends within this sub-domain. Ultimately, MoIL involves competency in each of these six trends, which together may contribute to making-up a coherent conceptual framework.

The emerging field of MoIL locates at the convergence of two greatly consolidated domains: IL and e-Learning. This conjunction has been significantly favoured by the rise of mobile technologies and the subsequent affordances of ubiquity and immediacy. These key components—information literacy, e-learning, and mobile technologies—are at the foundations of the embryonic MoIL domain; besides, we have been able to show that its convergence has increased in the last decade. These outcomes are in line with the Horizon Report (2018) and its recommendations for HE, which reflect initiatives such as the incorporation of technologies, adaptability in teaching and learning processes and the general use of the Internet in the educational environments.

Regarding possible future lines of research, the aforementioned intersections between IL and e-learning, with the mobile element as the necessary link, open up new perspectives. However, and although we do not have any concrete evidence of it, a gap can be intuited in the perception, use, and application of mobile technology for IL and e-learning processes. An analysis of the publications dealing with this digital gap, and contrasting them against the MoIL trends uncovered here, would constitute an important line of future research. Proof of it is the lack of publications in this direction. Only the works by Canuel and Crichton (2011), Farkas (2012), Foo et al. (2013), Wray and Mulvihill (2018) and Zakharov and Maybee (2019) point directly at MoIL. In the same path, an analysis of the geographical origin of the publications would be of interest. This way hypothesis of "universality" in trends or "regionality" in the digital gap could be tested.

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Appendix 1: A sample of MoIL database

Database	Authors, Primary	Title Primary	Periodical Full	Pub Year	Keywords
SCOPUS	Sapargaliyev, Daniyar	Development of mobile learning in Kazakhstani higher education	International Journal of Mobile Learning and Organisation	2012	Development;Higher education;Mobile learning
SCOPUS	Havelka, Stefanie	Mobile Information Literacy: Supporting Students' Research and Information Needs in a Mobile World	Internet Reference Services Quarterly	2013	information literacy;mlearning; mobile devices;mobile information literacy;mobile learning;mobile literacy;smartphones
SCOPUS	Kleinveldt,Lyn Tatum; Zulu, Mbali	Integrating tablet technology into information literacy training at CPUT libraries: a pilot project	Library Hi Tech News	2016	Blended learning;e-learning;Information literacy;Online learning environment;Student experience;Tablet technology
WOS	Magunje,Caroline;Brown,Cheryl	From Cellphone to Computer: University Students' use of Technology in First Year	Proceedings of the 8th International Conference on E-Learning	2013	mobile phones;digital literacy;first year experience;female students;Higher-education;Experience;Education & Educational Research
ERIC	Bosman,J.P.;Strydom, Sonja	Mobile Technologies for Learning: Exploring Critical Mobile Learning Literacies as Enabler of Graduateness in a South African Research-Led University	British Journal of Educational Technology	2016	Higher Education;Postsecondary Education;Qualitative Research;Graduation;Foreign Countries;Technology Uses in Education;Critical Literacy;College Students;Technological Literacy;Telecommunications;Skill Development;Teaching Methods;Handheld Devices
LISA	Hicks, Alison; Sinkinson, Caroline	Situated Questions and Answers: Responding to Library Users with QR Codes	Reference & User Services Quarterly	2011	Internet access , Smartphones , Cellular telephones , Internet , Technological change , Librarians , Instant messaging , Codes , Museum exhibits , Communication , Education , Information retrieval
LISA	Canuel, Robin; Crichton, Chad	Canadian academic libraries and the mobile web	New Library World	2011	Mobile communications networks , Web sites , Academic libraries , Software , Mobile commerce , Analysis , Studies , Canada
LISA	Mansour, Essam	Use of smartphone apps among library and information science students at South Valley University, Egypt	The Electronic Library	2016	Studies , Cellular telephones , Smartphones , Education , Teaching , Academic libraries , Research methodology , Learning , College students , Communication , University students , Researchers , Portable computers , Access to information , Library and information science , Schools of library and information science
LISA	Mullins, Kimberly	Research Plus(TM) mobile app: information literacy "On the Go"	Reference Services Review	2017	Academic libraries , Librarians , Studies , Higher education , Students , School environment , Library resources , Learning , Design , Internet , Information literacy , Designers , Educational technology , Portable computers , Smartphones , Digital literacy , Access to materials , Mobile libraries , Usability , User services
LISA	Parsons, Georgina	Information provision for HE distance learners using mobile devices	The Electronic Library	2010	Studies , Cellular telephones , Wireless communications , Library resources , Higher education , Foreign language learning , Internet resources , Academic libraries , Educational materials
LISA	Walsh, Andrew	QR Codes -- Using Mobile Phones to Deliver Library Instruction and Help at the Point of Need	Journal of Information Literacy	2010	Mobile learning, mlearning, QR codes, mobile phones, context appropriate information literacy, location aware devices , article, Information literacy , Distance learning , User training , Cellular telephones , Quick Response
LISA	Doi, Carolyn; Mason, James; Wiercinski, Jared	Mobile Access to Audio and Video Collections in Libraries and Other Cultural Institutions	Partnership : the Canadian Journal of Library and Information Practice and Research	2011	Library collections , Streaming media , Technology adoption , Mobile communications networks
LISTA	Blakesley, Elizabeth	Asked and Answered.	Journal of Academic Librarianship	2015	Academic libraries; Information literacy; RESEARCH; Distance education; Communication in education; Education
LISTA	Ko, Eddie H.T.; Chiu, Dickson K.W.; Lo, Patrick; Ho, Kevin K.W.	Comparative Study on m-Learning Usage Among LIS Students from Hong Kong, Japan and Taiwan.	Journal of Academic Librarianship	2015	Comparison; Culture; Learning management platforms; Library and Information Science (LIS); Mobile learning (m-learning); Smartphone
LISTA	Niauraite, Julija	Open e-learning-- A part of library services.	IATUL Annual Conference Proceedings	2011	Information literacy; Academic libraries; Web services; Vilnius (Lithuania); Lithuania; Mobile communication systems in education; Open learning
LISTA	Burkhardt, Andy; Cohen, Sarah Faye	Turn your cell phones on.	Communications in Information Literacy	2012	Information literacy; Academic librarians; Mobile communication systems; Québec (Province); Champlain College; Cell phones; Student response systems
SCOPUS	Sherriff,Graham	Guide on the Side and LibWizard Tutorials Side-By-Side: How Do the Two Platforms for Split-Screen Online Tutorials Compare?	Journal of Web Librarianship	2017	digital learning objects; flipped instruction; information literacy; learner performance data; online learning; split-screen tutorials; Web services
SCOPUS	Brabazon, Tara	The disintermediated librarian and a reintermediated future	Australian Library Journal	2014	disintermediation; information literacy; mobile learning; reintermediation
SCOPUS	Meurant, Robert C.	L2 Digital Literacy: Korean EFL students use their cell phone videocams to make an L2 English video guide to their college campus	Proceedings The 2007 International Conference on Intelligent Pervasive Computing, IPC 2007	2007	Computer graphics, Linguistics, Mobile phones,Students,Telecommunication equipment,Telephone,Telephone sets,Bilingual dictionaries,Cell phones,College students,Digital literacy,English languages,File conversion,Home pages,International conferences,Pedagogical applications,Pervasive Computing,Social networking,Ubiquitous computing
WOS	Gallego-Lema, Vanesa, Muñoz-Cristobal, Juan Alberto, Arribas-Cubero, Higinio Francisco, Rubia-Avi, Bartolomé	Ubiquitous learning: a learning process in Physical Education in the Natural Environment	Revista Latinoamericana de Tecnología Educativa-RELATEC	2016	Mobile Learning;Educational Technology;Teacher Training;ICT;Physical Education

Appendix 2: Top terms

See Tables 9, 10, 11 and 12.

Table 9 Top terms in digital literacy field

Topic	Subtopic	Top term	N
A. Digital literacy field			
Computer skills	Computer assisted instruction	Computer aided instruction	46
		Computer software	7
	Computer skills	Computer science	13
	Information and communication technology	ICT	41
		ICT in education	14
		ICT skills	18
e-Literacy	Digital literacy	Digital library	19
		Digital literacy	39
	e-Literacy	Information needs	12
		Technological literacy	17
	Online information services	e-Journals	16
		e-Resources	27
		Online information services	24

Table 10 Top terms in information literacy field

Topic	Subtopic	Top term	N
B. Information literacy field			
Academic library	Librarian	Information management	9
		Librarians	57
	Library instruction	Library instruction	34
		Web-based instruction	10
	Library services	Information and library science	48
		Libraries and education	11
		Library research	16
		Library resources	14
		Library services	20
	Library user training	Academic library	118
		User training	56
Critical thinking	Critical thinking	Critical thinking	16
	Instruction and embedded instruction	Embedded librarianship	17
	Use of E-resources	Usability	9
	Life-long learning	Adult education	12
Information literacy		Internet	12
		Life long learning	15
	Information literacy	Information literacy	204
		Information literacy instruction	23
		Information literacy practices	15
		Information literacy—research	21

Table 11 Top terms in instruments and methods field

Topic	Subtopic	Top term	N
C. Instruments and methods field			
Assessment	Best practices	Ethic and quality	15
	Educational outcomes	Performance	23
	Effectiveness	Self-efficacy	14
	Perceptions	Perceptions	12
	Students evaluation	Assessment	21
		Evaluation	15
Instruments	Methods	Instrument design and case studies	25
	Surveys and tests	Surveys	29
Quantitative techniques	Statistical analysis	Statistical analysis	25

Table 12 Top terms in teaching–learning process field

Topic	Subtopic	Top term	N
D. Teaching–learning process field			
Blended learning	Multimodal learning	Collaborative work online	26
		Multimodal methodologies	36
Distance education	Distance learning	Distance education	73
		Distance learning	40
	Virtual support	Platforms	19
Education resources	Open education	Internet in education	21
		Open courses	20
	Resource	Educational resources	31
	Web 2.0	Web 2.0	19
Faculty	Educational technology	Educational technology	22
		Instructional materials	12
	Faculty	Curriculum	17
		Faculty	16
		Learning	25
	Faculty development	Competencies	24
		Instructional development	16
		Instructional effectiveness	9
		Pedagogical innovations	16
	Higher education	Education	51
		Higher education	89
		Postsecondary education	35
		University and College	36
	Teaching learning methods	Cognitive style	19
		Teaching methods	35

Table 12 (continued)

Topic	Subtopic	Top term	N
Mobile and Ubiquitous learning	Mobile communication Systems in education	Mobile communication networks	20
	Mobile devices	Digital media	17
		Mobile devices and Smartphones	33
	Mobile learning	Mobile and Ubiquitous learning	39
	Social networks	Social networks	25
Online learning	E-learning	e-learning	56
		Online learning	73
		Learning management system	21
	Online instruction	Online courses	27
		Online instruction	39
	Tutorial programs	Tutorial programs	17
Students	Academic skills	Cognitive skills	14
		Informational skills	15
		Learning skills	11
	Graduated	Graduate students	16
	Learning practises	Learning experiences	21
	Teacher students relationships	Teacher-student relationships	15
	Undergraduates	Students	38
		Undergraduate students and College students	48

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