Research issues of the top 100 cited articles on information literacy in higher education published from 2011 to 2020: A systematic review and co-citation network analysis

Chao-Chen Chen
Chung Yuan Christian University

Ning-Chiao Wang
University of Wisconsin–Milwaukee

Kai-Yu Tang
National Chung Hsing University

Yun-Fang Tu
Fu Jen Catholic University

Information literacy is a core research topic in the field of library and information science. The developmental context of this field can be examined through a long-term retrospective analysis of relevant literature. This study explored the research trends and potential research issues in the top 100 most frequently cited articles on information literacy in higher education published from 2011 to 2020. In addition to a systematic review, this study employed bibliometric methods, including co-citation network analysis, to identify four main research streams in the field of information literacy in higher education: (a) the relationships among students' information literacy beliefs, competencies, attitudes and behaviour; (b) teachers', librarians' and students' perspectives on information literacy; (c) the relationship between students' information literacy and epistemic beliefs; and (d) the web search behaviour of digital natives. Accordingly, potential directions for future research and practitioner notes related to information literacy in higher education are proposed herein as a reference for researchers, teachers and policymakers.

Implications for practice or policy:
- For administrators of higher educational institutions, understanding the challenges of new digital technologies and providing training to develop information literacy skills are crucial.
- For teachers, designing teaching materials and pedagogy based on the latest information literacy standards and framework is useful.
- Collaboration with professionals from different disciplines is also useful for teachers to integrate information literacy into subject learning activities to cultivate the information literacy competencies of students.

Keywords: co-citation analysis, higher education, information literacy, systematic review, information literacy standards, research topics

Introduction

Information literacy is a core research topic in higher education (Albitz, 2007; Pinto, 2015). Since the dawn of the 21st century, the increasing use of the Internet and new technologies has highlighted the importance of information literacy and digital competency (Blau et al., 2020). Stopar and Bartol (2019) reported that information literacy is an important topic related to education, computing, information science and libraries and argued that these fields are closely related to each other. The rapid advancement and popularisation of computers and communication technologies have given rise to diverse conceptions of and questions related to information literacy (C. C. Chen et al., 2021). Rader (2002) identified a number of key topics related to information literacy from the perspective of library service: information literacy and higher education, user instruction in schools, user instruction in public libraries, user instruction in special libraries, information skills training in the workplace, assessment of information literacy, the global environment, national and

international conferences, notable websites, examples of model programmes and international programmes for information literacy.

Some researchers have explored the key components of information literacy and their relationships to learning. For example, Greene et al. (2014) investigated the relationships among the self-regulated learning, epistemic cognition and learning gains of college students who studied vitamins on the Internet. They reported that learning using the Internet did help the students increase their understanding of vitamins and that self-regulated learning and epistemic cognition were associated with digital learning gains. Çoklar et al. (2017) examined the relationships between online information search strategies and information literacy as well as digital nativity through a survey of 398 digital-native university students and discovered that information literacy exerted a greater influence on online information searching than did digital nativity. Blau et al. (2020) also explored methods of developing graduate students' digital literacy competencies through collaborative and active learning and highlighted the importance of self-regulation and familiarity with new technologies to students' digital literacy competencies.

Some researchers have also argued for the importance of conducting bibliometric analysis or systematic reviews to investigate the trends in research on information literacy in higher education (Pinto, 2015; Pinto, Fernández-Pascual et al., 2020). For example, C. C. Chen et al. (2021) used bibliometric mapping analysis and content analysis to explore research trends among studies on information literacy in higher education published from 2011 to 2020. Some researchers have integrated bibliometric lexical analysis and visualisation tools to map out research topics and social networks in studies on knowledge graph research (X. Chen, Xie et al., 2021) and personalised language learning (X. Chen, Zou et al., 2021). Moreover, some have adopted co-citation analysis, which was first proposed by Price (1965) and Small (1973), to measure the relationships among cited and citing articles in various fields, including educational leadership and administration (Hallinger & Kovacevic, 2019, 2021), e-book learning (Tang, 2021), nursing education (Chang et al., 2021) and virtual reality-supported education (Cheng et al., 2022). Recently, scholars have emphasised the value of analysing frequently cited publications in identifying research trends (Antonakis et al., 2014; Buta et al., 2016; Chang et al., 2021). Hsu et al. (2018) and Hwang and Tsai (2011) argued that such review studies enable researchers to quickly grasp research topics and trends.

In conducting information literacy studies, most researchers have used bibliometric analysis to investigate the development of information literacy as well as trends in information literacy literature (Majid et al., 2015), information literacy publications in the social sciences and humanities (Bhardwaj, 2017) and the global status of information literacy research (Kolle, 2017). However, few studies have visualised and examined studies on information literacy in higher education as related to specific settings or education levels (e.g., Pinto, 2015; Pinto, Fernández-Pascual et al., 2020), especially by using co-citation analysis. Some researchers have also pointed out that two frequently cited articles are not always necessarily frequently co-cited articles because the researchers conducting the studies described in the citing articles may not have similar research interests (Chang et al., 2021; Cheng et al., 2022; R. A. Smith, 2019). Drawing on the work of C. C. Chen, Wang et al. (2021), Lin and Hwang (2019) and Tang et al. (2021), this study analysed the top 100 most frequently cited articles on information literacy in higher education in the Social Sciences Citation Index made available through the Web of Science (WoS) database in terms of the participants, research methods, information literacy standards and research topics in the studies described therein and explored the relationships among the articles through co-citation network analysis. In addition, the main and isolated research streams were identified through an analysis of frequently co-cited articles and their follow-up citing articles. The main research questions raised in this study were as follows:

(1) What types of participants, research methods, information literacy standards and research topics were involved in the selected studies on information literacy in higher education?
(2) What are the main research streams and other isolated research streams in the field of information literacy in higher education?

Methods

Data sources and inclusion and exclusion criteria

In this study, the WoS database was used to search for articles on studies related to information literacy in higher education published in journals from 2011 to 2020. First, the database was searched for documents related to information literacy ("information literac*" or "metaliteracy" or "digital literac*" or "computer literac*" or "internet literac*" or "Big6" or "I-LEARN" or "SCONUL" or "media literac*" or "multiliterac*" or "new literac*") as well as higher education ("university" or "college" or "higher education") and relevant documents were identified on the basis of their subjects, abstracts and keywords (C. C. Chen, Wang et al., 2021; Pinto, Fernández-Pascual et al., 2020). Second, the document type was restricted to articles and 916 articles were obtained. Third, a manual review of the content of each article (including the subject, abstract and full text) was performed, and the articles that were not related to the main topic of interest in this study (namely, information literacy in higher education) or were not written in English were removed. To be included in this systematic review, the articles had to fulfil the basic criteria listed in Table 1; for example, only articles that involved information literacy in higher education as a primary research topic; were published in English from 2011 to 2020; were publicly available or archived periodical articles; were in the top 100 most frequently cited articles; and were not editorials, correction notes or early access articles. Finally, this study used the citations per year as the criterion for identifying frequently cited articles, and the top 100 most frequently cited articles were selected for inclusion in the co-citation network analysis.

Table 1
Inclusion and exclusion criteria

Inclusion	Exclusion
Must involve information literacy in higher education as a primary research topic.	Not involving information literacy in higher education as a primary research topic.
Must have been published in English.	Being an editorial, compilation of correction notes, or early access article.
Must have been published from 2011 to 2020.	Not in the top 100 cited articles.
Must be a publicly available or archived periodical article.	

Co-citation network analysis

In this study, co-citation network analysis was used to explore the relationships (cited and citing) among the top 100 most frequently cited articles. All the bibliographic citations of the selected articles were retrieved from the WoS database. Although some of the cited articles may have been cited from various sources (e.g., journal articles, book chapters, conference proceedings), only citations from journal publications were counted and collected for the subsequent analysis. This was to ensure the quality of both the cited and citing articles (J. S. Liu & Lu, 2012). The 100 articles included in this review had been cited a total of 1261 times.

According to Small's (1973) definition of co-citation, each selected article was paired. The co-citation frequency of each pair was then counted and integrated into a co-citation matrix. Gross and Latham's (2012) paper on university students' information literacy skills was identified as the most frequently co-cited paper in this study. The article by Gross and Latham (2012) was most frequently co-cited with another article by Gross and Latham (2011) as well as articles by Saunders (2012) and Pinto (2012), with eight, seven and seven co-citations, respectively. The 2011 article by Gross and Latham described the same authors' earlier research on university students' experiences with and perspectives on information literacy, whereas the articles by Saunders (2012) and Pinto (2012) detailed studies exploring faculty members' perspectives on university students' information literacy and history students' perspectives on information literacy, respectively. The aforementioned articles were all in the top 5 most frequently co-cited articles, reflecting strong scholarly interest in students' information literacy.

A social network was used to visualise the co-citation relationships among the 100 most frequently cited articles on information literacy in higher education. All the selected articles were visualised as nodes, and the co-citation relationships were visualised as links between the nodes. Betweenness centrality (Freeman, 1979) was used to identify the most important nodes in the co-citation network. Similar to the procedures of previous research, the NetDraw network visualisation tool incorporated into UCINet software (version 6.937; Borgatti et al., 2002) was used to position the selected articles in the co-citation network and to identify the central nodes (with betweenness centrality) in the network. The entire data collection and compilation process (i.e., determining the relationships among the 100 cited and 1,261 citing articles) took 2 weeks and was completed on 14 March 2021
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Coding scheme

To facilitate the analysis of trends in research on information literacy in higher education, a coding scheme was adapted from a similar scheme for systemic literature reviews proposed by C. C. Chen, Wang et al. (2021) and Lin and Hwang (2019), and the content of the 100 selected articles was analysed. The dimensions of analysis were the participants, research methods, information literacy standards and research topics in the studies described in the selected articles. Table 2 presents the coding scheme. Using this scheme, two of us (N.-C. W. & Y.-F. T.) independently coded all the articles by following the same coding procedure and classified the articles accordingly. The intercoder agreement during this stage was 86%. The two of us then reviewed any inconsistent coding results and resolved such inconsistencies through discussion.

Table 2
Coding scheme for studies on information literacy in higher education

Dimensions	Coding items
Participants	Undergraduate students, graduate students, teachers, librarians, adults, others, mixed and no participants.
Research methods	Quantitative methods, qualitative methods and mixed methods.
Information literacy standards	Information literacy competency standards for higher education (American Library Association, 2000), Framework for information literacy for higher education (American Library Association, 2016), courses with other reference standards, courses with mixed and no reference standards.
Research topics	Cognition (including learning achievement, higher-order thinking skills and collaboration or communication), affection (including technology acceptance, attitudes or effort, self-efficacy or beliefs, satisfaction or interest and learners' opinions or learning experiences), learning (skill) performance, learning behaviour, correlation or causal analysis, information literacy assessment, literature reviews and trend analyses and others.

Data distribution

Figure 1 illustrates the distribution of the 100 selected articles by publication year. The selected articles were divided into two groups according to the time periods in which they were published, one of which comprised the 49 articles published from 2011 to 2015 (the first period) and the other of which comprised the 51 articles published from 2016 to 2020 (the second period). This indicates that information literacy in higher education is receiving increasing attention from researchers.
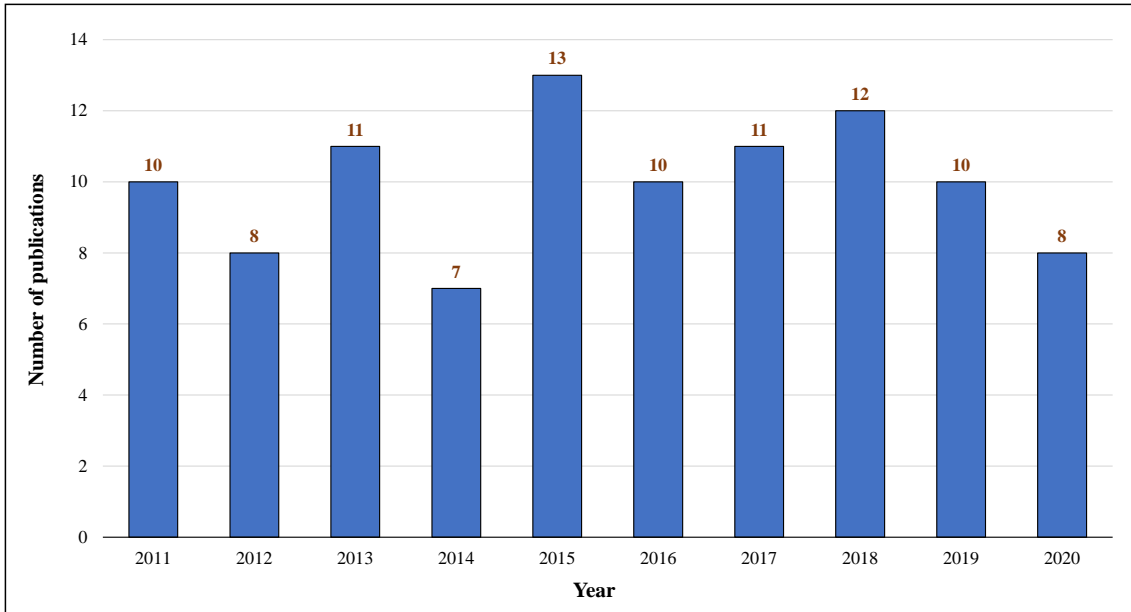
Figure 1. Distribution of the top 100 most frequently cited articles on information literacy in higher education

Research results

Participants, research methods, information literacy standards and research topics

Participants
As indicated in Figure 2, the most common participants in the studies described in the top 100 most frequently cited articles on information literacy in higher education were undergraduate students ($n = 68$), followed by teachers ($n = 8$), mixed groups ($n = 7$), graduate students ($n = 6$), no participants ($n = 5$), librarians ($n = 4$), adults ($n = 1$) and others ($n = 1$).
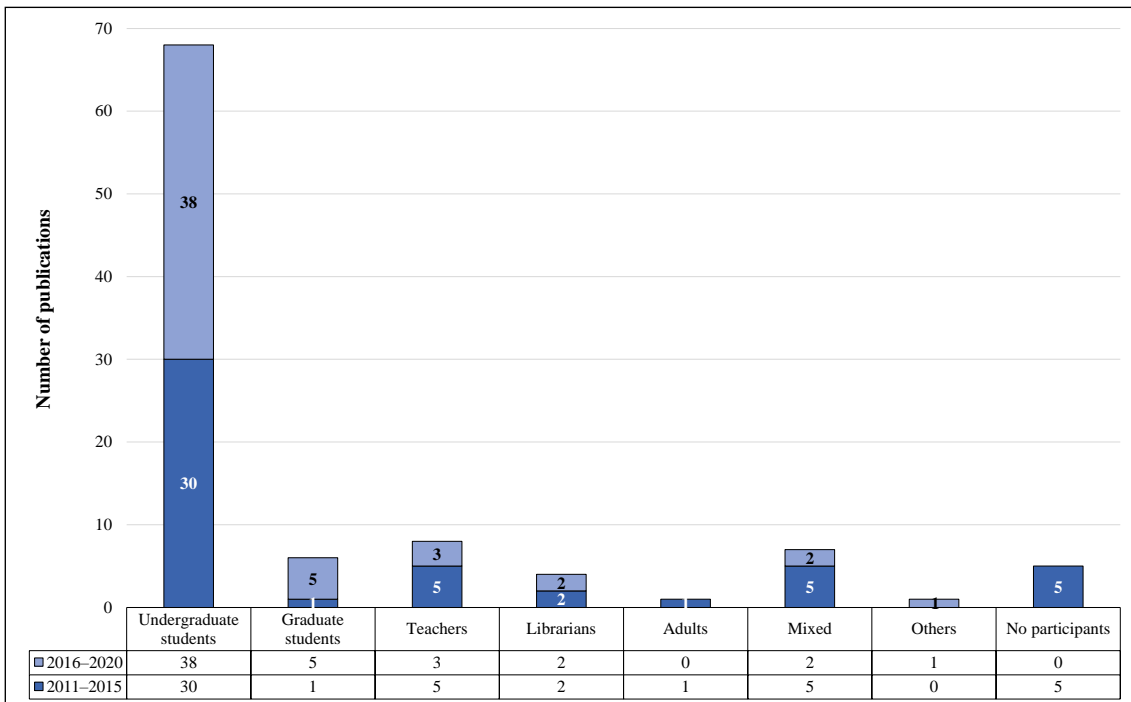

	Undergraduate students	Graduate students	Teachers	Librarians	Adults	Mixed	Others	No participants
2016–2020	38	5	3	2	0	2	1	0
2011–2015	30	1	5	2	1	5	0	5

Figure 2. Distribution of participants

Research methods

As indicated in Figure 3, most of the studies described in the 100 selected articles used quantitative methods ($n = 43$), followed by mixed methods ($n = 31$) and qualitative methods ($n = 26$). The number of studies using quantitative methods to explore topics related to information literacy in higher education increased from the first time period (2011–2015) to the second time period (2016–2020). For example, Julien et al. (2018) used an online survey to investigate the content of information literacy instruction provided by librarians to better understand how librarians adjust such content in response to changes in and challenges related to information literacy. Leeder (2019) surveyed the effects of university students' information-seeking behaviour and critical evaluation strategies on their ability to make judgments regarding fake news and misinformation. McGrew et al. (2019) used an experimental design to examine the impact of a critical thinking and writing course on university students' ability to evaluate the credibility of information.
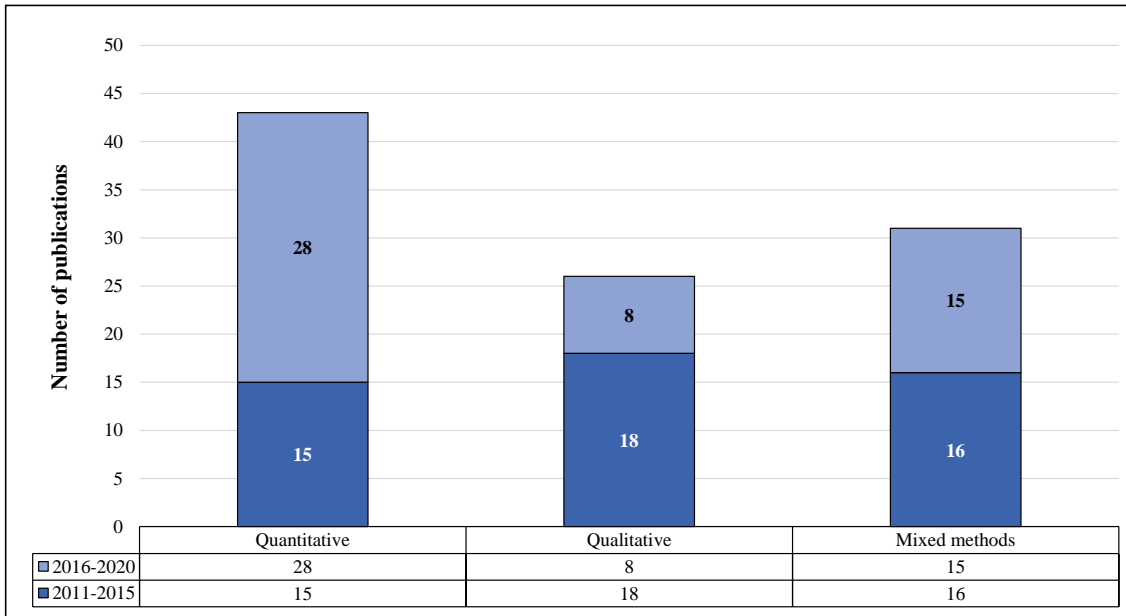

Figure 3. Distribution of the research methods

Information literacy standards

Figure 4 illustrates the reference standards used for curriculum design in the studies described in the top 100 most frequently cited articles on information literacy in higher education. Most of the articles did not mention the reference standards used for curriculum design ($n = 61$). Among those that did mention such standards, most mentioned the information literacy competency standards for higher education ($n = 28$), followed by the framework for information literacy for higher education ($n = 5$). In the first period, the reference standards for curriculum design were mainly based on the information literacy competency standards for higher education. The framework for information literacy for higher education was released in 2015 and formally implemented on 11 January 2016. It was first discussed in articles on information literacy in higher education during the second period. One of the three studies categorised as using mixed standards compared these two information literacy standards, mapping curriculum learning outcomes to the framework threshold concepts established by the American Library Association (as cited by Dubicki, 2019). Pinto, Sales et al. (2020) used these two standards to examine teachers' perspectives on the importance of using mobile technology in the teaching and learning of information competencies.

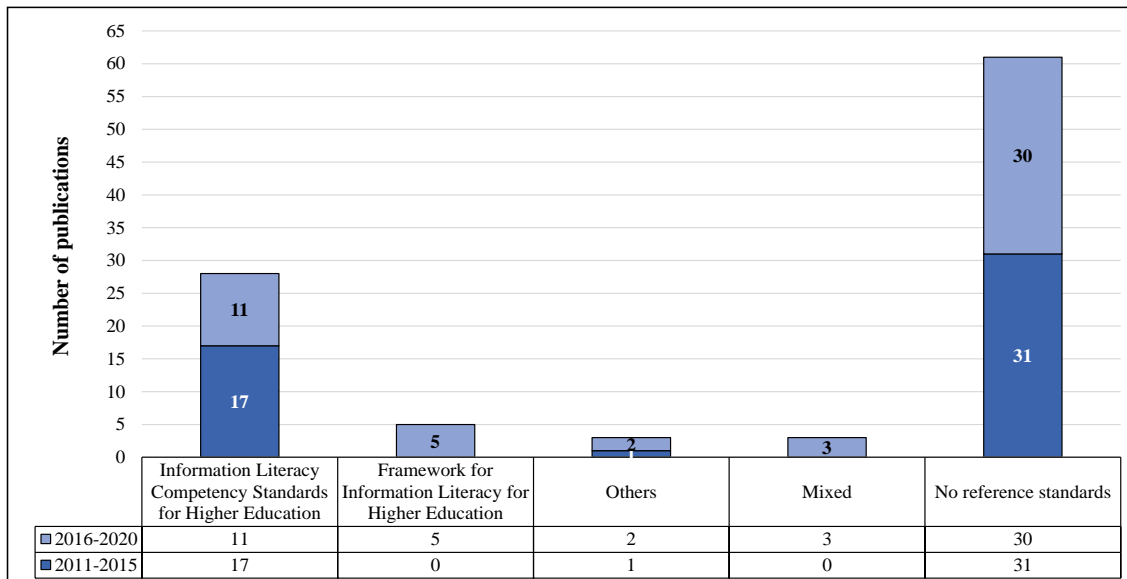|	Information Literacy Competency Standards for Higher Education	Framework for Information Literacy for Higher Education	Others	Mixed	No reference standards
2016-2020	11	5	2	3	30
2011-2015	17	0	1	0	31

Figure 4. Distribution of information literacy standards

In one article in which reference standards were not mentioned, the researchers reported that teachers and students expect to improve their information literacy skills and knowledge of relevant topics when participating in information literacy education (Maybee et al., 2017). Some researchers explored students' views on information literacy (Pinto, 2012) or the impact of subtitle reading on student academic performance (Kruger & Steyn, 2014). With respect to the information literacy competency standards for higher education, Taylor and Dalal (2017), Kim and Shumaker (2015) and Pinto and Sales (2015) explored the views of students, librarians and teachers on information literacy teaching as well as students' information literacy and self-assessment skills. Gross et al. (2018) argued that using the framework for information literacy for higher education can not only help teachers improve their teaching methods but also help other information professionals hone their skills. Furthermore, Squibb and Mikkelsen (2016) argued for the importance of a new information literacy paradigm for teachers, focusing on how teachers should approach information literacy in higher education in the future as well as how they should teach students new information literacy concepts and skills.

Research topics
As indicated in Figure 5, most of the top 100 most frequently cited articles on information literacy in higher education discussed research topics related to affection ($n = 82$), followed by cognition ($n = 50$), information literacy assessment ($n = 48$), other topics ($n = 33$), correlation or causal analysis ($n = 24$), learning behaviour ($n = 17$), literature reviews and trend analyses ($n = 5$) and learning (skill) performance ($n = 2$). The number of studies on research topics related to cognition, affection, learning behaviour, correlation or causal analysis and information literacy assessment increased significantly from the first period to the second period (e.g., Blau et al., 2020; Lanning & Mallek, 2017; M. Liu et al., 2017).
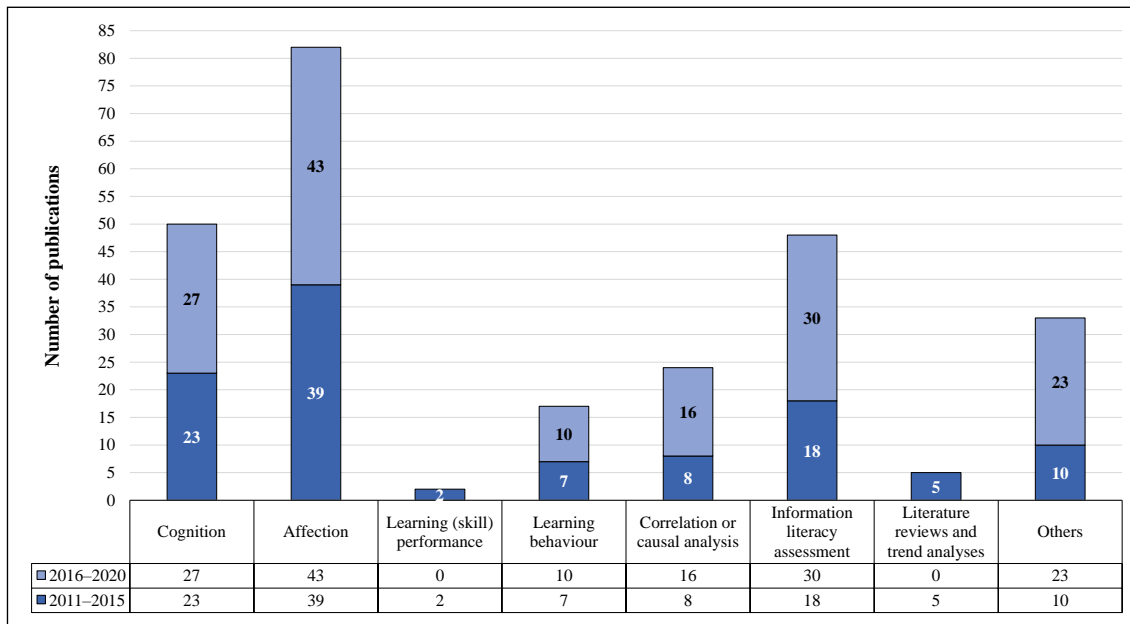
Figure 5. Distribution of research topics

	Cognition	Affection	Learning (skill) performance	Learning behaviour	Correlation or causal analysis	Information literacy assessment	Literature reviews and trend analyses	Others
2016–2020	27	43	0	10	16	30	0	23
2011–2015	23	39	2	7	8	18	5	10

Some of the 33 articles categorised as related to other topics discussed factors, such as information quality, system quality, service quality and user satisfaction, which influence undergraduate students' use of university library web portals in information literacy programmes (e.g., Y. H. Chen, 2015; Y. H. Chen & Chengalur-Smith, 2015). Some of the studies described in the selected articles explored the role of digital literacy in knowledge acquisition as well as the relationship between self-regulated learning skills and epistemic cognition and learning (Greene et al., 2014; Greene et al., 2018). Another study explored whether and how the instructional design of a course on various digital literacy competencies could help students regulate technology-enhanced collaborative learning and cope with their sense of psychological ownership over collaborative learning outcomes (Blau et al., 2020).

As indicated in Figure 6, learning achievement was the most common research topic in the studies described in the articles published during both the first and the second periods, followed by collaboration or communication and higher-order thinking skills. The affective research mainly discussed attitudes or effort, self-efficacy or beliefs, satisfaction or interest and learners' opinions or learning experiences. Of the articles published during the first period, articles on learners' opinions or learning experiences accounted for the largest number ($n = 28$), followed by those on learners' attitudes or effort ($n = 21$) and learners' self-efficacy or beliefs ($n = 11$). Of those published during the second period, articles on learners' attitudes or effort accounted for the largest number ($n = 32$), followed by those on learners' opinions or learning experiences ($n = 20$) and self-efficacy or beliefs ($n = 9$). Overall, the top 100 most frequently cited articles on information literacy in higher education focused on studies exploring learners' ideas and experiences as well as their attitudes towards and opinions on information literacy (e.g., Y. H. Chen, 2015; Saunders, 2012).
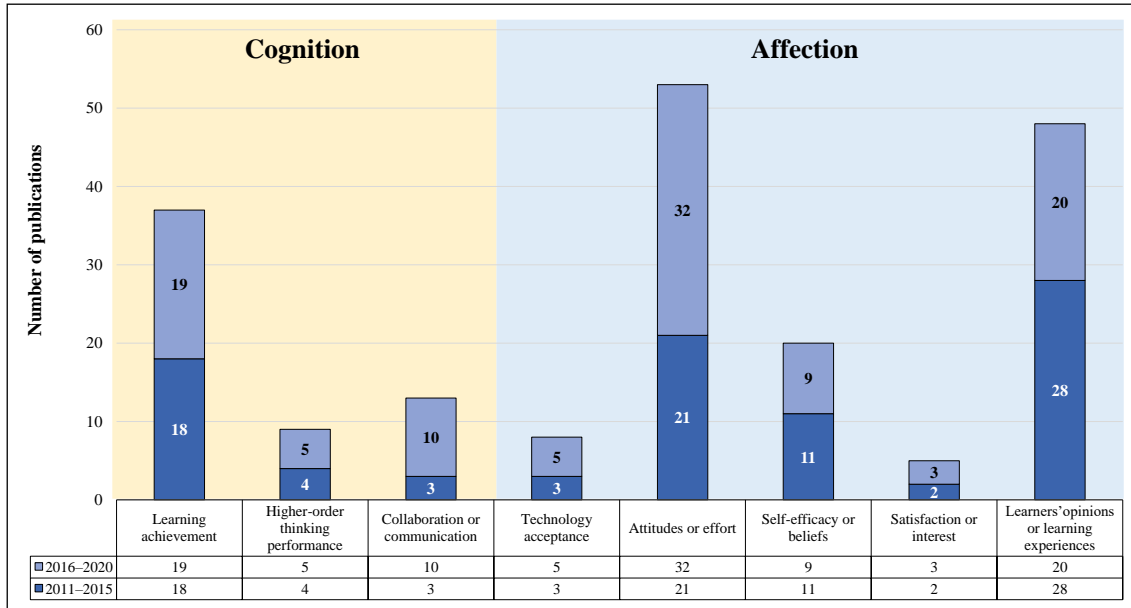
Figure 6. Distribution of articles on cognition and affection

Results of co-citation network analysis

The full co-citation matrix was treated as the input for further visualisation of the global co-citation network using UCINet (Borgatti et al., 2002). According to the results, 78 of the top 100 articles were linked to the main research streams in the network; the remaining 22 were isolated from the main research streams. Most of these 22 articles were published within the last 3 years of the study period (2018–2020) and had been cited at least once; however, they had not yet been co-cited with the other 78 articles. Therefore, the main implications of the co-citation network constructed in this study are related to the 78 articles linked to the main research streams. A total of 990 co-citations were identified. On average, pairs of the core articles were co-cited 2.7 times; the strongest co-citation links were those between nine pairs of articles (red and blue links, Figure 7) in the network.
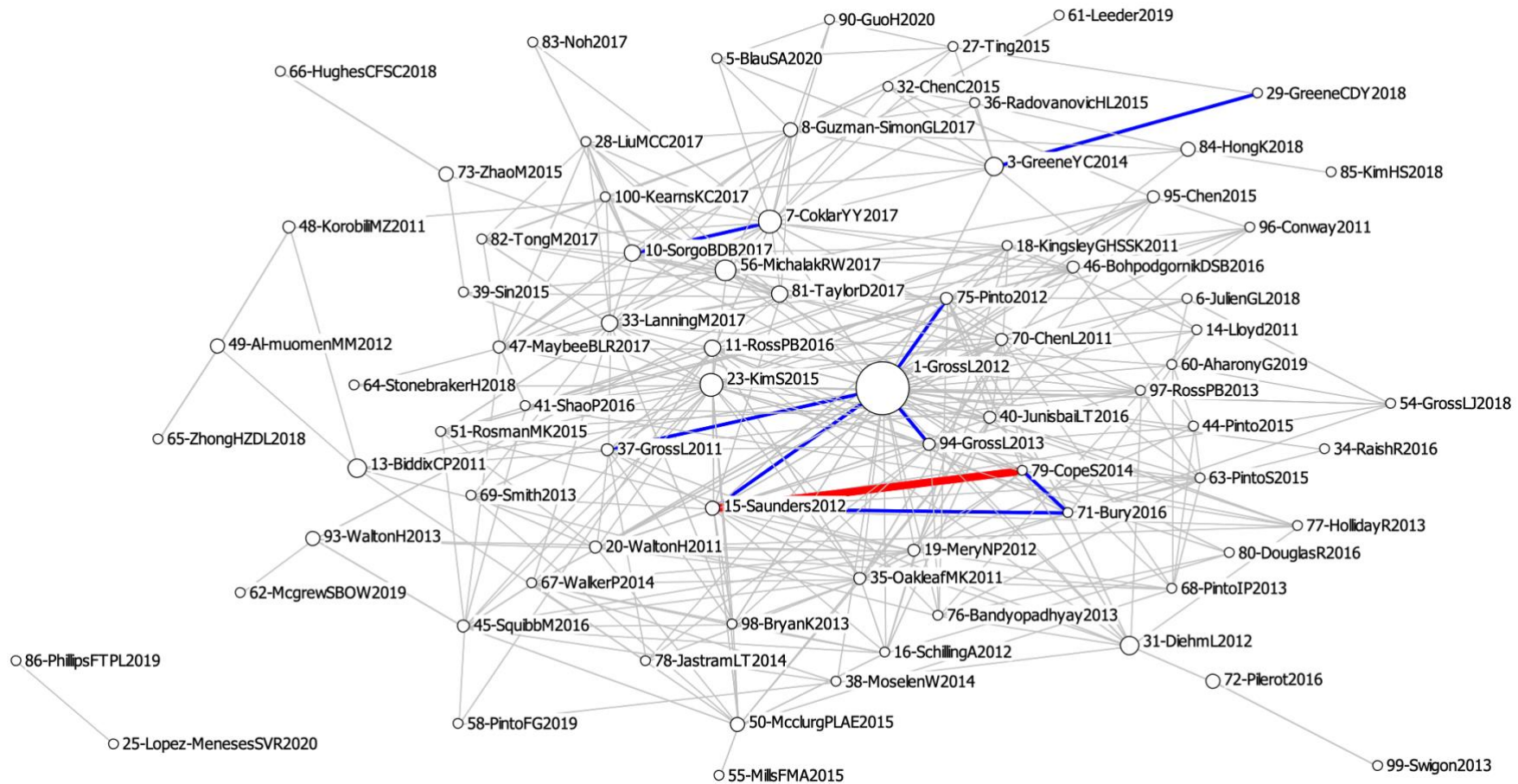
Figure 7. A co-citation network on information literacy in higher education
Note. The size of each node is proportional to betweenness centrality. The strength of the links between nodes are by the nodes' co-citation counts as follows.
Grey lines: Nodes co-cited 1–4 times.
Blue lines: Nodes co-cited 5–10 times (nodes #1, #3, #7, #10, #15, #29, #37, #71, #75, #79 and #94).
Red line: Nodes co-cited 12 times (the strongest co-citation link, nodes #15 and #79).

Among nine pairs of frequently co-cited articles, the most frequently co-cited pair of articles were the articles by Saunders (2012) and Cope and Sanabria (2014), with 12 co-citations (red link). Both of the studies described therein explored faculty perspectives on information literacy learning. The study by Saunders (2012) addressed teachers' views on student information literacy learning, whereas that by Cope and Sanabria (2014) focused on faculty perspectives on information literacy. In addition, most links among frequently co-cited articles were links to Gross and Latham (2012) and Saunders (2012). Specifically, four papers were co-cited with the 2012 article by Gross and Latham (2012) paper six to eight times each (blue links): the 2012 article by Saunders, the 2011 and 2013 articles by Gross and Latham and the 2012 article by Pinto. The articles by Saunders (2012) and Bury (2016) were co-cited seven times. This indicates that earlier research on information literacy in higher education focused on understanding teachers' perspectives on information literacy. Three frequently co-cited pairs of articles (blue links in the middle and upper network) were published in recent years: those by Bury (2016) and Cope and Sanabria (2014), Greene et al. (2014) and Greene et al. (2018) and Çoklar et al. (2017) and Šorgo et al. (2017). The articles by Bury (2016) and Cope and Sanabria (2014) were linked to other frequently co-cited articles in the main research streams, reflecting research interests similar to those reflected in earlier information literacy research. By contrast, the pairs of articles by Greene et al. (2014) and Greene et al. (2018) as well as by Çoklar et al. (2017) and Šorgo et al. (2017) were located separately. Both of these pairs had been co-cited five times, but they were not closely linked to other core articles in the network, reflecting research interests distinct from those reflected in articles linked to the main research streams. These pairs of articles were published in the last 5 years of the study period and the research interests reflected therein may provide insight into current trends in information literacy research. According to the results of the content analysis, several research streams centred on the aforementioned frequently co-cited articles were identified and are described as follows.

The first research stream focused on the relationships among students' information literacy beliefs, competencies, attitudes behaviour, comprehensively discussed by and many articles. Moreover, the article by Gross and Latham (2012) not only was the most frequently co-cited article in the network but also had the highest total link strength.. The relevant topics discussed in these articles included learners' attitudes towards information literacy and self-assessment (Saunders, 2012), the assessment of learners' information literacy behaviour and information searching skills (Gross & Latham, 2011), the relationship between learners' information literacy beliefs and skills self-assessment (Pinto, 2012) and the relationship between learners' objective values (knowledge and skills), subjective values (belief and self-efficacy) as well as information literacy competencies (Gross & Latham, 2013).

Most of the articles describing studies that explored students' self-assessment of, attitudes towards, motivations for and competencies in information literacy combined the information literacy competency standards for higher education and the framework for information literacy for higher education (Aharony & Gur, 2019; Pinto & Fernández-Pascual, 2019) or evaluated the use of information literacy teaching materials in different subject areas (Dreisiebner & Schlögl, 2019). Some researchers reported that most students believe that their information literacy skills are above average although they are, in fact, often below proficiency level (Gross & Latham, 2012; Saunders, 2012). In an article on students' belief in the importance of information literacy and skills self-assessment, Pinto (2012) pointed out that students often lack experience with objective cognitive self-assessment, causing them to overestimate their own problem-solving skills (including information searching skills). Pinto and Sales (2015) and Pinto and Fernández-Pascual (2016) used the Information Literacy-HUMASS questionnaire to explore the relationships among university students' belief in the importance of information literacy, skills self-assessment and preferred modes of learning. Pinto et al. (2019) used the Information Literacy-HUMASS questionnaire to explore the differences in the information literacy competencies of university students with directed (class-based, library-based or course-based) and self-directed (autonomous) learning styles. Some researchers investigated the relationship between students' objective values (i.e., knowledge and skills) and subjective values (i.e., belief and self-efficacy) and information literacy competencies (Gross & Latham, 2012, 2013) as well as methods for integrating knowledge, skills, beliefs and self-efficacy into course frameworks to provide better opportunities for students to hone their information assessment skills (Pinto et al., 2016). In addition, some researchers explored students' information literacy behaviour and information searching skills (e.g., Gross & Latham, 2011, 2013). Researchers have argued that before teaching information literacy, teachers should consider their students' previous experiences with information literacy (including their inquiry, reading, synthesis and critical thinking skills; Margolin & Hayden, 2015) as well as the fact

that most students possess insufficient information literacy skills when they first enter university (Gross & Latham, 2012).

The second research stream focused on teachers', librarians' and students' perspectives on information literacy. The articles in this stream covered three main topics: (a) the definition and evaluation of information literacy by librarians, teachers and students (Cope & Sanabria, 2014; Saunders, 2012); (b) the impact of information literacy teaching on students from the perspective of teachers (Bury, 2016; Cope & Sanabria, 2014); and (c) the relationships between different disciplines and information literacy teaching (Bury, 2016; Saunders, 2012). Regarding the definition and evaluation of information literacy by librarians, teachers and students, Cope and Sanabria (2014) and Saunders (2012) argued that faculty and librarians should express their thoughts on information literacy to effectively integrate ideas into disciplines and guide students. This stream also reflected the most important trend in the co-citation network, given that the articles linked to this stream had the highest number of co-citations. Some of the articles that discussed the impact of information literacy teaching on students from the perspective of teachers also encompassed topics related to reference services and library marketing (e.g., Baird & Soares, 2020; Huddleston et al., 2019). The articles that discussed the relationship between disciplines and information literacy teaching described studies that explored cooperation between teachers and librarians, the applications of information literacy in teaching different subject areas and teachers' perspectives on methods used to integrate information literacy into courses in different disciplines (e.g., Baird & Soares, 2020; Dawes, 2019; Guth et al., 2018). In addition, this stream included articles discussing the impact of libraries' information literacy programmes on the promotion of library reference services and marketing (Huddleston et al., 2019).

The remaining two research streams were centred on two distinct pairs of co-cited articles. The two most frequently co-cited pairs of articles, located near the top of Figure 7, discussed different topics related to information literacy in higher education. Regarding the articles that discussed the relationship between students' information literacy and epistemic beliefs, Greene et al. (2014) noted that the two keys to the digital literacy of university students are effective planning and management of information as well as integrating knowledge of information sources. They argued that digital literacy requires effective self-regulated learning skills and epistemic cognition. In the articles on the web search behaviour of digital natives, researchers described using information literacy standards to promote the information literacy of digital natives and highlighted the importance of information searching skills to information literacy (e.g., Çoklar et al., 2017; Šorgo et al., 2017).

Discussion

Participants, research methods, information literacy standards and research topics

Of the top 100 most frequently cited articles on information literacy in higher education published from 2011 to 2020, more were published during the second period (2016–2020) than during the first period (2011–2015). In the studies described therein, undergraduate students were the most common participants. In addition, most of the studies explored students' ideas about information literacy skills and the effects of information literacy courses on students' understanding of information literacy. By contrast, few of the studies discussed in the articles explored information literacy from the perspectives of adults and librarians. Some librarians have advocated for cooperation between librarians and teachers and for an approach to information literacy education that involves librarians instructing subject teachers to integrate information literacy and teaching content (Hammons, 2020). Regarding research methods, most of the studies described in the selected articles employed quantitative methods to explore participants' perspectives on information literacy and the effect of curriculum design on students' information literacy skills (Pinto, 2019; Pinto & Fernández-Pascual, 2019). Some of the studies used qualitative methods to assess students', teachers' and librarians' concepts of and perspectives on information literacy (Bury, 2016; Diehm & Lupton, 2012; Radovanović et al., 2015). In addressing the trend of interdisciplinary learning, Pinto, Fernández-Pascual et al. (2020) argued that various methods should be used to assess the information literacy competencies of learners and teachers in different fields. In addition, McGrew et al. (2019) and Leeder (2019) explored the impact of critical thinking and critical evaluation strategies on students' ability to distinguish between fact and fake news or misinformation.

Regarding the reference standards for curriculum design adopted in the studies described in the selected articles, most of the selected articles did not mention any reference standards for curriculum design. Among the articles that did, most mentioned the information literacy competency standards for higher education, followed by the framework for information literacy for higher education. Researchers have pointed out that the concept of information literacy has given rise to extensive research on new teaching methods, policies and courses, many of which have been incorporated into education (Reddy et al., 2021). Gross et al. (2018) also pointed out that the American Library Association's (2016) framework for information literacy for higher education emphasises helping teachers improve their teaching methods and helping other information professionals hone their relevant skills; that is, applying this framework in courses on information may help teachers improve their teaching methods and help students hone their information literacy skills (Dawes, 2019; Guth et al., 2018).

Regarding research topics, most of the top 100 most frequently cited articles on information literacy in higher education discussed research topics related to the affection and cognition of participants (including learners and teachers). Most of the studies on topics related to affection explored the attitudes or effort of the participants. Some of the researchers argued that libraries or librarians should be involved in teaching activities to help promote students' information literacy competencies (Guzmán-Simón et al., 2017; Ross et al., 2016; Šorgo et al., 2017). Most of the studies on topics related to cognition focused on student learning achievement, followed by collaboration or communication and higher-order thinking skills. Some of the researchers reported that collaboration and interactive learning can effectively improve students' information literacy (Blau et al., 2020; Lanning & Mallek, 2017). In addition, some of the researchers argued that the role of educational institutions in improving learners' information communication technology skills must be adjusted according to changes and developments in technology and educational environments (Reddy et al., 2021). Others argued for the importance of understanding how students are affected by the increasing accessibility of information as well as the spread of fake news; for example, El Rayess et al. (2018) examined learners' ability to evaluate fake news and argued for the importance of teaching media and information literacy. Overall, articles on information literacy in higher education not only convey the importance of information literacy to learners, teachers and librarians but also discuss the meaning and influence of information literacy and how they differ across various disciplines.

Co-citation network analysis

According to the results of the co-citation network analysis, two main research streams and two isolated research streams were identified. The first main research stream focused on the relationships among students' information literacy beliefs, competencies, attitudes and behaviour. Most of the articles linked to this stream described studies in which researchers referred to the research of Gross and Latham (2012) to investigate the information literacy skills and self-assessment abilities of university students. In addition, in some of the articles, researchers proposed that high school students who are about to enter university should be equipped with the information literacy skills necessary for academic work in the digital age. These articles described studies that explored the gap between the expectations of high school students and their actual information literacy skills (J. K. Smith et al., 2013). The second main research stream focused on teachers', librarians' and students' perspectives on information literacy. Most of the articles linked to this stream focused on topics related to the definition and evaluation of information literacy by librarians, teachers and students. For example, Bury (2016) examined teachers' definitions of information literacy as well as their views on and expectations regarding the information literacy knowledge and skills required in their respective subject areas. He reported that most teachers believe that information literacy is inseparable from academic literacies. Teachers tend to pay special attention to promoting the development of higher-order cognitive skills, especially cultivating students' ability to critically question, evaluate, contextualise and synthesise information sources. Other researchers also explored topics related to the integration of information literacy into subject pedagogy. For example, Dawes (2019) suggested that the American Library Association's (2016) framework for information literacy for higher education as well as the changes to the SCONUL seven pillars of information literacy may become common bases for teaching information literacy in university classrooms.

The articles on the isolated research streams discussed two main topics: (a) the relationship between students' information literacy and epistemic beliefs and (b) the web search behaviour of digital natives. For example, some of the researchers explored first-year university students' perspectives on information

literacy skills to determine methods for improving students' information literacy competencies and helping them to apply those skills in their own research (Gross & Latham, 2013; Kocevar-Weidinger et al., 2019).

Conclusion

This study examined the top 100 most frequently cited articles on information literacy in higher education in the WoS database published from 2011 to 2020. The key findings of this study can be summarised as follows: (a) most of the authors of the articles are from the United States of America; (b) the affect of undergraduate students was the topic most frequently explored in the studies described in the articles; (c) most of the studies described in the articles employed quantitative research methods; (d) most of the articles did not mention the use of reference standards for curriculum design; and (e) the four highly co-cited research streams were identified in the co-citation network.

This study has some limitations. On the basis of the results of this study, the following suggestions for directions for future research on information literacy in higher education were developed.

- Given the increasing influence of the Internet, technologies and social integration, academic and research institutions should follow the examples of institutions in leading countries or regions to promote the development of information literacy skills and digital competencies required for higher education through the establishment of long-term programmes.
- In future studies, researchers should account for groups that are rarely represented in studies on information literacy in higher education, such as teachers, graduate students, librarians and adults. For example, researchers can further explore information literacy teaching materials and pedagogy are shaped by cooperation between librarians and teachers. The evolution of the definition of information literacy as well as the rapid advancement and diversification of science and technology have caused higher education institutions to have higher expectations for faculty, students and librarians. Faculty, students and librarians should therefore receive training and opportunities to practice information literacy skills.
- In addition to quantitative analysis, researchers should conduct qualitative analyses or experiments and intervention studies to evaluate learners' views on, achievements in learning and experience with information literacy and to explore learners' information literacy behaviour in depth.
- Changes in the concept of information literacy will lead to changes in information literacy standards and will gradually come to influence the curriculum design of information literacy courses. Researchers and teachers should design curricula based on relevant and up-to-date standards to help cultivate students' information literacy competencies.
- The emergence of new digital technologies has not only effected enormous changes in education and society but also influenced teaching methods. Students' information literacy competencies must be improved accordingly, especially in the era of mobile technology. Researchers and teachers should cooperate with professionals in different disciplines and integrate information literacy into subject learning activities.
- In addition to focusing on topics related to information literacy through the lens of technological and scientific development of science and technology, researchers, teachers and libraries may also consider exploring topics that have been less frequently discussed in the past (such as technology acceptance, satisfaction or interest, knowledge and beliefs, search behaviour and higher-order thinking skills).

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Corresponding author: Yun-Fang Tu, sandy0692@gmail.com