A Review of Ten-Year Research through Co-citation Analysis: Online Learning, Distance Learning, and Blended Learning

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Abstract

This study reviewed evolving research trends in online, distance, and blended learning over the past ten years through co-citation analysis. Related peer-reviewed research articles in the Web of Science were obtained and the references in the articles were analyzed. The result showed that literature review and meta-analysis studies on distance education and studies on learners' discourse in asynchronous discussion were most cited in the first half of the ten year period. In the second period, the focus moved to online learners' satisfaction and self-regulation, informal learning, and learning through MOOCs. The Community of Inquiry framework was continually researched throughout the entire ten year period. Overall, this study identified features and changes in research trends in online, distance, and blended learning, providing a unique contribution to our understanding of publications and research themes in these fields. Direction for further research, which was derived from the findings, is discussed.

Keywords: research review, online learning, distance learning, blended learning, co-citation analysis

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The advent of the Internet has facilitated learning in diverse formats, especially enhancing learning from remote locations. Distance learning has long supported the democratization of higher education (Larreamendy-Joerns & Leinhardt, 2006), allowing anyone willing to learn to gain access to do so. Moreover, mixed forms of face-to-face learning and online learning provides blended learning in which students obtain knowledge through the combination of traditional and online learning (Siemens, Gašević, & Dawson, 2015).

As knowledge becomes more easily shareable with other students and teachers on the web, various aspects of online learning have been studied and reviewed (e.g., Spring & Graham, 2017; Zhou, 2015), including elements and features of learning in the online community (Garrison, Anderson, & Archer, 2000; Garrison & Cleveland-Innes, 2005; Hrastinski, 2009; Shea & Bidjerano, 2011). Further, researchers need to systematically investigate the development of the field as time passes to understand evolving research trends in this field (Bradea, Delcea, & Paun, 2015; Chen, 2006). In line with this need, the present study reviews highly cited and co-cited publications and research topics in online, distance, and blended learning ("online learning," hereafter) from 2008 to 2017.

Review of Relevant Literature

Evolution of Online, Distance, and Blended Learnings

The form of delivering knowledge has changed with the advent of the Internet. The channels have been diversified in and out of the virtual world with various combinations of the channels such as *online learning*, *distance learning*, and *blended learning*. According to Siemens et al. (2015), online learning means "a form of distance education where technology mediates the learning process, teaching is delivered completely using the Internet" (p. 101) and blended learning is "the practices that combine (or blend) traditional face-to-face instruction with online learning" (p. 101). Meanwhile, distance learning, more converging on achieving knowledge, has close meaning with distance education, which "is teaching and planned learning where the teaching occurs in a different place from learning" (p. 101). Distance learning has supported people who have difficulty attending classes by giving them a chance to learn. Students learning from distant locations were given instructions, assignments, and feedback through correspondence methods, typically through the mail (Holmberg, 2005). Methods for distance learning changed and expanded with technology advances and have included the use of radio, cinema, telephone, television, and other technological delivery methods. In the twentieth century, online learning was getting popular, along with computer networking (Harasim, 2000). Moving on to the late twentieth and the early twenty-first centuries, the emergence of new technology and the Internet accessed through World Wide Web (Berners-Lee, Cailliau, & Groff, 1992) facilitated the two-way online communication between instructors and students via email, computer conferencing, and synchronous and asynchronous discussions (Holmberg, 2005). Learning on the Internet from a distance enhanced both independent learning of those who prefer learning individually as well as collaborative learning through group activities (Harasim, 2000; Holmberg, 2005), and blending online and face-to-face learning offered students more fruitful channels of getting linked with peers and instructors (Shea & Bidjerano, 2011).

In order to review previous studies on the different forms of distance learning with the Internet and technology, previous researchers have summarized relevant papers in terms of types of papers, participants, published years, or major topics (e.g., Bernard et al., 2004; Siemens et al., 2015; Tallent-Runnels et al., 2006). Nonetheless, for a more in-depth investigation of the field, researchers still need to examine emerging research topics (Chen, 2006). They need to explore scholarly works and scholars that influence the growth of the field and project the fertile topics for future research. One method that shows promise is co-citation analysis. This approach prioritizes frequently cited and co-cited research for inclusion and analysis in reviewing the literature in a field of study.

Co-citation Analysis

When it comes to writing research papers, researchers reference academic knowledge in specific fields from other scholars and cite the knowledge in the references of the publications to support research outcomes and scholarly ideas. They read and cite other scholars' research when they acknowledge its scholarly impact and novelty (Case & Higgins, 2000). Influential research is likely to be cited frequently; thus, measuring the number of citations is one of the indicators to evaluate the importance of research (Merton, 1973; Thelwall, 2007). The investigation of citations patterns between research publications can reveal hidden features and research topics as publications referenced in the same paper tend to share relevant topics.

The initial idea of systematic evaluation of research impact began in the mid-1990s. Garfield (1955) proposed that counting citations evaluates the influence of research journals scientifically. Instead of calculating the absolute number of total citations to journal articles, *impact factor* measures "ratio obtained from dividing citations received in one year by papers published in the two previous years" (Garfield, 1996, p. 411). Another systematic way of evaluating the research impact is *co-citation analysis* (Marshakova, 1973; Small, 1973). *Co-citation* occurs when two different publications are referenced in the same publication. For instance, if a research paper A cites papers B and C simultaneously, this means the papers B and C are co-cited in the paper A. The analysis of co-citations investigates citation patterns of co-cited research items and their research impact (Tang et al., 2015). Since researchers tend to cite different publications in their single study if those publications deal with topics and contents related to their research, co-citation patterns show a scholarly connection between co-cited studies (Small, 1973). In this sense, co-cited documents can identify salient research topics and publications and describe characteristics of a scholarly field (Chen, Ibekwe-SanJuan, & Hou, 2010; Kuo & Yang, 2012; Zhao & Strotmann, 2008).

Cluster Analysis

Co-citation analysis examines specialized research topics that are classified into groups, which are called *clusters*, through *cluster analysis*. Cluster analysis analyzes shared themes among individual papers in clusters based on proximity between papers (Anderberg, 1973; Kaufman & Rousseeuw, 2009), assuming that papers in same clusters discuss similar research topics (Kaufman & Rousseeuw, 2009). It often adopts mapping techniques for co-citation analysis. While sorting out frequently cited papers across academic areas is critical to building a scholarly map, clustering cited papers enhances the analysis of the dynamic interrelationship between papers and its comprehensive structure in academic fields (Small, 2003). The combination of cluster analysis and visualization unfolds configuration of components in the citation network. Components that have strong relationships attract each other; on the other hand, those who have weak relationships push

each other away (Waltman, Van Eck, & Noyons, 2010). While there are various co-citation clustering indexes, the similarity between papers is generally calculated, which is measured by the number of simultaneous citations to two papers (see Chen et al., 2010 for examples of clustering algorithms). Beyond the number of co-citations, abruptly emerging co-cited papers and topics within a short period are also observed to figure out rising stars in disciplines (Chen, 2006).

This study, which replicates co-citation research in corpus linguistics (Park & Nam, 2017), reviews frequently cited and co-cited research items and unfolds clusters of co-cited documents to reveal evolving research trends in online learning (Chen et al., 2010; Tang et al., 2015). The present study examines notable journals, publications, and emerging research topics over time in online, distance, and blended learning (referred to as "online learning," hereafter) from 2008 to 2017. The following questions are addressed:

(a) What were the most cited journals and publications in online, distance, and blended learning over the past ten years?

(b) What were the most co-cited publications and research themes in online, distance, and blended learning over the past ten years? Also, how have the research trends evolved?

Methods

The data for this study was obtained from the Web of Science (WoS). The WoS is one of the biggest databases; it holds peer-reviewed articles, conference proceedings, book chapters, and other academic papers (Bradea et al., 2015). It has been used as a major dataset in citation research across diverse fields to investigate the relationship between academic papers or authors (e.g., Chen, 2006; Ozcinar, 2015; Palmblad & Eck, 2018; Tang, Tsai, & Lin, 2014). We used three search queries that were discussed in a review paper by Siemens et al. (2015) as follows: "online learning" OR "distance learning" OR "blended learning." As the combinational form of instruction using the Internet was diversified in the early twenty-first century (Holmberg, 2005) and to review online learning-related research trends of the recent decade, peer-reviewed journal articles published from 2008 to 2017 were downloaded. Since the purpose of the present study is to examine the evolutionary change of research trends over time (Chen, 2006; Park & Nam, 2017), the entire period was divided into the first time span between 2008 and 2012 and the second time span between 2013 and 2017. We included Social Sciences Citation Index (SSCI), Science Citation Index Expanded (SCIE), and Art & Humanities Citation Index (A&HCI) to include peer-reviewed journal articles only. The areas where our data belonged were limited to "education educational research," "education scientific discipline," "psychology educational," and "education special." As a result, a total of 2,780 journal articles were obtained for the first time period and 2,919 journal articles for the second time period. The articles in the first period had 71,512 references and those in the second period had 88,379 references.

Co-citation analysis was conducted to investigate research trends in online learning, identifying studies cited in the same paper simultaneously (Chen et al., 2010). In this study, *CiteSpace* (Chen et al., 2010) was utilized to probe co-citation patterns and calculate citations to research publications and journals. Analyzing the retrieved WoS dataset through CiteSpace built clusters of co-cited documents based on the words in the documents (e.g., titles, keywords, abstracts) and used burst-detection algorithms to capture suddenly emerging research trends in a timeline (Chen, 2006; Kleinberg, 2002). According to Chen (2006), "burst-detection algorithms

can identify emergent terms regardless of how many times their host articles are cited. Therefore, a new research front can be featured in the big picture even before it attracts enough citations" (p. 364). Thus, using this tool find the abruptly co-cited publications and their themes beyond the frequency of the co-citations to those publications. The present study by utilizing this tool figured out the clusters of abruptly emerging research articles in online learning, further revealing the noticeable research themes over the past decade.

Results

Most Cited Journals and Publications

Most Cited Journals. Table 1 presents journal titles most frequently cited in the collected peer-reviewed articles between 2008 and 2017. Two five-year time spans examined the most cited journals by the collected studies. Overall, six journals were found in both periods, while some journals were found in only one period. The most highly cited journals in both periods discussed research on diverse themes under the umbrella of educational technology and instruction.

More specifically, the six journals which appeared in the top rank in the whole ten years include *Computers & Education*, *The Internet and Higher Education, Journal of Asynchronous Learning Networks, Review of Educational Research*, *British Journal of Educational Technology*, and *Computers in Human Behavior*. In particular, *Computers & Education* and *The Internet and Higher Education* were on the first and second rank for the past ten years, respectively. *Computers & Education* started to be published in 1976. This journal publishes a wide range of research issues about using computers and technology to facilitate learning (*Computers & Education*, n.d.). *The Internet and Higher Education* has been published since 1998 on teaching and learning using the Internet in the higher education context. This journal was cited more than two times as frequently between 2013 and 2017 than in the previous five years (*The Internet and Higher Education*, n.d.). Both journals focus on the effects and implications of using computers and the Internet in educational settings in diverse disciplines.

The first period between 2008 and 2012 had five journals that did not appear in the next period—*American Journal of Distance Education*, *Distance Education*, *Teachers College Record*, *Instructional Science*, and *The Journal of the American Medical Association* (JAMA). Of them, three journals had articles primarily related to distance learning. *American Journal of Distance Education* has published articles since 1987, focusing on U.S. distance learning explicitly. Initially, the research focus was on older tools and methods (e.g., radio, television, or teleconferencing tools); more recently, it has been on state-of-the-art approaches like the Internet (*American Journal of Distance Education*, n.d.). The journal, *Distance Education* (*Distance Education*, n.d.), which began in 1980 and is managed by the Open and Distance Learning Association of Australia Inc. (ODLAA, n.d.), publishes research on learning from the distance. The third journal featured exclusively in the period span is *JAMA,* which is specialized in medical research while having research on distance learning in health education (e.g., Cook et al., 2008). This journal has been published since 1883 and belongs to an association of 13 peer-reviewed journals, including *JAMA Network Open* and 11 other specialized journals in medicine and health. The articles in this journal are openly accessible on its website, and each journal issue is provided with an audio summary of research (*JAMA*, n.d.).

Four highly-cited journals were found exclusively in the second period from 2013 and 2017—*The International Review of Research in Open and Distributed Learning*, *Research & Practice in Assessment*, *Educational Technology Research and Development*, and *Educational Technology & Society*. *The International Review of Research in Open and Distributed Learning*, which began publication in 2000 with its former name, *the International Review of Research in Open and Distance Learning*, provides open and free peer-reviewed research articles on the topic of open and distributed learning. This journal includes various topics in technology-enhanced learning, such as mobile learning, online learning, distance learning, and other related fields (*IRRODL*, n.d.). *Research & Practice in Assessment* has issued online articles since 2006. It publishes articles two times a year, covering diverse issues in education, using technology, big data, and learning analytics (*Research & Practice in Assessment*, n.d.). In particular, articles related to Massive Open Online Courses (MOOCs) and assessment (e.g., Balfour, 2013; Meyer & Zhu, 2013; Sandeen, 2013) and MOOCs and analytics (e.g., O'Reilly & Veeramachaneni, 2014) were published in this journal. *Educational Technology Research and Development* started publishing articles in 1953 on a broad range of methodological and educational contexts with regards to instruction and technology (*Educational Technology Research and Development*, n.d.). *Educational Technology & Society* has published articles four times every year since 1998. This journal was the only one in the list, which is published by a university in Asia. It covers a wide range of topics, from game-based learning to technology to big data and knowledge management (*Educational Technology & Society*, n.d.).

Table 1

Journals Frequently Cited in Collected Peer-reviewed Articles Published from 2008 to 2017

Period	Journal	Citations
2008–2012	*Computers & Education*	415
	The Internet and Higher Education	151
	Journal of Asynchronous Learning Networks	123
	Review of Educational Research	112
	British Journal of Educational Technology	93
	American Journal of Distance Education	83
	Computers in Human Behavior	39
	Teachers College Record	32
	Instructional Science	30
	Distance Education	30
	The Journal of the American Medical Association (JAMA)	26

Table 1 (continued)

Journals Frequently Cited in Collected Peer-reviewed Articles Published from 2008 to 2017

Period	Journal	Citations
2013–2017	*Computers & Education*	549
	The Internet and Higher Education	386
	The International Review of Research in Open and Distributed Learning	180
	Review of Educational Research	116
	British Journal of Educational Technology	92
	Research & Practice in Assessment	49
	Educational Technology Research and Development	36
	Journal of Asynchronous Learning Networks	34
	Educational Technology & Society	32
	Computers in Human Behavior	30

Most Cited Publications. Table 2 presents publications most cited in the collected peer-reviewed journal articles over the ten years from 2008–2017. D. Randy Garrison and Robert M. Bernard were steadily found in the top rank of the most cited publications. Garrison's (Garrison, 2011; Garrison & Anderson, 2003) book entitled *E-learning in the 21st century: A framework for research and practice* was frequently cited. Its first edition was on the top rank in the first period while the second edition was found in the second period. In addition to that, his research papers on the Community of Inquiry (CoI) framework were often referenced by other researchers. In the case of Bernard, his two meta-analyses of distance education were most cited in each period, respectively (Bernard et al., 2004; Bernard et al., 2009).

Some papers were frequently cited in each period. In the first period, research articles that discussed asynchronous discussion on the online community were frequently cited. For instance, De Wever and his colleagues (2006) reviewed theoretical frameworks of content analysis instruments for the investigation of online discourse. Two other empirical papers regarding online discussion were also frequently cited in this time. Schrire (2006) quantitatively and qualitatively investigated discourse in collaborative learning of doctoral students for their knowledge building, in terms of interactions between an instructor and students as well as the process of learning. Another paper by Pena-Shaff and Nicholls (2004) discussed a similar topic on students' interaction and their knowledge development in a bulletin board on the web.

In the second period between 2013 and 2017, research articles related to previous studies on the CoI framework and distance learning were frequently cited. For instance, in line with the studies on the CoI, Shea and Bidjerano (2009) tested relations between teaching, social, and cognitive presences. In the following year, they (Shea & Bidjerano, 2010) found teaching presence and social presence are correlated with learners' self-efficacy in online learning, suggesting an additional element to include in the framework—learning presence. On the one hand, articles on MOOCs were also found as frequently cited research. More specifically, Liyanagunawardena, Adams, and Williams (2013) reviewed 45 research papers discussing MOOCs, which were published from 2008 to 2012, discovering an increasing number of MOOCs-related articles. They found that many of the articles were published in journals and talked about the concept of MOOCs. Another frequently cited study by Breslow et al. (2013) analyzed learning data of students who took a course on edX, a MOOC platform created by Massachusetts Institute of Technology, revealing characteristics of MOOC course-takers and their learning patterns.

Table 2

Publications Frequently Cited in Collected Peer-reviewed Articles Published from 2008 to 2017

Period	Publication	Citations
2008–2012	Garrison, D., & Anderson, T. (2003). *E-learning in the 21st century: A framework for research and practice.* New York, NY: Routledge.	50
	Bernard, R., Abrami, P., Lou, Y., Borokhovski, E., Wade, A., Wozney, L.,…Huang, B. (2004). How does distance education compare with classroom instruction? A meta-analysis of the empirical literature. *Review of Educational Research, 74*(3), 379–439.	47
	Garrison, D., & Kanuka, H. (2004). Blended learning: Uncovering its transformative potential in higher education. *The Internet and Higher Education, 7*(2), 95–105.	44
	De Wever, B., Schellens, T., Valcke, M., & Keer, H. (2006). Content analysis schemes to analyze transcripts of online asynchronous discussion groups: A review. *Computers & Education, 46*(1), 6–28.	44
	Tallent-Runnels, M. K., Thomas, J. A., Lan, W. Y., Cooper, S., Ahern, T. C., Shaw, S. M., & Liu, X. (2006). Teaching courses online: A review of the research. *Review of Educational Research, 76*(1), 93–135.	43
	Garrison, D., & Cleveland-Innes, M. (2005). Facilitating cognitive presence in online learning: Interaction is not enough. *American Journal of Distance Education, 19*(3), 133–148.	38
	Schrire, S. (2006). Knowledge building in asynchronous discussion groups: Going beyond quantitative analysis. *Computers & Education, 46*(1), 49–70.	34
	Laurillard, D. (2002). *Rethinking university teaching: A conversational framework for the effective use of learning technologies* (2nd ed.). London: Routledge Falmer.	33
	Gee, J. P. (2003). *What video games have to teach us about learning and literacy.* New York: Palgrave Macmillan.	29
	Pena-Shaff, J., & Nicholls, C. (2004). Analyzing student interactions and meaning construction in computer bulletin board discussions. *Computers & Education, 43*(3), 243–265.	29

Table 2 (continued)

Publications Frequently Cited in Collected Peer-reviewed Articles Published from 2008 to 2017

Period	Publication	Citations
2013–2017	Garrison, D., Cleveland-Innes, M., & Fung, T. (2010). Exploring causal relationships among teaching, cognitive, and social presence: Student perceptions of the community of inquiry framework. *The Internet and Higher Education, 13*(1–2), 31–36.	52
	Bernard, R., Abrami, P., Borokhovski, E., Wade, C. A., Tamim, R., Surkes, M., & Bethel, E. (2009). A meta-analysis of three types of interaction treatments in distance education. *Review of Educational Research, 79*(3), 1243–1289.	52
	Liyanagunawardena, T., Adams, A., & Williams, S. (2013). MOOCs: A systematic study of the published literature 2008–2012. *The International Review of Research in Open and Distributed Learning, 14*(3), 202-227.	51
	Breslow, L., Pritchard, D., DeBoer, J., Stump, G., Ho, A., & Seaton, D. (2013). Studying learning in the worldwide classroom research into edX's first MOOC. *Research & Practice in Assessment, 8*, 13–25.	49
	Sun, P.-C., Tsai, R., Finger, G., Chen, Y.-Y., & Yeh, D. (2008). What drives a successful e-learning? An empirical investigation of the critical factors influencing learner satisfaction. *Computers & Education, 50*(4), 1183–1202.	47
	Allen, E., & Seaman, J. (2013). *Changing course: Ten years of tracking online education in the United States.* Babson Survey Research Group Report. http://www.onlinelearningsurvey.com/reports/changingcourse.pdf	46
	Garrison, D. (2011). *E-learning in the 21st century: A framework for research and practice* (2nd ed.). New York, NY: Routledge.	46
	Shea, P., & Bidjerano, T. (2010). Learning presence: Towards a theory of self-efficacy, self-regulation, and the development of a communities of inquiry in online and blended learning environments. *Computers & Education, 55*(4), 1721-1731.	45
	Shea, P., & Bidjerano, T. (2009). Community of inquiry as a theoretical framework to foster "epistemic engagement" and "cognitive presence" in online education. *Computers & Education, 52*(3), 543-553.	41
	Means, B., Toyama,Y., Murphy. R., Bakia, M., & Jones, K. (2009). *Evaluation of evidence-based practices in online learning: A meta-analysis and review of online-learning studies*. Washington, D.C.: U.S. Department of Education.	37

Co-cited Publications and Research Themes

With regards to clusters of major themes discussed in the online learning field during the past decade, Table 3 shows themes extracted from co-cited references of the collected peer-reviewed articles, with the number of co-cited references and average publication year of them. As a result, a total of 23 clustered themes were discovered—12 themes were found in the first

period, while 11 themes were revealed in the second. More specifically, the clustered themes in the first period included "knowledge construction," "blended learning," "inquiry framework," "online learning," "distance education," "clinical reasoning skill," "referencing skill," "epistemological belief," "faculty development," "effective feedback," "expertise," and "participation." In the next time span, the clustered themes were related to "cognitive presence," "MOOC," "blended learning," "satisfaction," "homework," "argumentative knowledge construction," "flipped classroom," "Facebook," "peer feedback," "podcast," "content knowledge," and "teacher community."

Table 3

Research Themes Extracted from Co-cited References

Period	Theme	Co-cited Reference	Average year of co-cited references
2008–2012	Knowledge construction	33	2004
	Blended learning	27	2006
	Inquiry framework	23	2004
	Online learning	18	2003
	Distance education	17	2005
	Online social software application	15	2006
	Referencing skill	11	2002
	Epistemological belief	11	2006
	Faculty development	10	2004
	Formative feedback	4	2006
	Expertise	2	2003
	Participation	2	2002
2013–2017	Cognitive presence	31	2008
	MOOC	26	2012
	Blended learning	24	2009
	Satisfaction	23	2008
	Homework	22	2008
	Argumentative knowledge construction	21	2007
	Flipped classroom	17	2013
	Facebook	17	2010
	Peer feedback	9	2007
	Podcast	9	2009
	Content knowledge	2	2005
	Teacher community	2	2009

Co-cited studies with suddenly increasing citations were further investigated to discover emerging research trends (Chen, 2006). In the first period, meta-analysis research or literature review papers on distance learning were found, including in health education. The CoI framework was also discussed in terms of knowledge advancement in asynchronous online learning. The more recent period discussed the CoI framework; in this period, they primarily focused on cognitive presence, such as review of the CoI framework or metacognitive constructs in collaborative learning that may be underrepresented in the CoI model. Also, using online platforms like social media and MOOCs was researched, and students' satisfaction in social platforms in informal learning was examined (see Table 3). The detailed findings with abruptly co-cited articles are presented in the following sections.

First Period (2008–2012)

Themes in the first period included "knowledge construction," "blended learning," "inquiry framework," "online learning," "distance education," "online social software education," "referencing skill," "epistemological belief," "faculty development," "formative feedback," "expertise," and "participation" (see Table 3). The network of co-cited articles across these themes is presented in Figure 1. According to Chen (2017), color in a co-citation network indicates the year in which two different publications in a themed cluster were co-cited for the first time. For instance, in the first time period as shown in Figure 1, themes in blue had the first co-citation in 2008 (online learning, referencing skill), sky blue in 2009 (knowledge construction, faculty development), green in 2010 (inquiry framework, distance education, epistemological belief), and yellow-orange in 2011 (blended learning, online social software application, formative assessment), respectively. Further, pink and relatively bigger-size publications are those with a sudden increase of co-citations (Chen, 2006).

Of the themes in this period, research articles were found in terms of knowledge construction, the CoI framework, and meta-analysis or review studies on distance education. Regarding knowledge construction, three articles were found—"Analyzing student interactions and meaning construction in computer bulletin board discussions" (Pena-Shaff & Nicholls, 2004); "Content analysis schemes to analyze transcripts of online asynchronous discussion groups: A review" (De Wever et al., 2006); and "Knowledge building in asynchronous discussion groups: Going beyond quantitative analysis" (Schrire, 2006). These articles were listed in Table 2.

The CoI framework was discussed in empirical studies on social and teaching presence. The book entitled *E-learning in the 21st century: A framework for research and practice* (Garrison & Anderson, 2003) appeared co-cited abruptly, which was also listed in the most cited publications shown in Table 2. Empirical research by Garrison and Cleveland-Innes (2005), also listed in Table 2, suggested the need for an adaptation of teaching presence and interaction in order for deeper knowledge improvement in asynchronous online learning. Richardson and Swan (2003) investigated the social presence level of students who took an online course, revealing that those with high social presence levels had high perceptions about their deep learning and were satisfied with the course instruction.

Meta-analysis and review studies appeared noticeable with regards to distance education. For instance, Bernard et al. (2004) conducted a meta-analysis to investigate comparative studies in distance education in diverse contexts such as age, type of media, assessment of the instructional method, and learning outcomes. Tallent-Runnels et al. (2006) reviewed 76 prior studies on online education, identifying features of learning settings and learners along with the administrative

aspects of schools. These two articles were included in the most cited publications as well (see Table 2). One study in a specific disciplinary field was also discovered—Cook et al. (2008) conducted a meta-analysis of online learning in health education. They compared the effect of using the Internet and that of not using it to instruct learners in health and medical fields.

Figure 1. A network of co-cited publications and themes from 2008 to 2012. Themes in blue had the first co-citation in 2008 (online learning, referencing skill), while those in sky blue in 2009 (knowledge construction, faculty development), green in 2010 (inquiry framework, distance education, epistemological belief), and yellow-orange in 2011 (blended learning, online social software application, formative assessment). The colored rings represent co-cited publications with a sudden increase of co-citations. The size of the rings gets bigger as they have co-citations.

Second Period (2013–2017)

Themes in the second period were "cognitive presence," "MOOC," "blended learning," "satisfaction," "homework," "argumentative knowledge construction," "flipped classroom," "Facebook," "peer feedback," "podcast," "content knowledge," and "teacher community" (see Table 3). Co-cited papers in these themes discussed the CoI framework, especially with the direction for future research, metacognitive constructs, educational and economic aspects of MOOCs, features of MOOCs learners, students' satisfaction with online learning, and online social platforms in informal learning.

During this period, research with abruptly emergent co-citations addressed cognitive presence (see Figure 2). As in the previous time span, Garrison's publications were searched as well under this theme. His book *E-learning in the 21st century: A framework for research and practice* (Garrison, 2011) and journal article (Garrison & Cleveland-Innes, 2005) were found here again. Also, Garrison and Arbaugh (2007) reviewed existing literature on the CoI framework and suggested direction for future research regarding the framework. More recently, Garrison and Akyol (2013) claimed that the CoI framework could help create an instrument to examine metacognitive constructs in collective learning. Other experimental studies applied the CoI framework in online learning environments (Akyol & Garrison, 2008; Akyol & Garrison, 2011; Arbaugh et al., 2008).

About MOOCs, social learning on MOOC platforms and features of learning on MOOCs were investigated. For example, Fini (2009) surveyed MOOC takers to identify learner characteristics. Rita (2011) pointed out three capabilities that learners need to have for their connectivist learning in MOOCs—directing learning themselves, having an adequate literacy level, and utilizing technology and tools to learn through interaction with other learners. A common aspect of these two papers (Fini, 2009; Rita, 2011) was that they discussed social engagement and interaction of learners for obtaining knowledge on the Internet in large scale online course formats. Besides, two reports were found to comprehensively illustrate the history and feature of MOOCs— one was written by Yuan and Powell (2013), which especially focused on the significance of MOOCs in the higher education context, and the other one by McAuley, Stewart, Siemens, and Cormier (2010), which described implications of MOOCs from the perspectives of economy and education.

Studies on students' satisfaction and informal learning settings on the Internet were found in recent years. Experimental research was conducted to reveal elements that influence student satisfaction, such as competency to use computers, positive attitudes from teachers, features of online courses and evaluation methods (Sun, Tsai, Finger, Chen, & Yeh, 2008) and importance of teachers' role and qualification to enhance students' motivation and satisfaction in online learning (Paechter, Maier, & Macher, 2010). In addition, an empirical study showed the possibility of using social media for social learning in higher education (Madge, Meek, Wellens, & Hooley, 2009). A theoretical framework was suggested with the idea that social media can be an informal learning platform to enhance students' self-regulated learning (Dabbagh & Kitsantas, 2012).

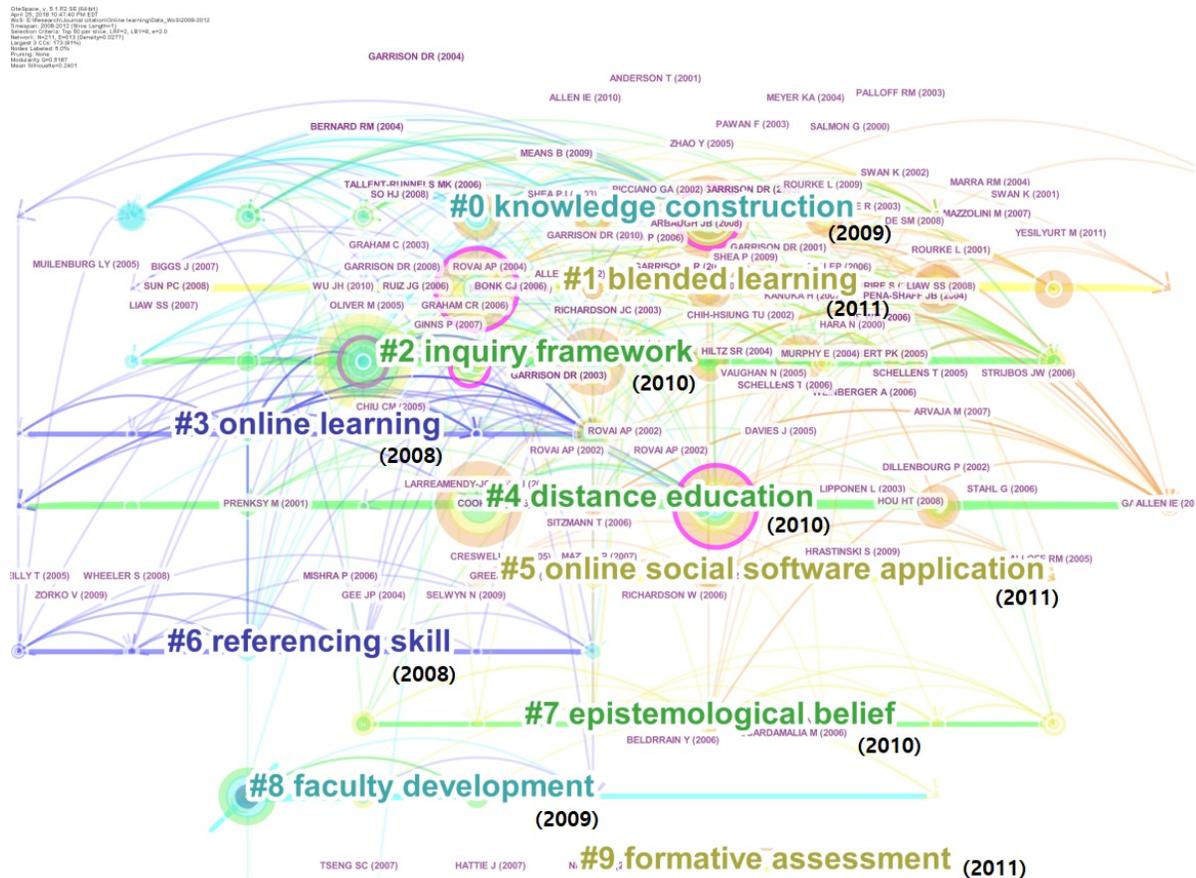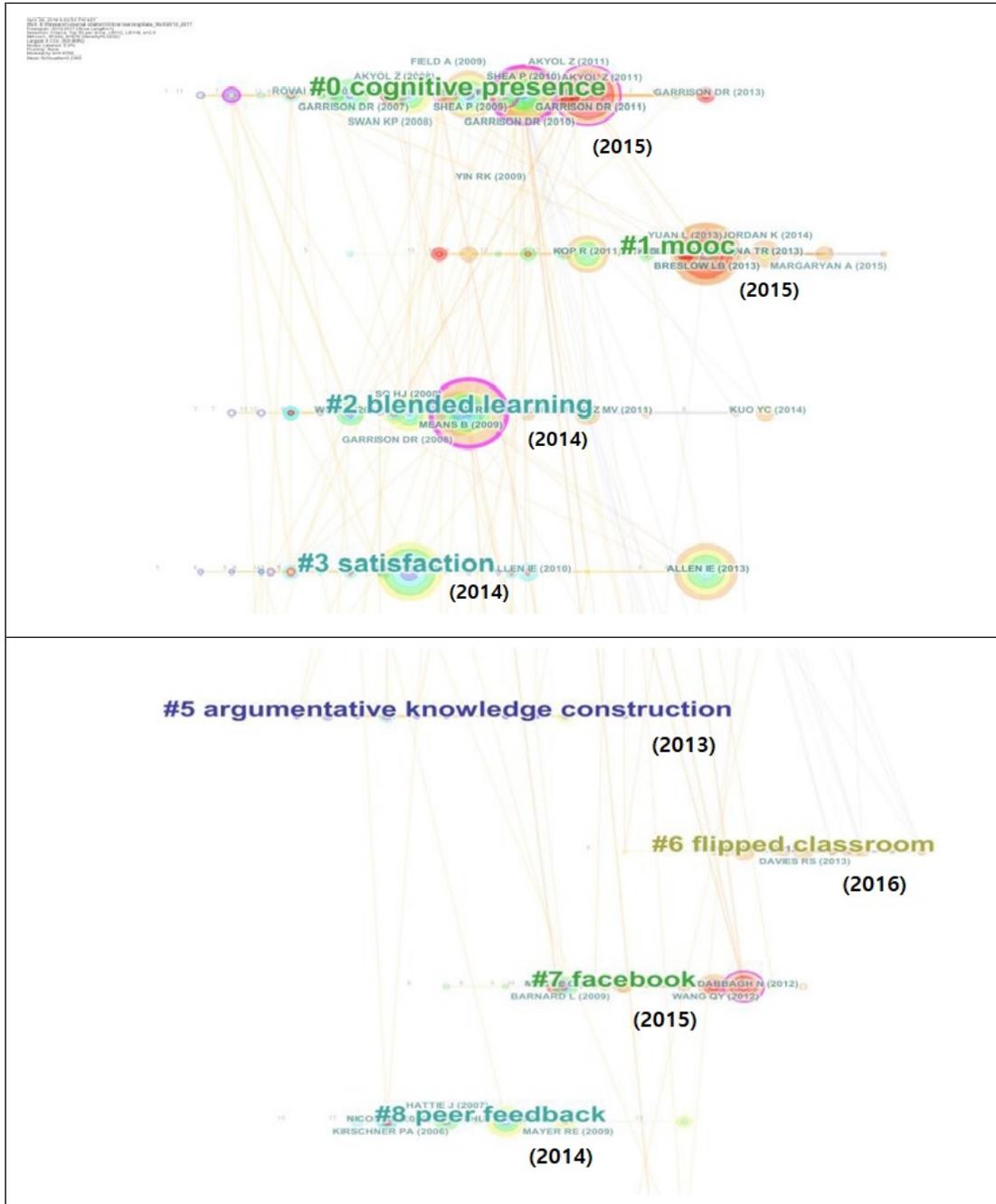*Figure 2*. A network of co-cited publications and themes from 2013 to 2017. Themes in blue had the first co-citation in 2013 (argumentative knowledge construction), while those in sky blue in 2014 (blended learning, satisfaction, peer feedback), green in 2015 (cognitive presence, MOOC, Facebook), and yellow-orange in 2016 (flipped classroom). The colored rings represent major co-cited publications with the sudden increase of co-citations. The size of the rings gets bigger as they have more co-citations.

Conclusion and Discussion

The present study investigated emerging research trends in online learning over the past ten years. Frequently cited journals and publications, emergent co-cited publications, and research themes by clustering co-cited publications were revealed and discussed in this study. As a result, journals about using technology and the Internet in education in various domains were steadily cited for the past ten years. Specifically, journals discussing research on distance education were frequently cited in the first five years. In more recent five years, journals publishing articles about adopting relatively new tools and technology in education were often cited, broadly covering big data, MOOCs, learning analytics, game-based learning, and other related topics.

Similar phenomena were identified when examining highly cited and co-cited research publications. In general, review studies and meta-analytic studies on distance education were highly cited for the first five years, leading to research on the use of MOOCs in learning and analysis of learners' interaction and their features on MOOCs platforms. Additionally, learners' discourse in asynchronous discussion in the virtual learning community was investigated in the first period, while students' satisfaction and self-regulation were studied in recent years. More recent studies discussed informal learning in online platforms such as social media. One more significant finding was that the CoI framework was continually researched over the past decade. This topic was discussed in journal articles and books, covering components of the framework and their relationship with other aspects of online learners such as interaction, perception, and metacognitive constructs in collaborative learning.

This study examined features and changes in research trends in online learning through co-citation analysis and discussed promising future research trends (Gmur, 2003). The visualized network of clustered themes enhanced our understanding of the configuration of important topics and academic publications in online learning based on a 10-year timeframe (Chen et al., 2010; Liang, Liu, Yang, & Wang, 2008). It is now getting more critical to consider online learners' characteristics, including their learning type, self-regulation, and motivation in online learning research. In recent years, the Internet played a significant role in facilitating learners' ubiquitous learning, along with their cognitive improvement in both formal and informal learning environments. For learners' intellectual advancement, it is highly necessary to design online courses beyond the simple use of online platforms. Appropriate pedagogy is as critical as state-of-the-art technology to take the best advantage of utilizing the technology in education. Without decent pedagogy for learning and teaching, the effectiveness of using educational technology will be diminishing. It is also important to facilitate interactions between students and students, students and instructors, and students and course content/assessment tools with timely feedback and monitoring of students' learning (Siemens et al., 2015). Students need to understand their learning progress and how to select and use reliable educational resources from the Internet to deepen high-quality knowledge. Meanwhile, it needs to be pointed out that the database in this study was only retrieved from the WoS, which might limit the range of the results. Further study should include expanded datasets such as Scopus or Google Scholar (Kuo, & Yang, 2012; Park Yoon, & Leydesdorff, 2016). Also, this study examined peer-reviewed articles downloaded using the three search queries. In order to cover more comprehensive data, future research can use more diverse search queries. Finally, conducting cluster analysis with supplementary analysis may improve the comprehensiveness of exploring citation patterns (Boyack, & Klavans, 2010; Braam, Moed, & Raan, 1991).

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