A bibliometric analysis of Community of Inquiry in online learning contexts over twenty-five years

Zhonggen Yu[1] · Ming Li[1]

Abstract

Since the outbreak of COVID-19, online learning has gained popularity among educators and learners, where Community of Inquiry (CoI) has caught researchers' attention. To bibliometrically analyze the framework of CoI over twenty-five years, we adopted both qualitative and quantitative research methods to examine the framework of CoI in online learning contexts. We concluded that teaching presence, social presence, cognitive presence, metacognition, and self-efficacy played important roles in the framework of CoI. This study also explored the top ten authors, sources, organizations, and countries using VOSviewer and established citation networks through the clustering techniques in CitNetExplorer. Future research could focus on how to motivate the educational institutes and educators to change their traditional educational methods and whether to include both metacognition and self-efficacy in the CoI framework.

Keywords Bibliometric analysis · Community of Inquiry · VOSviewer · CitNetExplorer · Online learning

1 Introduction

The sudden outbreak of The COVID-19 pandemic has greatly changed learners' knowledge acquisition styles and made online and blended learning a popular approach (Yu & Yu, 2021). To avoid physical contacts and keep social distance, learn-

✉ Zhonggen Yu
  401373742@qq.com

✉ Ming Li
  23743995@qq.com

[1] Faculty of Foreign Studies, Beijing Language and Culture University, 15 Xueyuan Road, Haidian District, 100083 Beijing, China

ers have to stay home receiving online or hybrid education from teachers who adopt various methods to enhance this special learning style by improving social interactions, peer collaboration, and academic efforts. Learners have to learn how to interact with peers, teachers, and friends using the online communicative technologies. Teachers should also master the skills of using online communication technologies to deliver knowledge to students and interact with them online or through a blended method (Yu, 2021). It is thus important to establish a framework to conceptualize and facilitate online learning.

Of the numerous frameworks used in online learning, the framework of Community of Inquiry (CoI) has gained popularity. An educational community aims to construct a community where learners could collaborate with each other to facilitate their understandings or perceptions of the target knowledge. The conception of CoI was initially proposed by pragmatist philosophers C. S. Peirce and John Dewey, who connected it to the inquiry in the process of knowledge acquisition (Pardales & Girod, 2006). The community of inquiry can thus be generally defined as a learning process or environment where learners can solve learning problems or address difficult issues through inquiries. In the framework of CoI, there are three important and independent factors, i.e. social presence, cognitive presence, and teaching presence (Garrison et al., 1999).

During the pandemic time, CoI appeared most significant for both learners and teachers to apply to their learning and teaching (Lau et al., 2022). Under the guidelines of CoI, students might be able to learn through proper strategies and acquire knowledge through effective cognitive approaches. Students could also share opinions, solve difficult problems, discuss thorny questions, and address various academic issues with peers and teachers. Teachers could showcase their lecture notes through online techniques and encourage students to engage in online academic activities (Yu et al., 2022). CoI was an appropriate theoretical model to connect these elements in online learning (Sen-Akbulut et al., 2022). Although CoI has undergone plentiful practical and theoretical explorations and examinations, very few studies have been devoted to the bibliometric analysis of CoI. This CoI-based bibliometric analysis is, therefore, necessary and meaningful.

We will conduct this study by combining the quantitative with qualitative analyses (Van Eck & Waltman, 2017). Firstly, this study will bibliometrically analyze the use of CoI in online learning involving the year-based trend of included publications and citations, as well as top ten authors, sources, organizations, and countries. Secondly, we will establish citation networks via clustering techniques. We then will drill down the citation networks to two longest citation paths for further analysis. We will finally conduct qualitative analyses of citation networks and explore some variables within the framework of CoI.

2 Literature review

2.1 The constructs within CoI

The major constructs within the CoI framework included teaching presence, social presence, and cognitive presence. Teaching presence, deemed as the most important construct influencing online learning contexts, indicated students' perceptions of teaching behaviors and performances in online or blended pedagogical approaches, aiming to improve learning outcomes and achieve learning goals (Garrison et al., 2010). Teaching presence could provide constructive references for course design, curriculum outlines, and teaching methods (Law et al., 2019). Teaching presence was positively correlated with students' evaluation of online or blended educational quality, which could bridge the gap between social and cognitive presences (Garrison, 2007).

Social presence indicated the capacity of learners to interact with peers and teachers and establish online or blended positive learning environments (Garrison et al., 2010). On one hand, the online interactions with peers might enhance learners' mutual trusts of those who felt lonely or isolated in the new online learning environment (Doo & Bonk, 2020). Online interactions might help increase learners' engagement in learning activities and enhance their learning belief, forming the acquaintance with their peers and superiors. On the other hand, if learners failed to interact with peers or teachers, they might feel alienated from the learning community, where they lost opportunities of consulting advanced learners or teachers to solve difficult problems (Ehrenberg et al., 2001). Social presence could thus be considered an important construct to establish a harmonious learning community and it could predict the degree of cognitive presence in CoI (Garrison et al., 2010).

Cognitive presence indicated the capacity of learners to establish cognitive abilities to understand the knowledge delivered through interactions or communications in the online learning process (Garrison et al., 2010). The innovative or challenging learning contents could stimulate learners' curiosity and encourage them to engage in interactive learning activities for further inferences, analyses, and computations (Garrison et al., 2010). Higher cognitive abilities could enhance learners' initiative, followed by strong learning motivation and high learning belief (Candy, 1991). Higher-order skills such as metacognition, critical thinking, and creativities might increase along with the improved cognitive abilities (Hu et al., 2016). Cognitive presence in CoI was referred to as the higher stage that learners aimed to achieve in online learning communities under the framework of CoI.

2.2 The relationship between three presences

There are positive and significant relationships between teaching, social, and cognitive presences in the framework of CoI. Teaching and social presences could promote epistemic engagement and enhance cognitive presence of online learners, and in turn, cognitive presence of online learners could exert a positive influence on teaching and social presences (Shea & Bidjerano, 2009). Teaching and social presence could greatly influence cognitive presence and teaching presence could greatly influence

social presence. Therefore, teaching presence plays an essential role in establishing CoI (Garrison et al., 2010). Teaching presence, as an important construct, included numerous influencing factors, e.g. course design, teaching organization, and teaching behaviors, which could be enhanced by CoI via an effective online learning environment (Arbaugh et al., 2008).

The strategies to establish an effective online learning community are worth exploring through social presence via CoI. The CoI framework is a beneficial tool to facilitate online learning. The interdependence of three presences in this framework could be thoroughly examined to provide useful references for online learning (Garrison & Arbaugh, 2007). The framework of CoI could be extended to more diversified learning methods except for online learning. It is also necessary to establish interpersonal relationships through social presence. Furthermore, as a basis for cognitive presence, social presence could be expanded to various purposes, rather than limited to the construction of society-emotional and interpersonal relationships (Garrison et al., 2010). Social and teaching presences could be highlighted to activate learning enthusiasm and improve collaborative learning outcomes.

2.3 Measurements of three presences

Traditional research methods might fail to examine teaching behaviors in online learning (Shea et al., 2010b). To measure three presences in CoI, researchers could focus their attention on the complete course rather than the collected survey data or focused discussion (Shea et al., 2010b) although a survey (Shea & Bidjerano, 2009) had been designed to measure three presences in the framework of CoI. However, the survey containing various questions to test certain items could explore three presences in CoI in case participants could cooperate with researchers and fill in the questionnaires based on their own perceptions. Discussion might also solicit the true opinions of participants and produce reliable data. A combination between a holistic course, survey, and focused discussion might be a solution to address the issue of measurements.

2.4 The framework of CoI

CoI was a model formed especially during the online learning process with a focus on an interactive community formed by fostering important constructs such as social, teaching, and cognitive presences (Garrison et al., 2001). These conceptual elements played an important role in online learning contexts. Collaborative online learning was considered an important learning style where appropriate instructional methods with teaching presence could improve online learning outcomes. Teaching presence could help set learning goals, construct learning outlines, organize learning activities, and deliver knowledge. The supportive peer-assisted learning style, i.e. social presence, could also facilitate online learning. The CoI model also included cognitive presence that was a multidimensional variable measured in the continuous online inquiry process in the learning community. The cognitive presence actually reflected the pragmatic aspect of online learning (Dewey, 1933; Lipmann, 2003).

Numerous online learning factors interacted with the constructs of CoI. The Internet data transfer speed, rather than gender and majors, could exert a significant influence on the CoI constructs such as teaching, social, and cognitive presences. Under the framework of CoI, learning abilities and behaviors were negatively related to learning anxiety that was also negatively related to cognitive, social, behavioral, and emotional engagements in game-based learning assisted with smart phones (Yang et al., 2021). Online learning satisfaction was positively and significantly correlated with learning engagement and experience (Chan et al., 2021). Learners' attitudes towards and acceptance of online learning could exert an important influence on online learning effectiveness.

Learners and learning presence could play an important role in enhancing the CoI. Learning presence involved numerous constructs, e.g. self-efficacy and self-regulation in terms of cognitive, behavioral, and motivational aspects, conducive to the formation and development of online learning constructs involved in CoI (Shea & Bidjerano, 2010). Based on the framework of CoI, learning presence was developed to facilitate collaborative learning in online learning contexts (Shea et al., 2012). Learning presence was positively and significantly correlated with CoI although it was not included in the constructs of CoI. Researchers could focus their attention on learners and learning presence in online learning.

The COVID-19 pandemic has caused dramatic changes to educational methods, where online learning under the framework of CoI has become an important solution. Teaching, cognitive, and social presences in the framework of CoI could predict learners' attitudes towards and their acceptance of the blended pedagogical approach (Bamoallem & Altarteer, 2022). Interactions with peers and teachers in a CoI could improve students' cognitive abilities, knowledge, and learning attitudes (Ahmad et al., 2021). However, the synchronous blended learning method might be merely a temporary style instead of a permanent solution to handle the teaching and learning problems during the COVID-19 pandemic with a view to maintaining a powerful and effective CoI (Hayes & Tucker, 2021). Besides, metacognition of learners might play a key role in online learning contexts.

2.5 Metacognition

Metacognition was deemed as the ability or awareness that learners could assume responsibility and regulate their learning behaviors to perceive meanings and acquire knowledge (Norman et al., 2019). It was defined as a higher-order skill that learners could be used to regulate, monitor, and moderate their cognitive processes and solve problems (Tobias & Everson, 2009). The former was demonstrated positively correlated with the latter (Young & Fry, 2008). While previous studies revealed that the improvement of meta-cognitive could positively influence learning outcomes (Stewart et al., 2007), few of them identified the metacognition in the online learning environment under the CoI framework. The construct of metacognition is important to explore especially in online learning contexts since meta-cognitive strategies such as self-regulation are considered necessary to be examined in online learning contexts where teaching supervision tends to be absent (Topcu & Ubuz, 2008).

2.6 Self-efficacy

Self-efficacy is an important factor that may influence the online learning effectiveness. A large body of studies has examined self-efficacy in online learning (e.g. Calaguas & Consunji 2022; Geng, 2022; Baroudi & Shaya, 2022). The motivational theory proposed by Bandura (1982) defined the learning self-efficacy as human belief or confidence in whether learners could achieve success in learning. Learning behaviors were under the influence of learning expectations and learning efficiency (Bandura, 1989). When learners believed that they could achieve success in learning they might possess strong self-efficacy to join academic activities (Britner & Pajares, 2006). There were positive relationships between self-efficacy, course satisfaction, learning motivation, and positive emotions. However, self-efficacy was negatively correlated with anxiety, frustration, and boredom (Cho et al., 2017). While plentiful studies have been committed to research into self-efficacy, there is a paucity of studies related to self-efficacy within the CoI framework in online learning contexts.

2.7 Research purposes and questions

Based on the literature review, this study aims to bibliometrically analyze the use of CoI in online learning and identify the important factors in the framework of CoI. The research questions are listed as follows:

RQ1: What is the year-based trend of included publications and citations?

RQ2: What are the top ten authors, sources, organizations, and countries among the studies on CoI in online learning contexts over twenty-five years?

RQ3: Does metacognition play an important role in the framework of CoI?

RQ4: Does self-efficacy play an important role in the framework of CoI?

RQ5: Do teaching, social, and cognitive presences play important roles in the framework of CoI?

3 Methods

This study attempts to conduct a bibliometric analysis using both VOSviewer and CitNetExplorer. We will analyze citation networks and conduct bibliometric analyses through clustering techniques and corresponding computations using both CitNet-Explorer Van Eck & Waltman 2014ab) and VOSviewer (Van Eck & Waltman, 2010; Eck & Waltman, 2014b). CitNetExplorer highlights the individual level by clustering the publications based on citation relations, while VOSviewer sheds light on the aggregate level for bibliometric analyses. Both of them can visualize the clustering results and the solution analyses to enhance the bibliographic analysis. In general, we will conduct a bibliometric analysis using VOSviewer at an aggregate level and analyze the citation networks using CitNetExplorer at an individual level.

Direct citation networks, rather than keywords, will be used to determine the relationship of publications. Keywords will not be used to establish the relationship because the exact meanings of a specific keyword are hard to be clarified. A keyword may have various kinds of interpretations dependent on different contexts,

which may confuse the classifications of clusters, leading to difficulty in analyzing clustering solutions. Co-citation and bibliographic coupling are in essence indirect calculations of relations so that they cannot provide direct or accurate information. Therefore, they will not be used as criteria to determine the relationship of publications (Waltman & Van Eck, 2012). The clustering techniques in CitNetExplorer are adopted to cluster publications based on their relationships. To avoid technical problems or analytical issues, we will assign a specific publication to a unique cluster rather than multiple ones (Van Eck & Waltman, 2017).

We will include various publications for bibliometric analyses using both VOSviewer and CitNetExplorer. In view of possible spellings of either *inquiry* or *enquiry*, we, on November 30, 2021, searched Web of Science by entering "community of inquiry" OR "community of enquiry" as topics, leading to a total of 885 results used in the bibliometric analysis assisted with VOSviewer. The document types included articles (N=724), meetings (N=140), review articles (N=25), early access (N=16), editorial materials (N=4), and others (N=7). We excluded 16 documents of the early-access type for further bibliometric analysis in CitNetExplorer (N=869) with a view to avoiding the technical problem, i.e. the null pointer exception. The null pointer exception is triggered by an event due to a technical issue or problem occurring during the execution of a certain program. The selection timeline ranged from the inceptions of online databases to the year 2021. Web of Science included numerous online databases such as Core Collection of Web of Science (1985 to present), KCI-Korean Journal Database (1980 to present), MEDLINE® (1950 to present), Russian Science Citation Index (2005 to present), and SciELO Citation Index (2002 to present).

To enhance the representativeness, the included publications will come from various sources and will be written in various languages. The main sources included Internet and Higher Education (N=57), Childhood and Philosophy (N=40), International Review of Research in Open and Distributed Learning (N=27), Online Learning (N=26), Computers & Education (N=20), INTED proceedings (N=18), Educational Philosophy and Theory (N=17). The languages of included documents included English (N=800), Korean (N=48), Spanish (N=20), Chinese (N=4), French (N=4), Portuguese (N=4), Italian (N=2), Croatian (N=1), German (N=1), Slovenian (N=1), and unspecified (N=1).

4 Results

4.1 RQ1: what is the year-based trend of included publications and citations?

Besides those for the bibliometric analysis, one more result was retrieved to analyze the trend due to the extension of the time range. The results included 25 review articles and 261 open-access documents, ranging from 1997 to 2022. The trend of included publications and citations is shown in Fig. 1, which showcases that the studies on CoI have become increasingly popular since her birth in 1997. The number of related studies fluctuated between 1997 and 2003 until it suddenly soared up in 2004. The number of relevant studies also went up and down between 2004 and 2008 until in 2009 and 2010 it rocketed up. From then on, the number of related studies climbed
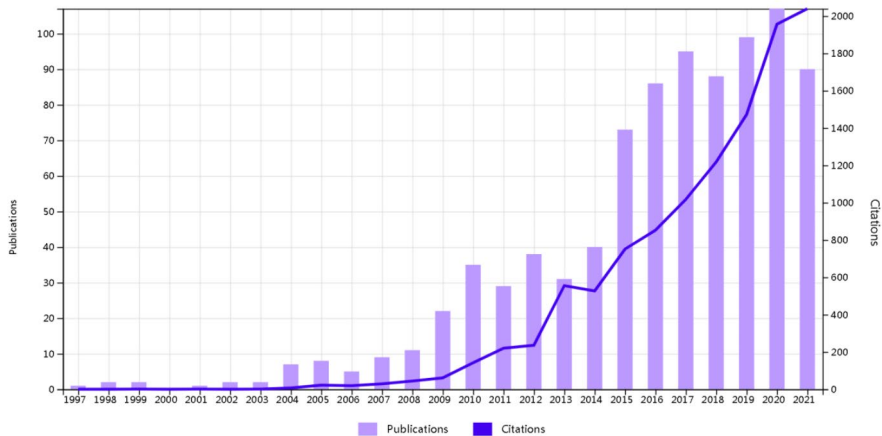
Fig. 1 The year-based trend of included publications and citations

up although there were ups and downs. The period from 2015 to 2021 witnessed a large number of publications related to CoI. As time elapsed, the number of citations remained nearly unchanged between 1997 and 2007. However, the year 2008 witnessed a gradual increase in the citation number until its peak in 2021.

4.2 RQ2: What are the top ten authors, sources, organizations, and countries among the studies on CoI in online learning contexts over twenty-five years?

To answer the second research question, we calculated the top ten cited authors, sources, organizations, and countries through VOSviewer (Table 1). As shown in Table 1, the top ten cited authors are Garrison, D. R., Shea, P., Arbaugh, J.B., Akyol, Z., Swan, K., Lipman, M., Anderson, T., Dewey, J., Rourke, L., and Rovai, A.P. The top ten cited sources are Internet and Higher Education, Computers & Education, Journal of Asynchronous Learning Networks, International Review of Research in Open and Distance Learning, American Journal of Distance Education, British Journal of Educational Technology, Journal of Distance Education, Computers in Human Behavior, Thesis, and Online Learning. The top ten cited organizations are University of Calgary, Athabasca University, State University of New York-University at Albany, SUNY, Furman University, Purdue University, University of Wisconsin, Kent State University, Simon Fraser University, SUNY Empire State College, and University of Illinois. The top ten cited countries are the USA, Canada, Australia, Turkey, England, Scotland, China, South Africa, Netherlands, and South Korea.

The clustering techniques integrated into CitNetExplorer categorized the included publications into three clusters. Seventy-six publications did not belong to any cluster due to the minimum size requirement. After choosing 100 most frequently cited publications in the citation network visualization, we obtained Fig. 2, including 901 publications (merely 100 of them can be visualized) and 6533 citation links. For each cluster, Table 2 showcases the details regarding publication numbers, citation links, the number of publications with more than 10 citations, and the number of publica-

Table 1 Top ten authors, sources, organizations, and countries

N	Cited author	Citation	Link	Cited source	Citation	Link
1	Garrison, D. R.	1711	10,973	Internet and Higher Education	1636	24,443
2	Shea, P	626	6820	Computers & Education	1136	19,451
3	Arbaugh, J.B.	495	5375	Journal of Asynchronous Learning Networks	905	13,967
4	Akyol, Z.	351	4122	International Review of Research in Open and Distance Learning	630	10,362
5	Swan, K.	328	3552	American Journal of Distance Education	458	7370
6	Lipman, M.	279	662	British Journal of Educational Technology	376	7862
7	Anderson, T.	265	2667	Journal of Distance Education	316	5250
8	Dewey, J.	223	1191	Computers in Human Behavior	256	4445
9	Rourke, L.	199	2174	Thesis	226	5000
10	Rovai, A.P.	125	2256	Online Learning	167	4867
N	**Organization**	**Citation**	**Link**	**Country**	**Citation**	**Link**
1	University of Calgary	1685	415	USA	5444	1733
2	Athabasca University	12	1512	Canada	2901	1299
3	State University of New York - University at Albany, SUNY	15	1016	Australia	558	437
4	Furman University	9	836	Turkey	551	511
5	Purdue University	18	674	England	470	222
6	University of Wisconsin	5	456	Scotland	291	284
7	Kent State University	7	320	China	254	333
8	Simon Fraser University	9	247	South Africa	230	114
9	SUNY Empire State College	5	234	Netherlands	141	117
10	University of Illinois	6	211	South Korea	140	102

Fig. 2 Visualization of citation networks of 100 publications
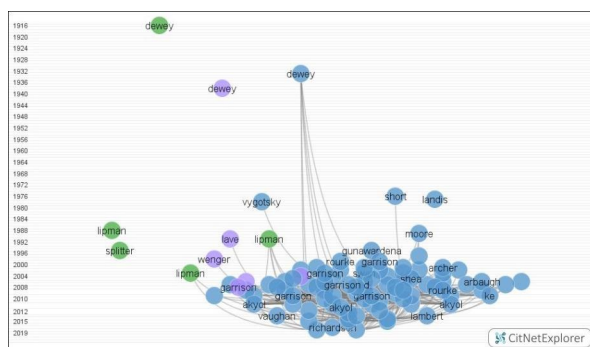
tions in 40 most cited publications (Table 2). The time period ranges from 1916 to 2019 in the citation network. We expanded the citation network by including both predecessors and successors, which accounted for the result that the publications in the network outnumbered the included studies.

Table 2 Three clusters and citation networks

Cluster	Color	No. of publications	No. of citation link	No. of publications ≧ 10 citations	No. of Publications in 40 Most Cited Publications
1	Blue	596	5685	172	36
2	Green	140	310	14	2
3	Purple	89	139	11	2

According to the publications with the highest citation score (N=415) (Garrison et al., 1999) in the first cluster, the community of inquiry included cognitive, social, and teaching presences and computer conferencing could play an important role in forming the CoI framework applied to the educational field. We analyzed the first *longest path* by selecting Garrison et al., (1999) and Garrison (2013), where eight publications (Shea & Bidjerano, 2009, 2010; Garrison et al., 2010; Arbaugh et al., 2008; Shea et al., 2010a, 2012; Akyol & Garrison, 2011; Garrison & Akyol, 2013) cited the study with the highest citation score (Garrison et al., 1999) (Fig. 3). We, therefore, discussed the main findings in this citation network. These citation networks introduced the relationship between three presences, measurements of three presences, metacognition, and self-efficacy in CoI.

4.3 RQ3: does metacognition play an important role in the framework of CoI?

The framework of CoI could provide indicators to account for the conception, social attributes, and online learning construction of metacognition (Akyol & Garrison, 2011). Socially and individually, metacognition could facilitate in-depth and meaningful learning, especially in a collaborative learning context, under the guidelines of
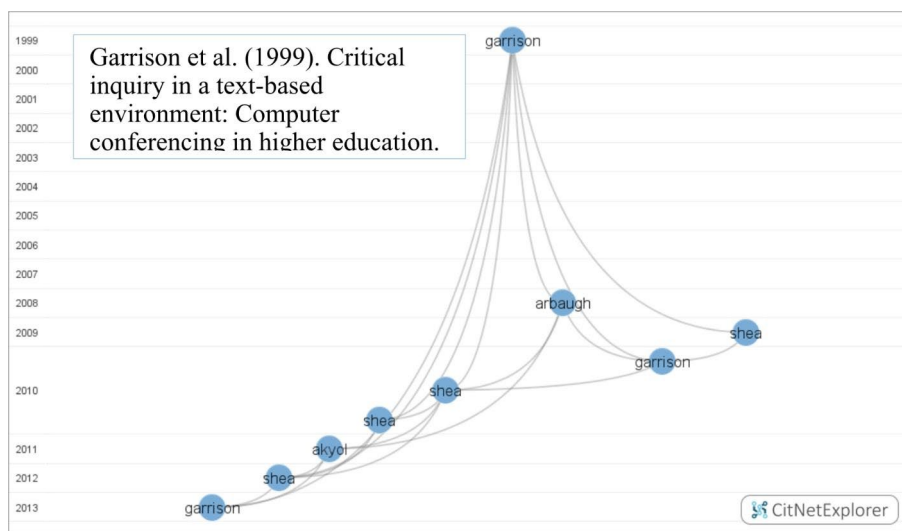
Fig. 3 Visualization of the first longest path analysis

the theory of CoI. Researchers could examine metacognition in terms of both individual and shared regulation rather than at a personal level (Garrison & Akyol, 2013). Representative samples might help researchers obtain enough data to analyze metacognition. With the advancement of information technologies, modern techniques could identify meta-cognitive by probing into brain activities. The interactions of three presences in CoI might facilitate the investigation of metacognition.

4.4 RQ4: does self-efficacy play an important role in the framework of CoI?

The CoI framework could help researchers and practitioners perceive effective online learning with a focus on engagement, where self-regulation acted as a strong indicator of the academic success achieved by online learners (Doo & Bonk, 2020). Self-efficacy was considered the learners' beliefs about their learning success or their perceptions about their abilities to achieve the set learning goal or arrive at the academic destination through a series of learning activities. Self-efficacy could be divided into outcome expectations and personal efficacy expectations. The former indicated the beliefs about the possibilities of obtaining learning outcomes or achieving learners' expectations, and the latter meant the beliefs about their abilities to carry out some learning activities or behaviors (Bandura, 1997). Self-efficacy, as an important predictor of academic success (Robbins et al., 2004), could bridge the gap between learner motivation and cognition. Self-efficacy could also enhance learners' self-regulation and persistence (Zimmerman & Schunk, 2001: 17–20). It is necessary to investigate the relationships between three presences and self-efficacy to study learner self-regulation and learner presence in online collaborative learning contexts.
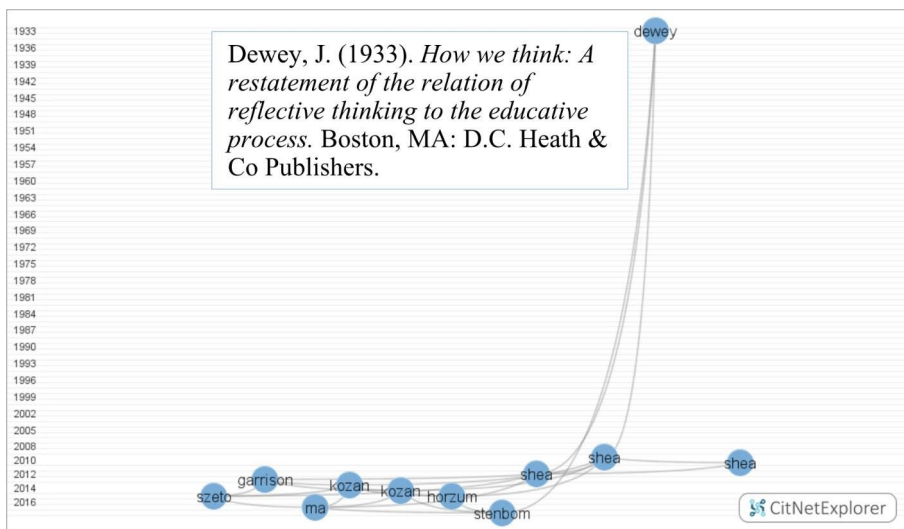

Fig. 4 Visualizing the second longest path analysis

4.5 RQ5: do teaching, social, and cognitive presences play important roles in the framework of CoI?

To address this question, we drilled down to the selected publications and secured another citation network after identifying the second longest path led by Dewey (1933) (Fig. 4). This citation network included 11 publications. After removing those similar to the first longest path, we will focus our discussion on these studies implemented by Shea et al., (2010b; Kozan & Richardson, (2014a, b; Stenbom, (2018); Szeto (2015)). Major findings in this path include the roles of teaching and cognitive presences and the design of a questionnaire survey based on CoI.

Teaching presence, indicating the appearance and instruction of teachers in online learning, can greatly influence teaching and learning behaviors. Teaching presence could exert significantly more influence on learning outcomes than social or cognitive presences (Zuo et al., 2021). Teaching presence could act as a pioneering role in improving students' performance compared with cognitive and social presences. Social presence plays an important role in perceiving online learning but it depends on teachers and students (Shea et al., 2010b). Teachers can give instructions to students, who follow them. In case the teaching presence arrives at a higher level, students' learning behaviors will be higher, and vice versa.

Under the CoI framework, cognitive presence could greatly influence the learning activities and the higher level of cognitive presence could activate the threaded discussion. Cognitive presence could exert a significant influence on the relationship between social and teaching presences. The relationships between teaching and cognitive presences and between cognitive and social presences were not subject to other relationships (Kozan & Richardson, 2014b). Nevertheless, the effects of three presences on teaching in blended learning might depend on specific contexts and situations (Szeto, 2015). Although cognitive presence could not play a more important role than teaching presence, the former could greatly influence the learning or social networks built based on CoI. A model is constructed including the influencing factors in CoI (Fig. 5).

Fig. 5 A model of influencing factors in CoI
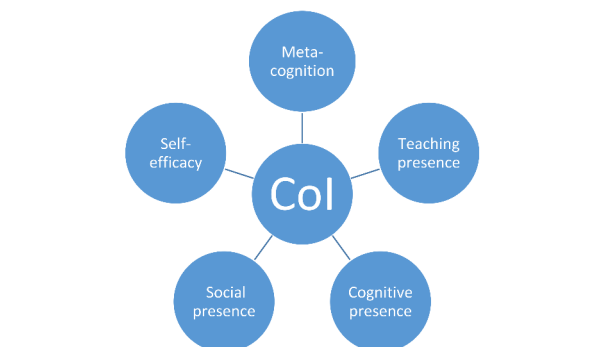
5 Discussion

The revealed top ten cited authors, sources, organizations, and countries can provide a meaningful reference for future researchers and practitioners. They can refer to the publications with higher citations and analyze the connections between them. For example, researchers can in the future examine the sources and authors with high citation scores since they can exert a great influence on other studies. A link indicates the association between items. For instance, a link of cited author indicates the association between cited authors; a link of organizations indicates the associate between organizations; a link of countries indicates the associate between countries. Future researchers can also examine literature based on the links found in this study.

The COVID-19 pandemic has forced a tremendous number of learners to stay home receiving online teaching (Yu, 2021), where the CoI framework can be extensively used. CoI could be integrated into the technological pedagogical content model to provide insights into the role of teacher and student in online learning contexts (Williams & Corwith, 2021). The technological pedagogical content model could reveal teaching performance and effectiveness with a view to improving technology-assisted teaching methods. CoI could foreground the role of learners in technology-assisted learning such as online learning, where the epistemic engagement was highlighted for collaboration (Shea & Bidjerano, 2009). CoI proposes that the ability of teachers and students could exert a great influence on online learning environments.

Teaching presence plays a dominating role in the framework of CoI (Dempsey & Zhang, 2019). Teachers can encourage students to join academic activities, keep up with peers, and complete the assignment in a timely manner. Along with the development of computer technologies, big data, cloud computing, mobile Internet, and multimedia technologies, merely three presences within the CoI framework cannot satisfy the demands of learners. Online learning communities can provide a sea of learning resources and create interactive means of communication between teachers, peers, and online learning platforms (Heymann et al., 2022). This has greatly changed the learning environments, where many kinds of presences such as learning presence, telepresence, video-presence, and artificial intelligence presence may be needed (Wang et al., 2022).

In an online learning community, teachers and students exert different influences on the learning process (Gutierrez-Santiuste et al., 2015). Teachers can design the curriculum and remind students of participation. Students are expected to actively participate in the threaded discussion, share opinions, and solve difficult problems with peers through the online learning platform. Students are supposed to be aware of their identities and make every effort to participate in the online learning to acquire as much knowledge as they can. They can work hard to gradually move from the periphery to the center of the online learning community (Wu et al., 2022). Teachers are supposed to organize the learning activities where new knowledge is delivered. They can also help students establish knowledge networks by interacting with them through online platforms (Ibert et al., 2021). They, as supervisors, can urge students to complete the assignment and join class punctually by scoring their learning performances.

Within the CoI framework, teaching presence and social presence could improve cognitive presence of students (Garrison et al., 2010). Teachers could gather students to establish an interactive learning community, where peers could mutually learn and assist, improving their cognitive presence. Teachers, who organize and observe students, could enhance students' self-regulation and establish criteria for question-answers. With the assistance of online learning technologies and teachers, students could actively express themselves and help those in need (Yu, 2021). They could also cultivate their confidence by frequently voicing their opinions and communicating with teachers and peers. Teachers could make progress with students together and cater to various cognitive needs of different students (Zhai, 2021).

With the rapid advancement of information technologies, cognitive presence in online learning contexts within CoI may not be limited to the presence of learners' cognition (Lee et al., 2022). Online technologies, including robots and artificial intelligence, could also develop their cognitive presences through deep learning. The human brain can presently govern machines, which may nevertheless form cognitions and show their presence in online learning communities, facilitating online learning and creating virtual learning contexts. Human students may interact with robot assistants to obtain constructive suggestions or proper guidelines when they are confused (Jimenez et al., 2014). Actually, human students keep communicating with online technologies during the learning process in terms of cognition, instruction, and social interactions.

The framework of CoI could include metacognition and self-efficacy since both factors might greatly influence online learning outcomes. Enjoyment and frustration could positively predict metacognition. Enjoyment of learners could positively predict the level of metacognition in online learning contexts, but the negative emotion, i.e. boredom, could be negatively correlated with metacognition (Artino, 2009). Surprisingly, another negative emotion, i.e. frustration, could positively predict the level of metacognition (Artino & Jones, 2012). Learners' technological self-efficacy could either directly or indirectly influence their learning perceptions and curriculum satisfaction (Wei & Chou, 2020). Learning self-efficacy of students could positively predict students' intention to continue using online learning platforms (Um & Jang, 2021). Self-efficacy could greatly influence cognitive engagement in several countries in online learning contexts (Aguilera-Hermida et al., 2021).

Validated questionnaires could be adopted to measure the constructs and online learning effectiveness based on the social networks established through CoI. Social network analysis is a useful method to analyze the behaviors of students and teachers in online learning contexts (Shea et al., 2010b). Researchers could take the questionnaire into account when they would like to launch a study where participants' opinions were needed (Delgado-Garcia et al., 2021). The questionnaire could include all the constructs within the framework of CoI, as well as other factors, e.g. metacognition and self-efficacy, since they greatly influence the online learning outcomes. When designing a questionnaire, researchers could also consider the different effects of three presences on online learning effectiveness.

The CoI framework could help researchers to design a questionnaire survey with a view to examining online learning and teaching. The CoI framework was further validated and enhanced using the questionnaire survey designed by Arbaugh et al.,

([2008](#)) in terms of social, teaching, and cognitive presences (Kozan & Richardson, [2014a](#)). The questionnaire survey based on the CoI framework was demonstrated valid and reliable to explore learning experiences and to compare various constructs in online and blended learning contexts (Stenbom, [2018](#)). Therefore, researchers could seriously consider the constructs involved in CoI in case they aim to examine the online learning effectiveness or measure online learning outcomes.

The framework of CoI, combined with the model of Unified Theory of Acceptance and Use of Technology (UTAUT), can be considered in the emergency blended or online education during the COVID-19 pandemic. Teaching, cognitive, and social presences in the framework of CoI can predict the acceptance and perceptions of emergency online or blended learning during the COVID-19 pandemic time. The influencing factors in CoI are positively correlated with some constructs in UTAUT, e.g. facilitating conditions and effort expectancy (Bamoallem & Altarteer, [2022](#)). Meta-cognition and self-efficacy could also be examined combined with UTAUT in the emergency learning and teaching since both factors play important roles in the framework of CoI.

6 Conclusions

This study, through both qualitative and quantitative research methods to examine the framework of CoI in online learning contexts, concluded that teaching presence, social presence, cognitive presence, metacognition, and self-efficacy played important roles in the framework of CoI. The findings are sourced from the first two longest path analyses. This study also explored the top ten authors, sources, organizations, and countries, as well as citation networks. However, this study, subject to the limitation of library resources, could not include all of the publications, which might have caused publication bias. Those with the highest citation scores might not be able to represent the research foci due to the various kinds of research directions. Findings are not significant since various studies had discussed the relationships between metacognition, self-efficacy, and CoI.

During the COVID-19 pandemic, many students and teachers were restricted to be home to experience a blended educational approach. While strong infrastructure and communications were established to handle this emergency, some educational institutes and educators were resistant to the change with rigorous and emotional supports (Williams & Corwith, [2021](#)). Future research could focus on how to motivate these educational institutes and educators to change their traditional educational methods. Future research could examine whether or not we should include both metacognition and self-efficacy in the CoI framework. Clips of videos and writing assignment could be used to identify the role of elements in the CoI framework to improve online learning effectiveness (Chen, [2022](#)). A Critical Transformative Community of Inquiry model could also be designed with a focus on social justice and equity in online learning (Brennan et al., [2022](#)).

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Availability of data and material We make sure that all data and materials support our published claims and comply with field standards.

Declarations

Conflict of interest/Competing interests We have no conflicts of interest to declare that are relevant to the content of this article.

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Zhonggen Yu Professor and Ph.D. Supervisor in Department of English Studies, Faculty of Foreign Studies, Beijing Language and Culture University, Ph.D. in English language, a dual Master-degree holder in applied linguistics and law, and a post-doctoral researcher in psycho-linguistics, has already published over 100 academic papers in distinguished journals based on rich teaching and research experiences. His research interest includes educational technologies, language attrition, and language acquisition.

Ming Li A doctoral student in Faculty of Foreign Studies, Beijing Language and Culture University, has already published around 20 academic papers in distinguished journals based on rich teaching and research experiences. Her research interest includes educational technologies, language attrition, and language acquisition.