A Systematic Review of Research on Online Learner Collaboration from 2012–21: Collaboration Technologies, Design, Facilitation, and Outcomes

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Abstract
Online Learner Collaboration (OLC) supports the development of knowledge and skills through social construction. In this systematic review of research spanning a decade, authors examined 63 articles for publication patterns, participant and context trends, and research methodology trends using an online learner collaboration framework consisting of the following elements: collaborative technologies, design, facilitation, and outcomes. The higher education context and education discipline had the most research conducted on OLC among the studies reviewed. All three research methods (quantitative, qualitative, and mixed methods) were used equally in the articles. The most commonly used technologies for OLC were learning management systems (LMS), discussion boards, writing tools, and synchronous tools. The most commonly used collaborative methods were group projects and discussions. The most common grouping size was small groups, and groups were commonly formed through random assignment, based on criteria, or student-formed. Instructors mostly assumed roles as designers, facilitators, supporters, and evaluators during OLC. Increased learning, communication and collaboration skills, and relationship building were the top three opportunities that OLC offered. Time, technical issues, and anxiety/fear/stress were challenges that appeared most frequently. Most of the research on OLC focused on cognitive and affective outcomes. The review has implications for online instructors and instructional designers who design and facilitate collaborative online courses.

Keywords: Online learner collaboration, virtual collaboration, systematic review, collaboration design, collaboration facilitation, collaboration outcomes

Oyarzun, B. & Martin, F. (2023). A systematic review of research on online learner collaboration from 2012-21: Collaboration technologies, design, facilitation, and outcomes. *Online Learning, 27*(1), 71-106. DOI: 10.24059/olj.v27i1.3407

Collaboration is routinely identified as an important skill in various job descriptions (Martin, et al., 2021) and is required of most professionals in all fields (Marutschke et al., 2019). Remote employment increasingly requires virtual collaboration as a crucial skill for college graduates. Technology affordances have developed such that learner collaboration can occur effectively and virtually, resulting in individual, group, and organizational success (Mitchell, 2021). The online learning environment is an ideal environment to teach virtual collaboration skills in higher education to better prepare students for a virtual collaborative working environment. Online learning has continued to increase in higher education institutions. According to the National Center for Education Statistics (2022), 11.8 million undergraduate students were enrolled in at least one online course, and 7 million were enrolled exclusively in online courses in the fall of 2020. The number of undergraduate students enrolled exclusively in online courses was 186% higher in 2020 than in 2019. One way to teach virtual collaborative skills is by incorporating collaborative learning activities to provide online opportunities for students to practice these skills. Researchers define online learner collaboration as student interaction that supports socially constructed meaning and the creation of knowledge (Palloff & Pratt, 2010). Student collaboration around shared goals can be designed and facilitated in various ways depending on the desired learning outcome. Some methods of learner collaboration include cooperative learning activities, group projects, case studies, peer reviews, debates, and discussions. All of these methods can be incorporated into online course design and delivery. Cooperative and collaborative learning are often used interchangeably but have distinct differences. Cooperative learning has more specific and structured methods of implementation (Panitz, 1999). For the purposes of this study, cooperative learning is considered a type or subset of collaborative learning. In addition, the focus of this review is on learner collaboration in online settings, and not broadly in all computer-supported settings. While Computer Supported Collaborative Learning (CSCL) could be used in face-to-face, blended, and online contexts, the focus of this review was learner collaboration specific to the online setting.

The effectiveness of collaboration in online learning has been explored in research in various ways. Means et al. (2009) conducted a meta-analysis and review on the effectiveness of online learning and found larger positive effect sizes for studies that included online learner collaboration as opposed to individual work. More recently, research has found that collaborative learning activities in the online environment increase students' motivation (Ozkara & Cakir, 2020), engagement (Alahmari, 2019), and achievement (Yunus et al., 2021). Overall, well designed and implemented online learner collaboration has been found to be beneficial for online learners in achieving learning outcomes and enhancing engagement.

However, challenges exist with online learner collaboration as well. Kauppi et al. (2020) studied the benefits and challenges of working and creating knowledge together, virtually, in a multidisciplinary group, and discussed students' need for guidance and support and the limitations of learning management systems. Similarly, Demosthenous et al. (2020) drew attention to the challenges of overcoming students' anxiety and low self-efficacy beliefs when working collaboratively online. Paterson and Prideaux (2020) suggest that challenges to collaboration and cohesion in online group settings can be overcome through intentionally applied design elements and a student-centric pedagogical approach.

Theories and Frameworks Used

Several theories and frameworks have been used to explore various aspects of online learner collaboration, all of them grounded in social constructivism which suggests that social

interaction plays a significant role in learning (Vygotsky, 1978). Collaborative learning creates an environment in which social interaction is more likely to occur. Online collaboration requires that learners collaborate completely virtually through various types of technological mediums. Table 1 presents some of the theories and frameworks used to examine online learner collaboration along with the major elements of each. The primary elements of the top three are often presented in Venn diagrams to show that the elements overlap to create an effective educational experience. The Online Collaborative Learning theory is presented more linearly and is concerned more with the process of how collaboration occurs.

Table 1

Frameworks Used to Examine Online Learner Collaboration

Framework Name	**Framework Components**		
Computer Supported Collaborative Learning (CSCL)	Computers	Collaboration	Learning
Community of Inquiry (COI)	Teaching Presence	Social Presence	Cognitive Presence
Three Types of Interaction	Learner to Instructor	Learner to Learner	Learner to Content
Online Collaborative Learning (OCL)	Idea generating	Idea organizing	Idea Convergence

Previous Systematic Reviews or Meta-Analyses on Online Learner Collaboration

Systematic reviews and meta-analyses have been conducted on online learner collaboration using all these frameworks. Previous systematic reviews and meta-analyses have focused on specific aspects related to online learner collaboration. These are summarized within each of the framework sections below.

Computer Supported Collaborative Learning (CSCL)

Computer Supported Collaborative Learning (CSCL) is defined as learning experiences mediated by technologies where small groups of learners interact to solve a complex problem (Johnson, Johnson & Stanne, 2000). CSCL has proven to be effective in various disciplines. For example, Jeong et al. (2016) conducted a meta-analysis on the effects of CSCL on STEM learning with 143 studies and 316 outcomes. Effect sizes were moderate (0.51) but notable. The largest effect size was on process outcomes followed by knowledge outcomes, then affective outcomes. These outcomes were moderated by types, learning levels, and domains of learning. The conclusion was that no single one-size-fits-all approach to implementing CSCL effectively in STEM learning exists. Other researchers have compared CSCL methods such as Radkowitsch et al. (2020) who conducted a meta-analysis of 53 primary studies comparing the effects of scripted CSCL versus unguided CSCL moderated with motivation, learning, and collaboration skills. The effect sizes were moderately positive (Hedges g =.72) for collaboration skills and a small positive effect on motivation (Hedges g = 0.24).

While these studies signal that CSCL is well researched, it is a broad framework that encompasses any instructional delivery medium in which computers can support collaborative learning. Online learning is included in that broad umbrella along with face-to-face and blended delivery methods.

Community of Inquiry (CoI)

The Community of Inquiry (CoI) framework was created to explain a quality online or blended learning experience (Garrison et al., 2000). The three major components are social presence, cognitive presence, and teaching presence. These components overlap to create an online learning experience that results in deep and meaningful learning. Researchers have explored the CoI's effects on various learning outcomes. For instance, Martin et al. (2022) conducted a meta-analysis of 13 studies on CoI presences and their correlations with learning outcomes, actual learning, perceived learning, and satisfaction. Strong correlations were found between cognitive presence and perceived learning (r=.663), cognitive presence and satisfaction (r=.586), and teaching presence and satisfaction (r=.510). The CoI framework contains a survey instrument often used in online learning research as an outcome measure to assess the presence of community. Stenbom (2018) conducted a systematic review regarding the use of the CoI survey and found it to be a valid and reliable measure that can be used to study the existence of community in online learning experiences. The CoI framework and presences are key for building and measuring quality online learning experiences. However, these experiences may or may not include collaboration.

Three Types of Interaction

The three types of interaction developed by Moore (1989) include learner-to-learner, learner-to-instructor, and learner-to-content interactions. A quality online course would ideally contain all three types of interaction throughout the course. Bernard et al. (2009) conducted a meta-analysis of the three types of interaction with 74 studies and 74 achievement effects. The results supported the importance of the three types of interaction and their effects on achievement outcomes (0.38). Borokhovski et al. (2012) reviewed a subset of 32 of Bernard's research studies on contextual and designed interaction treatments in distance education settings. According to Borokhovski and his colleagues, contextual interactions refer to environments when interaction conditions are present, but interactions among participants are not intentionally designed but student initiated. Designed interactions are intentionally implemented in collaborative instructional conditions for the purposes of improved learning outcomes and instructor guided. The results of their study suggested that the most effective student-to-student interaction treatments in online learning are designed and implemented intentionally to provide students with opportunities to work collaboratively. The presence of interaction, however, does not necessarily ensure that collaboration occurs.

Online Collaborative Learning

The Online Collaborative Learning theory focuses specifically on collaboration in the online learning context. Harasim (2012) discussed the three intellectual phases of online collaborative learning from idea generation and idea organization to the intellectual convergence stage. Approaching meta-synthesis from the theoretical perspective of online collaborative learning, Mnkandla and Minnaar (2017) concluded that shared space for discourse and interaction provided by social media is central to collaborative learning and knowledge building.

There was an emphasis on the importance of student support since support is vital to collaboration, especially in online settings. Cherney et al. (2018) used meta-synthesis techniques on 41 articles to investigate online collaborative learning and found inconsistent definitions, methodological issues, and a lack of interdisciplinary contributions. They recommended further research on group processes in online learning with stronger empirical methodology and various disciplines to glean practical suggestions for online course instructors and students.

Other online learner collaboration review articles focused on specific technological tools such as 3D virtual learning environments (Reisoğlu et al., 2017), Wikis (Deng, 2018), online collaboration competencies for higher education students (Kolm et al, 2022), and teamwork construction in e-learning (Abid et al., 2016). Table 2 summarizes the review studies on online learner collaboration based on the different frameworks.

Table 2

Summary of Review Studies

Authors	Review Focus	Type of Review	Number of Studies
Jeong et al.	Computer Supported Collaborative Learning	Meta-Analysis	132
Radkowitsch et al.	Scripted CSCL versus unguided CSCL	Meta-Analysis	53
Martin et al. (2022)	COI Presences on Learning Outcomes	Meta-Analysis	13
Stenbom (2018)	COI Survey to build Community	Systematic Review	103
Bernard et al. (2009)	Effects of Interaction	Meta-Analysis	74
Borokhovski et al. (2012)	Learner-Learner Interaction	Meta-Analysis	32
Mnkandla and Minnaar (2017)	Use of social media in e-learning	Meta-Synthesis	6
Cherney et al. (2018)	Online Course Student Collaboration	Meta-Synthesis	41
Reisoğlu et al., 2017	3D virtual learning environments in education	A meta-review	167
Deng (2018)	Participatory Learning through Wikis	Systematic Review	108
Kolm, et al, 2022	International Online Collaboration Competencies	Systematic Review	14
Abid et al. (2016)	Teamwork Construction in E-learning	Systematic Review	12

Framework for Online Learner Collaboration Research

Building on the various research studies and reviews, we developed the following framework to guide this systematic review specifically focused on the design, development, technologies, and outcomes of collaborative learning in online learning contexts. The Online Collaborative Learning (OCL) framework (see Figure 1) includes four components: (1) Collaboration Technologies, (2) Collaboration Design, (3) Collaboration Facilitation, and (4) Collaboration Outcomes which are briefly introduced.

Collaboration Technologies.

Collaboration technologies are the medium learners use to collaborate on tasks in the online learning environment. These technologies differ depending on the delivery method of the course. For instance, synchronous delivery methods may use a whiteboard or a breakout room for student collaboration whereas an asynchronous environment may incorporate technology such as Google Apps or Learning Management Systems tools to allow learner collaboration.

Technologies used for collaboration have been researched in various ways. For instance, Hernández-Sellés et al. (2019) explored the relationship between interaction, emotional support, and online collaborative tools, and found that collaborative tools had a positive influence on group interactions and emotional support. Biasutti (2017) compared the use of forums and wikis for collaborative learning and found that each tool had its own benefits and challenges regarding processes and functions. Wikis were used to produce content collaboratively, whereas forums were used to infer, evaluate, organize, and support while discussing and sharing ideas.

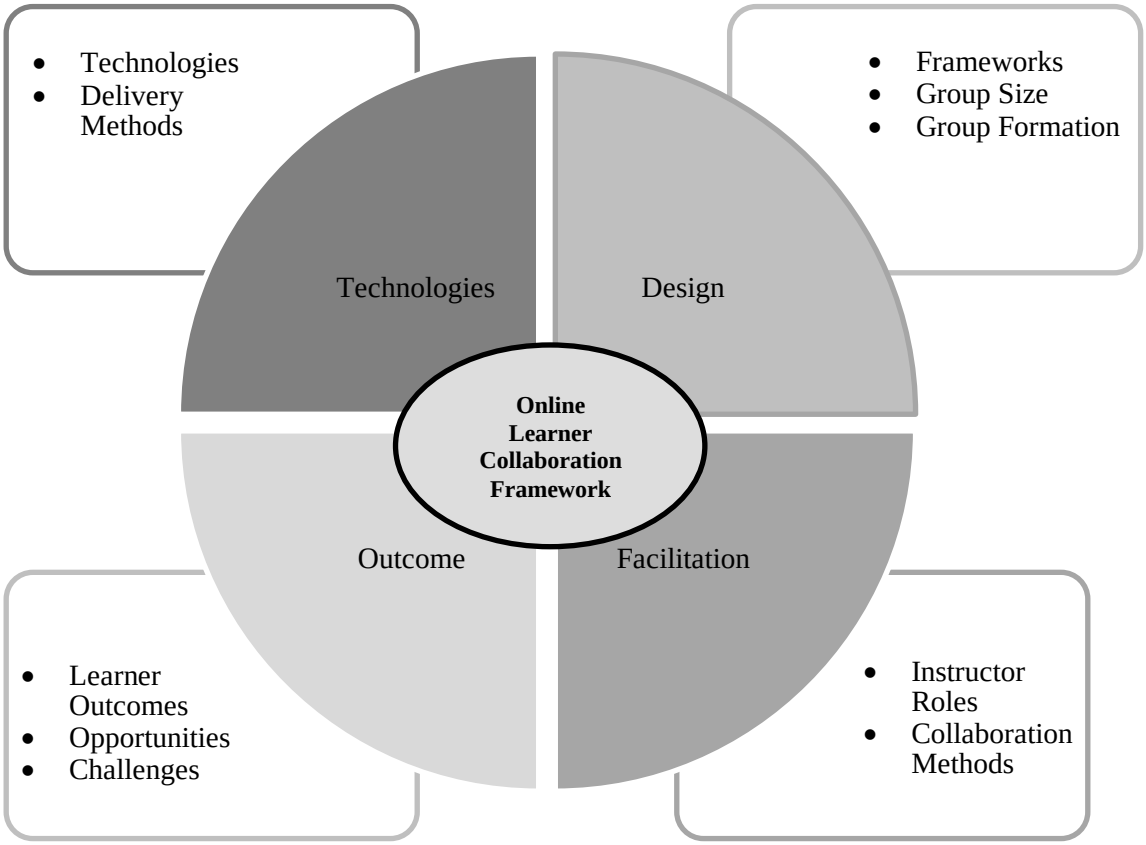
Collaboration Design. Collaboration design refers to how instructors foster collaboration through the design of online learning activities. The design of the activities includes frameworks used, group size, and group formation strategies. The design of online collaborative activities has also been explored to determine effectiveness. Zheng et al. (2020) used a design-centered research approach to investigate the alignment of the design and enactment of online collaborative activity. The alignment significantly improved in the second iteration after optimizing the design, which improved group performance. The results were used to produce a design framework that includes the following elements: goals, tasks, interactive approach, resources, and assessment methods.

Collaboration Facilitation. Collaboration facilitation refers to how instructors support and guide students during online collaborative activities and the methods they use. Altowairiki (2021) analyzed the process of online collaborative learning and found that social, pedagogical, and technical support play critical roles in facilitating successful online collaborative learning experiences. Zheng et al. (2019) explored the effects of metacognitive scaffolding on group performance and cognitive load. The metacognitive scaffolding significantly impacted group behavior and performance but did not increase cognitive load.

Collaboration Outcomes. Outcomes of online collaborative learning experiences refer to how successful the learning experience was and how that success was measured. For instance, Kurucay (2015) measured student perceptions of collaboration, sense of community, satisfaction, and perceived learning in two courses. One course had collaborative assessments while the other had individual assessments. They found that the students working in collaborative groups

reported significantly higher scores in perceptions of collaboration, sense of community, and achievement. Opportunities and challenges during online learner collaboration are also discussed as collaboration outcomes.

Figure 1
Online Learner Collaboration (OLC) Framework



Purpose of this Review and Research Questions

While the previous systematic reviews have looked at specific instructional strategies or tools in online learning and their relation to collaboration, our review fills a gap in the literature by considering the overall online collaborative learning activity's design, facilitation, use of technologies, and outcomes. Our review takes a broad approach to online learner collaboration studies by identifying publication patterns, participant and context trends, research methods, technologies and delivery methods used to collaborate online, collaboration design, facilitation, and outcomes by addressing the following research questions.

1. *Publication Pattern:* What are the publication trends of research on online learner collaboration? (i.e., the number of articles published each year, and journals that publish online learner collaboration research)
2. *Participant Characteristics and Context Trends:* What are the participant characteristics and contexts of online learner collaboration research published? (i.e., participant gender, age, countries represented, subject areas represented, and instructional settings)

3. *Research Methodology Trends:* What research methodology components are used in online learner collaboration research (i.e., research methods, data collection methods, and assessment measures)?
4. *Technologies:* What technologies and delivery methods are used in online learner collaboration research?
5. *Design of Collaborative Activity:* How are online learning collaborative activities designed in the research published? (i.e., frameworks, group size, and group formation strategy)
6. *Facilitation:* What instructor roles and collaborative methods are used to facilitate online learner collaboration in the research reviewed?
7. *Outcomes:* What learner outcomes, opportunities and challenges resulted during online learner collaboration in the research reviewed?

Methods

The study followed the five-step systematic review process described in the U.S. Department of Education, Institute of Education Sciences, What Works Clearinghouse Procedures and Standards Handbook, Version 4.1 (2020): (1) developing the review protocol, (2) identifying relevant literature, (3) screening studies, (4) reviewing articles, and (5) reporting findings.

Data Sources and Search Strategies

Six EBSCO databases, Academic search complete, APA PsycINFO, Education Research Complete, ERIC, Library, Information Science & Technology Abstracts with full text, and Teacher Reference Center were used in the search for the research on online learner collaboration between 2012 and 2021.

Two search rounds were performed with the keywords listed below. The keywords were selected because the researchers wanted to capture any and all types of collaboration occurring in online learning settings. “Design” was initially used because the initial focus was on how instructors designed effective collaboration activities in online learning settings that included methods, facilitation, and strategies. The second search was conducted upon completion of the coding of the first search as the coders realized some relevant studies had been eliminated that would be of interest but were not listed in the results of the first search results. Also, the use of the term “design” included other design fields in addition to education, such as architecture and interior design. The terms used in the second search were more specific to teaching and learning in the online learning setting. The title was used instead of subject terms due to the large volume of articles (n = 1,484) found in the search with subject terms on the first line of the second search.

Search 1

- Subject terms: "design" and "online"
- Title: "collabor*" or "group" or "team" or "cooperat*"

Search 2

- Title: "online learning" or "e-learning" or "distance education" or "online education"
- Title: "collabor*" or "group" or "team" or "cooperat*"

Inclusion/ Exclusion Criteria

Inclusion and exclusion criteria were developed, and each study was screened using this criterion to be included in this systematic review (Table 3).

Table 3

Inclusion/Exclusion Criteria

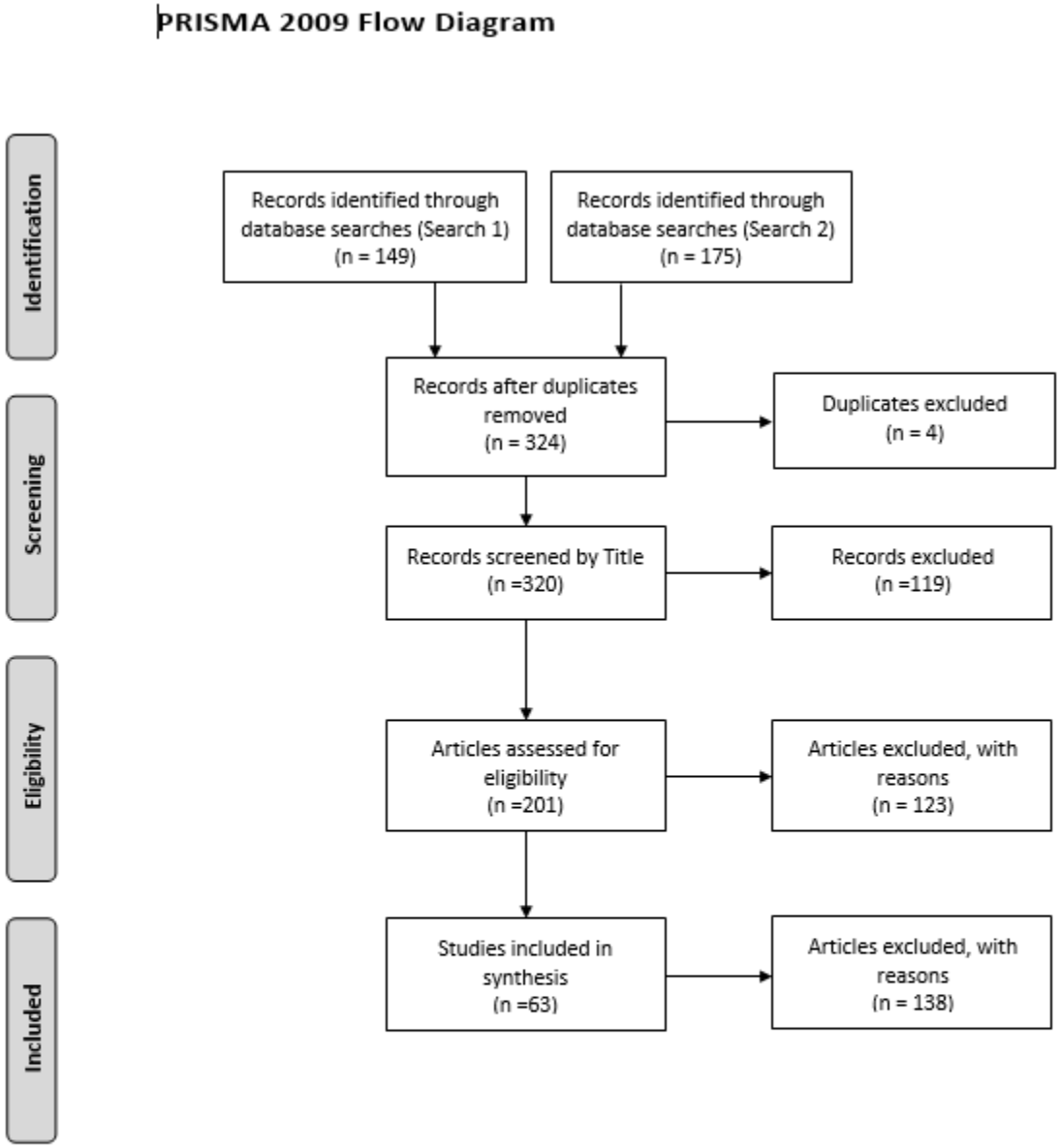
Criteria	Inclusion	Exclusion
Publication Date	Publication years 2012 to 2021	Prior to 2012 and after 2021
Publication Type	Scholarly articles of original research from peer-reviewed journals.	Book chapters, technical reports, dissertations, or proceedings
Focus of the Article	Articles focused primarily on online collaborative learning	Articles did not include online collaborative learning
Research Method and Results	There was an identifiable method and results section describing how the empirical study was conducted and the findings. Quantitative, qualitative, and mixed methods were included.	Reviews of other articles, opinions, or discussion papers that do not include a discussion of the procedures of the empirical study or analysis of data such as product reviews or conceptual articles.
Language	The Journal article was written in English.	Articles in other languages were not included.

Process Flow of the Systematic Review

The systematic process followed PRISMA guidelines proposed by the Ottawa Methods Center for reporting items for systematic reviews and meta-analyses (Moher et al., 2009). Figure 2 illustrates the identification, screening, eligibility, and inclusion steps of the process flow. The review began by identifying 324 articles in two searches, and through screening and assessing eligibility, resulted in 63 articles.

Figure 2

PRISMA Flow Diagram



Coding of Data and Interrater Reliability

The codebook was created based on prior research. However, the codebook was adapted during the coding process. The open-coded items were categorized to facilitate the coding process. Therefore, both deductive and inductive coding processes were used. The research team collaboratively coded the articles on a Google spreadsheet. The coding schemes are described in Table 4. The studies were reviewed and coded by a faculty researcher and a doctoral student researcher. Each researcher independently coded 10% of the articles per coding session and then discussed the coding to ensure reliability. When there was disagreement, the researchers discussed it before further coding. The items coded as open-ended items were then categorized into themes inductively based upon frequency and relationships of codes. For example, collaboration technologies were coded as an open-ended item and the name of each technology was coded when it was mentioned. These were collapsed inductively into tool categories such as LMS instead of naming each LMS collaborative technology such as discussion boards, blogs, and wikis.

Table 4

Description of the Coded Elements

Element	Description
Article Information	Full reference including author(s), year of publication, article title, and journal name.
Participant Demographics	The number of participants in the study, gender, age, and ethnicity.
Context	The instructional setting was coded as K-12, higher education, government, healthcare, military, or business and industry. K-12, subject area and country were open-ended.
Research Method	Codes included quantitative, qualitative and mixed-method. A study could have more than one method such as mixed methods or multimethod studies with both a quantitative and a qualitative component.
Data Collection	Open-ended. During analysis categorized into interview, focus group, observation, survey, content analysis, grades, and LMS/MOOC data.
Collaboration Measures	Open Coded
Delivery Method	This was coded as asynchronous, synchronous, or bichronous
Collaboration Technology	Coded as an open-ended item. During analysis categorized into LMS tools, discussion board, wiki, blogs, synchronous tools, social networks, annotation tools, and writing tools.
Theoretical Framework	Theoretical framework for online learner collaboration was coded as an open-ended item
Group Size	Coded as an open-ended item
Group Formation Method	Coded as an open-ended item. During analysis categorized into randomly assigned, student formed, algorithm, or combination of various methods.

Facilitation	The role of Instructor was open-ended and categorized into the following. Designer, facilitator, supporter, developer, coordinator, evaluator, and information provider.
Collaboration Methods	Coded as an open-ended item. During analysis categorized into, projects, discussions, peer review, social/informal and multiple methods
Opportunities and Challenges	Opportunities: Learner-Centered, Communication and Collaboration skills, Relationship building, Valuing perspectives, Problem-solving skills, Achievement, and Self efficacy. Challenges: Time, Workload, Group Composition, Technical issues, Inactive participation, and poor communication.
Learning Outcome	Coded as Cognitive, Affective, Behavior, and Other. Cognitive focused on thought, affective focused on feelings and behavioral focused on interactions. "Other" option was also included for those articles that focused on other outcomes.

Data Analysis

Descriptive statistics, including frequency and percentages, are included for publication outlets, participant characteristics (gender, age, and ethnicity), context (instructional setting, discipline, and countries), research methods and data collection. The frequency of measures in online learner collaboration research is also included. Publication pattern by year was depicted through a line chart. Delivery methods and technologies were open-coded but frequencies and percentages were tabulated. For design, conceptual and theoretical frameworks are collapsed into categories to identify themes. Group size and group formation methods are coded into categories and the frequencies and percentages are reported. For facilitation, the role of the instructor, and collaboration methods were coded and collapsed into categories to identify themes. For outcomes, learner outcomes were coded, and frequencies and percentages were tabulated. Opportunities and challenges were coded and collapsed into categories to identify themes. Examples of studies are included where it supports.

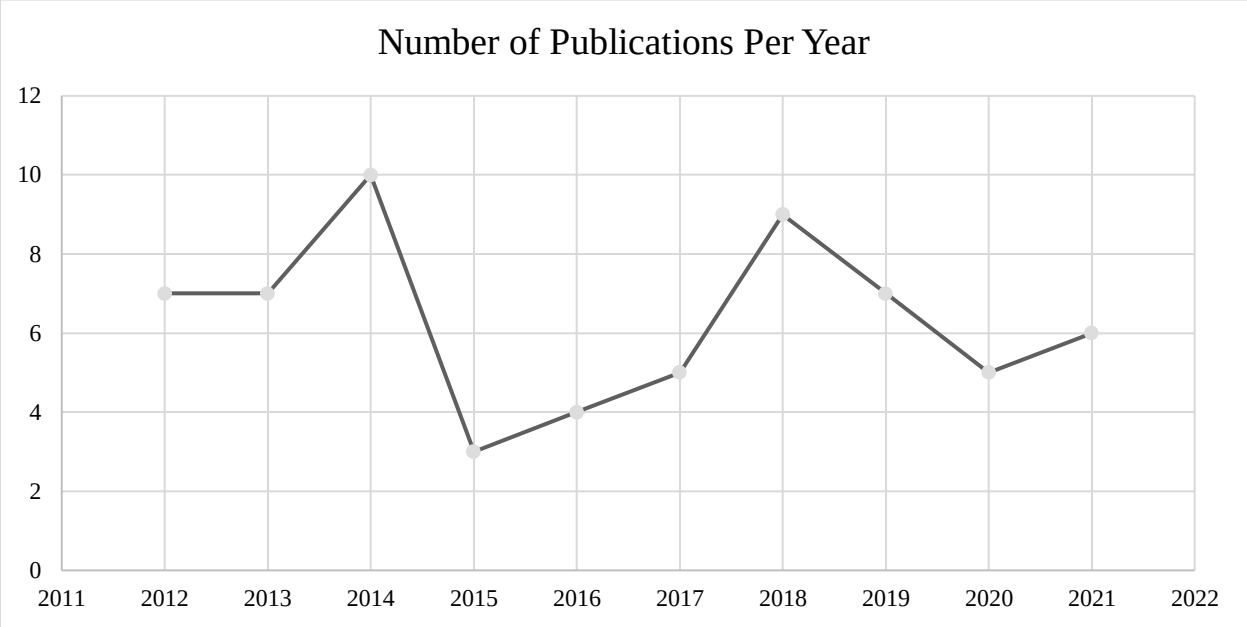
Results

The results section includes the findings from the review for each research question categorized by sections.

Research Question 1: Publication Patterns

To address the first research question, the publication patterns and outlets were examined. Figure 3 displays the publication trends of research on online learner collaboration in the last decade. The number of publications fluctuated with an increase that peaked in 2014 which then decreased and increased again in 2018.

Figure 3
Publications by Year



Six journals published more than one article on online learner collaboration. *International Journal of Emerging Technologies in Learning and Turkish Journal of Distance Education* published the most articles (n=5, 8.1%) on online learner collaboration, followed by *Online Learning* which published 4 articles. Three journals published two articles each (Table 5) and the remaining studies were published in various journals. Surprisingly, the *International Journal of Computer Supported Collaborative Learning* (IJCSCL) was not as represented in these results as the researchers anticipated. This journal had only two articles in the second search and none in the first search. Hence, articles in IJCSL may not use the search terms in their titles or subject terms given the scope of this review's focus on online learner collaboration.

Table 5
Journal Outlets for Online Learner Collaboration Research

Journal	Frequency	Percentage
International Journal of Emerging Technologies in Learning	5	8.1
Turkish Online Journal of Distance Education (TOJDE)	5	8.1
Online Learning	4	6.5
International Review of Research in Open & Distance Learning	2	3.2
British Journal of Educational Technology	2	3.2
International Journal of e-Collaboration	2	3.2

Research Question 2: Participant Characteristics and Context Trends

To address Research Question Two, participant characteristics (number of participants, gender, age, and ethnicity) and context (instructional setting, discipline, and countries) were examined.

Participants

The 63 studies represented a total of 5,600 research participants with studies ranging from 9 to 998. At least four studies did not include the number of research participants. Fewer students reported on the other participant characteristics. Twenty-four studies reported the gender of participants. Of the 2,126 participants in those studies, 1,407 (66.2%) were female, 716 (33.7%) were male, and three (.001%) were not reported. Twelve studies reported age data. The majority of those 993 participants were between 20 and 34 years of age. Only four studies reported ethnicity. The majority of those 389 participants were white (75%).

Instructional Setting

While studies from various instructional settings were included in this review, most of the studies were from higher education (n=58, 92.1%). There were two from continuing education/MOOC settings, one article from K-12 and two from other professional settings.

Discipline

Discipline was open coded, and the highest number of studies published were in Education (30.2%) followed by Computer Science and Information Technology (12.7%). Other disciplines are included in Table 6.

Table 6

Disciplines of Studies Published

Discipline	Frequency	Percentage
Education	19	30.2
Computer Science and Information Technology	8	12.7
Health Care	5	7.9
Library and Information Studies	3	4.8
Engineering	4	6.4
Writing	2	3.2
Sciences (STEM, Biology)	3	4.8
Business	4	6.4
Communication	2	3.2
Multiple	6	9.5
Other	6	9.5

Not Reported	1	1.6
Total	**63**	**100**

Countries

Research conducted in the United States (n=25, 39.7%) had the greatest number of published studies included in this review, followed by several studies (n=8, 12.7%) conducted in multiple countries. Four studies were published in several countries in Europe, three in Taiwan, and two each in Greece, Morocco, Spain, the United Kingdom, and Turkey. Thirteen studies were published in various countries.

Research Question 3: Research Methodology

To address Research Question Three, research methodologies, data collection methods, and measures used were analyzed.

Research Methods

There was about an equal distribution of all three research methods: Qualitative (n=22, 34.9%), Quantitative (n=21, 33.3%), and Mixed-Method studies (n=20, 31.8%).

Data Collection

In addition, the different data collection methods were open coded and tabulated in Table 7. Some studies used more than one data collection method. More than half of the studies used survey approaches as the data collection method (n=33, 52.4%) followed by content analysis (n=25, 14.5%).

Table 7

Data Collection Methods Used

Data Collection	Frequency	Percentage
Survey	33	52.4
Content Analysis	25	39.7
Interview	12	19.1
Grades	9	14.3
Focus Group	4	6.4
LMS/MOOC Data	6	9.5
Observations	2	3.2

Measures for Online Collaboration

Twenty-eight studies reported the measures used to investigate various aspects of online learner collaboration. The majority were researcher-developed surveys (n=10) measuring group regulation, group processing, attitudes toward teamwork, trust, stressors, the process of transferring expertise, challenges and roles of social networks, self-efficacy growth, learner

satisfaction, achievement, learning experiences, collaborative activities, cognitive aspects, social aspects, skills, knowledge, and problem-solving skills. The most used measure was to determine community either through the Community of Inquiry survey (n=3) or the sense of community scale (n=1). Self-efficacy and learning satisfaction measures were used in two studies. All other measures were only used once, including belonging, trust, sociability, presence, motivation, and learning.

Research Question 4: Collaboration Technologies

To address Research Question Four, delivery methods and technologies used in online learner collaboration research studies were examined.

Delivery Methods

The different delivery methods used in the research studies were coded. Online learning collaboration was mostly researched in asynchronous online (n=32, 50.8%) courses followed by bichronous online, a blend of asynchronous and synchronous online courses (n=25, 39.7%). Very few studies investigated online collaboration using only synchronous online delivery methods (n=5, 7.9%) though more studies explored bichronous online methods. One study did not report the online delivery method.

Technologies for Online Collaboration

Technologies used for online learner collaboration were open coded and categorized (Table 8). Some studies used more than one technology. These items were coded as presented in the articles. Some articles reported using the LMS without detailing what tools were used within it, and others reported specific tools without stating whether they were located within the LMS. Learning Management Systems was the technology used for online learner collaboration in most studies (n=16, 22.5%), and examples included WebCT, Blackboard, Schoology, Edmodo, Moodle, and WebTycho. Synchronous technologies included Google Hangout, Skype, Elluminate, and Go To Meeting. Researchers also specifically studied discussion boards (n=13, 18.3%) and writing tools (n=9, 12.7%) included Google Apps, Titan Pad, and MS Word. These were identified as the top three technologies studied.

Table 8

Technology Used

Technology	Frequency	Percentage
Learning Management System	16	22.5
Discussion Board	13	18.3
Writing tools	9	12.7
Synchronous technology	8	11.3
Wiki	7	9.9
Blogs	5	7.0

Social Network	3	4.2
Annotation Tools	1	1.4
Not reported	9	12.7

One study that used LMS technology was Ozkara et al. (2020) which implemented project-based learning both collaboratively and individually for comparison of learning outcomes, satisfaction, and motivation. The LMS tools used were different depending on whether the learner was working collaboratively or individually. No difference in achievement or satisfaction was reported, but the collaborative groups reported higher motivation. Discussion boards were used by Tawfik et al. (2014) to investigate whether discussions using case study methodology differ from more traditional discussions. The case study condition achieved more participation and more significant types of participation than the other group. Regarding synchronous technology, Cheng et al. (2013) used a chat tool entitled ThinkTank to investigate trust development in online collaboration. They found that trust development differs among groups when using such a synchronous tool. Mehlenbacher et al. (2018) used the writing tool Google Docs to investigate how students use cloud technologies for collaborative writing and found that cloud-based technologies such as Google Docs allow for easier digital collaboration. At the same time, they found that such online collaborative technology like Google Docs also requires instructors to rethink the methods in which these technologies are used.

Research Question 5: Design of Collaborative Activities

To address Research Question Five on collaboration design, theoretical and conceptual frameworks, group size, and group formation strategy were examined.

Theoretical and Conceptual Frameworks

The 63 studies were analyzed for the theoretical or conceptual frameworks that they used to study online collaboration. Four types of frameworks were used in the research studies on online collaboration (See Table 9). Some studies used more than one framework.

Table 9

Frameworks Used in Online Learner Collaboration Research

Framework	Frequency	Percentage
Collaborative (Computer Supported Collaborative Learning, Collaborative Learning, Online Collaborative Learning, Cooperative Learning, Group Work)	33	50.0
Social (Community of Inquiry, Sense of Community, Social Presence, Social Interdependence, trust)	20	30.3
Learning Theories (Active, Problem Based, Constructivist, ARCS, Connectivism, 3P (Presage, Process, Product)	10	15.1
Technology (TPACK, eLearning, Visualization tools)	3	4.5

An example from the social category is Wicks et al. (2015) who compared two courses designed with low collaboration strategies and high collaboration strategies, respectively. The Community of Inquiry survey and a survey of learning presence were administered to compare the courses. Findings revealed that students in the lower collaboration course perceived greater levels of teaching presence while students in the higher collaboration courses perceived greater levels of social presence.

From the collaboration category, Demosthenous et al. (2020) used the collaborative learning theory to explore group dynamics during collaborative work. Findings reported that student complaints were focused on time and logistical barriers. Findings also highlight students' low self-efficacy for collaborative work due to a lack of experience in online and traditional learning environments.

Focusing on the learning theories category, Verstegen et al. (2018) used the problem-based learning theory to investigate how teams collaborate without the guidance of the instructor in a MOOC. The teams successfully collaborated on tasks without extensive guidance. Explicit instructions about grouping and tasks, a positive tone, and acceptance of unequal contributions were identified as positive outcomes. Additional support for learners to prepare learners for collaboration and develop digital literacy skills was recommended to stimulate more elaborate collaboration.

Group Size

Group sizes were reported in various ways (See Table 10). Some reported a range for the group sizes and some had multiple groups within the study and reported that the size varied with each strategy. Some studies did not have specific group sizes but opted for descriptions of small or large groups. Excluding the not reported, descriptions, and various reports, the most popular group sizes were small groups of 2 to 4 members (n =23) from the various categories that include this range: two, three, four, two to four, three to four, three to five, and small. The three to five category was included in the small group, and the four to five category was included in the medium size group as they each straddled the cutoff.

Table 10

Group Sizes Used Online Learner Collaboration Research

Group Size	Frequency	Percentage
Small (2, 3, 4, 2-4, 3-4, 3-5, small)	23	33.8
Medium (5, 6, 4-5, 4-8, medium)	10	14.7
Large (9, 10, larger, whole class)	14	20.6
Various group sizes	8	11.8
Not Reported	13	19.1

Group Formation Strategy

The grouping strategies were the ways in which the groups were formed for collaboration (see Table 11). Some studies included various group formations as they had multiple collaborations occurring within the course such as group projects and whole-class discussions and peer reviews. Each collaboration had a different group formation strategy. The most popular method to group students for collaboration was randomly assigning groups (n=14, 21.9%). Table 11 summarizes the various group formation strategies used.

Table 11

Group Formation Strategy Used

Group Formation Strategy	Frequency	Percentage	Sample Studies
Randomly assigned	14	21.9	Chen et al. (2021), Demosthenous et al. (2020), Sharp (2018), Trespalacios (2017), Tawfik et al. (2014), Rawlings (2014)
Various grouping methods	9	14.1	Kupczynski (2013), Kumi-Yeboah (2018), Alzain (2019), Yeh (2014)
Based on criteria	8	12.5	Arndt et al. (2021), Adwan (2016), Aydin & Gumus (2016)
Student formed	7	10.9	Verstegen et al. (2018), Oyarzun & Morrison (2013), Ornellas et al. (2014)
Existing groups (n/a)	5	7.8	Schaefer et al. (2019), Huang (2019), Barra et al. (2014)
Instructor assigned	3	4.7	Han & Resta (2020), Liu et al. (2018) Mehlenbacher et al. (2015)
By algorithm	2	3.1	Ullmann et al. (2018), Prabhakar & Zaiane (2017)
Not reported	16	25.0	Lowell & Ashby (2018), Rebmann et al. (2017)

Research Question 6: Collaboration Facilitation

To address Research Question Six, we examined the role of the instructor and collaboration methods in online learner collaboration research.

Role of Instructor. The instructor's role in online collaboration was mentioned 60 times. The instructor assumed roles as the designer of the collaborative activity, facilitator of the collaboration, evaluator of the work, developer of the course content, coordinator of the course activities, and provider of instructional information. Overwhelmingly, the most mentioned role of the instructor is the designer of the activity (n=28, 46.7%). Facilitator (n=14, 23.3%) was the second most mentioned role of the instructor followed by a supporter (n=8, 13.3%). Other roles

mentioned were evaluator (n=4, 6.8%), developer (n=2, 3.3%), coordinator (n=2, 3.3%), and information provider (n=2, 3.3%). Many studies mentioned more than one role for the instructor. For example, Paterson and Prideaux (2020) interviewed faculty members regarding their design use of collaborative online learning activities and found that structured design coupled with supportive facilitation was important for collaborative learning activities' success. Similarly, Ornellas and Carril (2014) used project-based learning, computer-supported collaborative learning, and a participatory culture to design and test an online collaborative learning activity and found that providing a rich design and adequate support helped ensure learner success.

Collaboration Methods

We refer to collaboration methods as those methods instructors used within the design of collaborative activities that required online learner collaboration. Table 12 includes the various collaboration methods used in the studies reviewed. These included a group or collaborative project, group or whole-class discussions, peer review, or social/informal discussions/backchannel.

Table 12
Collaboration Methods Used

Methods	Description	Frequency	Percentage
Project	Group of students collaborating to create a paper or presentation	45	59.2
Discussions	Group or whole-class discussion taking place within a discussion board on an assigned topic	19	25.0
Peer Review	Consists of students reviewing each other's work and providing feedback for improvement	9	11.8
Social/informal	Informal or social discussions might be done through social media or chat during the collaboration.	2	2.6
Collaborative Experience Survey	Various institution's teachers and students were surveyed about their online collaboration experiences	1	1.3

Many studies used multiple collaboration methods to encourage collaboration among learners. For example, Trespalacios (2017) required small groups to analyze case studies and collaboratively create and record a presentation on the main issues of the case using VoiceThread. This study also incorporated collaborative discussion requiring students to lead a whole-class discussion on a case as well. Peterson et al. (2018) used both asynchronous and synchronous discussions to investigate the differences in process, belonging, engagement, and emotions in the cooperative process. Asynchronous learners reported higher levels of

individualism, competition, and negative affect while synchronous learners reported higher levels of cooperation, belonging, and positive emotion. Discussion boards are prevalent in online learning environments, but they are not always part of an intended collaborative learning activity in which learners have to work together; for example, to solve a case study, lead a discussion as a group, or collectively diagnose patient symptoms. The discussions in the studies included in this review went beyond the traditional use of forums using discussions as part of a collaborative learning experience.

Research Question 7: Collaboration Outcomes

To address Research Question Seven, learner outcomes achieved were examined, as well as opportunities and challenges from online learner collaboration.

Learner Outcomes

Learner outcomes were coded as cognitive, affective, and behavioral. The largest number of studies had affective outcomes (n=23, 36.5%) followed by cognitive outcomes (n=22, 34.9%). Behavioral outcomes were included in only four studies (6.4%). Multiple outcomes were explored in 11 studies (17.5%) and other outcomes focusing on the collaboration process (i.e., the role technology plays and the role of the instructor) was examined in three studies (4.8%).

Opportunities in Online Collaboration

Online collaboration affords learners opportunities to develop new skills in addition to learning. A total of 74 opportunities were mentioned throughout the 63 studies. Increased learning was the opportunity mentioned the most (n=12, 16.22%). The second most mentioned category surrounded communication and collaboration skills (n=11, 14.86%) including increasing these skills or changing learners' perceptions of them. The third most mentioned benefit involved relationship building (n=9, 12.16%). This category included building trust, increasing social presence, and the opportunity to socialize. The fourth most mentioned benefit was having the learning tasks student-centered (n=8, 10.81%). The terms mentioned included learner autonomy and personalized learning. Other opportunities were: increased problem solving/critical thinking skills (n=7, 9.46%); increased awareness of other perspectives (n=5, 6.76%); reflection (n=4, 5.41%); increased confidence/self-efficacy (n=4, 5.41%); authentic tasks (n=3, 4.05%); peer support (n=3, 4.05%); and increased interaction/engagement (n=3, 4.05%).

Challenges in Online Collaboration Participants.

Challenges were not mentioned as frequently in these studies (n=49). Time (n=7, 14.29%), technical issues (n=5, 10.20%), and anxiety/fear/stress (n=5, 10.20%) were the challenges that appeared most frequently. Other concerns included group composition, poor communication, inactive participants, and workload issues (each had n=4, 8.16%).

Discussion

Trends in Publication, Participants, Contexts, and Methods

Among the 63 studies reviewed on online collaborative learning, 92% were in higher education and 30.2% of the studies were in the field of education. Such findings show that online collaborative learning is investigated more with higher education students than the K-12 students or in other contexts. Also, researchers in Education studied collaboration the most, followed by researchers in Computer Science and Information Technology more than the other disciplines. In addition to higher education researchers in the field of education who see the value of online collaboration, online collaborative learning was also studied Computer Science which indicates the importance of online collaboration in computing jobs.

The studies in this review were predominantly (39.7%) conducted in the United States. Such dominance is perhaps indicative of the importance of online collaboration in the US context but it could also have been because the researchers of this review are based in the US and might have had access to mostly US-based databases and analyzed articles only written in English. Notably, all three research methods (quantitative, qualitative, and mixed methods) were used equally in the articles in this review. This finding highlights the importance of all these methods in online collaborative learning research. In addition, surveys, content analysis, and interviews were the most commonly used data collection methods. There is a need for additional data collection methods such as observations, LMS data, focus groups, and achievement data through grades and tests.

Technology is Paramount for Online Collaboration

Among the studies used in this review on online learner collaboration, half of the studies were conducted in asynchronous online settings (50.8%), followed by bichronous online settings (39.7%). This fact demonstrates the opportunity for online collaborative learning. However, this also shows the need for more research on online collaborative learning in synchronous online settings. This could also have been such that most courses are asynchronous or bichronous online (Martin et al., 2020) and few courses exist that are only synchronous online without the use of asynchronous functionality.

Learning Management Systems, discussion boards, writing tools and synchronous technology were the tools most used to support online collaboration in the studies reviewed. Such data highlight the potential and importance of using these tools to support collaborative activities. Of course, Learning Management Systems are the backbone of online courses and include a number of functionalities including discussion boards that support online learner collaboration. Some of the functionality of Learning Management Systems include discussion boards, Q&A forums, and team submissions. Importantly, researchers have found that using Learning Management Systems such as Edmodo help to motivate learners but also helps to maintain interest and engagement (Olson, 2014). While a systematic review concluded that there is no consensus among researchers on best practices for asynchronous online discussions (Fehrman & Watson, 2020), some researchers did find empirically based strategies to maximize engagement in online asynchronous discussions.

Writing tools like Google Docs and Microsoft Word were also used in several studies. Cloud-based technologies such as Google Docs have made the virtual collaborative writing process and communication easier. More recently, group awareness tools have been developed specifically to increase engagement. Peng et al. (2022) developed a group awareness tool to

increase engagement in online collaborative writing. The tools contained functionality to chat, collaboratively write, peer review, and provide visualization for social and cognitive awareness. Group awareness information is also visualized in word clouds and word counts gathered from the writing and the peer review. These visualizations had positive effects on learner engagement and writing performance.

Also, widely used by researchers in this review were synchronous technologies. Synchronous tools can be embedded within the Learning Management System or can be external to it. Synchronous tools come with a variety of collaborative functionalities such as breakout rooms, whiteboards, chat options, screen sharing, file upload, download, and polling (Bower, 2011). Bower identified various synchronous collaborative competencies that included operational, interactional, managerial and design aspects. Synchronous technologies can also be used for the collaboration of virtual and remote laboratories (Jara et al., 2012). In addition to the use of technology to support online learner collaboration, it is critical to carefully select learning tasks, sequence of activities, and arrange tools to support knowledge construction to maximize the use of technology for online collaboration (Jeong & Hmelo-Silver, 2016). As Martin and Borup (2022) revealed in a recent study, synchronous online tools can enhance engagement through collaboration. Research focusing on how learners can collaborate effectively in such real-time settings should benefit both instructors and students.

Design of the Collaborative Activity is Critical for Effective Online Learner Collaboration

Designing online collaboration includes using a theoretical or conceptual framework to guide collaboration, deciding on group sizes and formation methods, and taking learner characteristics into account. Such findings highlight the importance of design in setting up a collaboration activity. About half of the studies (50%) in this review used a framework focused on collaboration. This collaboration focus included Computer-Supported Collaborative Learning, Collaborative Learning, Online Collaborative Learning, Cooperative Learning, and Group Work. The second most pervasive focus was on the social aspect, which was included in 30.3% of the studies and included Community of Inquiry, sense of community, social presence, social interdependence, and trust. Both social and collaborative aspects were considered valuable by the researchers. A few researchers also used learning theories as the guiding theoretical framework. It is important for research and practice design to be guided by theoretical and conceptual frameworks for effective online collaboration.

In this review, we also found various grouping sizes used by researchers with the most-commonly used sizes being small groups containing from two to five students (n =23). Depending on class size, collaboration activity scope, and learner needs, the instructor can decide the grouping sizes. Zheng et al. (2015) studied the impact of small learning group composition on student engagement and success in MOOC and concluded that small groups might reduce student drop-out rates. Wang (2011) discusses the importance of grouping strategies and assignment design in cross-cultural online collaboration and found that having strict requirements for communication between partners and using technology tools for informal communication was helpful.

Also, of various group formation strategies, the most commonly used in this review were random assignment, based on criteria and student-formed, which has been used by previous researchers for collaboration although not in online settings (Chan et al., 2010; Hilton & Philips, 2010). Surprisingly, self-grouping was not more prevalent in these studies as some research suggests that allowing learners self-select into course groups is preferable given the various time

zones and schedules of online learners (Li et al., 2020). Based on instructional context and learners' needs, online instructors could adopt different group formation strategies in collaboration activity design. Notably, researchers have emphasized the importance of accounting for factors such as student ability, gender, and ethnicity for effective collaborative work, as heterogeneity favors collaborative learning (Scheurell, 2010). Lei et al. (2010) recommended that, while grouping, future researchers consider six factors as fundamental for group formation: gender, ethnicity, familiarity among members, ability, motivational level, and source. Irrespective of the group formation strategy used, it is important for instructors to take learner characteristics into account during group formation.

Facilitation is Key to Effective Online Collaboration

Though design is critical for online collaboration and emphasizes how the instructor forms the group, designs the activity, and chooses the theoretical or conceptual framework to guide it, collaboration is enhanced during course facilitation. Instructors can assume several roles during facilitation to support the collaboration process. During online collaboration, instructors acted as designers, facilitators, supporters, developers, coordinators, information providers, and evaluators. Some of these roles, though, originate during collaboration design while several of them continue through facilitation. Instructors act as facilitators, supporters, coordinators, information providers, and evaluators during facilitation. This underscores the critical nature of the role of the instructor during the entire collaboration process. In fact, our prior research (Martin et al., 2021) has found that these are some of the key roles that instructors assume in online courses: subject matter expert, course designer and developer, course facilitator, course manager, advisor/mentor, assessor/evaluator, technology expert, and lifelong learner. In that study, Martin and colleagues explore the frequency of use of various competencies within those eight roles. Of the competencies for the course facilitation role, facilitating online discussions and fostering interaction among learners were two competencies frequently used by online instructors to engage the learners.

When reviewing collaboration methods, projects were the most used (59.2%) followed by discussions (25%). Designing online collaborative projects should involve a careful selection of tasks and activities, provide guidelines for who sets the goals, who regulate and what is regulated, and focus on team dynamics, team acquaintance, and instructor support (Järvelä & Hadwin, 2013; Ku et al., 2013). Researchers have also found that empirically based strategies such as peer-facilitated discussions and providing feedback during facilitation maximize engagement in asynchronous discussions (Guo et al., 2014; Xie & Ke, 2011). Additional collaboration methods used in the research studies included peer review and social/informal. Regarding peer review, Zhao et al. (2013) studied peer review groups in asynchronous computer conferencing and found that participation, interaction, and social presence are essential for online collaboration. Social/informal collaboration refers to student-initiated collaboration on social media platforms or in other informal ways to build social ties and learning support networks outside the formal learning environment. Gilmore (2020) discovered that strong social ties build social inclusion and create a more effective learning experience.

Stephens and Roberts (2017) discussed four strategies that can be used to facilitate online collaboration in groups. These strategies include creating groups, establishing expectations, communication tools, and assignments and activities. Their suggestions are aligned with some of the findings from this review. In addition, Haythornthwaite (2006) proposed several recommendations for facilitating online collaboration including the promotion of "an information

sharing culture, model group norms, setting some, but letting others emerge, model good communication behaviors, establish social and/or technical means for synchronous or near-synchronous communication, provide means for faster feedback, build community capacity by providing means for students to socialize and get to know each other, provide both public and private means of communication" (p.17). These strategies are helpful to facilitate effective online collaboration.

Online Collaboration Has Several Outcomes

Most studies on online learner collaboration included either affective or cognitive outcomes, with little focus on behavioral outcomes. Prior research has demonstrated that the use of technology to collaborate could have a significant impact on student learning, satisfaction, and engagement (Ku et al., 2013), and studying behavioral outcomes in addition to affective and cognitive outcomes is important. Increased learning, communication and collaboration skills, and relationship building were the top three opportunities during online collaboration. Researchers have found that collaboration engages the learner and results in increased learning (Ng, et al., 2022); similarly, it also increases their communication and collaboration skills (Owens & Hite, 2020). Finally, in online courses where students are isolated, collaborative opportunities assist them with building a sense of community and building relationships with others which is critical for them to be successful in online courses (Qureshi et al., 2021).

These prospects were also discussed by Jeong and Hmelo-Silver (2016) who identified seven opportunities afforded by technology for collaboration including "(1) engage in a joint task, (2) communicate, (3) share resources, (4) engage in productive collaborative learning processes, (5) engage in co-construction, (6) monitor and regulate collaborative learning, and (7) find and build groups and communities" (Jeong & Hmelo-Silver, 2016, p. 247).

Time, technical issues, and anxiety/fear/stress were the challenges that appeared most frequently in this review. Some of these challenges can also be due to the lack of time management for online collaboration or technical expertise. Online learner collaboration can also be challenging because team members do not see each other in person (Capdeferro & Romero, 2012) and this could result in anxiety, fear, and stress related to working in a team (Demosthenous et al., 2020). Additional challenges found in this review were due to group composition, poor communication, inactive participants, and workload issues. This is aligned with Ku et al. (2013), whose study found that team dynamics, team acquaintance, and instructor support was critical for online teamwork satisfaction.

Limitations

Several methodological limitations in this review can be identified. For instance, a limited number of search terms were used in this study. Although the search was performed twice, it is likely that certain studies that did not use the search terms used in this study were excluded. Since the search terms were broad and not specific to collaborative technology, some of the studies focusing on specific collaborative technology might have been excluded. Second, only articles published in English and selected databases available to researchers were included. This could have excluded other online learner collaboration work published in other languages or other databases could have been excluded. Third, only peer-reviewed articles were included. Such an approach could have excluded high quality empirical research published in other sources. Fourth, there is the possibility of researcher bias during the coding process. Finally, when examining the delivery method, students could be collaborating using additional

technologies and modalities outside the online course. These tools and methods could therefore not be collected or examined. For example, learners could collaborate synchronously or meet face-to-face while taking an asynchronous course.

Future Directions for Research

More research is needed on online collaborative learning in synchronous online settings and in disciplines besides education. There is also a need to standardize the terminology regarding online learner collaboration to help researchers successfully locate the appropriate research. This is consistent with the findings of Cherney et al. (2017) who point out the lack of conceptualization and various definitions of the term "social presence." The current frameworks and theories are either broader than the online learning context or focused on online but broader than collaborative learning. Even though two searches were conducted for this review, articles that would have met the inclusion criteria for this research were excluded and may have changed the results. Particularly, few articles from the *International Journal of Computer Supported Collaborative Learning* (IJCSCL) were located with the search terms used in this study. If an online collaboration framework were implemented in more studies, then researchers would have a consistent way to search and present research in this area. Hopefully, the OLC framework proposed in this study can provide that guidance and structure for future researchers.

It is also recommended that more research be conducted on group formation strategies in an online learning context to ensure learner satisfaction and success. More research is also needed on the use of social collaborative methods and social collaborative technologies to further understand how social ties inclusion plays a role in increasing the success of online learner collaboration. Additionally, group formation in online courses utilizing various strategies warrants in-depth examination. While cognitive and affective outcomes have been often investigated, there is a need for more studies to explore behavioral outcomes. One of the challenges is that researchers do not describe the specifics of how online collaboration occurs using technology such as in the LMS.

Implications

The collaboration methods and strategies discussed in this review will benefit both online instructors and instructional designers who support instructors in designing online courses. This review also discusses the various design and facilitation aspects that instructors can integrate into online courses for effective online collaboration. Implications can be found in all areas of the framework.

Technology can enhance or create barriers to online learner collaboration. Using learning management systems, discussion boards, writing tools, synchronous tools, wiki, blogs, social network tools, and annotation tools can enhance online collaboration if selected to support the learning outcome rather than focusing solely on the use of the tool. Instructors should encourage students and provide technologies that allow them to collaborate both formally and informally both inside and outside of the learning environment.

When designing collaborative online learning experiences, instructors consider learner characteristics, guiding frameworks, and grouping methods. It is valuable for the instructor to keep class size, learner needs, and scope of the collaboration in mind during design and group formation. Consider a framework to guide the design and have students create a group work profile that would assist them in self-grouping or the instructor in creating groups.

The instructor assumes various roles during the facilitation of online collaborative learning experiences as structured collaborative activities should have multiple ways of interaction and assessment to provide a richer educational experience. Instructors can use various collaboration methods to support learning outcomes such as projects, discussions, peer reviews, and social/informal activities in their online courses. In addition, instructors can also use a collaborative experience survey to measure the learner experience from the online collaboration process.

The outcomes of online collaborative learning experiences can be focused on (1) cognitive (achievement), (2) affective (satisfaction, motivation), and (3) behavioral (participation) when designing and facilitating online collaboration depending on the desired learning outcomes. Instructors should study opportunities and challenges during the design and facilitation of online collaboration. Online learner collaboration will include some challenges, but the opportunities must outweigh these barriers for instructors to include online collaboration in their courses.

Conclusion

This systematic review of research on online learner collaboration fills a gap in the literature by studying the overall research based on online collaborative learning activity's design, facilitation, use of technologies, and outcomes. Our review takes a broad approach to online learner collaboration studies by identifying publication patterns, participant and context trends, research methods, technologies and delivery methods used to collaborate online, collaboration design, facilitation, and outcomes. The Online Learning Collaboration framework will guide both researchers and practitioners in studying and implementing online collaboration activities. This review has identified implications for the online learner, instructor, and instructional designer.

Declarations

The author(s) declare no potential competing interests with respect to the research, authorship, and/or publication of this article.

Data are available via link to this Appendix containing citation information for 63 articles used in the systematic review.

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