

Collaborative Online Learning in Undergraduate Medical Education: A Scoping Review

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Abstract

Background:

Collaborative online learning is an active learning method that stimulates interaction between learners and teachers and fosters interest and motivation in learning in a virtual learning environment.

Aim:

The primary aim of this scoping review is to examine the extent and nature of academic publications on collaborative online learning in undergraduate medical education.

Methods:

We used a standardized framework for conducting scoping reviews to identify suitable publications and to analyze the content.

Results

Thirty-six published articles from January 1990-March 2019 met the inclusion criteria. There were 16 interventional studies, 8 reviews, 7 commentaries and 5 survey studies. Most work originated in the UK or the US. These studies found that collaborative online learning demonstrated educational value by personalizing learning to fit individual needs, promoting social interaction and active learning, and helping to build professional networks. Connectivity, ease of use, and accessibility were enablers of collaborative online learning while technical challenges were the main barrier.

Conclusion

There is a relatively small but promising body of work currently published on collaborative online learning in undergraduate medical education. Further work and innovation in this area may be forthcoming in response to the need for alternatives to traditional learning in times of crisis.

Background

What is collaborative online learning?

Collaborative online learning is an active learning method that stimulates interaction between learners and teachers and foster interest and motivation in learning in a virtual learning environment (1). Since the advent and popularization of the internet in the 1990s, the growing influence of digital and social media has reshaped the teaching and learning ecology in medical education. Online learning has been an increasingly popular means to engage learners and teachers in medical education (2, 3) particularly as students have access to computer technology in learning, through personal smartphones, laptop computers, and other wireless mobile devices. (4) Collaborative online learning in medical education uses a variety of tools for teaching and learning such as blogs (5, 6), Facebook (7, 8), Google Sites (6, 9), Moodle (10, 11), Twitter (7, 12), etc. all of which have shown encouraging educational outcomes.

Why is it collaborative online learning important?

Numerous studies have shown that collaborative online learning can supplement conventional teaching practices and provide a more engaging and effective learning environment for teachers and learners (2, 13-15).

The interactive nature of collaborative online learning encourages active learning and enhances the learning experience by connecting and allowing dynamic creation of knowledge for students in individual and collective levels (16). Students can attain a higher degree of engagement in an online and can engage in team discussions and share their experiences with peers (4). Collaborative learning allows students to feel that they are part of a supportive community where they can share relevant knowledge, give effective feedback, ask for help and support through difficult stages, draw encouragement from other facing similar issues, and work constructively towards a common goal (11, 17).

Online collaborative learning improves learning effectiveness (14), cost (2, 18), and promotes efficient use of time (4, 19). It has been associated with higher academic achievement, deeper levels of learning, and retention of learned information for longer times (11). Online collaborative learning can also train students to be self-motivated (4) and help students to acquire learning skills such as, better problem solving and higher-order critical thinking skills (11). The online platforms are effective for time management and facilitate schedule constraints by providing flexibility for students to work on their own time and pace (4).

Collaborative online learning allows learners to co-create learning materials that suit their needs and learning styles. There is also evidence that collaborative online learning in medical education accommodates different learning styles of learners, is responsive to learner needs, and is effective in changing the learning outcomes of learners (19). These outcomes relevant to medical education include competencies like professionalism (5, 15, 20), and interprofessional collaboration (2, 21).

Why do we need to have a scoping review on this topic?

Online collaborative learning is an opportunity for medical education to take advantage of the increasing availability and potential for mobile and technology-driven approaches (6). The application, advantages, and challenges of using collaborative online learning in medical education are currently under-explored (22) and it is important to identify factors that will promote collaborative online learning and foster the effectiveness of this mode of learning in a technologically advanced and information-rich world (13). It is also necessary to develop and implement novel teaching and learning strategies to boost collaborative online learning in medical education (16).

What do we want to explore?

This scoping review aims to examine the extent and nature of research articles published on collaborative online learning in the medical education literature. This will help to inform research directions and pedagogical applications for collaborative online learning in medical education in the future.

Methods

A scoping review is a subtype of systematic review aiming to map the available research studies related to the key concepts underpinning a specific topic area with time (when it was published), location (country), source (peer-reviewed or grey literature), and or origin (healthcare or academic discipline) (23). It aims to understand the influence of such work and the depth and breadth of the field, to identify gaps in the research studies, and report on the types of research studies that address and inform practice (23). It enables the clarification of complex areas of inquiry and refines and expands the essential concepts on the areas of subsequent research studies (2). This is often a preliminary part of an effectiveness review and leads to refined search strategies etc. (24).

We followed the BEME Guide No. 3 systematic searching for evidence in medical education (24) and Arksey and O'Malley's five-step framework for interpreting scoping literature reviews (25) to conduct this scoping review.

Stage 1: Identifying the Research Questions

To explore the literature on collaborative online learning in medical education, the following research questions were generated:

- What is the extent and nature of the academic publications on collaborative online learning in medical education?
- What insights about collaborative online learning have we learned from the literature?

Stage 2: Identifying Relevant Studies

Guided by the research questions and following a consultation with the university medical librarian, we searched for articles using MeSH terms in PubMed and expand the search to relevant terms in other databases. These key terms "collaborat*", "online learning" (MeSH), "eLearning", "internet", "Education, Medical, Undergraduate" (MeSH), "medical education", "undergraduate". We searched these terms in seven electronic databases: PubMed, ERIC, JSTOR, ProQuest (including Australian Education Index, Education, Collection, Medical Database, and PsycINFO) for articles from 1990 to March 2019.

We undertook an additional search of online publications through Google and Google Scholar, and a further hand search of the reference list of all selected articles.

Stage 3: Study Selection

The inclusion criteria for this review were: 1) academic publications published in English; 2) relating to one or more of the three key concepts: "collaborative", "online learning", "medical education", and/or "undergraduate program" 3) involving medical students as the subjects or topic.

We excluded papers based on the following **exclusion criteria**: 1) solely non-medical education, (e.g. those solely focused on nursing, dentistry, occupation therapy, pharmacy, physiotherapy, etc.) and 2) solely non-undergraduate level of studies (e.g. those solely focusing on postgraduate education, continuing medical education (CME), distance learning with unrestricted participants, etc.).

After the first screening of title and abstract by the first reviewer, 183 articles were selected for a full review. Four study team members (PL, JT, HT, KC) conducted the reviews. Each article was screened independently by two reviewers to determine if the article fulfilled the inclusion and exclusion criteria. Where there was ambiguity, three team members (PL, JT, HT) reviewed the article together in full, and resolved differences by consensus. Articles that consisted of abstracts or brief discussions were excluded. A flow chart of the article screening process is shown in Figure 1.

Of the 36 articles, 17 related to all four key areas: "collaborative", "online learning", "medical education", and/or "undergraduate program". Four papers did not specifically mention collaborative learning but discussed online learning in general including its collaborative features. Three papers did not specifically mention online learning but addressed it from a wider perspective. Two papers included mix of students from different

disciplines including medical students. Ten papers involved undergraduate education to some extent, and eight papers did not specify the level of education.

Stage 4: Charting the Data

Key information was extracted by categorizing the nature of the selected articles. The following information was extracted from each of the included studies:

- study aims
- population, sample size
- types, period, location, and duration of the intervention
- methods /analysis
- reported outcomes

Stage 5: Collating, Summarizing and Reporting the Results

A thematic analysis was undertaken to identify the key issues addressed in each paper which were then subdivided into themes. Information was tabulated and collated to gain insight into the features of collaborative online learning in medical education.

Results

The Extent and Nature of Research Studies

Characteristics of Selected Studies

Of the 36 relevant papers that underwent a full review, we found that 16 of were empirical studies focused on implementation and evaluation of an education program/element, 5 studies reported survey results on the use of social media, 7 were systematic or scoping reviews, and 8 were expert perspectives on collaborative online learning in medical education. ([Table 1](#))

The progressive prominence of personal computing and the Internet since the 1990's provided a favorable environment for collaborative learning (26). However, the earliest article related to collaborative online learning in medical education appeared in 2003 with a steady increase in publications since 2007. In each year, there was an average of 2 to 4 papers published on this topic. ([Table 1](#))

Author	Year	Country	Methods/ Analysis	Population (course, year, university)	Sample Size	Aim/Purpose of study	Conclusion	Focus
Surveys								
Dommett, E. J.	2019	UK	Online survey	full-time undergraduates, King's College London	50	To investigate the students' perception of the use of online forums and twitter in learning, relating use to learning outcomes and rating the importance of different factors in using each tool	Twitter provides access to news media and those outside their program whilst forums support discussion with peers. A key factor was whether students felt that use of a tool would increase their grade, indicating that assessment outcomes are strongly linked to use of both tools, despite them differing in terms of interactions and specific uses.	Prevalence of usage
Gray, K., et al.	2010	Australia	Paper survey and case studies	undergraduate medical students, a large metropolitan university	759 + 4 Study Groups	To investigate the extent to which medical students were using Facebook and to detail the approaches, experiences and outcomes in cases where they were using Facebook to support their learning and to gain insights into the benefits and challenges of using social networking software for learning and teaching in medicine and in higher education generally	Using Facebook as part of learning and teaching is as much of a challenge for many students as it may be for most educators.	Prevalence of usage, Effectiveness
Lemley, T. and J. Burnham	2009	US	Online survey	medical and nursing educators, (DR-ED, AACN, AAHSL)	55	to investigate the actual use of web 2.0 tools in the medical and nursing curriculum in an effort to ascertain whether or not use of these tools has increased, thereby creating a potential role for medical librarians	Web 2.0 tools portends a growing trend in education, training for medical students, faculty and practitioners is a golden opportunity.	Educational value, Prevalence of usage
Sandars, J., et al.	2008	UK	Paper survey	1st year, University of Leeds	212	To identify the nature and extent of the use of social software by first year medical students	Medical educators need to recognize the potential of social software in undergraduate medical education but it is essential that students maintain the informality and privacy of these sites.	Prevalence of usage
Sandars, J. and S. Schroter	2007	UK	Online survey	medical students + practitioners, British Medical Association	593	To identify the current familiarity and use of Web 2.0 technologies by medical students and qualified medical practitioners, and to identify the barriers to its use for medical education	The potential of Web 2.0 technologies for undergraduate and postgraduate medical education will only be achieved if there is increased training in how to use this new approach.	Prevalence of usage, Enablers and barriers

Author	Year	Country	Methods/ Analysis	Population (course, year, university)	Sample Size	Aim/Purpose of study	Conclusion	Focus
Interventional Studies								
Saqr, M., et al.	2018	Saudi Arabia	Social network analysis	clinical reasoning, Qassim University	82	To investigate how social network analysis (interactivity, role in information exchange and role in collaboration, group cohesion) can be used to monitor online collaborative learning, find aspects in need of improvement, guide an informed intervention, and assess the efficacy of intervention using an experimental, observational repeated- measurement design in three courses over a full-term duration	The intervention has significantly enhanced student-student and teacher- student interactions. SNA can be used for monitoring and supporting teaching and learning in higher education.	
Ho, A., et al.	2018	Singapore	Data analytics	1st and 2nd year, National University of Singapore	300	To share a case of using a closed Facebook group to disseminate health-related new articles, and facilitate discussions that facilitate co- learning of real- life ethical issues, by analyzing comments and reactions	Facebook group did not require extensive curriculum changes and was an efficient pedagogical platform.	Effectiveness
Cole, D., et al.	2017	UK	Survey	case-based learning, 1st year, Cardiff University	71	To explore how university- supported curation platform and external social media (Facebook) could support collaborative small group working in case- based learning, by surveys, data and group activities	Optimum use of social media depends on sufficient training of both staff and students, and an opportunity to practice using them, with ongoing support. The platforms can all support collaborative learning, and may help develop digital literacy, critical appraisal skills, and awareness of wider health issues in society.	Effectiveness

Author	Year	Country	Methods/ Analysis	Population (course, year, university)	Sample Size	Aim/Purpose of study	Conclusion	Focus
Peacock, J. G. and J. P. Grande	2016	US	Survey	pathology, 1st year, Mayo Medical School	44	To explore the effectiveness of using Google online app platform, a free and widely-accessible online app platform to manage and teach a first-year pathology course	The online app platform allowed faculty to build an efficient and effective classroom teaching and management system. The ease of accessibility and opportunity for collaboration allowed for collaborative learning, grading, and teaching.	Effectiveness
Diug, B., et al.	2016	Australia	Survey, Exam grades	biomedical science, 1st year, Monash University	236	To evaluate whether social media, in particular Twitter, can be successfully used as a pedagogical tool in an assessment to increase student engagement with staff, peers and course content	Use of social media as an additional, or alternate, teaching intervention is positively supported by students. Specific use of micro-blogs such as Twitter can promote greater student-staff engagement by developing an ongoing academic conversation.	Effectiveness
Avila, J., et al.	2016	Switzerland	Survey, Focus Group, Data analytics	cardiovascular system, digestive system, 2nd year, University of Zurich	25	To design and evaluate an ePortfolio system with mobile capabilities using WordPress, a commercially free and open source software solution assessing technical implementation and usability by online questionnaires and focus groups	The implementation of WordPress should be accompanied by introductory courses in the use of the software and its apps in order to facilitate its usability.	Ease of use

Author	Year	Country	Methods/ Analysis	Population (course, year, university)	Sample Size	Aim/Purpose of study	Conclusion	Focus
Mi, M. and D. Gould	2014	US	Survey, Focus Group	neuroscience, 1st year, Oakland University	75	To provide a formative evaluation of the wiki group project and to examine how wiki technology was utilized to enhance active and collaborative learning of first-year medical students in the course and to reinforce information literacy skills.	Given its ease of use and facilitation of collaborative learning and authorship, Google Sites or other wiki products may be leveraged as a potentially enriching learning and teaching tool to promote active learning in medical education or any educational setting.	Learning design
Hall, P., et al.	2012	Canada	Case study, reflection	medical students, The University of Ottawa	600	To describe the evolving ePortfolio program, reflect on the challenges have faced in its development and implementation, and share the lessons have learned on the way to a successful and sustainable program	A successful and sustainable program should be user-friendly, ensure that faculty and students understand the value of the ePortfolio program, can soliciting student input to improve the program and increase student buy-in; and providing faculty development opportunities and recognition.	Learning design
Bahner, D. P., et al.	2012	US	Survey	followers on Twitter and Facebook	27	To demonstrate a supplement to a curriculum using "push technology" via Twitter and Facebook to deliver educational content to mobile devices	Due to ease of use and widespread applicability, Twitter and Facebook are excellent applications of "push technology" as a means to deliver educational content. This pilot project demonstrates the potential of social media to both supplement and enhance traditional educational methods.	Learning design, Effectiveness

Author	Year	Country	Methods/ Analysis	Population (course, year, university)	Sample Size	Aim/Purpose of study	Conclusion	Focus
Potts, H. W.	2011	UK	Interview, Focus Group, Ethnographic data	peer-assisted learning, 5th year & postgrad, University College London,	53	To understand students' affective and other experiences of generating content to be shared online with peers (e.g. in online discussions) by online interviews, focus groups, research log and transcripts	Successfully introducing user-generated content into medical education requires attention to practical details and an awareness of the student anxiety that can arise.	Enablers and barriers
Varga-Atkins, T., et al.	2010	UK	Data analytics, survey, focus group, interviews	problem-based learning (PBL), 1st year, The University of Liverpool	32	To explore the effectiveness of developing professionalism through the use of wikis, using survey, focus groups, facilitator interviews and wikis usage statistics	Wikis acted as a shared knowledge base for hard-to-find resources on professionalism. Second, it was precisely when students reflected on the difference between interacting in wikis and their online social spaces, or when they considered whether or not to post a resource that their sense of professionalism emerged.	Effectiveness
Chretien, K., et al.	2008	US	Content analysis, Survey	basic medicine clerkship rotation, George Washington University	91	To explore the use of blogs in reflective writing and peer feedback on professional development using collaborative, web-based technology by student evaluation and analysis of posts	Blogs can promote reflection, uncover elements of the hidden curriculum, and provide opportunities to promote professional development.	Effectiveness
Baker, P. G., et al.	2005	Australia	Content analysis, Survey	rural medicine rotation, 3rd year, The University of Queensland	83	To evaluate the ease of use and access and the educational value of a web-based Clinical Discussion Board, and interest in pursuing a rural medicine career by survey and transcripts on CDB	A web-based Clinical Discussion Board offers a unique way to understand the concerns and interests of third year medical students. It highlights the issues they need to discuss with their peers, and offers the potential to guide future curriculum changes in response to identified needs.	Educational value, Ease of use

Author	Year	Country	Methods/ Analysis	Population (course, year, university)	Sample Size	Aim/Purpose of study	Conclusion	Focus
Taradi, S. K. and M. Taradi	2004	Croatia	Data analytics, Questionnaire, Exam grades	physiology, 2nd year, University of Zagreb Medical School	55+195+220	To describe the use of a free, asynchronous online forum to expand student- teacher discussions beyond the time/place constraints of the physical physiology classroom by assessing the administration data, questionnaire and final exam	Faculty vary considerably in both their abilities and their attitudes toward the new technologies, and institutionally based attempts to engage the faculty must take these variations into account to be successful.	Effectiveness
Bernardo, V., et al.	2004	Brazil	Data analytics, Questionnaire, Quiz	experimental surgery, 3rd year, Federal University of São Paulo	56	To describe and discuss the process and the lessons learned involved in developing and implementing a web-based course for UG medical students, and to analyze the students' attitude and receptivity towards this educational environment by accessing knowledge gain, web usage data, and course evaluation	This study indicated that a web-based course for undergraduate students may be successfully developed and implemented in medical settings and the students seem to be quite supportive. We encourage undergraduate medical learning strategies involving the Web.	Learning design, Effectiveness
Wiecha, J. M., et al.	2003	US	Interview, Focus Group, Questionnaire	medical interviewing, 1st & 2nd year, Boston University and University of Massachusetts	10	To evaluate a 4- week online elective course for medical students to teach the cognitive basis for interviewing skills, with a moderated, asynchronous discussion board	Online education has significant potential to augment curriculum on the medical interview, particularly among students trained in community settings geographically distant from their academic medical center.	Effectiveness

Author	Year	Country	Methods/ Analysis	Population (course, year, university)	Sample Size	Aim/Purpose of study	Conclusion	Focus
Literature reviews								
Reeves, S., et al.	2017	UK/Ireland	Scoping review	Medline, CINAHL, BEI, PubMed, Scopus, Web of Science	23/1568	To review what is the nature of evidence on online postgraduate education for primary healthcare inter- professional teams? What learning approaches and study methods are used in this context? What is the range of reported outcomes for primary healthcare learners, their organizations and the care they deliver to patients/clients?	E-learning can enhance an education experience, support development, ease time constraints, overcome geographic limitations and can offer greater flexibility. However, it can also contribute to the isolation of learners and its benefits can be negated by technical problems.	Learning design
Guraya, S.	2016	Saudi Arabia	Systematic review	ERIC, CINAHL, Cochrane library, and EMBASE	10/1188	To determine the medical students' extent of usage of SNSs for educational purposes	Understanding and knowledge of the significant use of SNSs by the medical students demand inclusion of such domains in medical curricula. This will train tomorrow's doctors in fostering their skills of digital technology for educational purposes.	Prevalence of usage
Batt-Rawden, S., et al.	2014	US/UK/Australia	Systematic review	MEDLINE, CINAHL, ERIC, EMBASE, PsycINFO, Proquest, Cochrane Library, Web of Science and Scopus	14/928	To identify examples of how social media may be used to help promote the achievement of clinical excellence in medical learners	SM may help facilitate the achievement of clinical excellence.	Learning design

Author	Year	Country	Methods/ Analysis	Population (course, year, university)	Sample Size	Aim/Purpose of study	Conclusion	Focus
Smith, T. and R. Lambert	2014	UK	Systematic review	AMED, BNI, CINAHL, EMBASE, MEDLINE, PsycINFO, PubMed, the Cochrane Library, Australian Education Index, and British Education Index	16/876	To evaluate the use, attitudes and perceptions of both teachers and students towards social media platforms (Facebook and twitter) in healthcare higher education practice	Facebook and Twitter are perceived as potentially useful adjuncts in healthcare higher education practice, which enhance communication and increase accessibility of students to real-world practices and expertise. Whilst students perceive this to be of value, some have reservations regarding the possibility of faculty members spying or infringing on their "virtual" social community. Faculty members expressed some reservations regarding the perceived boundary between student-staff relationships.	Educational value, Prevalence of usage
Cheston, C. C., et al.	2013	US	Systematic review	MEDLINE, Scopus, Embase, Cochrane Library, CINAHL, Web of Science, PsycINFO, ProQuest, ERIC	14/928	To review how have interventions using social media tools affected outcomes of satisfaction, knowledge, attitudes, and skills for physicians and physicians-in training? and what challenges and opportunities specific to social media have educators encountered in implementing these interventions?	Social media use in medical education is an emerging field of scholarship that merits further investigation. Educators face challenges in adapting new technologies, but they also have opportunities for innovation.	Effectiveness, Enablers and barriers

Author	Year	Country	Methods/ Analysis	Population (course, year, university)	Sample Size	Aim/Purpose of study	Conclusion	Focus
Hollinderbäumer, A., et al.	2013	Germany	Systematic review	PubMed	20/1245	To summarize the manner in which the integration of Social Media and Web 2.0 into education	The integration of Web 2.0 and Social Media is the modern form of self-determined learning. It stimulates reflection and actively integrates the students in the construction of their knowledge. With these new tools, the students acquire skills which they need in both their social and professional lives.	Learning design, Effectiveness
Cartledge, P, et al.	2013	UK/Rwanda	Systematic review	Medline, Embase, PsycINFO, ERIC, CINAHL, Cochrane library, BIE, RDRBWEB	9/1047	To ascertain if social networking sites have been used successfully in medical education to deliver educational material, and whether healthcare professionals, and students, are engaging with social networking sites for educational purposes	Social-networking sites have been employed without problems of professionalism, and received positive feedback from learners. However, there is no solid evidence base within the literature that social-networking is equally or more effective than other media available for educational purposes.	Educational value, Effectiveness

Author	Year	Country	Aim/Purpose of study	Conclusion	Focus
Expert perspectives					
Hammerling, J. A. M. S. H. M. S. M. L. S.	2012	US	To discuss the best practices of course design and successful delivery of online clinical laboratory science (CLS) courses, and informs educators about the effective use of currently available educational technology tools used to increase student engagement	Technology has provided the tools for distance learning, and online education reaches more students than conventional classroom education can.	Learning design, Enablers and barriers
Popoiu, M. C., et al.	2012	Romania	To promote scholarly inquiry about the development and adoption of best practice in teaching and learning in medical education with social media	There is an increased need for training in how to use these technologies to enhance teaching and learning to support undergraduate and postgraduate medical education.	Educational value, Enablers and barriers
Wells, K. M.	2011	US	To share the author's own experience and observation in using social media for communication, up-to-date knowledge, life-long learning related to medical education	Social media will shape general surgery and surgical specialties through shared information among the global community of surgery	Educational value
McGee, J. B. and M. Begg	2008	US/UK	To review the unique features of Web 2.0 technologies, addresses questions regarding potential pitfalls and suggests valuable applications in health science education.	Web 2.0 gives educators an opportunity to use the Internet to craft engaging, student-focused, self-generating and sustainable learning experiences. Web 2.0 has the potential to fundamentally change the relationship between teacher and student.	Enablers and barriers
McLean, R., et al.	2007	UK	To discuss the use of web 2.0 in medical education in providing health information "any time, any place"	The medical community needs to be aware of these Web 2.0 technologies and their increasing role in providing health information "any time, any place".	Educational value
Sandars, J. and C. Haythornthwaite	2007	UK/USA	To discuss how web 2.0 offers new learning opportunities, importance of developing connections between a wide variety of learning resources	New adaptive technology has the potential to create personalized, yet collective, learning. The future implications for e-learning in medical education is considered.	Educational value
Kamel Boulos, M. N. and S. Wheeler	2007	UK	To discuss the use of web 2.0 in health and health care education	There is a need to raise awareness of Web 2.0 tools and the possibilities they offer, and an urgent need to conduct quality research to inform better use of Web 2.0 applications.	Educational value
Boulos, M., et al.	2006	UK	To explore some of the current uses of Web 2.0 tools in the education of medical/nursing students, the continuing professional development and education of healthcare professionals, and patient education	If effectively deployed, wikis, blogs and podcasts could offer a way to enhance students', clinicians' and patients' learning experiences, and deepen levels of learners' engagement and collaboration within digital learning environments.	Learning design, Effectiveness

Table 1

Summary of selected articles

Of the 36 included articles, 13 originated in the UK, 11 in the USA, the rest from Australia (three), Brazil (one), Canada (one), Croatia (one), Germany (one), Romania (one), Saudi Arabia (two), Singapore (one), and Switzerland (one). Five collaborative papers were led by the UK and the USA, supported by Australia, Ireland, and Rwanda.

A wide range of journals accepted papers on collaborative online learning in medical education led by Medical Teacher (9 papers), BMC Medical Education (3 papers), and Academic Medicine (2 papers). (Table 2) Medical educators are encouraged to publish their works and share their practical experience with other medical educators.

Table 2. Journal publications of selected articles

Journal Publication	Authors	Number of articles
Academic Medicine	Hall et al. (2012), Cheston et al. (2013)	2
Advances in Physiology Education	Taradi and Taradi (2004)	1
BMC Medical Education	Boulos et al. (2006), Avila et al. (2016), Cole et al. (2017)	3
BMJ Open	Reeves et al. (2017)	1
Clinical Teacher	Batt-Rawden et al. (2014)	1
Education and Information Technologies	Dommett (2019)	1
Education for Health	Diug et al. (2016)	1
GMS Z Med Ausbild	Hollinderbäumer et al. (2013)	1
Health Education	Smith and Lambert (2014)	1
Health Info Libr	Kamel Boulos and Wheeler (2007)	1
Int J Med Inform	Bernardo et al. (2004)	1
Journal of General Internal Medicine	Chretien et al. (2008)	1
Journal of Medical Internet Research	Wiecha et al. (2003)	1
Journal of the Medical Library Association	Lemley and Burnham (2009)	1
Labmedicine	Hammerling (2012)	1
Med Ref Serv	Mi and Gould (2014)	1
Medical Education	Ho et al. (2018)	1
Medical Journal of Australia	McLean et al. (2007)	1
Medical Teacher	Bahner et al. (2012), Cartledge et al. (2013), Gray et al. (2010), McGee and Begg (2008), Peacock and Grande (2016), Potts (2011), Sandars and Haythornthwaite (2007), Sandars et al. (2008), Varga-Atkins et al. (2010)	9
North American Journal of Medical Sciences	Guraya (2016)	1
PLoS One	Saqr, et al. (2018)	1
Postgrad Med J	Sandars and Schroter (2007)	1
Procedia - Social and Behavioral Sciences	Popoiu et al. (2012)	1
Rural Remote Health	Baker et al. (2005)	1
Surgery	Wells (2011)	1

Description of Study Population

Among the five studies of surveys on the usage of collaborative online learning, two studies were focused on members of medical associations, in which some members are undergraduate medical students, three studies are based on samples of students in one single university. The sample size ranged from 50 participants to 759 participants generally, with larger sample sizes for surveys than interventional studies. (Table 1)

There were 16 interventional studies on collaborative online learning. There was a wide range of study populations in the studies. Fourteen were based on an intervention at a single university, one was conducted in two different universities, and one targeted a more general population of followers on Twitter and Facebook including medical students. The sample size ranged from 10 participants to 300 participants. While single site studies are easier to conduct it is encouraging to know that a collaborative studies have been undertaken to provide more robust data on effectiveness and validity.

The interventions reported on a variety of applications in different courses. Eight interventions focused on a particular area of study, including a clinical clerkship, biomedical science, cardiovascular system and digestive system, experimental surgery, neuroscience, pathology, physiology, and rural medicine. Two focused on more generic clinical skills, including clinical reasoning, and medical interviewing. Three interventions focused on particular teaching and learning pedagogies, including case-based learning, peer-assistant learning, and problem-based learning. Among the interventional studies, nine studies involved students in the junior years (Year 1 and 2), and four studies involved students in the senior years (Year 3 or above).

Methodological Approaches

The outcome measure of collaborative online learning can be measured by 1) Self-reported satisfaction, 2) Self-reported knowledge gain, 3) Self-reported confidence gain, 4) Self-reported interests in pursuing certain career path, 5) Course evaluation, 6) Data analytics on platform usage (access, posting, duration), 7) Qualitative analysis of content (posts, comments, reactions), 8) Group interaction, student engagement, 9) completion rate of activities, and 10) Academic outcome.

Key Insights from the Literature

Several key educational issues emerged from this review: how collaborative online learning can influence learning (pedagogy), what modalities are useful in delivering collaborative online learning effectively (e-platforms and apps) and what are the enablers and barriers towards implementation. (Table 1)

Pedagogical Perspectives

- Educational Value

Many selected articles discussed the educational value of collaborative online learning and recognized its importance in medical education. Lemley & Burnham pointed out the increasing trend of using collaborative online learning in medical education that encourages “anytime anyplace learning”, personal engagement that suit preferred learning styles (3).

The novelty of using online learning generated interest in learning among students (18). Sandars & Haythornthwaite highlighted the capacity of this learning module provide personalized learning that fit individual learning needs(16). Baker, Eley, & Lasserre described how the online teaching tools they used helped them to understand students’ concerns and interests in their learning, and hence provide useful guidance for curriculum development and career support.

The online mode of learning encouraged more interaction and sharing among students and teachers. It also helped build professional networks (18, 20), facilitated curriculum development (15, 18) and helped introduce future career paths (18).

The dynamic virtual learning environment provided by collaborative learning applications encouraged student engagement in discussions and active learning. Cheston stated in his review that ten studies reported the use of social media in online learning stimulated interaction and promoted active learning (27).

- Learning Design

Nine articles discussed the learning design of collaborative online learning. Among these, one study suggested that the improved social interaction and sense of community belonging was a feature that made collaborative online learning effective (13). This can be undermined by a complicated and cumbersome design which underscores the importance of the selection of an appropriate application with a user friendly interface (15). Students are concerned about the extra workload imposed by collaborative online learning (9, 10) so ensuring that there is sufficient support is a crucial factor in successful online learning design (15). An example of support is pre-launch training and technical support targeting learners and educators with less confidence or ability in using online applications (4, 15, 27, 28).

- Learning effectiveness

Fifteen papers discussed the effectiveness of using collaborative online learning in medical education. Studies showed the sound effectiveness of collaborative online learning (2, 4), particularly when using social media (27), forum (13), discussion forum (14).

- E-platforms and Applications

There is a spectrum of e-platforms and applications, or apps, for collaborative online learning. These include blogs, document management systems, instant messaging, learning management systems, media sharing, online discussion, online games, social bookmarking, social networking and wikis. Social networking applications are most frequently discussed in and Facebook and Twitter are the most commonly used. Most of the used applications are commercially developed, with only 1 using a self-developed site for collaborative online learning. (Table 3)

Table 3. Variation of collaborative online learning applications used or discussed in the selected articles

Category	Examples	Number of papers
Blogs	Blogger, Wordpress	16
Document management system	Google Suite (Google Doc, Google Drive, Google Form, Google Sheets, Google Slides), SharePoint	6
Instant messaging	Messenger, Skype	5
Learning management system	Nicenet's Internet Classroom Assistant (ICA; http://www.nicenet.org) Blackboard, Moodle, Flubaroo,	10
Media sharing	Podcast, Videocast (YouTube), Photo sharing (Flickr)	18
Online discussion	Chatroom	3
Online game	Dumb Ways to Die	2
Social bookmarking	Pinterest, Scoop.it, Del.i.cious	7
Social networking	Facebook, Twitter, LinkedIn, Myspace	30
Wikis	Wikipedia, Google Sites, TeamsLX	17
Other	Self-developed site	1

Seven studies focused on prevalence of using a particular application in collaborative online learning. Studies found that collaborative online learning applications are useful for knowledge acquisition (29, 30).

- Enablers and Barriers

This review found that 6 of the 36 included studies provided reports of the enablers and barriers for using collaborative online learning. Enablers include the accessibility of “any time, any place” learning in the online space provided powerful learning experiences for teachers and learners (18, 31, 32). Collaborative online learning connects people with common interests (29, 31, 33). Two articles described the ease of using collaborative online learning. The familiarity in using social media is not only easy but also enables learners to share information online freely (18, 29). A further study echoes that the ease of using is an important factor and advantage of successful online learning (34). Among these, several studies also pointed out the cost-effectiveness of using collaborative online learning (2, 4, 18, 35).

One of the key barriers is the technical challenges (29). The ever-evolving online technology provided a novel platform for learning. Though most students in the Web 2.0 generation understand how to use online learning (4) and most applications require little or minimal technical expertise (28, 36). Using collaborative online learning platforms demand some competence in handling technical techniques (14, 37). Appropriate technical support is still necessary (38). Failure of software and connection to online learning platform (18), un-familiarization of the application (39), the requirement of extra technical supports (2), and time and manpower to develop collaborative learning (14) are technical challenges of using collaborative online learning.

Other barriers of collaborative online learning including the concern of privacy issues (29), quality of information available online (28), difficulties with access to information online (28), learners’ self-discipline (34). In contrast, some also pointed out that cost is a barrier in using such learning strategies (2, 27, 37)

Discussion

We sought to answer two questions with this scoping review:

- What is the extent and nature of the academic publications on collaborative online learning in medical education?
- What insights about collaborative online learning have we learned from the literature

The Extent of Research Studies

The 16 empirical studies of implementation showed that there is an increasing trend of using collaborative online learning in medical education but the relatively low prevalence of articles may suggest that medical educators are hesitant to adopt it until its effectiveness is well-proven or until the technological and pedagogical barriers are overcome. On the other hand, the steady number of papers published each year, shows that there is ongoing interest and implementation of this learning mode. In particular, there is potential for furthering its use in specialty-specific courses, medical skills training, and pedagogical development.

The majority of relevant studies were conducted in the UK and the USA, which may indicate that online learning started earlier, became more popular and gained more attention in those countries. The absence of empirical studies from Asia, Europe, and other regions is surprising, given the high smartphone penetration and high rate of technology adoption in Asian countries, for example. It may be that such innovations have just not been formally evaluated and published as this review was restricted to English language publication and did not cover the papers presented in medical education conferences and web-based publication. On the other hand it might also signify the potential of exploring how collaborative online learning in medical education is used in different cultural settings. The internet has no boundary, and online learning also has no geographical restriction which creates immense potential for collaborative work to explore how collaborative online learning in medical education can be pushed beyond current practices. Medical educators are encouraged to publish their work as a means of dissemination, networking and globalizing medical education.

The Nature of Research Studies

From this review, we found that the studies on the topic have been limited in scope with mostly small scale studies involving relatively small sample sizes. These may be pilot studies and perhaps some unsuccessful studies might not be reported. However, as the nature of online learning is geared towards large populations of learners, there is good potential for future interventions involving more learners resulting in studies with better validity for extrapolation and generalization of findings.

Our review showed that intervention studies are more popular in junior years than in senior years in medical school. This might be due to the junior years are more relevant and suitable for online learning, which can cater to larger classes. This indicated that the novel online learning pedagogy is more popular among the foundation years as it gives more space for teachers and learners to explore new technology that could enhance their learning experience. In the clerkship years, the nature of teaching would require more patient-based learning and require more face-to-face contact. However, with the recent COVID-19 outbreak, many institutions have been forced to find alternatives to face-to-face teaching and there may be many new collaborative online learning innovations born from this crisis in both clerkship and pre-clerkship settings.

A range of qualitative or quantitative research methods were used in the studies included in this review including one that used social network analysis (SNA) to understand the effectiveness of collaborative online learning. This approach provided a visual analysis of how learners collaborate online and helped to identify problem areas that require further attention and intervention. New research questions and corresponding research methods and approaches to analysis, such as SNA, adopted from other disciplines or domains, can help to understand the issues from other perspectives and further the scope of research.

As suggested by some reviewed articles, it would be interesting to expand the research in collaborative online learning by exploring how students interact with each other. This is an era of Web 2.0 and 3.0, researchers and medical educators must be upfront to the emerging development of technology and keep abreast of the demands and expectations of the learners. The exploration of new applications that fit the needs of online learners is crucial. (36)

Strengths and weaknesses

This scoping review included many empirical studies, which show the current usage of collaborative online learning in medical education and provide good insights into understanding how the intervention works. Those large scale surveys provided a macro-view on the extent of usage of collaborative online learning in medical education. The literature reviews on the topic provided an overview of the existing literature related to the topic. Many scoping reviews exclude opinion papers and commentaries, however, they are the ones that can give a more general understanding of the issue and provide an overview of how collaborative online learning is situated in the medical education and medical profession. Limitations of this scoping review include: absence of any quality assessment of the selected articles so there was no relative weighting or importance among the papers, restriction to English language papers, exclusion of conference papers and web-based publications, difficulty with synthesis of information due to the heterogeneity of sources.

Conclusions

Collaborative online learning has good educational value that can encourage active learning and enhance student engagement. The selected studies highlighted the importance of learning design, especially providing sufficient support for learners and teachers when introducing new technology to optimize the learning experience and outcomes. Social networking applications have a leading role. The exploration of using a commercially developed application and adopting its function for education would be a challenging but rewarding pedagogical breakthrough. Technological challenges remain a notable and constant barrier for collaborative online learning and will continue to require ongoing support for teachers and learners. With the relatively small body of work currently published on collaborative online learning in medical education, further work and innovation in this area may be forthcoming in response to the need for alternatives to traditional learning particularly in times of crisis.

Abbreviations

BEME Best Evidence Medical Education

CME continuing medical education

MeSH Medical Subject Headings

SNA social network analysis

Declarations

Ethics approval and consent to participate

Not applicable

Consent for publication

Not applicable

Availability of data and materials

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

PL contributed to the design and implementation of the research, analysis of the results and was a major contributor in writing the manuscript. JT, HT, KC performed the literature reviews of the articles. JC was involved in editing and overall supervision of the project. All authors read and approved the final manuscript.

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Figures

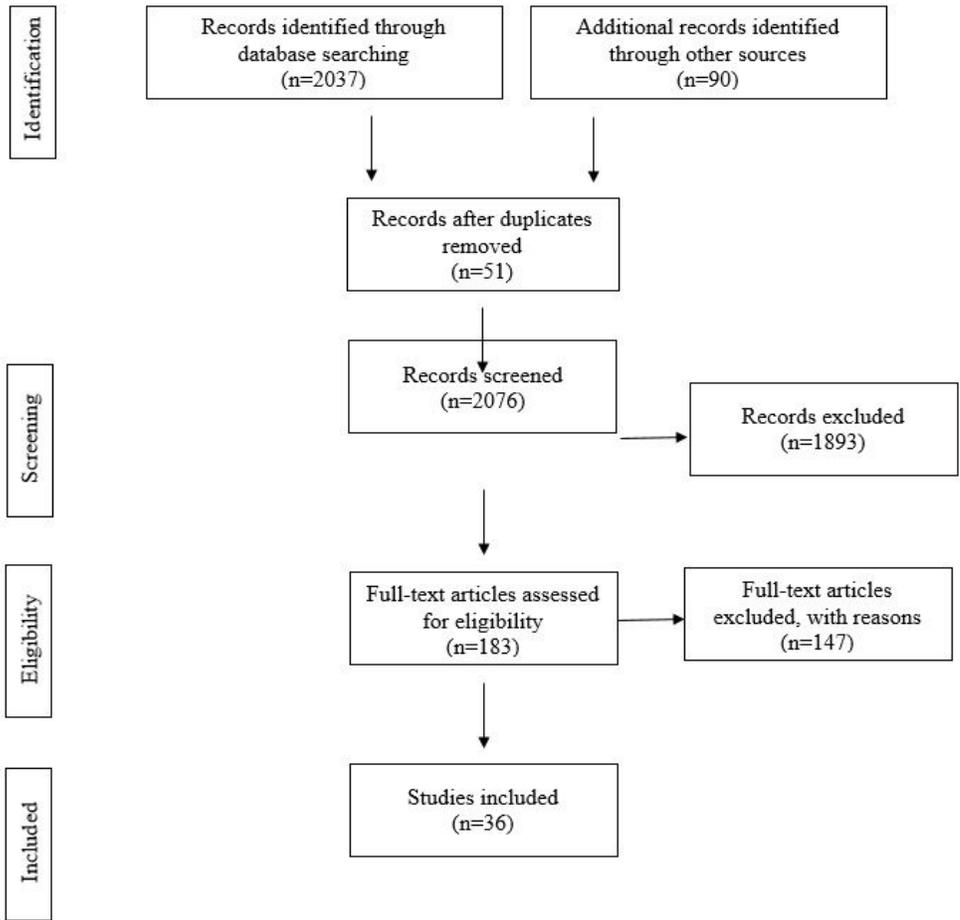


Figure 1

Flowchart of the screening process