

Online Learning in Medical Education: What Does the Evidence Show?

James Crabtree (✉ crabtrej@tcd.ie)

Trinity College Dublin

Asmaa Alazemi

Trinity College Dublin

Ellen Howie

Trinity College Dublin

Nora Alotaibi

Trinity College Dublin

Nurul Ishak

Trinity College Dublin

Tara Daly

Trinity College Dublin

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Abstract

Introduction: Educational institutions, including postgraduate medical education and medical schools, are increasingly utilising online learning to aid the delivery of their curricula. The purpose of this research is to investigate articles that discuss the effectiveness and perceptions of online learning in medical education.

Methods: PubMed, ERIC and Google Scholar were used as search tools in this literature review. Filter limitations including articles published from 2011 onwards and English language only were applied.

Results: A total of 1281 articles were retrieved. After duplicates were removed and exclusions applied, 17 articles were selected for detailed analysis. Multiple studies supported that online learning is an effective learning tool in medical education and helps to supplement traditional face-to-face teaching.

Conclusion: The most successful learning resources implemented by medical schools both before and after the COVID-19 pandemic were virtual patient simulations, instructional videos and telehealth platforms. This paper also outlines a number of limitations and knowledge gaps that must be addressed so that the unique needs of medical students can be met and online learning can be considered a suitable substitute for traditional methods.

Introduction

Education has historically been taught in ways that included physician led in-person didactic lectures, small group teaching sessions and hands-on laboratory components that allowed students to learn concepts in the classroom and apply them to real world situations. The COVID-19 pandemic has forced educational institutions worldwide to quickly shift from traditional face to face teaching methods to an online-based learning system. But even before the pandemic, educational institutions, specifically medical schools, have more and more begun using online teaching methods in a way to supplement face-to-face learning in an effort to safely allow medical students to learn effectively. Researchers worldwide are currently investigating exactly how effective online learning is. With countless ongoing studies, much of the collected data is still pending. This study investigates already published material with regards to online medical education and discusses what can be made of the current evidence available.

Methods

Participants

Studies that reported on undergraduate medical students including first-year, second-year, fourth-year and final year medical students. This literature review highlighted the contribution of online learning in both undergraduate and postgraduate medical education.

Outcomes

The main outcome of interest is the impact of e-learning on medical education with regards to academic performance, engagement as well as potential barriers and solutions. Secondary outcomes include the impact of COVID19 on medical education and the role of online learning during the pandemic.

Types of Articles: The following types of Articles were included: literature review, experimental study, randomised controlled trials (RCT) with qualitative and quantitative analyses, systematic review and meta-analysis, data analysis, integrative review, retrospective analysis, mixed-method study, cross-sectional survey and single-centre randomised survey.

Information Sources

Database search

The search was performed on October 16th, 2020 on PubMed, ERIC and Google Scholar. The search strings and boolean operators⁽¹⁾ applied for each database are illustrated in Fig. 1. The process of article inclusion is displayed in a PRISMA flow chart, shown in Fig. 2. A total of 1281 articles were identified from the database searches. After removing duplicates manually, 540 articles remained. Articles that were unrelated to the search topic 'online learning in medical education' were excluded, which were 488 articles in total. Full-text screening of the remaining 52 articles was undertaken and further articles were excluded on the basis of data extraction criteria. This resulted in 17 articles remaining to be fully analysed in order to identify the findings of the articles. Below is an explanation of both inclusion and exclusion criteria used in this process.

Inclusion criteria

This study included reviewing online available full-text articles, written in English, that highlighted the role of online learning in medical education with respect to medical students and medical professionals. Due to the limitations on the scope of this review, it was decided to limit the search to articles published in the year 2011 or onwards and published in either European or North American journal articles.

Exclusion criteria

Publication date prior to 2011, non-European and non-North American countries and unavailable full-texts.

Results

Included studies

The summary of the included studies can be found in Table 1. The included articles were appraised using the Oxford CEBM Levels of Evidence 2009⁽²⁾.

Main findings

From the studies analysed, there is extensive evidence for the effectiveness of online learning within the medical education community. The majority of the studies support that online resources are valuable educational tools for enhancing learning. Online resources also continue to serve as an excellent supplement for traditional face-to-face teaching⁽³⁻⁸⁾, especially in the midst of COVID-19 pandemic, where the use of online resources and platforms are more prevalent than ever⁽⁵⁾. However, there is no strong evidence that online learning is more effective in enhancing learning than offline learning^(6,9) and can replicate real-life clinical experience completely⁽¹⁰⁻¹²⁾. Therefore, a combination of both online and offline learning would be the most effective for student learning⁽¹³⁾. Some barriers to online learning were also highlighted which need to be addressed before the implementation of any online platforms as a means of learning.

Discussion

An examination of the online resources implemented both before and after the COVID-19 pandemic reveals which are the most beneficial for medical student education and what areas exist for further research.

Online teaching resources are needed in the continued education of medical students⁽⁶⁾. Enhanced clinical experience using instructional videos was studied in 2011 when medical students were asked to watch the short videos before interacting with a patient and presenting the case⁽⁷⁾. A survey showed that the students' perceived confidence and effectiveness of the case presentation were improved after viewing the video. Although this does not empirically prove the benefits of instructional videos, it implies that there is a place for hand-held mobile learning technology in a clinical setting. Further analysis carried out in a systematic review of 20 papers concluded that online instructional videos benefitted postgraduate medical students in learning and retaining clinical skills⁽¹⁷⁾. This study suggests that further research could identify what makes instructional videos effective.

Online resources could completely replace in-person patient interactions. Final year students in Rutgers New Jersey Medical School participated in patient consultations via the virtual platforms collectively known as telehealth⁽¹²⁾. In particular, students valued the sense of purpose or usefulness that the platform provided. Not only did they appreciate the opportunity to practice the essential skill of history taking but they felt encouraged by the chance to aid front line workers with "decision making, patient and family counselling, and the planning of implementations". Virtual patient simulations (VPS) are another way to gain clinical experience in a rural setting. A study in 2016 introduced interactive digital patient cases to first-year medical students⁽¹⁸⁾. VPS was found to be an effective classroom technique that increased engagement among the students.

Resources like telehealth and VPS offer hope to students in continuing their clinical education during the 'educational crisis'⁽⁵⁾ caused by the COVID-19 pandemic. However, written exams will also be a concern to students, with remote teaching and learning posing new challenges to students' exam performance. In a study by Bientzle et al., online learning techniques were assessed in the context of exam performance⁽³⁾. Medical students that used online learning cards, MCQs and took individual notes were analysed. The higher the number of learning cards, test questions or MCQs used, the higher the percentage of questions answered correctly by the student in the exam. Those taking individual notes from online also answered a higher percentage of questions correctly than those who didn't take any notes. The conclusion to this study found that online learning resources can be very helpful to medical students that engage in the learning material online.

Student engagement with online learning resources was also studied in the context of online mentorship. A RTC was carried out that compared mentored and unmentored doctors that had to do their continued medical education (CME) in a remote or distant setting. An odds ratio implied that doctors that were mentored were three times more likely to complete the CME modules compared to those that weren't mentored. Mentored doctors also seemed to engage in the reflection at a higher level. Mentors felt that their contribution had little impact and both mentors and mentees found it difficult to make contact. Perhaps a larger scale study with more support and structure for communication would produce more statistically significant results⁽¹⁵⁾.

The question remains: are there aspects of medical education that simply cannot be performed digitally? There is little evidence that interactions via telehealth⁽¹²⁾ thoroughly prepare student doctors for the hospital environment. Inadequate infrastructure and technical difficulties appear to be unnecessary barriers in the online setting that distract from learning⁽¹⁰⁾. Students taking part in virtual patient simulations report difficulties with navigating technology, overwhelming text and limited tutor guidance⁽¹²⁾. There is low-quality evidence supporting students' ability to develop a rapport or connection with patients through the confines of a computer screen⁽¹¹⁾ and it is unclear how this may stunt a student's communication skills. It appears that whilst virtual patient interactions can be a useful adjunct to clinical experience, it is most beneficial as part of a blended learning approach⁽¹¹⁾.

Students rated their own preparedness as relatively unchanged by the shift to online teaching due to the adoption of virtual assessment tools⁽¹⁵⁾. However, this solution has a number of limitations. For one, the delivery of these assessments and the validity of their results relies greatly on the infrastructure provided by the school. Many universities have far to go in improving their LMS⁽⁸⁾, especially for the purposes of more high stakes examinations. Secondly, online methods of assessment create potential inequality between students. Stable internet connection, quiet home environment and access to a personal computer are essential for proper completion of an online exam, possibly creating an unfair advantage for more privileged students⁽¹⁹⁾. Medical schools must address these issues before online assessments can be used beyond a supplementary tool.

'Clinical thinking' and problem-solving are important skills for student doctors and one way medical schools can encourage this kind of critical thinking is through PBL sessions. Students asked to interpret a virtual patient preferred a written account of the problem to a video version⁽¹³⁾. The video was thought to slow down the pace of the session and inhibited students from being able to critically review the information given⁽¹³⁾. This shows the cost of technical difficulties and poor infrastructure to student development⁽¹⁴⁾ and demonstrates the advantage of traditional methods in situations where technology creates unnecessary barriers to student engagement.

Conclusion

Examination of the online learning resources implemented by medical schools both before and after the COVID-19 pandemic revealed the strengths, weaknesses and areas for further research in this technology. Streamlined LMS, issues of equality and "articulation of goals and objectives and tools for curricular evaluation"⁽¹⁶⁾. However, online learning can still serve to enhance medical students' skills and knowledge compared to offline learning⁽⁶⁾. Most medical schools have adopted a blended learning technique or technology-enhanced learning (TEL)⁽⁹⁾ that incorporates face-to-face teaching, paper textbooks and lecture notes with online learning software⁽¹⁹⁾. A combination of 'unidirectional' resources and more interactive material, is the most effective method to support student learning⁽¹³⁾.

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Table 1

Table 1 is available in the Supplementary Files section.

Figures

<p>PubMed ("Medical Education"[Title]) OR ("e-Learning"[Title]) OR ("Medical Students"[Title]) OR ("Remote Learning"[Title]) OR ("Virtual Learning"[Title]) OR ("digital education"[Title]) AND ("2011"[Date-Publication]) AND English [Language])</p> <p>ERIC ("Medical Education"[Title]) OR ("e-Learning"[Title]) OR ("Medical Students"[Title]) OR ("Remote Learning"[Title]) OR ("Virtual Learning"[Title]) OR ("digital education"[Title]) AND ("2011"[Date-Publication]) AND English [Language])</p> <p>Google Scholars ("Medical Education"[Title]) OR ("e-Learning"[Title]) OR ("Medical Students"[Title]) OR ("Remote Learning"[Title]) OR ("Virtual Learning"[Title]) OR ("digital education"[Title]) AND (2011-2020) AND English [Language])</p>

Figure 1. Search strings for each database.

Figure 1

See image above for figure legend.

Figure 2: PRISMA Flow Diagram

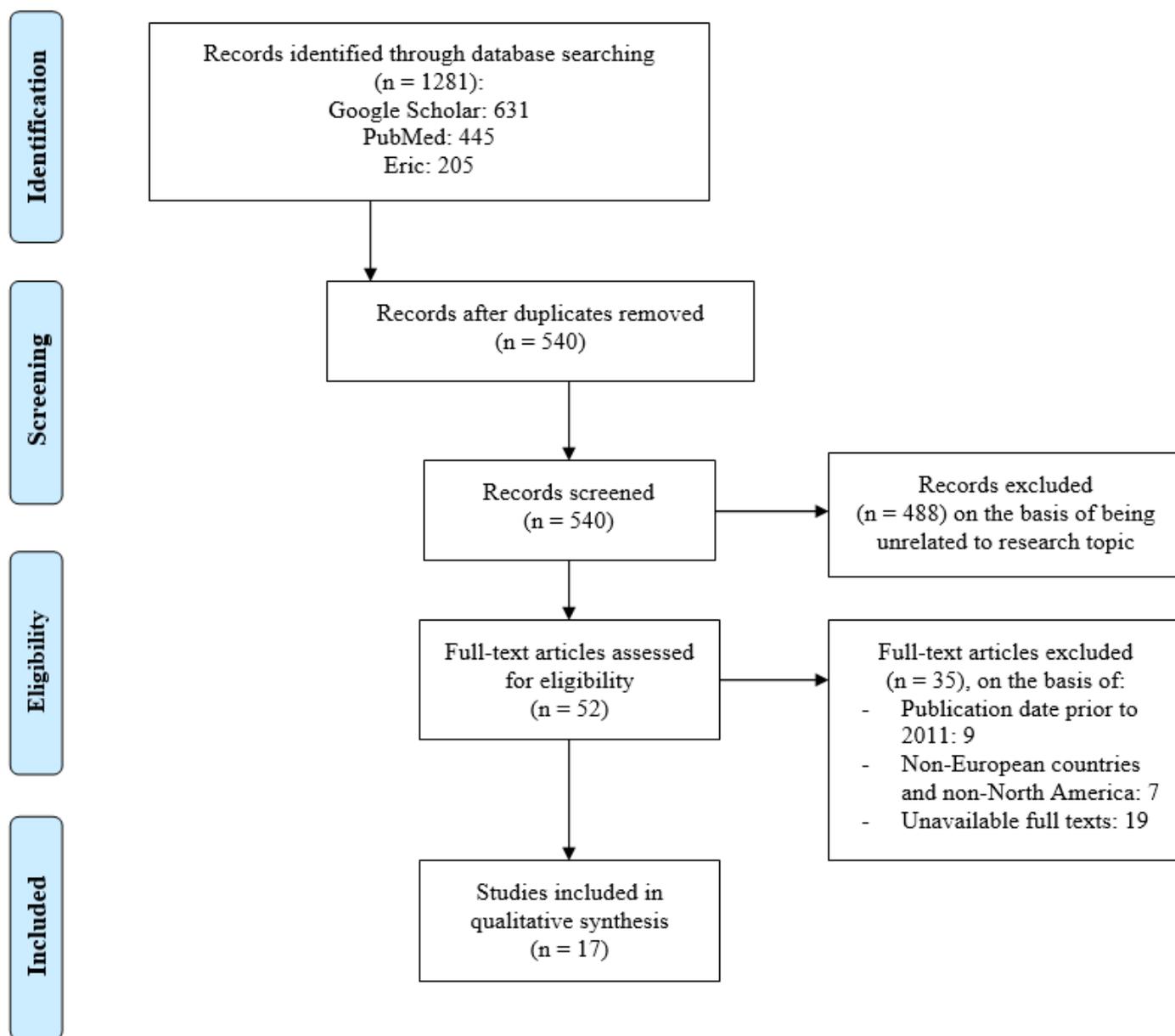


Figure 2

See image above for figure legend.

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- [Table1.docx](#)