‘Learning from home’: role of e-learning methodologies and tools during novel coronavirus pandemic outbreak

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ABSTRACT

Background

During the crucial time of coronavirus pandemic, education is being remodelled: opening the doors of electronic learning (e-learning). The review emphasises on the various e-learning methods that can be used in the current scenario.

Methods

The review was based on Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines on databases, namely, PubMed, Google Scholar and Cochrane. Out of 1524 identified articles, after the process of screening and based on the eligibility criteria, 45 full-text articles were reviewed.

Results

Though there are many caveats on the path of successful implementation this is the right time that we step towards e-learning. The article discusses the methods and tools in e-learning that can modify the traditional ways of content delivery, record maintenance, assessment and feedback.

Conclusion

During the period of ‘planet arrest’, when the whole world is locked down with the motive of social distancing, let us stay connected with e-learning.

INTRODUCTION

Novel coronavirus pandemic outbreak in 2020 is a world-shattering event affecting all domains of lives.[1] In order to curtail the spread, lockdown across the globe is being implemented. With the closure of educational institutions, the students face doldrums in their academic activities. In these trying times, technology comes to the fore, transforming teaching and learning into a novel experience.

Electronic (e)-learning is the most convenient tool that is being used reliably transcending geographical frontiers and time zones. E-learning is defined as any educational intervention that is mediated electronically via the internet.[2]

Education technology firms are going to be uplifted in the wake of the coronavirus outbreak. Organisations and institutions are at present keenly interested in offering blended mode of learning to facilitate better education and for accreditation purposes.[3] Moreover, e-learning is befitting to the colleges with greater annual intake of undergraduates, owing to its capability to address large group learners at a single point. It is high time that medical teachers learn and orient themselves in the realm of e-learning. The process of e-learning enhances self-motivation of the current smart generation and offer learners control over content, learning sequence, allows the learner to work at their own pace, provides opportunity to build on their previous experience and offers a problem-centric learning environment. Thus, e-learning offers increased learner autonomy and self-direction, thus fulfiling the adult learning principles.[4]

Taking all these facts into consideration, probably, Information Communication Technology (ICT) will facilitate to temporarily fill the present gap in education, by enhancing the learner’s knowledge, keep automated records of individual student activities, evaluate them and track their academic performance for a specified period of time.

With this perspective in mind, the current review aimed to explore the available e-learning modalities that can be employed to foster medical education. This review may serve as a resource material to a beginner and an update to regular users of e-learning.

METHODS

We followed Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines and recommendations as depicted in the PRISMA flow diagram[5] (figure 1).

We searched PubMed, Google Scholar and Cochrane from the year 2000 to March 2020 for all published articles on e-learning in education.

Search strategy

The search was conducted using the following, Medical Search Headings (MeSH) terms and keywords, namely, ‘Online learning’, ‘Medical education’, ‘E-learning’, employing Boolean operators like AND, OR.

Inclusion criteria

All original and review articles fulfiling the following eligibility criteria were included in the study: (i) e-learning methods and tools enabling the teaching learning process and (ii) articles published in peer review journals in English from 2000 until March 2020.

Exclusion criteria

Articles were excluded, if they belong to any one of the following categories: (i) commentaries, case studies, case series, letters, thesis, dissertations, reports,

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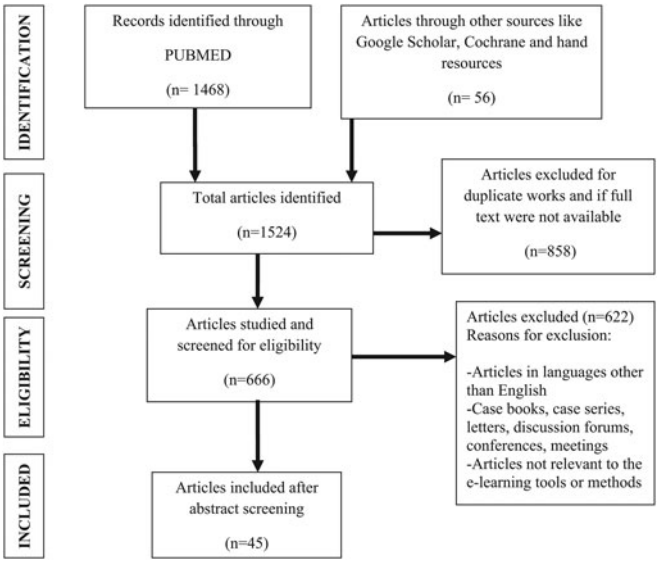

Figure 1 PRISMA search strategy flow diagram.

posters, conference abstracts or discussion papers; (ii) articles not published in peer review journals; and (iii) no full-text available.

Screening

Two authors independently extracted relevant information by using standard proforma and one author reviewed the data. The research question was taken into consideration during the process of screening the data. The research question framed was, 'What are the available e-learning tools and methods that can be used to facilitate medical education during the current coronavirus pandemic period?'

Of the initial 1524 identified references, 858 records were obtained after removing the duplicate works and based on the availability of full texts. References were then randomly distributed for abstract screening among the two researchers. If there was any in-sufficiency in the information provided, the article was taken up for the next level of full-text screening. After examining the full texts of 666 articles, 45 eligible full-text articles were retained and considered. Conflicts that arose during the selection process and extraction were discussed until a consensus was achieved. Further discussions were carried out on, how to categorise the data and an outline was planned.

DISCUSSION

In the past decade, call for competency-based medical education, changes in the societal expectations, rapidly developing healthcare environment were the driving factors for the implementation of e-learning in medical education.[6] In India, e-learning had been maximally used for literature search, and utility of e-learning for other purposes was in a nascent stage.[7] Yet, in the current period of indefinite lockdown, e-learning is growing viral; starting from schools, colleges, institutions, and universities wide across the globe. This indirectly has opened new avenues for engaging the students and has exposed many e-learning tools, beyond the tip of the iceberg. The graduate attributes, dictated by the Medical Council of India, could be effectively attained with learner-centred, technology-driven, self-paced e-learning. This review article is formulated in CAPS format (**C**urrent state of knowledge, **A**rea of interest, **P**otential Impact of Knowledge **S**uggestions from experts), with the intention of unveiling the e-learning tools, that could be effectively used for the teaching and learning from home.[8]

Prerequisites for e-learning

E-learning is a two-way process requiring an earnest effort from both the learner and the faculty. The requisites are as follows:[9]

i. Highly motivated, self-directed and self-regulated learner with basic knowledge on ICT
ii. Trained and motivated faculty
iii. Learning materials which can be non-interactive (documents, PowerPoint presentations, video or audio files, developed in accordance with the learning objectives) or interactive e-lessons (web-based training where there is provision for questions and feedback, links to online resources)
iv. A good learning atmosphere with adequate internet facilities
v. Technology or tools from a basic email account to the availability of learning management system (LMS).[10]

Table 1 highlights the various advantages and challenges in e-learning. Table 2 shows the various e-learning methods and tools that can be used to replace the traditional way of learning.

Synchronous and asynchronous e-learning

Synchronous e-learning refers to real-time learning and it requires the learner and teacher to be online at same time at different locations. This facilitates the learners to be the participants in a group where active interaction occurs in a synchronous way rather than isolated communication.[11] Benefits of synchronous e-learning include, instant feedback, motivate interaction, socialism and emotional support.[12] Videoconferencing, instant messaging and chats are examples for synchronous modes and complement with face-to-face meetings. Synchronous learning is preferred in discussion of less complicated issues and planning.

Asynchronous e-learning refers to offline e-learning where instructor and learner need not be online at the same time. It offers flexibility for the learners to access the documents and reading materials at any time, send messages to teachers or peers. It gives time for the learner to understand and refine their thought process. emails, discussion forums and blogs are examples for asynchronous e-learning modes. For reflecting on complex issues and where synchronous meetings are not feasible due to practical and technical difficulties asynchronous mode is preferable.[13]

In the present situation, a hybrid model that employs both synchronous and asynchronous mode of e-learning can be beneficial for the students. These two modes complement each other and motley of these will help the students to learn from different activities.

E-learning methodologies and relevant e-learning tools

For content delivery and student participation

The traditional way of content delivery includes, lecture classes, practical sessions, and reading with reference books. Mostly these are teacher-centric methods where information flows in one direction. E-learning can facilitate content delivery through the collaboration platforms which are highly student-centric.

Non-interactive/linear methods

There is linear presentation of the content in a sequence. It is useful to teach static processes, where the content is delivered in predetermined linear manner, in multimedia format.

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Table 1 Advantages and disadvantages/challenges from students, teachers and institutional perspectives

Advantages	Disadvantages/challenges
Student's perspective	
► Self-paced ► Interactive ► Self-assessment ► Independent and active learning ► Flexibility in terms of time and place ► Scope for personalisation ► Diverse learning styles may be addressed ► Increase self-confidence ► Autonomy ► Can track their own progress ► Learner-centred ► Ease access to huge amount of information ► Enhanced collaborative learning	► Instructor may not be available all the time ► In-depth understanding may be difficult ► Tendency for isolation ► Lack of motivation ► Lack of basic knowledge of technical skills ► Lack of self-discipline among learners
Teacher's perspective	
► Flexibility ► Professional development and personal training in the use of digital tools is facilitated ► Uniformity in content delivery ► Saves time ► Repeatability ► Learning material can be stored and updated periodically ► Can address more number of learners	► Lack of direct control over the learners ► Difficulty in controlling fraudulent acts ► Lack of personal touch ► Communication skills cannot be imparted. ► Resistance to change from traditional methods ► Lack of motivation ► Lack of training
Institution's perspective	
► Compensates for scarcity of teaching faculty ► Group training ► Accreditation purposes	► Investment in the purchase of technological equipment ► Support staff recruitment ► Factors in the enabling environment: policies, rules and norms internal to the organisation

Table 2 E-learning methods and tools replacing the traditional way of learning

Traditional way	E-learning	E-tools/platforms
Content delivery		
Lecture, small group discussions and practical classes	Virtual classrooms	Zoom, Google meet, Cisco Webex, Skype, ClickMeeting, Adobe Connect, Free Conference, StartMeeting, Big Blue Button, Microsoft teams, VEDAMO virtual classroom, Google Hangouts
Seminars	Webinars	
Blackboard	Interactive white board	Live Board, Explain everything
Notes	PDFs, PPTs, e-books	Resource materials sharing via, email, classroom management software (Google classroom, Edmodo, Blackboard learn, Apple classroom, Canvas, Class Dojo, Microsoft Classroom, Sakai, Moodle), Learning management systems (Next learning platform, Gnomio, Google site for teachers, Schoology)
Home assignments	e-assignments	
Classroom views	Polling/e-voting	Poll Everywhere
Journals/diaries	Blogs	WordPress, Blogger, Edublogs
Record maintainence		
Portfolios of achievement	e-portfolios	Portfolios, Evernote, Voice Thread, Open School e-Portfolio
Workbooks	Online self assessments	
Assessment and grading		
Quiz	e-Quiz	Google forms, Socrative,VIZIA, Edpuzzle, Pear Deck, Mentimeter, Kahoot, Quizizz, iSpring
Tests and Exams	e-Assessment	Mettl's online platform, Merrittrac, Edcite
Paper grading	e-Grading	Gradescope, Google Classroom, Learning management systems
Feedback		
Face to face meetings	Videoconferencing	Video calls, WhatsApp video calls, Zoom, Google meet.

Audio and video files

The simplest way of delivering the content is by using audio and video to create sound or video files and that can be uploaded in the official websites or LMS after editing using sound-editing tools. The process of delivery of audio/video recorded content in digital format is called as podcasting. These documents can then be accessed by students through mobiles, desktops, laptops, etc.[14–16]

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E-textbooks

It refers to the digital version of a book. It is available in Portable document format (PDF) that can be downloaded in smartphones, laptops or computers. It is observed that e-textbooks are more frequently accessed.[17] It is also found that e-books are preferred for quick searches and for concise reading purposes.[16 18]

Interactive methods/collaborative learning

It is a kind of social learning where learners share knowledge and perform tasks in a collaborative manner and that may be aided by a facilitator. It may be a synchronous mode or asynchronous mode of content delivery. Virtual classrooms offer adaptable learning environment favouring synchronous form of learning, with provision for online chat rooms promoting high interactivity among the learners.

Social media

Social media play a major role in enhancing e-learning and also highly embraced by the medical students.[19 20] They are employed to access, exchange and collaborate ideas or information. YouTube,[21 22] Facebook, WhatsApp,[23] and Twitter[24] are the widely used social media by the current generation. Of these, Facebook and YouTube are widely evaluated educational tools for learning. Though these social media can be employed to facilitate learning but they are not exempted from disadvantages and risks of addiction, cyber-bullying, contrasting effects on academic performance, maintenance of privacy, integrity and security issues.[23]

Virtual classrooms

These are simulated classrooms linked via ICT. Here the learner and instructor are not physically present but virtually connected synchronously via the internet. Softwares like CiscoWebEx, Click meeting, Adobe Connect allows interaction through webcams and real-time chat. Interaction in the form of questions, group activities, poll and instant feedback can be done. Software likes VoiceThread and Zaption can further upgrade the interactions in a virtual classroom.[25] Other platforms that support videoconferencing include Free Conference, Hangouts Meet/Google meet (Video calls supported with other Google G-Suite tools), Microsoft Teams, Skype and Zoom (Cloud platform for video and audio conferencing, chats and Webinars), Start Meeting, Big Blue Button and VEDAMO Virtual Classroom. Virtual platforms like Zoom offer provision for small group discussion in break rooms, where a group of participants may interact on a particular concept.

Webinars

Webinar is a web-based seminar which helps to offer a presentation, lecture or seminar using videoconferencing software. People are connected using virtual platforms and can interact synchronously in real-time. Many studies employing webinars are observed to be effective in disseminating knowledge and skills.[26 27]

Group discussions

In Discussion forums, there is asynchronous communication between the participants. Google groups offer the advantages of asynchronous learning through discussion boards/forums that can be used by the participants for private or public view modes. Wikis are formed as a result of collaborative work, which is open for editing by the readers.[28]

Journals/diaries

Blog is an online journal created by one individual but turns out to be a public domain, encouraging comments from the readers. Free Open Access Medical education (FOAM) is an online platform for sharing free information accessed by medical professionals and other learners. This helps to accelerate the research to practice. These include blogs, podcasts, tweets, videos and other web-based media. Blogs form a core part of FOAM. These are the online journals or diaries in which the web pages are modified frequently with dated entries maintained by authors and used personally or for public view. This platform helps for reflection and peer interaction.[28]

E-learning tools used in collaborative learning include websites and applications for discussion boards (Usenet, Quora, Google groups), blogging (WordPress, Blogger), networking (Facebook, Twitter, LinkedIn, Google) and wikis (Wikipedia).

Massive Open Online Courses (MOOC)

These are online courses which offer unlimited access through the web, favouring unlimited participation. They can be accessed through smartphones and other digital devices. Coursera, EdX and SWAYAM, NPTEL from India are some of the platforms offering MOOCs. They are encompassed with course materials. Interactive courses with social media discussion forums have shown high course completion rates.[29]

Simulations

The digital simulation technologies have emerged providing medical knowledge to students through virtual laboratories,[30] virtual microscopy and virtual patients. Learners can see and interact with the simulated representations of real-life scenario. Virtual patients are computerised representations of clinical conditions used in medical education to teach clinical reasoning skills and has shown to enhance the student learning experience.[31 32]

Interactive whiteboards and PowerPoint presentations

There are many tools that may make online collaboration interactive, such as Prezi, which help to make highly interactive PowerPoint presentations in the online lectures. Similarly, interactive whiteboard tools like Liveboard, Explain Everything bring convenience and flexibility in learning and also increase the level of engagement of students and teachers.[33 34]

Record maintenance

E-portfolio

These are owned by the learners and represent dynamic digital workspaces where they capture their ideas, access their work collection, reflect on their learning process, share it, set goals, seek feedback. In short, it represents the showcase of their learning and achievements over time. Poole *et al* in 2018 has discussed in detail the various roles of e-portfolios, the challenges and opportunities in implementation in education.[35] However, training in the integration of e-portfolio in regular teaching-learning process may augment the learning process.[36] It can also be employed as formative method of assessment.[37] E-portfolio is more apt and beneficial for postgraduates who require documentation of their day to day activity. So it is important for documentation or tracking the student's progress in the learning process.

Assessment

E-assessment

This is commonly called as digital assessment or computer-based assessment. The various forms of e-assessment tools employed

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are Google forms (create forms with hyperlinks, images and videos, can be used to create quiz also); Poll everywhere (a real-time polling app); Socrative.com (a free web-based service for an immediate view of understanding level of students); Kahoot (free class quiz game); Quizalize; Triventy (helps for making group surveys and quiz games) and many other applications. E-assessment can be used to evaluate knowledge, performance, behaviour or attitude.

For remote purpose multiple-choice questions (MCQs), true/false, matching questions and predetermined short answer questions are the options for assessing the knowledge. Of these MCQs are commonly used.[38 39] Objective Structured Clinical Exams (OSCE) or virtual patient cases can be used to assess performance and based on their discussions and proceedings on the discussion forum behaviour or attitude assessment can be done. After the process of assessments are completed, spreadsheets are supported that help to keep the track of grades of all students and intimate them. Individuals can see their marks and the overall performance of their class. Further real-time communication technology will facilitate to conduct viva voce online or perform clinical examinations that can be observed by the examiner. Also, many proctored online exam platforms are available that can be considered for E-assessment like Mettl, Eklavvya with use of artificial intelligence. Platforms like Gradescope, Google classroom aid in grading the scanned answer sheets.

E-assessment tools always have a provision of instant feedback, which enhances the learner engagement and retention. It also helps the facilitators to plan appropriate remedial measures.[40] However, the integrity of the assessment tools may be enhanced by creating questions of higher-order type, using varied type of questions, shuffling the order of questions and choices and restricting the testing window period.

Though these e-tools can be efficiently used for formative assessment but their usage for summative assessment is under debate. Practically, the adult learning principles are difficult to thread into online summative assessments. Moreover, whether these e-assessment grades are accepted by the medical bodies and universities is doubtful due to issues like fairness, validity, and authentic depiction of learning process.[41]

E-feedback

E-platforms offer provision for both providing and obtaining feedback in the teaching-learning encounter. Tools like Google forms, survey monkey are widely used for obtaining feedback from the students over the fruitfulness of academic sessions. Meanwhile, formative e-assessments through Google forms offer advantages over providing instant feedback for wrong answers, thereby enriching the learning experience.

Digital badges represent an electronic mode of certification of accomplishment, may appear as an icon or logo, and accessed from curriculum vitae of the learners, e-portfolio, LMS and also may be placed in the social media. They help the learners to identify their strengths and areas of improvement.[25]

Integrated learning environment for e-learning: learning management system

There are many modes of e-content delivery. Yet there is a common tool that integrates all the above-mentioned categories like content delivery, student participation, record maintenance, assessment and feedback into a common platform called the learning management system.

Digital learning management systems (LMS): Many colleges and institutions are adapting the LMS to systematically implement and manage e-learning. It can be a proprietary software (closed source) or open-source software or developed by the ICT department of self-institution. The closed source software can be easily installed but offers less flexibility when compared with the open-source and self-developed platforms. The open-source software is those whose codes are available for anybody to access and modify through open collaborations. They are free of cost and offers greater flexibility. The disadvantage is that it offers no official support, security and warranty.

This software administers trains, delivers the content and keeps automated track of all details. Literature search indicates that LMS is widely used for undergraduate training[42 43] in medical fields and helps to offer a structured-blended curriculum. LMS help in content delivery through sharing of PowerPoint presentations, PDFs and other contents. It helps in student participation via, discussions, chats, messages. It keeps the track of individual student progress and assignments submitted and student evaluation is done through quizzes and other assessments. The advantage of using LMS is that it can incorporate contents in various formats like video, audio, text, pictures and others. The contents can be accessed remotely and properly documented. The major disadvantage is that implementation requires good in-house built technology infrastructure by the institution.

The various resources and tools available in market are Blackboard, Century Tech, ClassDojo (Connects teachers with parents and students), Edmodo, EkStep (Open learning platform), Google Classroom, Moodle (Globally supported open learning Platform), Schoology and Skooler (converts Microsoft Office software into education platform).

These LMS require instructors and Learners to be registered for the phase to gain access. Based on the assigned roles (teacher/student/mentor), participants can make use of the variety of tools and services designed by the instructor or technologist.

Facing the constraints

- Online Faculty development programs on e-learning to sensitise the faculty and overcome the resistance from them.
- In area of no connectivity, it is wise to run an LMS on local area network (LAN) in the client-server architecture or offline.
- Adopting institutional strategies for improvising the infrastructure may serve the dual-purpose of supporting the e-learning process and also help in meeting the accreditation standards.[44]
- Integrity of assessment may be improved by multiple tests, with higher-order questions restricting the testing window, so that available time can be used only for answering and not searching.[45]

Future scope: mobile learning, telemedicine

Mobile phones especially smartphones are now of pivotal importance in everyone's life. Mobile learning will further enhance the digital trend communication between instructor and learner. With the mobile networks covering larger areas, the advantages offered by mobile learning includes convenience, accessibility, low expenditure and self-assessment making learning comparatively easy.[46] m-learning offers an enjoyable learning experience to the learners.[47] Another mobile device gaining popularity in the current trend is the Personal Digital Assistants (PDA). These are handheld devices with features of computation, faxing and networking. In simple terms, these are handheld laptops or pocket personal computer. Literature search indicates that they are being used by physicians and health professionals for patient healthcare and computing purposes[48]

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but their role in learning is not yet properly defined. Successful implementation of m-learning is an upcoming digital trend that needs collaboration between the individual profession and technology.

Development of e-learning models

ADDIE model is widely employed for developing the e-learning models.[49 50] The five steps involved in this are: Analysis, Design, Development, Implementation and Evaluation (figure 2). Other model approaches include the ASSURE model (Analyse the learner, State objectives, Select media and materials, Use media and materials, Require learner participation and Evaluate), Gangne's 9 event model (gaining learners attention, informing the objectives to learners, stimulating recall of prior knowledge, presenting the content, learning guidance, eliciting performance, providing feedback, assessing performance, enhancing retention and transfer); Merrill's model (five principles: task-centred, activation, demonstration, application and integration) and Kemp model (identify needs and specify goals, learner characteristics, identify subject content, state objectives to learner, sequencing, design instructional strategy, plan, develop evaluation instrument, select resources to support instruction).[51]

Principles behind the success of e-learning

- Clearly stated objectives
- Motivated learners
- Trained and dedicated instructors
- Adequate workspace
- Well-chosen instructional methods and mode of delivery

CONCLUSION

During the current coronavirus pandemic outbreak, where there is indefinite lockdown imposed worldwide, implementing and execution of e-learning strategy is really a challenging task. In the current scenario, when stringent safety measures are being adopted like social distancing, large group learning such as lectures are possible only through e-learning. Despite the practical and technical difficulties that can be encountered, this is high time to open the door for e-learning technology for social connectivity amidst the social distancing to break the chain of coronavirus spread and make learning an enjoyable experience for the millennial generation.

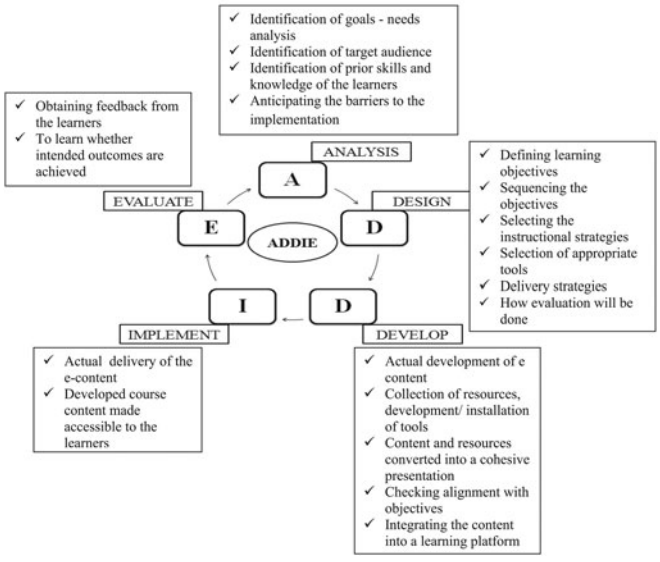

Figure 2 ADDIE model of e-learning content development.

Current research questions

- What are the available e-learning tools and methods that can be used to facilitate medical education during the current COVID pandemic period?
- What are the important motivating factors for e-learning?
- How can the process of e-learning, enhanced and made appealing to the students?

Main messages

- E-learning is a convenient way to continue the teaching learning process during the coronavirus pandemic outbreak and beyond.
- Learning management system (LMS) can integrate content delivery, record maintenance, assessment and feedback processes.
- Though many barriers and challenges are in the way of successful implementation of E-learning but the need of the hour is to step forward with e-learning technology.

Self assessment questions

1. Instant messaging and feedback are given through
   A. Synchronous e-learning
   B. Asynchronous e-learning
   C. Blogs
   D. Discussion forums
2. Which one of the following is NOT an example of asynchronous e-learning?
   A. Email
   B. World Wide Web
   C. Videoconferencing
   D. Blogs
3. What is the full form of FOAM?
   A. Free Online Access Medicine
   B. Free Open Access Meducation
   C. Full Open Access Medicine
   D. Full Open Access Meducation
4. Which of the following is the function of learning management system (LMS)?
   A. Content delivery
   B. Student Participation
   C. Assessment
   D. All of the above
5. Which is the correct sequence of e-content development as per the ADDIE model?
   A. Analysis, Design, Develop, Implement, Evaluate
   B. Analysis, Develop, Design, Implement, Evaluate
   C. Analysis, Discover, Demonstrate, Implement, Evaluate
   D. Analysis, Demonstrate, Discover, Implement, Evaluate

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Answers

1. A
2. C
3. B
4. D
5. A

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