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RESEARCH ARTICLE

Implementation of supplemental E-learning models for blended learning in pharmacology

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ABSTRACT

Background: Pharmacology, an ever-expanding volatile subject, requires continuous reinforcement and self-learning. Lectures supplemented with E-learning activity like solving multiple choice questions (MCQs) online may help students to self-learn. **Aims and Objectives:** The project was designed to develop E-learning models (ELMs) and to evaluate perceptions of the students toward those. **Materials and Methods:** Three ELMs comprising 40 MCQs each were prepared for three different pharmacology topics and delivered to II MBBS students (n = 180) using web-based facility in three different ways: (1) Presupplemental model: First supervised pretest was conducted followed by online post-test on unexposed topic (i.e., before the lecture), (2) postsupplemental model: Lecture, followed by supervised pretest then followed by online post-test and (3) Replacement model: Supervised pretest on an unexposed topic followed by uploading of presentation on the topic for self-study followed by online post-test. The scores of the supervised test and online post-test were compared and feedback was collected from all students. **Results:** Out of 40, the average marks ± SD for supervised pretests were 6.5 ± 2.3, 11.2 ± 3.1, and 4.5 ± 1.5, whereas the online post-test scores, viz: 32.6 ± 4.8, 33.3 ± 6.7, and 34.7 ± 3.2 in model 1, 2, and 3, respectively ($P < 0.0001$). Students felt that E-learning activity improved understanding (57%), motivated self-learning (70%), and played supplementary role (73%). **Conclusion:** Students perceived that supplementation of lectures with E-learning activity in the form of online tests appeared beneficial and opined that it should be continued.

KEY WORDS: Blended Learning; E-learning; Supplemental Models, Medical Education; Multiple Choice Questions

INTRODUCTION

It is essential for medical education and training to require continuous modernization to keep up with fast-paced advances in medicine. There have been many innovative approaches in the field of medical education including E-learning, wherein a student is expected to do self-learning of various concepts from an online resource.[1] Advancement in disease management and with the increase in drug innovation, pharmacology as subject is ever expanding. It is a vast, vital and at the same time perceived as volatile subject by the students. Thus, continuous reinforcement and self-learning are required. There is a constant need to supplement traditional teaching–learning methods by newer techniques which, on the one hand, make the subject more interesting and relevant to the learner, and on the other hand, are less dependent on the availability of trained faculty and infrastructure. In this scenario, E-learning resources and assignments are beneficial. Studies have also reported that E-learning can be used as an active learning strategy which promotes self-directed learning.[2] In today's era students are more computer literate and the demand for technology-based learning at a time convenient to them has increased. Thus, there is shift of focus from classroom teaching to

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self-directed online learning environment which allows students to concentrate effort on useful information that they need to know and enhance retention of material.[3]

Despite the advances in online technologies, it is recognized that medicine is a competency-based discipline and it is not desirable to fully replace traditional medical education with online learning.[4] Attempts have been made to blend E-learning technology with traditional instructor-led training.[5] Increasingly, there are concerns about how both traditional and online teaching can be combined for effective "blended" learning.[6] There have been generally positive student opinions reported in the small number of studies on blended learning in medical education and students' perceptions have varied considerably depending on the nature of online and face-to-face components, subject content and accessibility to computers.[7,8]

Although blended learning has been well practiced, there are no studies which have assessed whether the reinforcement through E-learning should be provided before or after traditional teaching (imparted through didactic lectures) in the subject of pharmacology. Hence, we designed this study to develop and introduce E-learning models (ELMs) and blend them with conventional teaching–learning strategies at different time points and evaluate the perception of students toward them in addition to their performance.

MATERIALS AND METHODS

The study design was prospective, single-group study. After obtaining the permission from the head of the Department of Pharmacology and Therapeutics and Institutional Ethics Review Board, the project was initiated. The IInd year MBBS students entering 3rd semester in August 2011 in our institute and who provided voluntary consent were eligible for participation in the study.

Initially, students were evaluated for computer literacy. Those who would answer that they have never used a computer or accessed internet were given basic training in computer/ internet usage by the department faculty. The email ids were collected from all the students.

The study was conducted in three phases to test three different models of E-learning, namely: (1) Pre-supplemental model, (2) postsupplemental model, and (3) replacement model. The topics selected were antithyroid drugs, psychopharmacology, antihelminthic drugs for models 1, 2 and 3, respectively. For each model, the authors developed three sets of multiple choice questions (MCQ) tests having 40 questions each to cover all aspects of the topics. Out of the 40 MCQs, 15 were of the recall type, 13 were of comprehension type, and remaining 12 were of application type. More than 50% MCQs were case based. These MCQs carried one mark each, thus maximum score student could achieve was 40. Students who scored more than 75% marks in the pretest were excluded from the study. The cutoff score for passing the test was 50%. For a particular topic, the same set of MCQ was used for both the pretest and post-test. However, pre-test was a supervised written test, whereas post-test was conducted online using the facilities provided by www.surveymonkey.com where students were instructed to answer it from their home anytime within 8 days, and they were allowed to refer to textbook and other resource materials.

Specific learning objectives (SLOs) along with standard power point presentations were also prepared for the didactic lectures in all the three models. These SLOs, AV presentation of all the 3 topics and MCQ-based test were presented by the authors, which were critically evaluated and refined by six internal pharmacology experts and four external pharmacology experts. The answer key with explanation and marks allotment was also prepared.

E-learning Models (ELMs)

1. Presupplemental model: In this model, the students first underwent a supervised pretest (i.e., students could not refer to resources) to assess their knowledge on a topic (antithyroid drugs) to which they were not exposed beforehand in their academic pharmacology curriculum. Once the pretest was answered, the same test was uploaded online, and students were instructed to answer the test after referring to resource materials. Hence, pretest and post-test were conducted before routine didactic lecture on the topic.
2. Postsupplemental model: This model was evaluated after a gap of 1 month, in this the didactic lecture of a selected topic (psychopharmacology) was covered first, which was then followed by the supervised pretest and finally by the online post-test which students could answer after referring to resources. Hence, routine teaching–learning activity was supplemented with E-learning afterward.
3. Replacement model: It was implemented again after a gap of 1 month. The students were given a pretest like in the first model, which was then followed by uploading of a standard, validated power point presentation on the topic (antihelminthic drugs) and the students were instructed to access the same for learning. After 2 weeks, the online post-test on the topic was conducted. Hence, in this model, routine lecture was completely replaced by E-learning activity.

The procedure and sequence of supervised pretest, online post-test and didactic lecture in each model is depicted in Figure 1.

Assessment

To assess students' perceptions regarding given ELMs a student feedback questionnaire (14 items, refer Table 1) with closed questions and responses scored on Likert scale (5 = strongly agree and 1 = strongly disagree) and comment

Table 1: Students' perception about ELMs using the 14 item feedback questionnaire (*n*=165)

Item number	Questions	Perception count (%)				
		Strongly agree	Agree	Neutral	Disagree	Strongly disagree
1	Good understanding of the topic is achieved by this teaching technique	20 (12)	75 (45)	32 (19)	32 (19)	6 (4)
2	As a student I was comfortable with this teaching technique	18 (11)	65 (39)	48 (29)	26 (16)	8 (5)
3	As a student I was satisfied with this teaching technique	18 (11)	66 (40)	52 (32)	26 (16)	3 (2)
4	This type of E-learning has increased interactions between students and teachers	6 (4)	33 (20)	60 (36)	49 (30)	17 (10)
5	This teaching model has motivated me for self-reading-learning	39 (24)	77 (47)	35 (21)	12 (7)	2 (1)
6	I expect to score better in this topic as a result of this teaching model	18 (11)	67 (41)	57 (35)	19 (12)	4 (2)
7	The knowledge and skills acquired about this topic through this teaching model will help me in clinical practice	23 (14)	74 (45)	49 (30)	16 (10)	3 (2)
8	The webpage of the E-learning model was easy to understand and navigate	45 (27)	76 (46)	32 (19)	8 (5)	4 (2)
9	E-learning models are not useful and should be removed from the course	11 (7)	23 (14)	46 (28)	55 (33)	30 (18)
10	E-learning should replace the didactic lectures	7 (4)	17 (10)	50 (30)	51 (31)	40 (24)
11	E-learning should only supplement the didactic lectures but not replace them	38 (23)	83 (50)	33 (20)	6 (4)	5 (3)
12	Textbooks are more useful for self-learning than the internet	5 (3)	27 (16)	50 (31)	56 (34)	27 (16)
13	Reviewing the E-learning material before didactic lecture has helped me to understand the topic better	18 (11)	54 (33)	60 (36)	24 (15)	9 (5)
14	E-learning has encouraged me to attend the lectures	16 (10)	54 (33)	58 (35)	23 (14)	14 (8)

ELMs: E-learning models

Table 2: Cognitive gain in students exposed to different E-learning models

Variable	Model 1 (*n*=168)	Model 2 (*n*=165)	Model 3 (*n*=173)
Mean supervised pretest scores out of 40 marks (%)	6.5 (16.25)	11.2 (28)	4.5 (11.25)
Mean online post-tests scores out of 40 marks (%)	32.6 (81.5)*	33.3 (83.25)*	34.7 (86.75)*
Absolute learning gain=(% post-test score-% pretest score)	65.25	55.25	75.5
Relative learning gain=(% post-test score-% pretest)/% pretest score	4.02	1.97	6.71
Class-average normalized gain g=(% post-test score-% pretest score)/(100-% pretest score)	0.78	0.77	0.85

*$P<0.0001$, paired *t*-test

section on advantages/disadvantages/suggestions was prepared after literature review. The feedback questionnaire had subcomponents like perceived learning, value-addition as learning strategy, and acceptability of the learning medium. Finally, the questionnaire had a section in which students had to tick which ELMs they preferred on a 5 point scale (1 = least preferred and 5 = most preferred). Content validity of the questionnaire was checked by six experts in medical education. The questions which were agreed by more than three experts were included in the final questionnaire.

Statistical Evaluation

The pretest and post-test marks were compared using paired *t*-test. Pre- and post-test scores and responses to the feedback questionnaires were analyzed using Microsoft Excel version 2013 and described as percentages.

RESULTS

A total of 180 students who consented had adequate computer literacy and none of them required computer training. The number of students that participated in the individual models were different (168, 165 and 173 for first, second, and third models, respectively) since the models were executed at different time points.

The average pretest scores were 6.5 ± 2.3, 11.2 ± 3.1, and 4.5 ± 1.5 while online post-test scores were significantly better

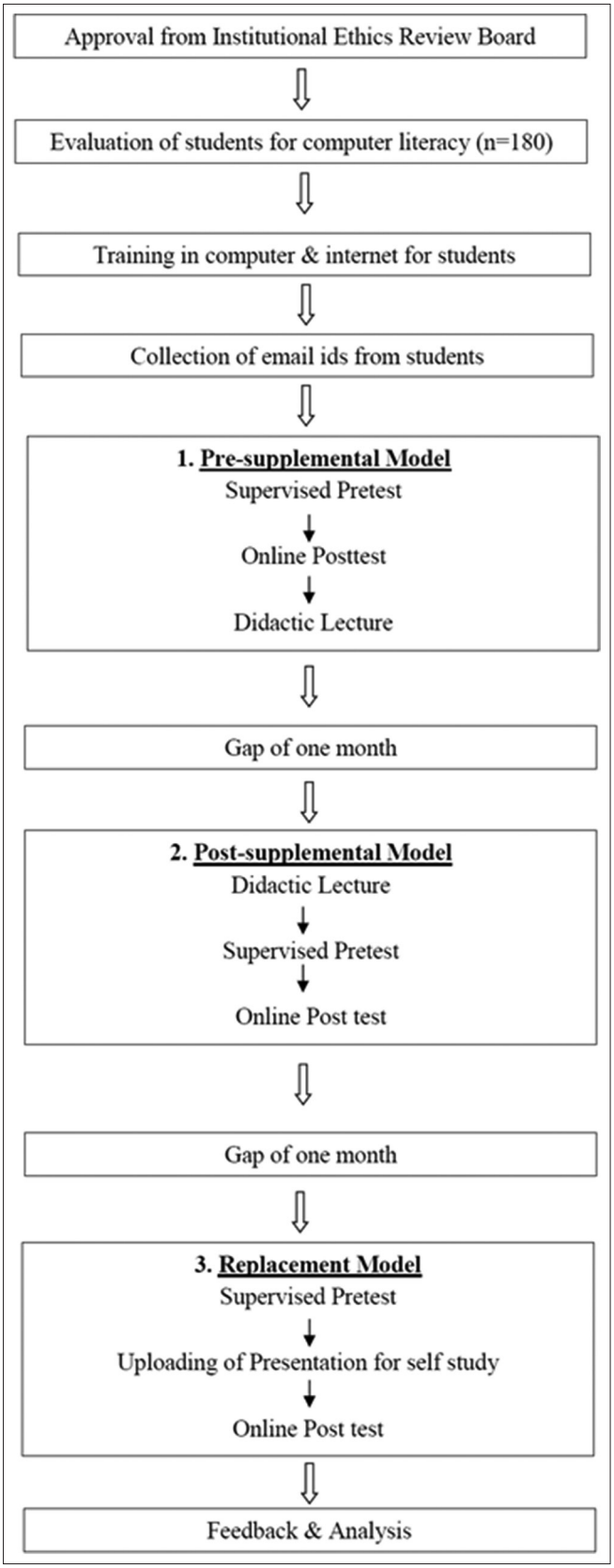

Figure 1: Schematic representation of the study procedure and E-learning models

32.6 ± 4.8, 33.3 ± 6.7, and 34.7 ± 3.2 in ELMs 1, 2 and 3, respectively ($P < 0.0001$). The absolute and relative cognitive gain is also presented in Table 2.

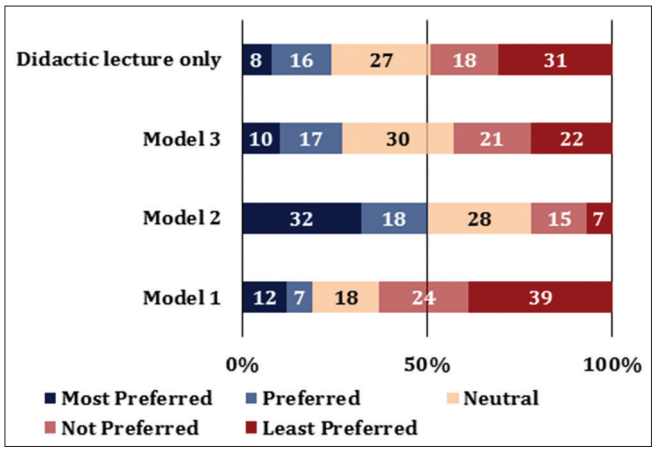

Figure 2: Perception of participants regarding different models

In all the models, none of the students could score more than 50% marks in pretests. The number of students passing in the post-tests conducted after each model is shown in Table 3.

Student feedback on ELMs was collected from students who were present for all the three ELMs (n = 165 students). In the student feedback questionnaire regarding perception of ELMs, 57% students have opined that good understanding of the topic was achieved with ELMs, 51% students stated they were was comfortable and satisfied with ELMs. 70% students stated that ELMs had motivated them for self-reading-learning. Nearly 51% students also agreed that by incorporating ELMs they expect to score better in the examination and 59% students opined that the knowledge/skills acquired by ELMs will help in clinical practice. The most students (73%) were also agreeable that the webpage of the ELMs was easy to understand and navigate. In addition, 50% students had preferred learning through internet than printed textbooks and 73% students felt that the E-learning technologies should only supplement the didactic lectures but not replace them. The responses to the 14 item student feedback questionnaire are depicted in Table 1. When the students were asked to compare the three ELMs presented to them, among themselves, and with the traditional didactic system of teaching with a five-point assessment scale, model 2 had the most approvals (Refer Figure 2).

DISCUSSION

Blended learning models combine face-to-face education and online learning activities so that an effective learning environment can be ensured where students benefit from online learning technologies, and at the same time, continue to interact with teachers and other students.[9] More learner-centerd activities utilizing computers and internet have immensely increased. Literature search has demonstrated that researchers have used various forms of E-learning tools such as streaming video, multimedia, and web-based interactive modules.[10-12] In pharmacology too, researchers have used

Table 3: Students scoring>50% marks in the pre- and post-tests of E-learning models

Model number	Supervised pretests	Online post-tests (%)	Total number of students (*n*)
1	0	109 (64.88)	168
2	0	121 (73.33)	165
3	0	140 (80.92)	173

E-learning tools to improve prescribing skills, delivering concepts in clinical pharmacology and therapeutics.[13,14]

In our study, out of the three ELMs considered, models 1 and 2 represent two different approaches to the blended learning technology since they utilize traditional didactic teaching supplemented with internet resources. In model 1, the supplementation of E-learning technique was done before the didactic lecture (presupplemental model), and in model 2, the supplementation was done after the lecture (postsupplemental model). Model 3 represents pure E-learning because there was no lecture involved at all: Instead, a prevalidated power point presentation of the topic was made available to all students online (replacement model). In all the models, the online MCQ test was used as learning strategy as students solved these MCQs at their own pace and had freedom to utilize any learning resources. MCQs were used as learning source rather than posing with brief answer questions or essay questions.

All the three models did show increase in student performance as evident from class-average normalized gain which was 0.78, 0.77 and 0.85 in models 1,2, and 3, respectively (Table 1). The class-average normalized gain is categorized as follows: 0.1-0.29 low gain, 0.3-0.69 medium gain, and 0.7-1.0 high gain by Hake, indicating the effectiveness of a given educational intervention.[15] Although the replacement model showed highest cognitive gain, it has to be noted that topic selected in this model was antihelminthic drugs. This topic is covered even under the subject of microbiology and community medicine. Hence, students while attempting this entire model may be aware of antihelminthic drug content from other disciplines. Students had preferred the postsupplemental model but knowledge gain was least in this, in spite of lecture being taken first. The topic selected for this model was psychopharmacology which is perceived as difficult topic. While analyzing the performance data the authors realized that topics selected such as antithyroid drugs, psychopharmacology, and antihelminthic drugs for all the models may be of different difficulty levels though at project initiation they had perceived these topics of different systems having same difficulty level. In addition, the pretest scores in model 1 and 3 were low because they were conducted on unexposed topics and it revealed baseline knowledge of the topic, either due to preclinical or clinical teaching. However, in model 2, pretest which was taken immediately after the didactic lecture, score was higher than other two models indicating reinforcement.

When the perception of the students toward the ELMs is considered, it is evident that the students had favored ELMs. The students were not only comfortable and satisfied with the new technique but also had a better understanding of the subject and were confident of scoring better in examination and developing into better clinicians. More importantly, the technique motivated most of the students for self-reading-learning. However, among the three different models employed in the study, the postsupplemental model (model 2) was observed to be the most favored model. This perhaps is because this model was closer to the traditional mode of teaching the didactic lecture (demanding less adaptability from the students) was followed by a supervised test and later with online test. Hence, students were already exposed to the topic and they were in better position to solve the online test by referring to the right resources adequately. Both the presupplemental model (model 1) and the replacement model (model 3) were not that well received by the students. However, it is interesting to note that the post-test passing percentage of the students in the replacement model was better than the other two models.

All the three models employed in this study had their own distinct advantages and disadvantages. The presupplemental model provides the student with ample amount of knowledge before he can attend the lecture on the same topic by the subject expert, and in this lecture, the doubts that may have arisen during the self-study of the topic beforehand may be resolved. However, the vast amount of information available from the internet may overwhelm the average student and may reduce the interest to learn in him. The vastness of the subject of pharmacology, combined with the limited attention span of the average student restricts the amount of knowledge that can be shared in a single didactic session. As a result, no topic can be covered in its entirety in an hour-long lecture. The postsupplemental model excellently overcomes this inherent disadvantage of the traditional learning technique. This, perhaps, is also the reason why the post-supplemental model was the best received by the students.

Finally, though the replacement model totally obviates the need for trained faculty to impart knowledge in the classroom, it also suffers from the total lack of interaction between the students and the teacher. Surprisingly, it is this model in which the students showed the best performance in terms of post-test passing percentage as well as online post-test scores. It may be because the topic selected was relatively short and simple and because of increased sense of responsibility among students since they had to read it by their own without having luxury of attending didactic lecture.

Students had favored postsupplemental model (didactic lecture followed by online supplementation, i.e., model 2) clearly depicting that blended learning has been well-accepted among the students. The same view has been shared by Trukhacheva and Pupyrev that students see E-leaning as a

complementary component to the traditional instructor-led training, forming a part of a blended-learning strategy.[16] A recently published study evaluated the outcome of blended learning involving lectures and E-learning in clinical pharmacology for dental postgraduate students. At the end of the study, the participants had reported to have benefitted from the blended learning technology, and they appreciated the "change of the role of the teacher from being a regular classroom instructor to a supportive facilitator."[17]

Various studies have been published which demonstrate the benefits of blended learning in various subjects other than pharmacology. In a controlled study involving 46 students of physiotherapy, the group which received internet access regarding musculoskeletal palpation and ultrasound assessment in addition to books on the same topic were found to obtain significantly higher scores in the skills in palpation ability and ultrasound assessment rather than the group which had access to only books.[18] In another study involving 130 participants, blended learning including an educational compact disc and a class session resulted in better satisfaction of learning the topic, and the authors concluded that blended learning was "an effective approach in making a profound learning of academic subjects".[19] Further, Kose used blended learning technique for the instruction of mathematics to 150 high school students, over a period of one educational year. The methodology adopted in their study was very much similar to the model 2 that was used in our study: A didactic lecture was followed by online activity. At the end of the course, when the student feedback was obtained, it was observed that the students accepted the blended learning model as a successful learning approach.[9] Finally, Sancho et al. report that even in the subject of microbiology, blending virtual laboratory technology with conventional classroom teaching resulted in the students acquiring "necessary but otherwise unreachable competences."[20]

In pharmacology subject too, Gaikwad and Tankhiwale evaluated the effectiveness and acceptability of an interactive E-learning module in endocrine pharmacology among 2nd year medical students.[7] Pre- and post-test scores showed that the intervention was moderately effective and well received. Similarly, Tse and Lo. described web-based E-learning course for 1st year nursing students which integrated pathophysiology of systemic diseases to pharmacology which was perceived by students to encourage understanding of subject and also enhanced their problem solving and critical thinking abilities.[21]

The limitations of the study are that faculty feedback was not taken and it was implemented for selected 3 topics and not at same time. Thus, similar to Morton et al. study,[22] ELMs as part of blended learning was acceptable and of interest to undergraduate students learning pharmacology. They expressed a desire for these models to continue and identified that the "blend" was beneficial in postsupplemental setting rather than purely online learning.

CONCLUSION

To conclude, in our study, while the students were most comfortable with the postsupplemental model, the best results were seen with the replacement model. However, all the three models were perceived by the students to be better than the traditional didactic method of teaching. Thus, inclusion of this model of learning-teaching in the medical curriculum in all the subjects would result in inculcation of inquisitive behavior in students, promotion of self-learning behavior, and ultimately, the formation of doctors with better understanding of the subject.

REFERENCES

1. Imperial College London, World Health Organization E-learning for Undergraduate Health Professional Education: A Systematic Review Informing a Radical Transformation of Health Workforce Development. January; 2015. Available from: http://www.whoeducationguidelines.org/content/eLearning-report. [Last accessed on 2017 Apr 14].
2. Ellaway R, Masters K. AMEE guide 32: E-learning in medical education Part 1: Learning, teaching and assessment. Med Teach. 2008;30(5):455-73.
3. Gureckis TM, Markant DB. Self-directed learning: A cognitive and computational perspective. Perspect Psychol Sci. 2012;7(5):464-81.
4. Khogali SE, Davies DA, Donnan PT, Gray A, Harden RM, McDonald J, et al. Integration of E-learning resources into a medical school curriculum. Med Teach. 2011;33(4):311-8.
5. Masie E. Blended learning: The magic is in the mix. In: Rossett A, editor. The ASTD E-learning Handbook. New York: McGraw-Hill; 2002. p. 58-63.
6. Thorne K. Blended Learning, How to Intergrade Online and Traditional Learning. London, Sterling: Kogan Page Limited; 2003.
7. Gaikwad N, Tankhiwale S. Interactive E-learning module in pharmacology: A pilot project at a rural medical college in India. Perspect Med Educ. 2014;3(1):15-30.
8. Naaj MA, Nachouki M, Ankit A. Evaluating student satisfaction with blended learning in a gender-segregated environment. J Inf Technol Educ. 2012;11:185-200.
9. Kose U. A blended learning model supported with Web 2.0 technologies. Procedia Soc Behav Sci. 2010;2(2):2794-802.
10. Davids MR, Chikte UM, Halperin ML. Development and evaluation of a multimedia e-learning resource for electrolyte and acid-base disorders. Adv Physiol Educ. 2011;35(3):295-306.
11. Schilling K, Wiecha J, Polineni D, Khalil S. An interactive web-based curriculum on evidence-based medicine: Design and effectiveness. Fam Med. 2006;38(2):126-32.
12. Bridge PD, Jackson M, Robinson L. The effectiveness of streaming video on medical student learning: A case study. Med Educ Online. 2009;14:11.
13. Maxwell S, Mucklow J. E-learning initiatives to support prescribing. Br J Clin Pharmacol. 2012;74(4):621-31.
14. Maxwell SR. How should teaching of undergraduates in clinical pharmacology and therapeutics be delivered and assessed? Br J Clin Pharmacol. 2012;73(6):893-9.

15. Hake RR. Interactive-engagement versus traditional methods: A six-thousand-student survey of mechanics test data for introductory physics courses. Am J Phys. 1998;66:64-74.
16. Trukhacheva N, Pupyrev N. Blended-learning strategy in the Altay state medical university. Stud Health Technol Inform. 2012;174:72-5.
17. Rosenbaum PE, Mikalsen O, Lygre H, Solheim E, Schjøtt J. A blended learning course design in clinical pharmacology for post-graduate dental students. Open Dent J. 2012;6:182-7.
18. Arroyo-Morales M, Cantarero-Villanueva I, Fernández-Lao C, Guirao-Piñeyro M, Castro-Martín E, Díaz-Rodríguez L. A blended learning approach to palpation and ultrasound imaging skills through supplementation of traditional classroom teaching with an E-learning package. Man Ther. 2012;17(5):474-8.
19. Karamizadeh Z, Zarifsanayei N, Faghihi AA, Mohammadi H, Habibi M. The study of effectiveness of blended learning approach for medical training courses. Iran Red Crescent Med J. 2012;14(1):41-4.
20. Sancho P, Corral R, Rivas T, González MJ, Chordi A, Tejedor C. A blended learning experience for teaching microbiology. Am J Pharm Educ. 2006;70(5):120.
21. Tse MM, Lo LW. A web-based E-learning course: Integration of pathophysiology into pharmacology. Telemed J E Health. 2008;14(9):919-24.
22. Morton CE, Saleh SN, Smith SF, Hemani A, Ameen A, Bennie TD, et al. Blended learning: How can we optimize undergraduate student engagement? BMC Med Educ. 2016;16:195.

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