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A Novel Blended Learning Module in Family Medicine: An Interventional Study at the Faculty of Medicine, Suez Canal University, Ismailia, Egypt

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ABSTRACT

Blended learning (BL) has been reported as an effective method for teaching family medicine to undergraduates in high-income countries; however, studies of its effectiveness are limited in low- and middle-income countries. This study aimed to assess the effectiveness of an innovative BL module in family medicine including knowledge, skills and attitudes (KSA), and e-learning experiences. The grades of the fourth-year medical students at the Faculty of Medicine, Suez Canal University were correlated with the above items. A pre–post interventional study was conducted on a convenience sample of 117 fourth-year students in the educational year 2017–2018. Their KSA were assessed using valid and reliable questionnaires before and after the intervention was implemented. The intervention combined the traditional training in primary healthcare settings with the newly designed asynchronous e-learning module on the Moodle platform. The prepared website consisted of e-sections and an e-forum which was validated by expert staff. A questionnaire about students' e-learning experiences was used to assess students' satisfaction. The students' final fourth-year marks for the family medicine module were correlated with their KSA and e-learning satisfaction. The overall means of students' KSA were statistically significantly improved post-implementation. The posttest students' skills were positively correlated with their marks in family medicine (r_s = 0.308, p = 0.001). Students valued the e-resources and their relevance to the face-to-face activities. They were satisfied with their e-learning experiences (54.7%). Their e-learning satisfaction was positively correlated with the improvement in their knowledge (r_s = 0.20, p = 0.031). BL had positive effects on students' KSA and their satisfaction with the family medicine module. Combined asynchronous and synchronous e-learning in the COVID-19 era was applied in this study.

Keywords: *Blended learning, E-learning, Family medicine, Satisfaction, Undergraduates*

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INTRODUCTION

The Faculty of Medicine at Suez Canal University (FOM-SCU) has adopted community-based education as one of its innovative strategies since its establishment in 1978, aiming to educate its undergraduates about primary healthcare (PHC) approaches. The Family Medicine Department (FMD) at FOM-SCU was the first established in Egypt in 1979, and it is responsible for providing community-based education activities (1–2).

Education in family medicine (FM) for undergraduates at FOM-SCU also adheres to other innovative educational strategies of the undergraduate educational programme, such as problem-based learning (PBL), evidence-based medicine (EBM), student-centered education, and horizontal and vertical integration with other basic and clinical disciplines (2).

Traditional face-to-face learning in clinical training faces some challenges, such as limited time to practice and few chances to receive feedback from trainers. These limitations are the result of student enrolment having risen steadily in recent years (3). These drawbacks could be solved by implementing blended learning (BL) (4).

BL is defined as the combination of traditional face-to-face learning and e-learning. The advantages of e-learning include its collaborative nature, its ability to transcend space and time boundaries, and its capacity to provide up-to-date knowledge using interactive multimedia (5). In low- and middle-income countries, e-learning may alleviate the burden of severe health worker shortages and deliver affordable access to high-quality medical education (6). Moreover, during the COVID-19 pandemic, e-learning helped medical schools all over the world survive (7) after they had adopted universal e-learning strategies (8).

E-learning also has some disadvantages, such as the high cost of preparing multimedia materials, the continuous costs of maintaining and updating platforms and learners' feelings of isolation in virtual environments (5). Furthermore, the development and implementation of e-learning in medical schools have faced many challenges, such as a lack of infrastructure, inadequate technical skills, negative attitudes towards this method of learning, time constraints and a lack of institutional strategies (9–10). Therefore, e-learning may enhance but should never fully replace face-to-face learning with real patients (11).

In a recent systematic review, it was found that BL positively impacts knowledge outcomes compared with traditional learning (12). Another systematic review reported that BL had the potential to improve medical students' clinical competencies (4). Makhdoom et al. (13), concluded that the BL approach was an effective method for teaching FM to undergraduates. Lewin et al. (14) reported that students valued a BL course that used an interactive online curriculum to enhance their clinical learning in PHC. Bösner et al. (15) found that BL using the inverted classroom approach had a significant effect on students' satisfaction, skills and knowledge in the teaching of differential diagnosis in PHC. Engel et al. (16) revealed that BL was feasible for integrating EBM into the general practitioner clerkship.

Medical schools in Egypt have implemented BL in public health and community medicine, paediatrics and medical education for undergraduates. A prospective interventional study found that using an e-learning reproductive health module enhanced the learning experiences of fourth-year medical students (17). Another Egyptian intervention revealed that using an online paediatrics EBM assignment was effective in teaching EBM to fifth-year medical students (18). An interventional study at FOM-SCU showed that near half of the third-year students were satisfied with the BL course and the positive effect of e-learning on the PBL sessions (19).

In light of the potential of BL for FM education and the limited studies of its effect on Egyptian undergraduates, this study was conducted to evaluate the effect of an innovative BL module in FM on FOM-SCU fourth-year students' knowledge, skills, attitudes (KSA), and e-learning experiences, and to correlate these items with their final marks.

METHODS

This was a quasi-experimental (pre–post interventional) study. It was held in the academic year 2017–2018 at FOM-SCU. Data were collected over two semesters: the first semester was from October 2017 to January 2018 and the second semester was from March to June 2018. Convenience sampling was applied to all fourth-year medical students (120 students). However, three students were excluded during the post-intervention analysis because their absenteeism during clinical training exceeded the maximum percentage stipulated in the faculty bylaws. Therefore, a total of 117 students participated in this study. All students agreed to participate in this intervention and provided informed consent after the voluntary nature of participation had been clarified and they had been reassured that their grades would not be affected if they refused to participate. This study was conducted in three phases: (a) preparatory, (b) implementation, and (c) evaluation and scoring of questionnaires.

Preparatory Phase

This phase included the preparation of the questionnaire, the pre and post tests for the skills assessment, and the development of the BL module. The questionnaire consisted of five parts: (a) sociodemographic data, (b) students' FM needs assessment, (c) technology perceptions, (d) students' knowledge and attitudes (KA) assessment; and (e) e-learning experiences. The questionnaire was designed by the researchers based on relevant literature and revised by two experts in medical education to ensure the validity of its content.

The technology perceptions part of the questionnaire was used to assess the students' perceptions of computer and online technology. It was developed based on related literature (20). It ascertained students' mean hours of usage per week, periods of using the Internet, type of Internet used, most used apps and places of Internet use (school and home).

Part 4 of the questionnaire assessed the students' knowledge about children's and women's health using 20 multiple-choice questions (MCQs). The assessment of the students' attitudes included 10 statements that were answered on a 5-point Likert scale from 1 (strongly disagree) to 5 (strongly agree). This assessment was based on the ABC model (21), with the statements designed to cover three components: affect, behaviour and cognition. Affect denotes the students' feelings about or emotional responses to an attitude object, e.g., "I am confident in assessing a pregnant lady at initial and follow-up visits." Behaviour denotes the students' tendencies regarding an attitude object, e.g., "I will provide counseling for family planning in primary care settings." Cognition denotes the students' beliefs about an attitude object, e.g., "Learning integrated management of child illness is very helpful for me, patients and the community." The students' skills were assessed using 10 developed objective structured clinical examination (OSCE) stations. The researchers designed the stations to assess certain skills to be acquired in children's and women's health. Each station had a score from 0–10. The stations included interpreting complete blood count in pregnancy and ordering other tests; diagnosing skin changes in diabetes; interpreting a developmental hip dysplasia examination; assessing and managing a child with rickets; distinguishing signs of dehydration; interpreting a dual-energy X-ray absorptiometry report and treating

osteoporosis, and plotting and interpreting the 2006 World Health Organization growth chart.

Part 5 of the questionnaire, e-learning experiences, assessed the students' satisfaction with the designed module after implementation. It consisted of 32 items answered on a 5-point Likert scale. It was adapted from the student course experience questionnaire to be context-specific for online learning (22). This part of the questionnaire had eight scales:

a. Good e-teaching scale: 7 items (3, 4, 5, 9, 12, 15 and 28).
b. Good e-resources scale: 4 items (8, 17, 20 and 23).
c. Clarity of goals and standards scale: 3 items (13, 19 and 29).
d. Appropriate workload scale: 3 items (11, 14 and 22).
e. Appropriate assessment scale: 3 items (1, 10 and 26).
f. Interaction and engagement scale: 4 items (7, 16, 18 and 21).
g. Students' management scale: 3 items (2, 6 and 31).
h. BL scale: 4 items (24, 25, 27, and 30).

These eight scales covered 31 questions. Question 32 assessed the students' overall satisfaction with the e-learning experience.

A pilot study was conducted among 20 fourth-year medical students in the academic year 2016–2017 to assess the clarity, acceptability, meaning and reliability of the KA questionnaires and skills assessment using OSCE stations. Cronbach's alpha was used as an internal consistency estimate of the reliability of the scales for students' knowledge (0.9), attitudes (0.6) and skills (0.6).

Development of the BL course

Face-to-face learning continued as normal in the form of clinical training at seven PHC facilities affiliated with the Ministry of Health and Population. This training took place once weekly for 14 weeks. Each session lasted four hours to develop students' clinical skills, such as their patient data collection, communication, clinical examination and evidence-based problem-solving skills.

The researchers and the technical engineer designed the e-learning website on the Moodle platform at www.fmdelearning.com/moodle. It consisted of 10 sections. The children's health sections included the topics of cough, diarrhea, sore throat, danger signs, ear pain, growth and development, and fever. The women's health sections covered antenatal care, contraception and menopause. Each section consisted of photos, videos, interactive questions, a variety of text and image-based questions, lectures, links to additional online resources and assignments. Review quizzes using the MCQ format with feedback were also added. Completing the quizzes for each section was not compulsory, and there was no limit on the number of attempts permitted for each quiz. Each section was accessible to students once a week, in line with the clinical training, to cover each topic with BL.

The designed website was sent to a panel of five experts who had previous experience in e-learning (the three co-authors affiliated with FMD, the first author, and an assistant professor of medical education at FOM-SCU) to get their feedback using the Delphi technique. The expert panel suggested adding recorded lectures and incorporating e-activities on more chronic disease topics.

Implementation Phase

The first author held in-person orientation sessions for students at FOM-SCU to explain how to use the website, answer frequently asked questions and address

common navigation problems. In addition, the nature of the online sections and methods of communication with staff and colleagues were discussed. A manual on how to familiarise oneself with the module was distributed to the students with details of how to proceed in each section. Students' log-in usernames and passwords were distributed before the implementation of the module. The students completed the FM needs assessment, technology perceptions, and KA questionnaires and the OSCE stations as pretests before the implementation of the BL module. Students' skills were assessed by a group of faculty members of the FM department in addition to the first author.

Some modifications were made to the designed website based on the students' responses to the needs assessment questionnaire regarding the FM module. For example, the FM e-forum was designed and introduced during the implementation phase. This forum consisted of online discussions between tutors and students, and between the students themselves that enhanced students' participation and engagement. Lectures were included on this e-forum and orientation notes for the final exam (including the OSCE, the clinical exam and the written exam) were discussed.

Evaluation Phase and Scoring of the KSA Questionnaire

The students completed the posttest KA and the e-learning experience questionnaires and performed the OSCE stations again after their exams and before their final marks were revealed. The percentage of correct answers to the MCQs for knowledge evaluation was calculated to represent the knowledge score for each student. The total score was calculated and converted into a percentage. The attitudes scores were summed and converted into percentages (20%–100%) to represent the attitude score for each student. Positive perceptions of each item were defined as the strongly agree and agree options of the Likert scale, so the cut-off point was ≥ 80%. The maximum score for the e-learning experience questionnaire was 160. Each question was condensed into three categories: agree category (the sum of strongly agree and agree), neutral category, and disagree category (the sum of strongly disagree and disagree). For each student, the total score was then converted to a percentage. For OSCE, each skill was calculated out of 10 marks. For each student, the total skills score was summed and converted to a percentage. The mean, standard deviation, median and interquartile range were then calculated.

Ethical Approval and Consent to Participate

The approval of the research ethics committee of the Faculty of Medicine at Suez Canal University was obtained before this study began. Permission was attained from the relevant authorities to implement the study and obtain the students' final marks. Written informed consent was taken from all students before any data were collected. Participants had the right to withdraw from the study at any time without providing any reason for doing so.

Statistical Analysis

Data were analysed using IBM SPSS version 24. The Wilcoxon signed-rank test was used to assess changes in students' total KSA scores and their score for each skill item in the pre–post intervention. McNemar's test was used to compare changes in knowledge and positive attitudes. Spearman's rank correlation coefficient analyses were conducted to test for associations between students' KSA, to assess the correlation between students' KSA and other variables, and to investigate correlates of the e-learning experience scales.

RESULTS

Students' Baseline Characteristics and Needs Assessment

The mean age of the 117 participants was 21.21±0.60 years and 64.1% of them were females (Table 1). Most of the students indicated that they need to acquire learning experience in minor complaints/disorders in pregnancy (93.3%), bronchial asthma (89.9%), family planning (87.4%) and common health problems in children (85.7%), including cough, vomiting, diarrhea, sore throat, ear problems, fever, abdominal pain, anemia and malnutrition. Acquiring experience with behavioural disorders was the least reported need (68.1%).

Table 1: Baseline characteristics of the students in the pre–post intervention

Variables	Total	%
Gender		
Male	42	35.9
Female	75	64.1
Marital status		
Married	1	0.8
Single	116	99.2
Final course mark		
Excellent (≥85%)	39	33.3
Very good (75% to <85%)	57	48.7
Good (65% to <75%)	18	15.3
Fair (60% to <65%)	3	2.7

Students' needs assessment regarding online technology

The participants had spent 10.95±3.37 years using computers and spent 33.05±18.02 hours on the Internet each week. Most of the students used computers every day (82.9%), at home (76.9%) and with a wireless connection (67.5%). Regarding the most used applications, 28.4% of the participants reported that they used social applications such as Facebook, Twitter, Instagram and WhatsApp, while PDF file viewers were the least used.

Students' activity log

All students logged into the e-forum including 26.5% of them logged into ≥ 9 sections and 39.3% of them logged into 8 sections. The sections for antenatal care (91.45%), and growth and development in children (82.05%) were the most visited, while the section for menopause was the least visited (64.95%). In terms of the students' final marks, 45.3% earned a B, 29.1% earned an A and 22.2% earned a C. The D and F marks were equal in distribution (1.7%).

Changes in students' KSA during the pre–post intervention

The means of students' KA increased from 22.13%±8.96% (K) and 53.58%±9.86% (A) in the preintervention to 88.63%±7.86% and 82.80%±6.78%, respectively, in the postintervention. The mean of students' skills (S) increased from 22.13%±8.96% to 88.63%±7.86%. In this pre–post intervention, all items of KSA significantly increased after implementation ($p < 0.001$).

Students' E-learning Experiences

More than half (54.7%) of the students were satisfied with the quality of the online materials and the activities on the designed website. Regarding the e-resources scale, 64.1% of the students felt that the online teaching materials were designed to make the topics interesting, and 62.4% of them reported that the online learning helped them to be prepared for face-to-face learning situations (Table 2).

Table 2: Students' e-learning experiences

Items	Likert scale (%)			Mean	±SD	Median	IQR
	Agree	Neutral	Disagree				
32. Overall, I was satisfied with the quality of the online materials and activities of this unit of study	54.7	22.2	13.1	3.40	1.16	4	3–4
Good e-teaching							
3. Received too much feedback online	38.6	23.1	38.3	2.97	1.23	3	2–4
4. Teacher's responses online motivated me	48.8	25.6	25.6	3.23	1.13	3	2–4
5. Teacher helped to guide online discussions	48.8	35.0	16.2	3.48	1.10	3	3–4
9. Teacher's interaction with me online encouraged	49.6	27.4	23.0	3.29	1.11	3	3–4
12. Teacher's online responses motivated me to do more	40.2	45.3	14.5	3.34	1.00	3	3–4
15. Didn't receive enough helpful online feedback	34.2	19.7	46.1	3.13	1.14	3	2–4
28. Teacher focuses online discussions between students	46.1	36.8	17.1	3.36	1.07	3	3–4
Clarity of goals and standards							
13. Information needed to understand purpose and contents	47.8	28.2	24.0	3.23	1.17	3	2–4
19. Guidelines for using online discussions	47.0	33.3	19.6	3.34	1.07	3	3–4
29. Information needed for assignments	44.5	31.6	23.9	3.23	1.26	3	3–4
Good e-resources							
8. Online teaching materials good at explaining things	55.6	32.5	11.9	3.61	1.02	3	3–4
17. Online activities are designed to get the best out of students	55.6	25.6	18.8	3.47	1.16	3	3–4
20. Online teaching materials are designed to make topics interesting	64.1	20.5	15.4	3.58	0.94	3	3–4
23. Online learning helped to learn during face-to-face situations	62.4	20.5	17.1	3.53	1.06	3	3–4
Appropriate workload							
11. Workload for the online component is too heavy	29.9	24.8	45.3	2.81	1.28	3	2–4
14. Generally had enough time to understand the things	42.8	18.8	38.4	3.05	1.27	3	2–4
22. The sheer volume of work for the online component cannot be always comprehended	21.4	34.2	44.4	2.76	0.99	3	2–3
Appropriate assessment							
1. Do well in the online quizzes	40.2	34.2	25.6	2.81	1.28	3	2–4
10. Online quizzes helped me to learn effectively	52.1	32.5	15.4	3.05	1.27	4	3–4
26. Online materials support key assessment	49.7	25.6	24.7	2.76	0.99	4	2–4

(continued on next page)

Table 2: *(continued)*

Items	Likert scale (%)			Mean	±SD	Median	IQR
	Agree	Neutral	Disagree				
Interaction and engagement							
7. Reading other students' online submissions clarified some of my own ideas	39.3	26.5	34.2	3.05	1.04	3	2–4
16. Interacted with students' online postings/ submissions	37.6	25.6	36.8	3.00	1.13	3	2–4
18. Other students' online submissions helped understand ideas from a new perspective	39.5	41.2	19.3	3.61	1.87	3	3–4
21. Students' online submissions encouraged to investigate further sources of knowledge	45.3	33.3	21.4	3.18	1.09	3	3–4
Students' management							
2. Teacher used the online environment to keep students informed about results	54.7	34.2	11.1	3.55	0.90	4	3–4
6. Teacher used online environment to regularly update students about relevant unit of study information	55.5	27.4	17.1	3.44	1.01	4	3–4
31. The teacher ensured continuous access to the relevant online materials throughout the semester	51.3	26.5	22.2	3.35	1.14	4	3–4
Blended learning							
24. It was clear if online resources related to assessment	60.7	23.1	16.2	3.64	1.07	4	3–4
25. Online activities helped understand face to face activities	51.3	34.2	14.5	3.53	1.07	4	3–4
27. Relationships between online resources and whole study unit were clarified on the unit's website	57.3	18.8	23.9	3.30	1.10	4	3–4
30. It was clear to me how the website for this unit related to the whole unit of study	57.3	18.8	23.9	3.44	1.12	4	3–4

Note: IQR = Interquartile range

Correlates of Students' KSA, Activity Log and E-satisfaction

There was a statistically significant correlation between students' posttest skills scores and their final marks for the FM module (r_s = 0.308, p = 0.001, Table 3). The BL scale strongly correlated with the e-learning scale (Table 4). A weak positive correlation was found between the difference in the knowledge score and the students' activity log on the designed e-learning website (r_s = 0.228, p = 0.012). The students' final fourth-year marks for the FM module were not correlated with the students' activity log in the e-learning website. E-learning satisfaction was positively correlated with the difference in the knowledge score (r_s = 0.20, p = 0.031, Table 5).

Table 3: Correlation of students' KSA scores with the demographic variables and fourth year grade in the postintervention

Variables	Knowledge score		Attitudes score		Skills score	
	Correlation coefficient	*p*-value	Correlation coefficient	*p*-value	Correlation coefficient	*p*-value
Age	0.031	0.741	0.171	0.066	0.171	0.061
Gender**	–0.126 ^{rpb}	0.175	0.170	0.076	0.084	0.638
Marital status	0.059	0.528	0.129	0.157	0.059	0.524
Fourth year grade	0.075	0.421	0.100	0.282	0.308	0.001*

Notes: * Correlation is significant at the 0.05 level (2-tailed); ** ^{rpb} Point biserial correlation, Spearman's rank correlation coefficient analyses were conducted for others variables.

Table 4: Correlation between the students' overall satisfaction and e-learning experience subscales

Subscales	COS	Ge-TS	AWS	AAS	IES	SMS	BLS	e-LRS
Good e-teaching	0.687*							
Appropriate workload	0.025	0.042						
Appropriate assessment	0.597*	0.603*	0.171					
Interaction and engagement	0.579*	0.560*	.0130	0.547*				
Student management	0.446*	0.387*	0.187	0.486*	0.419*			
Blended learning	0.625*	0.641*	0.102	0.588*	0.493*	0.562*		
E-learning resources	0.606*	0.649*	0.008	0.536*	0.604*	0.486*	0.697*	
Overall satisfaction	0.139	0.258*	0.199	0.358*	0.214*	0.573*	0.472*	0.359*

Notes: Spearman's rank correlation coefficient analyses were used; * *p*-value < 0.05 statistically significant.
COS = Clear outcome scale, Ge-TS = Good e-learning scale, AWS = Appropriate workload scale, AAS = Appropiate assessment scale, IES = Interaction and engagement scale, SMS = Student management scale, BLS = Blended learning scale, e-LRS = E-learning resources scale.

Table 5: Correlation of activity log on the e-sections and e-learning satisfaction with fourth year grade and differences in students' KSA in the pre–post intervention

Variables	Students' activity log		E-learning satisfaction	
	r_s	*p*-value	r_s	*p*-value
Knowledge difference	0.228	0.012*	0.200	0.031*
Attitudes difference	0.061	0.612	0.001	0.991
Skills difference	0.129	0.166	0.013	0.887
Fourth year grade	0.080	0.389	0.011	0.906

Note: * Spearman's rank correlation coefficient is significant at the 0.05 level (2-tailed).

DISCUSSION

To the best of our knowledge, this is the first Egyptian study to electively combine an innovatively designed e-learning website with traditional face-to-face learning in FM education with the aim of evaluating the effectiveness of a BL course. In this study, we used fourth-year medical students as they are the only cohort in the clerkship phase to receive FM training in PHC settings.

According to the literature, the level of student engagement in e-learning is mostly measured by behavioural indicators, such as the number of logins, questions asked, lectures attended, articles posted on the e-learning board and times they participated in online discussions (23). Accordingly, we can claim that the level of student engagement in our FM e-learning module was excellent. All the students logged on to the e-forum, while more than two-thirds of them explored eight sections or more. The orientation and discussion about OSCE stations, the clinical and written exam, the availability of lectures, and the responses provided regarding students' concerns and questions might have led to this participation in the e-forum.

The needs assessment that was conducted before the implementation of the course guided the course design and modification. For example, the assessment revealed that the students needed to learn more about antenatal care and well as childcare, so these items were added to the website. The sections that included these items revealed the highest activity log. Furthermore, all the students accessed the forum after it was added to the website upon their request.

The current study showed that the BL module in FM had a significant effect on students' KSA, as evidenced by the statistical differences in the pre–post intervention. This finding has also been reported in other research. For instance, a comparative cross-sectional study in Saudi Arabia showed that a BL course in FM improved fourth-year medical students' KSA more than traditional learning (13). Goodie et al. (24) also found that a BL curriculum effectively improved third-year FM clerkship students' KSA concerning health behaviour change counselling.

This study revealed a weak positive correlation between students' fourth-year marks and their posttest skills scores. This result was inconsistent with Rowe et al.'s (4) conclusion, which stated that BL did not always manifest in better marks, despite an improvement in clinical competencies. Our finding could be explained by the orientation and discussion that we provided concerning OSCE and clinical exams on the website, in addition to the regular face-to-face clinical training.

We did not find any correlation between students' final marks and their history of logging in to the online sections. This finding was incongruent with another study, which determined that students' final course marks were significantly higher after completing more than 90% of the online modules (25). The reason for this discrepancy might be the considerable variation in the interaction with the online e-sections, in line with individual students' needs.

In the current study, more than half of the participating students were satisfied overall with the quality of the online materials and the activities on the designed website. This result was comparable to another study's results, which showed that nearly half of third-year medical students were satisfied overall with a BL course on PBL (19).

The assessment of students' perceptions of e-teaching showed that almost half of the participants had positive attitudes towards teachers' online interaction, guidance of online discussions and ability to motivate students through their responses. These findings could be explained by the use of asynchronous online discussions on our forum. Most of the discussions were

initiated by the tutors, who encouraged the students to participate and interact. These findings can be confirmed by Jung and Lee's notion that students learn successfully when they feel a high level of teaching presence through continuous interaction with the instructor in e-learning courses (26).

Regarding the assessment of the online resources, nearly two-thirds of the students felt that the online teaching materials were designed to make the topics interesting and that the online learning helped prepare them for face-to-face situations. This positive response can be attributed to the fact that the students' needs were considered during the website design and various materials such as scenarios, quizzes, MCQs, PDFs and lectures were included. In addition, links to videos about physical examinations, recordings and images of different physical findings were included, which helped the students during their face-to-face training.

The evaluation of the student management scale showed that more than half of the students had a positive attitude towards their teachers' continuous access to relevant materials and topics on the e-learning website and regular updates of the units on the website. As previously mentioned, this can be explained by the fact that in an e-learning environment, students' level of interaction and engagement is higher when they sense a teacher presence, similar to what they feel during face-to-face learning (26).

About 60% of the students reported that the online resources were relevant to their assessment. This could be attributed to the introduction of quizzes as a teaching method in response to the students' needs assessment. Moreover, the assessment guidelines and bylaws were clarified for the students on the e-forum.

Students' overall satisfaction with the e-learning experience in the current intervention was significantly related to good e-teaching, BL, e-learning resources, appropriate assessment, interaction and engagement, the role of the e-teacher in student management, and the students' acquisition of knowledge. AlKhadragy et al. (19) also found that student satisfaction was positively related to their interaction. Students' e-learning satisfaction was not correlated to their age, gender, marital status, or final module marks. This finding was consistent with a study which showed that there was no significant difference in student satisfaction between male and female students who experienced BL courses (27).

Based on this study, the student cohorts in the academic year 2018–2019 and the first term of the academic year 2019–2020 electively engaged in our online learning site and expressed their satisfaction in the feedback reports. The prepared e-learning materials greatly helped the FMD during the beginning of the COVID-19 pandemic as the FM faculty members added recorded lectures, in addition to using other platforms such as Telegram, Zoom, Microsoft Teams, WhatsApp and Facebook. After our college built its e-learning website on the Moodle platform for all departments in response to the COVID-19 pandemic, our developed FM blended module continued to be used.

LIMITATIONS OF THE STUDY

This study could not include a control group as it would have been unfair to implement two different teaching methods on the same batch of students. There is also potential bias as three of the authors trained the students face-to-face and were the evaluators of the clinical and OSCE exams.

CONCLUSION

This study concludes that BL was an effective method for knowledge acquisition, positive attitude changes and skills development. Additionally, there was a satisfactory achievement in FM. The role of the e-teacher in student management, their interaction with e-learners, the effectiveness

of e-resources and their relevance to face-to-face learning were positively perceived. In this study, combined asynchronous and synchronous e-learning was used in the COVID-19 era. Further studies about the challenges that learners and educators face while implementing BL are recommended.

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ETHICAL APPROVAL

The ethical approval for this study was obtained from the Research Ethics Committee of Faculty of Medicine, Suez Canal University, Ismailia, Egypt (Ref No. 3191/2017, dated 17 July 2017).

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