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GOOD PRACTICES

Developing, Implementing, and Evaluating an Online Course on Evidence-based Medicine (EBM) for Medical Clerkship Students

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Abstract

Purpose: Evidence-Based Medicine (EBM) plays a crucial role in clinical decision-making and patient care. Integrating EBM principles into medical education is essential to equip future physicians with the necessary skills to critically appraise and apply evidence in their practice. This study reports the stages of developing, implementing, and evaluating an online course on EBM for medical clerkship students.

Method: A six-step model of curriculum development was employed to design the EBM course, ensuring alignment with program objectives, and utilizing learner-centered educational methods. The course was delivered online, and its effectiveness was evaluated through a pretest-posttest control group design comparing the performance of the intervention group with a control group. Additionally, a survey was conducted to gather students' perceptions of the course. The survey employed a 7-point Likert scale. Descriptive statistics were used, and results were presented as means and standard deviations. Independent samples t-test was used for comparison of means. Repeated measures ANOVA was used to compare intervention and control groups. A p-value < 0.05 was considered as a cut-off point of statistical significance. Analysis of qualitative data (responses to open-ended questions) was done through counting and categorizing the responses.

Results: The results indicated a significant improvement in students' scores from pre-test to end-of-course assessment, suggesting a positive impact on their performance. Survey findings revealed a positive overall experience with the course, with favorable ratings for course materials and presentation quality. However, students expressed the need for additional support in certain areas. Gender differences were observed, with female students rating the course higher than male students in several aspects. Year 3 and Year 4 students had similar experiences with the course.

Conclusion: This study highlights the successful development, implementation, and evaluation of a short online EBM course for medical clerkship students. The course showed a positive impact on students' performance, with significant score improvement. Students generally had a positive experience. Suggestions for improvement included addressing connectivity issues and incorporating face-to-face or hybrid components.

Keywords: Evidence-based medicine, Online courses, Student performance, Student satisfaction

1. Introduction

Since its emergence early in the middle of the 19th century in France [1], evidence-based medicine (EBM) has been considered as a paradigm shift toward scientific-based clinical practice [2]. EBM plays a pivotal role in contemporary healthcare. It focuses on the application of research-derived evidence in patient care and can be defined as "process of systematically identifying, appraising

and using the best available research findings, integrated with clinical expertise, as the basis for clinical decisions about individual patients" [3].

EBM integrates clinical experience and patient values with the best available research evidence [4] and focuses on conscientious, judicious, and reasonable use of such research evidence in providing care for individual patients in different health care settings [5]. Among the important merits of EBM are improved patient outcomes and shortening of the time needed by the physician to manage patients and maintaining high standards of clinical practice [6].

Proficiency in EBM is essential for medical clerkship students as they transition from the theoretical learning phase to the practical application of medical knowledge [7,8]. Medical educators are paying increasing attention to teaching EBM as an important area that should be addressed in the undergraduate medical education curricula. It is argued that the basic skills of EBM should be taught to undergraduate medical students as an integral part of the medical curriculum [9]. This will help medical students to stay up to date in their medical information, be able to cope with the heavy and rapidly changing information explosion [10], and eventually to become effective residents and practicing physicians who will make informed clinical decisions about patient care [11].

EBM teaching has been implemented widely globally with different teaching strategies and with different degrees of coverage of contents related to EBM principles, concepts, and practices [12—15]. Despite its importance, the teaching of EBM in our eastern context is not prominent in our medical education curricula [16]. Only a few trials could be traced. Examples include introducing a short introductory course on the concept of EBM at a private medical college in Saudi Arabia [16], introducing a short introductory course on EBM as a special study module at the Faculty of Medicine, King Abdulaziz University in Saudi Arabia [17], introducing a module on EBM in the Family Medicine rotation at King Saud University Medical School in Saudi Arabia [10], and another trial at the Faculty of Medicine, Suez Canal University (FOM-SCU) in Egypt to introduce the principles of EBM within the problem-based learning tutorials [18]. All those trials were conducted through the face-to-face mode, while the course in our study is conducted as an online course employing Zoom® videoconferencing platform for live sessions and Moodle® as a learning management system for managing the course and facilitating learning and interaction between faculty and students during period of suspension of onsite education because of the COVID-19 pandemic.

In recent years, online learning platforms have emerged as a popular and effective educational tool in medical training [19—22]. Online courses offer flexibility, accessibility, and opportunities for interactive learning experiences, making them an ideal platform for teaching EBM to medical students [23,24].

Our course aimed at providing comprehensive instruction in EBM principles and equipping medical clerkship students at the FOM-SCU with the necessary skills to critically evaluate medical literature and apply evidence to patient care. This study reports the stages of developing, implementing, and evaluating that course.

2. Method

The course was developed and taught as an elective online course to a group of third- and fourth-year clerkship students at the FOM-SCU during the academic year 2020—2021. This course was based on a FAIMER™ project work by the first author.

For development of the course, we followed the six steps of curriculum development for medical education of Kern et al. [25] The six steps were as follows.

2.1. Steps 1 and 2: Problem identification and needs assessment

Despite its importance, formal teaching of EBM at the FOM-SCU was not addressed at any stage of the undergraduate medical curriculum, except for a few individual trials to introduce the concept to raise the awareness of medical students. This means that EBM was neither formally taught as an integral part of any other courses nor it is taught as a separate core or elective course. Formal discussions with program administrators as well as faculty from the Medical Education and Community Medicine Departments revealed the need for an introductory course on EBM for clerkship students before they graduate and start their practice. This was also backed up by informal discussions with a sample of clerkship students who showed the interest in and need for learning BEM. Moreover, the Egyptian National Academic Reference Standards for medical education [26] indicate that schools of medicine must educate their students on EBM.

2.2. Step 3: Setting course goals and objectives

For formulating the goals and objectives of the course, the general objectives of the medicine program were reviewed first. The course objectives were aligned with them. The next step was writing

the intended learning outcomes of the course in a SMART format (specific, measurable, attainable, relevant, and time bound) and aligning them with the teaching/learning and assessment methods (Box 1).

2.3. Step 4: Choosing the educational methods

The online mode was chosen for this course to overcome the challenge of onsite attendance of medical students and because it is suitable for the nature of the course, which is supported by evidence. The educational methods were chosen based on the nature of the learning outcomes. A state of alignment was ensured between the learning outcomes and the teaching/learning methods. For knowledge outcomes, interactive live lectures through Zoom®, discussion forums through Moodle®, solving examples of evidence-based medicine cases, and self-learning activities were planned. For practical outcomes, workshops on the application of the steps of evidence-based medicine on a group of prepared cases and formative assignments (with feedback) were planned (Box 1).

2.4. Step 5: Implementation

The course was implemented as one of a list of elective courses for a group of students who chose that course (n = 54) over the period of four weeks. To guarantee smooth implementation, full support of the administration of the FOM-SCU was obtained. Resources were then allocated. Resources included faculty for teaching the course, e-learning

tools (Zoom® and Moodle®), and timetables. Regarding the faculty, the course was taught jointly by faculty members from the Medical Education and Community Medicine Departments who have knowledge and expertise in EBM. Regarding the e-learning tools, a Zoom® account was provided by the FOM-SCU. A Moodle® space for hosting the course was also provided by the FOM-SCU, in addition to technical support and training of the teaching faculty on creating the course on Moodle®. Timetables were adjusted to allow sufficient time for implementation of the course.

2.5. Step 6: Evaluation

This step employed the first two levels of Kirkpatrick's model for evaluating training programs [27], namely: reaction and learning. It included both course evaluation (reaction) and student assessment (learning). Student assessment was based on the learning outcomes. Knowledge outcomes were assessed through a written test in the form of multiple-choice questions. The test was conducted as a Moodle® quiz with online proctoring through synchronous Zoom® videoconferencing (students were asked to join a Zoom® session while taking the quiz and the teachers were proctoring them to prevent cheating). Practical outcomes were assessed through a practical test in which each student was provided with a short clinical case on which they were instructed to apply the steps of EBM (i.e., formulating the clinical "PICO" question, searching for the evidence, critically appraising the evidence, and applying the evidence to solve the case). Evaluation

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Box 1. Learning outcomes of the course aligned with teaching/learning and assessment methods.

Course Learning Outcomes	Teaching/Learning Methods	Assessment Methods
Knowledge - Definition evidence-based medicine. - Discuss the uses of evidence-based medicine. - Describe the steps of applying evidence-based medicine. - Discuss the components of the clinical questions in evidence-based medicine (Patient-Intervention-Comparison-Outcome, or PICO). - List the scopes of PICO questions. - Discuss the common evidence databases.	- Interactive online lectures - Discussion forums - Solving examples of evidence-based medicine cases - Self-learning	Multiple-choice questions test
Skills (Practical) - Write answerable PICO questions for given evidence-based medicine cases. - Search for evidence in evidence-based medicine databases. - Conduct critical appraisal of the obtained evidence. - Answer the clinical question to provide evidence on treatment, diagnosis, prognosis, or harm.	- Workshops for application of the steps of evidence-based medicine - Assignments (with feedback)	Practical exam (answering cases of evidence-based medicine)

of students' practical work was guided by a marking scheme that included the steps of EBM.

Course evaluation was conducted through a descriptive, cross-sectional, mixed-method study and depended on data on the effectiveness of the course and data on students' satisfaction with the course.

Data on the effectiveness of the course was obtained through a pretest-posttest control group methodology [28]. The students who were enrolled in the course were considered the intervention group. Another same-level group of students weas randomly selected and employed as a control group (they did not take the course). Both groups had the same pre-test and post-test (end-of-course). The purpose of having a control group was to control for other (confounding) factors that could lead to change in students' knowledge and skills other than the course.

Students' scores on a pre-test (a set of multiple-choice questions on the different topics of the course) were compared to their scores on the end-of-course test (post-test) for each group. Both the pre-test and the end-of-course test were comparable in terms of content and difficulty.

Data on students' satisfaction with the course were obtained through a validated survey [29] composed of 46 items (four of them were reverse scored) that covered all aspects of the course (Course content and design, Course activities, Interaction with instructors, Interaction with peers, Individual learning processes, Presentation quality, Learning outcomes, Administrative and technological support, and Overall satisfaction). The survey employed a 7-point Likert scale, where 7 = Strongly Agree and 1 = Strongly Disagree. In addition, two open-ended questions were added at the end of the survey: "What was the best in this course for you?" and "What would make this course better?".

Data was collected at the end of the course after converting the survey into an electronic format (Google® Form) and distributing it to the students through Moodle®.

Analysis of quantitative data was carried out using the Statistical Package for Social Sciences (SPSS) version 25. Descriptive statistics were used, and results were presented in the form of means and standard deviations. Independent samples t-test was used for comparison of means. Two-way repeated measures analysis of variance (rmANOVA) was used to explore the influence of the course on the assessment results of the intervention group compared to the control group. A p-value < 0.05 was considered as a cut-off point of statistical significance.

Analysis of qualitative data (responses to open-ended questions) was done through counting and categorizing the responses. Results were presented in the form of frequencies and percentages, together with quotes from students' responses.

The study was approved by the Research Ethics Committee of the FOM-SCU. All participants were given the choice not to respond to the survey, and their decision would have no negative consequences. By completing the survey, participants were giving their consent to participate in the study.

3. Results

All the course participants completed the survey (response rate = 100 %; n = 54). About 70 % of the participants were third year students, while 30 % of them were fourth year students. Males represented about 65 % of the participants, while females were 35 %.

Table 1 presents descriptive statistics of the assessment results for both the intervention group and the control group. It shows that the mean assessment results of the pre-test for the intervention group and for test 1 of the control group are comparable (56.26 ± 15.71 and 56.20 ± 16.06 respectively). However, the mean assessment result of the post-test for the intervention group (78.25 ± 8.22) is higher than that of test 2 of the control group (58.90 ± 15.70).

The two-way repeated measures ANOVA shows that there was a statistically significant difference in assessment results between the intervention and control groups (F (1, 1) = 13.29, p = 0.000). These results strongly suggest that the course had a significant positive influence on enhancing the intervention group's test scores compared to the control group (Table 2 and Fig. 1).

Table 3 presents the means and standard deviations of students' responses to a survey that measures various aspects of the EBM course. The means for each subscale range from 4.89 to 5.64, with the highest mean (5.64) for presentation quality and the lowest mean (4.89) for individual learning

Table 1. Descriptive statistics of the assessment results of the intervention group (pre-test and post-test) and the control group (first test and second test).

Group	n	Test	Mean	Standard Deviation
Intervention Group[a]	54	Pre-Test	56.26	15.71
		Post-Test	78.25	8.22
Control Group[b]	41	Test 1	56.20	16.06
		Test 2	58.90	15.70

[a] The first test was a pre-test (before the course). The second test was a summative (end-of-course) test.
[b] The second test was conducted 4 weeks after the first test (same duration of the course); with no intervention (course).

Table 2. Comparison of the influence of the course on the assessment results of the intervention group versus the control group with two-way repeated measures ANOVA test.

Source of Variation	Sum of Squares	df	Mean Squares	F	Sig. (p-value)
Between-Groups	4390.88	1	4390.88	13.29	0.000[a]
Within-Groups	7108.04	1	7108.04	108.46	0.000[a]
Error	6095.12	93	65.54		

[a] Statistically significant.

processes. Overall, the means suggest that students had a positive experience with the course, with responses ranging from slightly above average (4.89) to slightly above very good (5.64). However, there are some areas where students had lower scores, such as individual learning processes, which may indicate a need for additional support or resources in this area. The reverse scored items 16 and 17 suggest that some students may have missed the personal contact and relationships that come with face-to-face courses, which is not unexpected in an online course. However, the overall high scores for the survey items suggest that the online course was generally well-perceived by the students and effective in meeting their needs.

Table 4 compares the means between male and female students on various subscales of the survey and overall satisfaction using independent samples t-tests. The results show that there are statistically significant differences in mean scores between male and female students on several subscales. Female students rated course content and design, course activities, individual learning processes, presentation quality, and overall satisfaction significantly higher than male students. These differences are moderate to large, as indicated by the t-values and p-values. On the other hand, there were no statistically significant differences in mean scores between male and female students on interaction with instructors and administrative and technological support. These findings suggest that female students had a more positive experience with the course compared to male students, particularly in areas related to course content, activities, and presentation quality. Overall, the differences in mean scores between male and female students are relatively small, with standard deviations that overlap for many of the subscales. Therefore, while the results are statistically significant, they may not be practically significant in terms of the actual differences in students' experiences.

Table 5 compares the means between Year 3 and Year 4 students on various subscales of the survey and overall satisfaction using independent samples t-tests. The results show that there are no statistically significant differences in mean scores between Year 3 and Year 4 students on any of the subscales or overall satisfaction. The differences are not
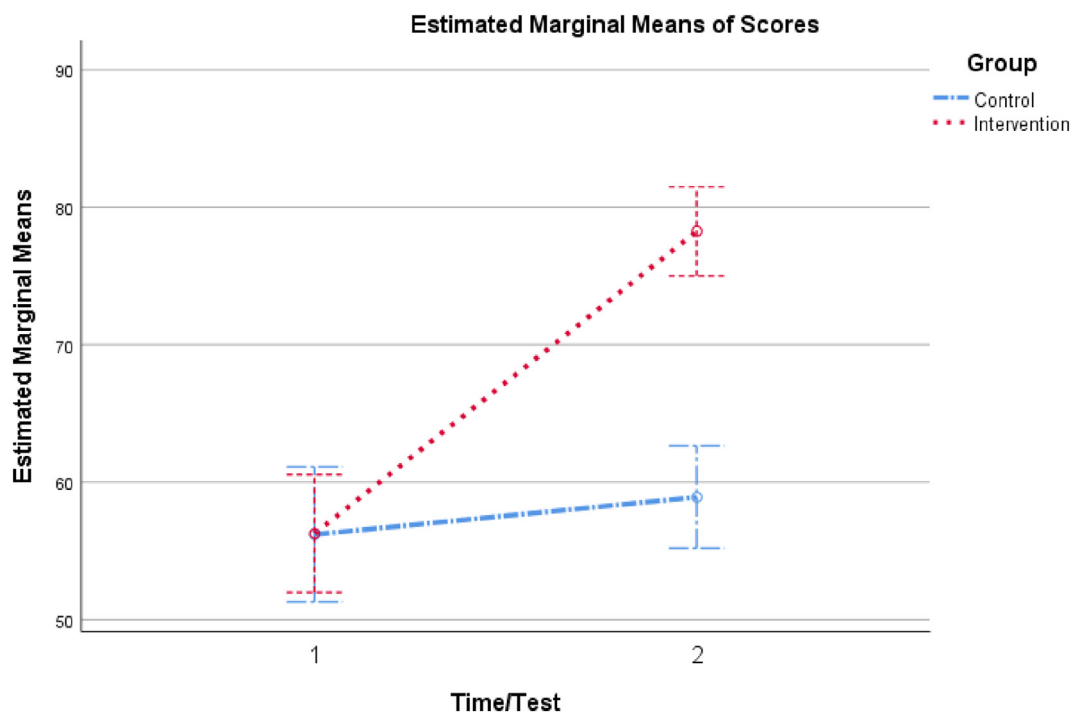

Fig. 1. Profile plots of estimated marginal means of scores of the intervention and control group students (repeated measures ANOVA).

Table 3. Means and standard deviations of students' responses to the survey items (n = 54).

No.	Survey Subscales and Items	Mean (±SD)	Min − Max
	Course content and design:	**5.62 (±1.60)**	
1	The course content was in line with the course description	5.70 (±1.70)	1−7
2	The materials covered in the course were at the right level for me	5.39 (±1.80)	1−7
3	The course itself and the learning materials were clear and well structured	5.72 (±1.77)	1−7
4	The learning environment was user friendly	5.70 (±1.63)	1−7
5	The course was well-balanced in terms of the blend of media and methods that were used	5.76 (±1.59)	1−7
6	The assignments in this course facilitated my learning	5.46 (±1.78)	1−7
	Course activities:	**5.47 (±1.67)**	
7	I felt actively engaged throughout the course	5.33 (±1.80)	1−7
8	The activities designed in the course were appropriate for retrieving and understanding the materials presented	5.52 (±1.75)	1−7
9	The time allocated for the activities was appropriate to the task	5.65 (±1.71)	1−7
10	The feedback I received on the activities was helpful and clear	5.44 (±1.77)	1−7
11	Exercises were pitched at the right level for me	5.43 (±1.77)	1−7
	Interaction with instructors:	**4.99 (±1.02)**	
12	When I needed advice from my instructor, I could easily get in contact with her/him via email, chat, forum … etc.	5.69 (±1.66)	1−7
13	My instructors had a high level of expertise in the implementation of e-learning course	5.70 (±1.68)	1−7
14	My instructors gave fast feedback via email, chat, forum … etc.	5.70 (±1.63)	1−7
15	My instructors supported and counseled me with regards to my learning processes	5.72 (±1.64)	1−7
16	I missed the personal contact with my instructors (R)	3.50 (±2.18)	1−7
17	Due to the online communication in the course, personal relations were neglected (R)	3.61 (±1.82)	1−7
	Interaction with peers:	**4.93 (±1.00)**	
18	I could exchange knowledge easily and quickly with other course participants via email, chat, forum … etc.	5.46 (±1.61)	1−7
19	There were ample opportunities in the course to establish personal contact with other course participants	5.37 (±1.48)	1−7
20	The online communication tools facilitated establishing new contact with other course participants	5.30 (±1.70)	1−7
21	Learning and cooperation with other course participants were facilitated in the course	5.43 (±1.55)	1−7
22	Using the computer-mediated communication facilities complicated group work (R)	3.11 (±1.73)	1−7
	Individual learning processes:	**4.89 (±1.06)**	
23	I could decide on my own at what times and where to learn	5.15 (±1.61)	1−7
24	I could decide on my own about the pace of learning and the use of learning strategies	5.30 (±1.50)	1−7
25	The learning environment offered opportunities to increase my knowledge	5.44 (±1.51)	1−7
26	I found it difficult to motivate myself and to maintain my learning motivation in the course (R)	3.69 (±1.71)	1−7
	Presentation quality:	**5.64 (±1.36)**	
27	Presentations were concise and informative	5.74 (±1.46)	1−7
28	Presentations contained practical examples that help explain the theories/concepts	5.63 (±1.45)	1−7
29	The visual aids used during the presentations were effective	5.54 (±1.61)	1−7
30	I could easily hear and understand the presenters at all times	5.67 (±1.41)	1−7
	Learning outcomes:	**5.31 (±1.50)**	
31	My knowledge and skills related to evidence-based medicine increased as a result of this course	5.35 (±1.60)	1−7
32	I intend to apply what I have learned from this course to my own practice	5.28 (±1.61)	1−7
33	I gained new ways of thinking about using the Internet or other online tools for learning	5.35 (±1.63)	1−7
34	I intend to share parts of the course with other colleagues	5.26 (±1.57)	1−7
	Administrative and technological support:	**5.36 (±1.22)**	

Table 3. (continued)

No.	Survey Subscales and Items	Mean (±SD)	Min − Max
35	I did not experience Zoom connectivity problems during the synchronous sessions	4.48 (±1.54)	1—7
36	I was able to access and download the course materials easily on Moodle	5.44 (±1.62)	1—7
37	I was able to read and post messages on Moodle without difficulty	5.30 (±1.53)	1—7
38	Submitting the assignments on Moodle was a straightforward process	5.50 (±1.51)	1—7
39	When I had a technical problem, it got solved quickly	5.22 (±1.55)	1—7
40	I was satisfied with communication from the course team	5.72 (±1.51)	1—7
41	I found the course team to be helpful and professional	5.70 (±1.55)	1—7
42	I liked the assignment reminders during the course	5.54 (±1.45)	1—7
Overall satisfaction:		**5.33 (±1.42)**	
43	I am very satisfied with this online course	5.67 (±1.61)	1—7
44	I would recommend this course to others	5.63 (±1.71)	1—7
45	I learned as much in this online as compared to a face-to-face course	4.98 (±1.74)	1—7
46	I feel online courses are as effective as face-to-face courses	5.06 (±1.82)	1—7

R = Reverse scored item.

Table 4. Comparison of means between male and female students regarding survey subscales and overall satisfaction using independent samples t-test.

Survey Subscales	Males (n = 35) Mean (±SD)	Females (n = 19) Mean (±SD)	t	Sig. (p-value)
Course content and design	5.35 (±1.79)	6.12 (±1.06)	1.99	0.052
Course activities	5.12 (±1.85)	6.13 (±1.04)	2.56	0.013[a]
Interaction with instructors	4.83 (±1.08)	5.27 (±0.85)	1.53	0.132
Interaction with peers	4.75 (±1.09)	5.27 (±0.73)	1.88	0.065
Individual learning processes	4.68 (±1.09)	5.29 (±0.91)	2.08	0.043[a]
Presentation quality	5.36 (±1.48)	6.17 (±0.93)	2.48	0.017[a]
Learning outcomes	5.04 (±1.64)	5.82 (±1.05)	1.87	0.067
Administrative and technological support	5.26 (±1.36)	5.56 (±0.89)	0.87	0.389
Overall satisfaction	5.04 (±1.58)	5.88 (±0.85)	2.55	0.014[a]

[a] Statistically significant.

statistically significant (p-value >0.05). These findings suggest that Year 3 and Year 4 students had similar experiences with the course, with no significant differences in their perceptions of any of the subscales or their overall satisfaction.

Table 6 shows students' responses to open-ended questions in a survey about an online course. The first question asked students about the best aspects of the course. The most common response was learning new things, such as PICO questions, critical appraisal, and search strategies. Several students also appreciated the easy and engaging way in which the course teachers presented the information. The importance of the topic for daily clinical practice after

Table 5. Comparison of means between Year 3 and Year 4 students regarding survey subscales and overall satisfaction using independent samples t-test.

Survey Subscales	Year 3 (n = 38) Mean (±SD)	Year 4 (n = 16) Mean (±SD)	t	Sig. (p-value)
Course content and design	5.57 (±1.79)	5.76 (±1.05)	0.50	0.622
Course activities	5.42 (±1.88)	5.61 (±1.05)	0.49	0.628
Interaction with instructors	4.93 (±1.09)	5.13 (±0.83)	0.64	0.525
Interaction with peers	5.01 (±1.08)	4.75 (±0.77)	0.87	0.388
Individual learning processes	4.96 (±1.19)	4.73 (±0.67)	0.88	0.382
Presentation quality	5.66 (±1.51)	5.61 (±0.94)	0.14	0.887
Learning outcomes	5.26 (±1.68)	5.44 (±0.96)	0.40	0.689
Administrative and technological support	5.25 (±1.32)	5.63 (±0.91)	1.03	0.310
Overall satisfaction	5.27 (±1.57)	5.48 (±1.00)	0.50	0.617

Table 6. Students' responses to survey's open-ended questions.

Question	Response Categories	Response Frequency	Response Percentage	Quotes
What was the *best* in this course for you?	Learning new things, like PICO questions, critical appraisal, and search strategies.	18	26.9 %	*"The best thing in this course is that the teachers were very helpful. They explained the content in a good way that facilitates understanding them."*
	Easy and engaging way of presenting the information by the course teachers.	12	17.9 %	*"I enjoyed learning a lot of new information throughout this course."*
	The importance of the topic for our daily clinical practice after graduation.	9	13.4 %	*"Knowing information about a new branch in medicine was the best thing for me."*
	Interaction and easy communication with the course teachers.	8	11.9 %	*"I was happy to have the opportunity to actively participate during sessions and to interact with my peers and teachers."*
	Organization of the course on Moodle and organization of the online live sessions.	7	10.4 %	
	The ease of using the online resources of the course.	6	9 %	*"This course helped me a lot in using the internet more effectively, completing t asks, and helping me to learn research methods."*
	Learning how to use the internet more effectively for learning and research.	4	6 %	
	Interaction between peers during the course.	3	4.5 %	*"The course helped me learn how to formulate a proper clinical question, which is important for my career after graduation."*
	Total question responses	**67**	**100 %**	
What would make this course *better*?	Having better internet connection, especially during the live sessions of the course.	12	38.7 %	*"For me, I think face-to-face sessions would have been better for interaction and communication."*
	Making the course face-to-face or hybrid (partly online and partly face-to-face).	9	29 %	*"I think the course might have been better if it has both face-to-face and online components."*
	Supplementing the course with more videos and interactive materials.	5	16.1 %	*"It isn't about the course itself, but the internet in my area that made my tasks and exam very difficult to do."*
	Reducing the workload of the course.	3	9.7 %	
	More cooperation from the course teachers.	2	6.5 %	*"More videos about the use of the searching strategies would have benefit us more."*
	Total question responses	**31**	**100 %**	

graduation was also mentioned as a positive aspect of the course. Some students highlighted the interaction and communication with course teachers, the organization of the course on Moodle, and the ease of using online resources. Other positive aspects included learning how to use the internet more effectively for learning and research and interaction with peers during the course. The second question asked students what would make the course better. The most common response was having a better internet connection, especially during live sessions of the course. Some students suggested that the course could have been better with face-to-face or hybrid components. Others suggested supplementing the course with more videos and interactive materials, reducing the workload of the course, and more cooperation from course teachers. Overall, Table 6 suggests that students appreciated the content and delivery of the online course but faced some challenges related to internet connectivity.

4. Discussion

Teaching of EBM, according to the literature, is an essential component medical education programs that is needed for medical students to develop the skills necessary to critically appraise and apply the best available evidence to clinical practice. This study reports the stages of development, implementation, and evaluation of an online course on EBM specifically designed for medical clerkship students.

For this work, we employed the six-step model of medical curricula development of Kern et al. [25], which includes six steps, namely: problem identification and needs assessment, goals and outcomes, educational strategies, implementation, and evaluation and feedback.

According to the needs assessment that was done, including all stakeholders, and utilizing all available information sources, there was a real gap in knowledge and need to introduce this EBM course. Several studies have also highlighted the importance of incorporating EBM into the curriculum of undergraduate medical education. For example, a study by Dorsch et al. [30] discovered the need for EBM teaching and found that medical students who received EBM training demonstrated improved critical appraisal skills and were more likely to use evidence-based resources in their clinical practice. Further studies by Acharya et al. [31] and Hasabo et al. [32] emphasized the need for early exposure to EBM concepts and skills in medical education. The authors argued that introducing EBM principles early on can help students develop a solid foundation and foster a lifelong commitment to evidence-based practice.

The intended outcomes of the course were written in alignment with the program objectives. Based on the learning outcomes and the online nature of the course, interactive learner-centered educational methods were selected. A state of alignment was created between the teaching/learning and assessment methods and the outcomes. The importance of writing and aligning learning objectives and outcomes was emphasized in literature [25,33−35]. Furthermore, a systematic review by Ilic et al. [36] examined the effectiveness of different EBM teaching methods in undergraduate medical education and found that using interactive and learner-centered teaching methods are effective in teaching medical trainees' evidence-based medicine.

The findings of the two-way rmANOVA study suggested that the EBM course had a positive influence on the performance of the intervention (course) students, as evidenced by the significant improvement in their mean and median scores from the pre-test to the end-of-course (post-test) assessment compared to the control group students (supporting the hypothesis that the improvement in students' test performance was due to the course). The narrower distribution of scores in the end-of-course assessment indicates a reduction in the variation of student performance, suggesting a more consistent level of knowledge and skills among the students after completing the course. In similar studies, Weberschock et al. [37], Al-Faris et al. [10], Hassanien [17], Barghouti et al. [38], Atwa and Abdelaziz [16], and Çakmakkaya [39] reported positive effects of similar courses on their students' skills and competences of EBM.

Analysis of the survey data indicates that students had a positive experience with the EBM course overall. The high mean scores for most subscales suggest that students found the course materials, presentation quality, and overall experience to be favorable. This aligns with previous research evaluating EBM courses and interventions, which have shown positive student perceptions regarding feasibility, acceptability, and educational effectiveness [10,16,17,38−40]. However, there were areas, such as individual learning processes, where students expressed the need for additional support or resources. This echoes findings from prior studies that have highlighted the importance of addressing students' concerns and enhancing support in specific areas, ultimately improving students' application of evidence-based decision making [5,9,41,42].

Additionally, the impact of the online format on student experiences is evident, with some students expressing a sense of loss regarding personal contact and relationships typically associated with face-

to-face courses. This aligns with studies comparing student perceptions of online and traditional educational formats, where students have reported differences in their experiences and preferences. [43,44] Nevertheless, the overall high scores for the survey items indicate that the online EBM course was generally well-perceived by the students and effectively met their needs. This supports previous research that has demonstrated positive student perceptions and satisfaction with evidence-based educational interventions [45,46].

In our study, female students rated course content and design, course activities, individual learning processes, presentation quality, and overall satisfaction significantly higher than male students. These differences are moderate to large in effect size, suggesting meaningful distinctions in the perceptions of male and female students. Similar findings have been reported in previous research. For example, a study by Harreiter et al. [47] found that females held significantly more positive attitudes toward and were more interested in e-learning medical courses with Moodle® than males. This aligns with the higher ratings given by female students in the current study. However, others found no gender differences in attitudes toward online courses [48]. On the other hand, other researchers found that males held more positive attitudes toward online learning than females [49,50]. However, the practical significance of these gender differences is limited, as the standard deviations overlap for many subscales. Yes, these findings provide insights into the different perceptions of male and female students, highlighting potential areas where efforts can be made to enhance the course experience for all students, regardless of gender.

The results showed that Year 3 and Year 4 students had similar experiences with the course, as there were no significant differences in their perceptions across the various subscales measured or their overall satisfaction. This implies that students in both years had comparable views on aspects such as course content, design, activities, presentation quality, and other relevant factors. The lack of statistically significant differences between Year 3 and Year 4 students could be attributed to the fact that Year 3 and Year 4 at the FOM-SCU are related to one phase and the teaching methodologies are consistent across both years, resulting in similar experiences for students. Additionally, the students' level of maturity might have reached a plateau by Year 3, leading to fewer variations in their judgments and perceptions compared to Year 4 students.

In response to two open-ended questions, the students highlighted the best things they found in the course and their suggestions to make the course better. Regarding the best things, they mentioned learning new things, such as PICO questions, critical appraisal, and search strategies, indicating that they found the course content informative and valuable for their academic development. This can be explained based on the fact that these are new, yet important, concepts for them. Additionally, students appreciated the easy and engaging presentation style of the course teachers and the interaction and communication with them, which likely contributed to their positive learning experiences. The practical relevance of the course topic for daily clinical practice after graduation was also highlighted as a positive aspect, indicating that students recognized the importance of the content in their future careers. Similar results were reported by Al-Faris et al. [10], Hassanien [17], Acharya et al. [29], and Atwa and Abdelaziz [16].

The second question in the survey asked students what would make the course better. The most common response centered around the need for a better internet connection, particularly during live sessions of the course. This suggests that students faced challenges related to internet connectivity, which could have affected their participation and engagement in real—time activities. Internet connectivity was proven to be a major challenge for all online programs, especially during the pandemic as everyone was using it as the only alternative for learning. This put load on internet lines and led to frequent disconnection and instability. A similar study by Ofori Atakorah [51] reported that the students encountered major connectivity problems during their online studies and recommended improving the communication and internet services in the country.

Some students suggested that incorporating face-to-face or hybrid components into the course could enhance the learning experience, indicating a preference for more in-person interactions or a blended learning approach. This suggestion is supported by a study by Zhang et al. [52], who found that using a blended education approach in EBM courses can improve students' learning, motivation, autonomy, and satisfaction. It is also supported by several studies that reported that blended learning is preferred and could be more effective than online learning [43,53—55].

This study has a few limitations. First, qualitative data was obtained only through two open-ended questions, while the best practice was to have in-depth discussions with the participants, like focus group discussions. Second, our study has a relatively small sample size, which could limit the generalizability of the evaluation findings to a

broader population. Third, there is a chance that this study might suffer from self-reporting bias, as a big part of the data was self-reported.

However, the strength of this work is that it reports the entire process of developing, implementing, and evaluating an important course for medical students, which fills a gap in their medical education and could be of help for them in their future practice.

5. Conclusion

This study highlights the successful development, implementation, and evaluation of a short online course on EBM for medical clerkship students. The results showed that the course had a positive impact on students' performance, as evidenced by significant improvement in their scores. The survey findings indicated that students had a positive overall experience with the course, finding the materials and presentation quality favorable. However, students expressed the need for additional support in certain areas. Although the online nature of the course added to its value as it facilitated learning and added flexibility to the course planning, implementation, and evaluation, some students suggested adding face-to-face or hybrid activities in future courses. Despite limitations, this study contributes to the literature on EBM education and emphasizes the importance of integrating EBM principles early on in medical training.

Ethical approval

The study was approved by the Research Ethics Committee of the FOM-SCU.

Other disclosure

None.

Conflicts of interest

None.

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