EE-6S: an integrated approach for introducing early clinical exposure in the new Egyptian medical curriculum

© Ansam Aly Seif,1 Hayam M. Eldamanhoury,2 Khaled Darahim,2 Dina N. K. Boulos,3 Nevine Bahaa,4 Ciraj A M,5 Saleena Ummer Velladath,6 and © M. Ganesh Kamath7

1Department of Physiology, Faculty of Medicine, Ain Shams University, Cairo, Egypt; 2Department of Cardiology, Faculty of Medicine, Ain Shams University, Cairo, Egypt; 3Department of Public Health, Faculty of Medicine, Ain Shams University, Cairo, Egypt; 4Department of Histology and Cell Biology, Faculty of Medicine, Ain Shams University, Cairo, Egypt; 5Department of Microbiology, Melaka Manipal Medical College, and Manipal FAIMER International Institute for Leadership in Interprofessional Education (M-FILIPE), Manipal Academy of Higher Education, Manipal, India; 6Department of Medical Laboratory Technology, Manipal College of Health Professions, Manipal Academy of Higher Education, Manipal, India; and 7Department of Physiology, Melaka Manipal Medical College, Manipal Academy of Higher Education, Manipal, India

**Abstract**

The electrocardiogram (ECG) is the primary diagnostic tool in cardiovascular diseases. Hence its interpretation is a core competency in medicine, where obvious deficiencies have been reported among learners. The aim of this study was to introduce the fundamentals of ECG knowledge and interpretation through early clinical exposure (ECE) based on a six-step approach for preclinical students (n = 110) and to study its influence on their knowledge and interpretation skills thereafter. The first step employed a blended learning format using didactic lectures on normal and pathological ECGs, each preceded by preinstructional videos. The second step focused on psychomotor skills and utilized laboratory exercises for ECG recording and interpretation. The third step focused on vertical integration, where the clinical relevance of the procedure was established with integrated lectures. The fourth step used the Moodle platform, where opportunities for peer interactions and clarifications by clinical faculty were made available. The fifth step incorporated clinical and diagnostic reasoning through cardiology ward visits and interpretation of patient ECGs. The sixth step was designed for critical thinking and problem solving through case-based discussions with peers and faculty. Students were assessed with multiple-choice questions and objective structured practical examination. Learner perceptions of the approach were evaluated with a feedback questionnaire and focus group discussion. Statistical analysis showed that ECE through a six-step approach significantly enhanced knowledge and interpretation of ECG as evidenced by the pre- and posttest scores. Analysis of the focus group data revealed that learner engagement and skills of critical thinking were enhanced along with diagnostic and clinical reasoning.

**early clinical exposure; Egyptian medical curriculum; electrocardiogram interpretation; preclinical curriculum; six-step approach; undergraduate medical students**

**INTRODUCTION**

Cardiovascular diseases are estimated to be the leading cause of death around the world by the year 2020 and beyond (1). The electrocardiogram (ECG) continues to be the primary diagnostic tool in detecting cardiovascular diseases. Although ECG interpretation is a core skill regarded as one of the Entrustable Professional Activities (EPAs) (2), obvious insufficiencies among medical students, residents, and physicians in the practice of this skill have been reported (3–5). Analysis of ECG strips by medical students needs adequate reinforcement, as deficiencies in learning this skill can be potentially dangerous for patients through errors committed in the investigative procedures leading to invalid diagnosis and flawed management practices thereafter (3, 6).

Until the recent past, medical schools in Egypt utilized a French curricular model in which the Bachelor of Medicine and Bachelor of Surgery (MBBS) was clearly divided into a preclinical and a clinical phase for a total duration of 6 yr (7). The curriculum delivery during preclinical years largely focused on didactic lectures and laboratory sessions, with no introductory experiences in the clinical setting, often resulting in reduced engagement and reduced interest of the learner toward the educational program (8, 9). For the same reasons, during their early undergraduate years the students find it difficult to link basic science knowledge to real-life clinical scenarios (8). This approach can also compromise the development of clinical reasoning abilities, a skill that needs to be honed in the very early phase of the medical curriculum (9).
Recent years have witnessed medical schools across the globe moving from a discipline-based model toward a competency-based curriculum (8, 10). In line with these changes, based on the recommendations of the Egyptian Supreme Council of Universities, starting in the year 2018 all Egyptian medical schools have begun their transition to a 5-yr undergraduate curriculum that aims to produce medical graduates who are knowledgeable (cognitive skills) and competent (psychomotor skills) in clinical reasoning as per standards accepted across the globe. This curriculum has a student-centered learning approach and includes horizontal and vertical integration, which aims specifically toward early clinical exposure (ECE) (7, 11–13). Besides the cognitive and psychomotor aspects, inclusion of ECE also addresses affective and behavioral domains by the learners visualizing the illness from the patient’s perspective (13–15).

Teaching the importance of ECG and its interpretation to undergraduate students requires harmonized work by faculty in the preclinical and clinical phases (8). However, in the earlier medical program followed in Egypt, undergraduate medical students were first introduced to clinical aspects of ECG interpretation during their cardiology courses in their fourth year of medical school. There were a total of 5 h assigned for ECG interpretation study, which was challenging for both educators and students.

Given the urgent need for introducing ECE in the newly adopted medical curriculum in Egypt, and for addressing the persistent problems associated with ECG interpretation by students, we decided to implement an alternate flexible and systematic way to learn and practice ECG interpretation (16). Because of their wide acceptance among millennial learners, adoption of blended and e-learning platforms was considered to be an integral part of this novel approach for enhancing motivation and attainment of deep learning (8, 17, 18).

The aim of this study was to introduce the fundamentals of ECG knowledge and interpretation through ECE, based on a six-step approach for preclinical students, and to study its influence on their knowledge and interpretation skills thereafter.

**MATERIALS AND METHODS**

**Study Population and Setting**

This intervention was done with the 2019 batch of second-year medical students (n = 110; consisting of 71 men and 39 women) enrolled for the Extended Modular Program of Ain Shams University, Cairo, Egypt, during the 9-wk period of the Cardiovascular Module. The project protocol was approved by the Research Ethics Committee at the Faculty of Medicine, Ain Shams University (ASU) (FMASU, REC), which conforms to the guidelines of the US Office for Human Research Protections and the US Code of Federal Regulations and operates under Federalwide Assurance No. FWA 000017585. Written informed consent was obtained from students before participation in this study.

**Student Orientation**

Before the start of the Cardiovascular Module, students were oriented with the ECG-ECE-6-Step (EE-6S) approach via e-mail and Moodle instructions, as well as through an orientation session conducted by the principal investigator (PI).

**Steps Involved in the Approach**

The stages involved in the EE-6S approach are depicted in Fig. 1. A brief description of methods involved in each step along with data collection is provided below:

**Step 1: Blended learning (lectures preceded by preinstructional videos).**

A week before the planned lectures, the links of related instructional ECG videos were mailed to the students. These videos of ~5- to 8-min duration were selected from YouTube by the investigator. The content and construct validities of these videos were established through peer validation. The didactic lectures included descriptions of normal ECG along with their interpretations (part 1), which was followed by ECG changes due to commonly encountered pathophysiological conditions (part 2) along with interpretations. The effect of blended learning on student knowledge was measured with case-based multiple-choice questions (MCQs) in a pre- and posttest design.

**Step 2: Laboratory exercises on ECG.**

A 2-h training session was conducted to ensure hands-on training of ECG recording. A total of five sessions were repeated by faculty, each having 22 students. In each session, students were further divided into four subgroups (consisting of 5 or 6 students). Peers within the group volunteered as subjects, which was followed by interpretation of data from ECG strips that were generated.

**Step 3: Integrated lectures.**

This step focused on vertical integration, where Physiology and Cardiology faculty gave joint lectures highlighting pathophysiological ECGs with medically important findings like hypertrophy of ventricle, myocardial infarction, and fibrillations. Interpretations of individual tracings like R-R interval, rhythm, electrical axis, aspects of conduction, and morphologies were also discussed in detail.

**Step 4: Open forum.**

The Moodle platform was employed to facilitate peer interactions and foster collaborative learning. The total number of students was divided into three groups (36 or 37 students in each group) for this open forum. At the start of this module (week 3), Cardiology faculty uploaded ECGs on the forum and gave the students 3 days’ time to interpret the ECG and justify their interpretation. This was followed by discussion on the open forum pertaining to the ECGs posted. Attendance and participation in the discussion by all students were mandatory for this session. In addition, faculty ensured online engagement by providing clear guidelines, by using prompts, and by giving effective feedback as and when required. Similar interactive discussions between students and faculty were repeated seven times for seven consecutive weeks (from week 3 to week 9) during this step.

**Step 5: Cardiology ward visits.**

This step focused on reinforcement of ECG interpretation skills combined with the skills of clinical reasoning. Students

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divided into groups of four were allocated four ward visits located in the cardiology department sectors of Ain Shams University Hospital that included in-patient ward, coronary care unit, cardiac echo unit, and cardiac catheterization unit. ECG tracings generated from patients were analyzed and interpreted with the guidance of Cardiology faculty.

**Step 6: Case-based discussion.**

Five case studies that dealt with the common cardiac diseases in the Egyptian context were developed and validated by Physiology and Cardiology faculty. With block randomization, the entire class of 110 students was divided into seven groups (consisting of 15 or 16 students per group), who initially met among themselves for peer discussion of the cases. Besides consultations in the peer group, they were also encouraged to refer to physiology and medicine textbooks along with validated digital resources uploaded on the Moodle platform. Clarifications were addressed by faculty who were a part of the forum. After this, case-based discussions (~3-h duration) focusing on critical thinking and problem solving were held for all seven groups. This modality was repeated five times (all groups went through all 5 case studies) for every group, once every 10 days. The faculty from the Departments of Physiology, Biochemistry, Pathology, Pharmacology, and Microbiology served as facilitators. Before the start of this modality, all facilitators who were involved were briefed and a discussion was held about the content and processes. A Cardiology faculty member was present along with the facilitators during each session. Feedback was provided in groups and individually, if required for the content and process.

**Data Collection**

**Quantitative data.**
At the end of the blended learning and laboratory exercises on ECG (steps 1 and 2), the students’ knowledge was assessed with case-based MCQs (a sample MCQ used is provided in the APPENDIX) that were a part of the continuous modular assessment. An objective structured practical examination (OSPE) was conducted at the end of the module examination. The OSPE stations incorporated pathological ECGs along with relevant clinical findings (an OSPE item used in

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Figure 1. Stages involved in the ECG-ECE-6-Step approach. MCQ, multiple-choice questions.
one of the stations is provided in the APPENDIX). These stations assessed students on their skills for ECG interpretation along with clinical and diagnostic reasoning. The assessment of student performance on the online forum and case-based discussion (CBD) was formative to ensure a safe learning environment and immediate feedback and for helping learners generate plans for feedforward action.

After the intervention, a questionnaire was used to collect feedback from the participants about the EE-6S approach. The questionnaire focused on finding the students’ overall satisfaction with the module, their perception of each step of the EE-6S approach, and their likelihood of recommending the module to other students. The satisfaction survey consisted of 28 questions, 26 of which were questions with a five-point ordinal response format where participants were asked to provide their opinion on each item by choosing a number between 01 and 05 (where 01 was considered “strongly agree” and 05 considered “strongly disagree”). Additionally, two open-ended questions were included, where students opined on the single most important factor that facilitated learning during the EE-6S approach, with valid reasons for their choices. They were also encouraged to provide suggestions to make this approach a better one (a copy of the questionnaire is furnished in the APPENDIX).

Results

Effect of Blended Learning (Pre-Post Design)

Ten MCQs were asked in relation to the student knowledge for interpretation of normal ECGs (step 1, part 1) and another ten MCQs in relation to interpretation of ECGs with pathophysiological changes (step 1, part 2). We found a significant increase in mean score ± SD compared with their preassessment values (2.74 ± 1.5 vs. 6.77 ± 1.8, paired t test = −17.8, P < 0.01), signifying an overall improvement in students’ knowledge. A similar pattern was observed with step 1, part 2, where pathophysiological aspects were discussed. Accordingly, a significant increase in mean score ± SD results compared with their preassessment values (4.78 ± 2.1 vs. 7.93 ± 2.4, paired t test = −8.6, P < 0.01) were seen, indicating a progress in knowledge in the relevant domain.

Continuous Assessment and OSPE Results

There was a significant difference in the mean score ± SD for continuous assessment ECG exam results of the students in the 2018 batch compared with the students in the 2019 batch (3.94 ± 0.49 vs. 4.82 ± 1.10, respectively, t test = 7.6, P < 0.01). A significant proportion of students (>90%) from the 2019 batch scored >90% aggregate scores compared with 33.6% from the 2018 batch (P < 0.01) in the final OSPE exam.

Results of Feedback Questionnaire

The questionnaire explored organization, learning, interpretation, and reasoning related to ECG. It also probed the satisfaction of the learner with the novel approach and the possibilities of recommending the approach in the educational delivery of the new preclinical curriculum of Egypt. The response rate was 56.3%, with 62 of the 110 students participating in the survey. The results of the survey are provided below.

Student Perceptions of Premodule Instructions and Orientation Session

Forty-three (69.3%), 49 (79.0%), 42 (67.7%), and 45 (72.5%) students among the 62 students mentioned that overall organization, e-mail instructions, Moodle instructions, and orientation session, respectively, were clear and well organized. The details are presented in Fig. 2.

Student Perceptions about the EE-6S Approach

Among the 62 students, 43 (69.3%) indicated that their interpretation skills of ECG were enhanced by case studies, whereas 46 (74%) said that the field visits were relevant and helped them understand the concepts of ECG. Thirty-nine (62.8%) students pointed out that integrated lectures enhanced their understanding of the concepts, whereas 48 (77.4%) students highlighted the utility of preinstructional ECG videos in the process of learning. The overall impression about the steps of the approach was found satisfactory, as evidenced by the results depicted in Fig. 3.

Student Perceptions about the Usefulness of the EE-6S Approach

Responses to item numbers 2.11 and 2.18 in the questionnaire indicate the relevance to real-life application and the
provision of a safe learning environment built into the EE-6S approach, respectively. Figure 4 shows that 52 (83.8%) of learners rated the EE-6S approach more efficient than the traditional lectures. Fifty-two (83.8%) students endorsed the EE-6S approach for its applicability in real-life settings. In addition, students also attributed their interpretation skills ($n = 48; 77.4%$), and enhancement of knowledge ($n = 50; 80.6%$) of ECG to the novel approach.

### Student Perceptions about Motivation for Self-Directed Learning and Enhancing Self-Confidence

Fifty-four (87.0%) students suggested the implementation of the EE-6S approach in the new Egyptian medical curriculum, and an equal number of students mentioned they would recommend this approach for future medical students. Fifty-one (82.2%) students stated they were satisfied with this approach. Forty-four students (70.9%) recognized that the EE-6S approach motivated them for self-directed learning. Heightened self-confidence in their capability for ECG interpretation was also identified as an outcome of this approach by 51 (82.2%) students. The details are provided in Fig. 5.

### Results of the Open-Ended Feedback Questions

*The single most important factor that facilitated learning during the EE-6S approach and the reason for that.*

Fifty-seven (91.9%) out of 62 students stated that the integrated clinical lectures, visiting patients, and relating ECGs to their clinical conditions were the most important facilitating factors in their learning during the EE-6S approach. Forty-five (72.5%) students reported that prelecture videos

![Figure 2](image1.png)

**Figure 2.** Student perceptions ($n = 62$) of premodule instructions and orientation session of the ECG-ECE-6-Step approach, corresponding to questions 1.1, 1.3, 1.4, and 1.5. $x$-Axis denotes % of students, and $y$-axis denotes the premodule orientation methods applied.

![Figure 3](image2.png)

**Figure 3.** Student perceptions ($n = 62$) of the ECG-ECE-6-Step approach, corresponding to questions 2.1, 2.4, 2.5, and 2.7. $x$-Axis denotes % of students, and $y$-axis denotes the teaching approaches used.
significantly prepared them for the topic and motivated them to view similar videos on their own. Thirty-nine (62.9%) students thought that case studies and patient visits in addition to the forum were the most important factors that resulted in better understanding of the clinical relevance of ECG along with enhanced interpretation skills. For 57 (91.9%) students the approach, which focused on tackling the topic systematically from diverse points of view, helped in a stepwise build-up of knowledge and skills, thereby identifying the EE-6S approach itself as the most important enabling factor. Moreover, 27 (43.5%) students commented on the facilitation skills of the instructors along with better coordination of the module as the empowering factor, which helped in the development of a safe learning environment and maintenance of an ideal pace for effective learning.

**Students’ suggestions to make the EE-6S approach even better.**

Among the recommendations received from students for making the EE-6S approach better, provision of an integrated forum that incorporates lectures and performance along with interpretation of ECG figured prominently. Fifty-four (87.0%) of the student responses indicated the need for more practice opportunities and timely feedback. A few learners proposed the construction of an integrated study guide, more like an ECG booklet, that incorporates links to more relevant ECG videos and clinical vignettes. Suggestions on inclusion of gaming platforms for more ECG practice were also received. Organizing ECG competitions for medical students at both national and international levels was yet another recommendation received.

**Figure 4.** Student perceptions (n = 62) of the usefulness of the ECG-ECE-6-Step approach, corresponding to questions 2.11–2.14. x-Axis denotes % of students, and y-axis denotes the impact of the approach.

**Figure 5.** Student perceptions (n = 62) of motivation for self-directed learning and enhancing self-confidence of the ECG-ECE-6-Step approach, corresponding to questions 2.15–2.17 and questions 3.1 and 3.2. x-Axis denotes 5% of students, and y-axis denotes the overall satisfaction toward the new approach and suggested recommendations.
Focus Group Discussion

The FGDs and interviews conducted with students and faculty identified five key themes, which included 1) effectiveness of blended learning, 2) benefits of active and experiential learning, 3) fostering clinical and diagnostic reasoning, 4) opportunities for self-directed learning (SDL), and 5) provision of a safe learning environment.

The descriptive statistics of the identified themes along with representative quotes are given below.

Effectiveness of blended learning.

Of the 11 students, 9 (81.8%) mentioned the usefulness of pre-lecture videos in comprehending the topic of ECG and its interpretation. Responses that convey this feeling are stated below:

“Without the background information from the videos, I think I would never have understood the lecture; As if they lighted lamps about the topic.” (participant 7)

“We need this type of learning in other areas of Physiology because these topics need more elaboration and explanation and coming to the lecture with some previous knowledge from the videos was highly beneficial.” (participant 5)

“Students asked me for more video links and PowerPoint presentations. They even asked about useful ECG textbooks for further training.” (Lecturer, Department of Cardiology)

Benefits of active and experiential learning.

Four (36.3%) students favored the approach because of the active and experiential learning built into the framework. This was evidenced by quotes like the following:

“It is absolutely true that we are becoming active learners this way rather than being spoon fed.” (participant 1)

“One of the best components of the strategy was actually seeing ECG performed with leads in place and ECG strip coming out of the machine, then holding the strip in our hands and interpreting it.” (participant 10)

“I clearly saw students’ definite excitement and enthusiasm as they were discussing and interpreting ECG strips during the hands-on training of ECG recording on their peers.” (Assistant Professor, Department of Physiology)

“The subspecialty of cardiology emerged from internal medicine only after the invention of ECG; ECG is the cornerstone of cardiology and there’s no excuse for the medical graduates and residents not to be efficient on the subject. I’m glad I could share in taking steps towards that goal.” (Professor, Department of Physiology)

Fostering clinical and diagnostic reasoning.

The integrated approach using six steps was also commended for fostering clinical and diagnostic reasoning, as indicated by 7 (63.7%) participants. Representative quotes that convey this are provided below:

“Physiology lectures gave me the important basic knowledge about normal and abnormal ECG, of course they are irreplaceable. All ECG detailed mechanisms were made clear. Then understanding of cardiology built on that information and made ECG interpretation easy.” (participant II)

“The forum meant a lot to me; much practice which greatly enhanced my interpretation skills.” (participant 2)

“Early exposure and practice with patient ECGs made the difference.” (participant 3)

“I’m really impressed by the students’ amazing skills in ECG interpretation; even for tricky ECGs that I uploaded on the Moodle.” (Professor, Department of Cardiology)

“I’m happy to see students follow the simplified scheme provided for ECG interpretation to reach the diagnosis.” (Professor, Department of Physiology)

Opportunities for SDL.

Exploration of the SDL opportunities was seen as an added benefit of this intervention, as specified by 6 (54.5%) of the 11 students. The evidence is provided below:

“The videos posted on the forum made me interested to know more and encouraged me to look for more ECG videos, which were related to the topic; I enjoyed watching them.” (participant 8)

“Practice made me perfect.” (participant 7)

“Whenever I meet one of the older colleagues, he would say not to mind much about ECG because it’s a tough topic, which will never be understood. Now I’m telling them ECG is so easy to learn by ourselves and they are astonished to hear that.” (participant 9)

“Many students asked me to organize more visits to cardiology wards, whereas some others mentioned that they go there on their own to do more practice. I was happy to hear that some of them intend to do more training in cardiology wards during their summer vacation.” (Lecturer, Department of Cardiology)

Provision of a safe learning environment.

 Provision of a safe learning environment provided by this approach was emphasized by three (27.2%) learners during FGD. The quotes below explicitly describe the learning environment to be dynamic yet safe:

“It was a very nice experience to get exposed to eminent cardiology professors while we are just second year students, gaining from their experience and knowledge; I felt important and cared for.” (participant 4)

“I was asked to provide my email, my WhatsApp number as well as my office hours’ schedule for further inquiries. I think we made them love the subject.” (Professor, Department of Cardiology)
Analysis of the quantitative and qualitative data strongly suggests students’ preference for the novel approach using ECE over the traditional approach to learning and interpretation of ECGs. Faculty opinion was also found to be encouraging and favoring the inclusion of this approach in the new preclinical curriculum.

**DISCUSSION**

The present study focuses on the impact of a six-step approach introduced as an ongoing curricular reform in Egypt that utilizes a new competency framework for undergraduate medical courses. The novel framework recognizes the new-age graduate doctor as a health care provider, health promoter, professional, scholar and scientist, member of the health team, part of the health care system, and lifelong learner and researcher. ECE is an ideal platform to accomplish these desired competencies, as several studies have described the ECE experience and its positive contributions to medical education (9, 15, 19, 20). If implemented effectively, ECE can greatly enhance the graduates’ eagerness to learn, passion for the profession, and ability to provide holistic care for patients with compassion, thus exhibiting general professional competencies that meet the expectations of the community (12, 15, 21). However, there are only a few reports on the use of ECE around the Middle East and North Africa (MENA) region. Various studies report approaches like interactive lectures, case-based learning (CBL) sessions, and visits to the hospital for the execution of ECE (8, 11, 12, 22–24). This article describes the design and implementation of a pedagogic model that merges the aforementioned approaches into a single, six-step approach for introducing ECE through ECG interpretation exercises in the second year of the new medical curriculum.

ECG is not only one of the most important diagnostic tools in the medical profession but also a skill that medical educators often find challenging to teach (5, 25). Identified as a core skill and linked to distinct milestones and EPAs, ECG interpretation is a must-know area for medical students (5, 26, 27).

The most common barriers to teaching ECG were identified as lack of sufficient time, reluctance shown by faculty in teaching ECG interpretation, and the phasing of ECG instruction at different stages of the medical curriculum (6, 16). A survey done by the Clerkship Directors of Internal Medicine (CDIM) points out the fact that ECG is often taught to preclinical students through didactic lectures and lacks a hands-on ECG practical session (16). Limited opportunities for practice and feedback can lead to poor ECG interpretation skills. Using the EE-6S approach, we have tried to address this limitation by inclusion of exercises that were skill based and performed on a real-time basis. In addition, it also provided opportunities for timely feedback from the physiologists and cardiologists who were readily available on a Moodle platform. The issue of limited time availability, which was often identified as a hindering factor, was addressed through online platforms that helped students learn at their own pace. The judicious use of technology during the entire approach also ensured reinforcement of knowledge and skills related to ECG.

Recent studies cite blended learning formats as useful adjuncts for inculcating ECG analysis and interpretation skills, leading to a higher level of competence and confidence than conventional lectures (18, 28, 29). The first step in this approach utilized YouTube videos as preinstructional learning material. The study results show that students, while being highly appreciative of this format, also demonstrated substantial learner engagement and enhancement of knowledge along with improved interpretation skills in ECG. This was evidenced by the significant increase in the scores of the postassessment results after video exposure compared with their preassessment values.

The practice of case-based ECGs using small-group peer discussions as one of the steps in the present approach addressed the clinical and diagnostic reasoning of the learner in a collaborative manner. There is evidence in the literature that the practice of attaching cases to the ECGs used during instruction improves learning and retention (6, 16). Experiential learning was ensured by employing case-based formats, making the EE-6S approach highly engaging and interesting to the learner. Studies emphasize the importance of repeated practice sessions for improving the ECG interpretation skills of undergraduate medical students (6). Besides the experiential learning format, the EE-6S approach provided abundant opportunities to practice, to obtain feedback from experts, and to reflect and make necessary changes if required. Previous reports that emphasized changes in ECG teaching/learning methods have also suggested the requirement of more practice opportunities (5, 6).

Substantial evidence that favors the link between expectancy-value beliefs and academic achievement has emerged in the recent past (30). “Expectation” refers to learners’ views of their capabilities of undertaking and completing a task. Self-efficacy is an essential component of expectation. “Intrinsic task values” are the reasons why students engage in an academic task (31, 32). The EE-6S approach adopted clearly demonstrates the link between learner self-efficacy beliefs and intrinsic value and their roles in the academic performance of the 2019 batch in particular, compared with the 2018 batch, as evidenced by the significant increase in continuous assessment and OSPE scores. Student responses during FGDS clearly demonstrate that the EE-6S approach empowered them with motivational beliefs and made them feel more confident in a topic like ECG. Most students appreciated the EE-6S approach and described it to be “inspiring,” “motivating,” “highly beneficial,” and “the perfect way of learning.” This may be because of the safe learning environment that learners envisioned, partly due to the helping nature of the faculty involved and the motivation derived from the relevance they attached to the task. The quality and nature of feedback provided also may have had a strong influence on motivation of the learner (6).

In most of the preclinical curricula practiced in the region, the practice of curriculum delivery hitherto has been through the use of didactic modes accompanied with laboratory exercises. Physiology is one of the basic sciences that is the foundation of medicine and should be learned in the clinical context if the competencies outlined for future medical graduate are to be addressed. This study demonstrates the power of the EE-6S approach in reducing rote learning and in fostering clinical and diagnostic reasoning through a...
case-based approach. Learners felt it helped them see the relevance of basic science in clinical practice. In addition, the EE-6S approach seemed to help students develop an altruistic attitude toward patient care, as demonstrated by their reflections during the interview that were linked to empathy and compassion.

The utility of this EE-6S approach in inculcating the basic tenets of SDL was also evident, as a good number of students contacted clinician educators thereafter to pursue their interest in the subject. There was also evidence gathered on increased utilization of print and online resources, which predominantly included medicine textbooks and videos on ECG. The EE-6S approach increased their eagerness for SDL and passion for the profession, adding to the competence of lifelong learning inherent to the practice of medicine.

**CONCLUSION**

With a good number of competencies related to the new medical graduate being addressed, the inclusion of EE-6S approach in the new Egyptian medical curriculum is justified and highly recommended.

**APPENDIX**

### EXAMPLE OF A CASE-BASED MCQ USED IN CONTINUOUS MODULAR ASSESSMENT

A 62-yr-old man presented to ER with chest tightness for 2 h. This was accompanied by a sensation of heartburn and abdominal discomfort. Examination revealed shortness of breath with cold clammy skin. His ECG tracing is shown in Fig. A1.

Based on this ECG, identify the best possible underlying diagnosis from the responses given below:
1. Anterior ST-elevation myocardial infarction (STEMI) with high lateral extension
2. Inferior STEMI
3. Atrial fibrillation
4. Left bundle branch block
5. First degree heart block

**EXAMPLE OF AN OSPE QUESTION SHOWING AN ECG STRIP FROM A CASE OF ANTERIOR MYOCARDIAL INFARCTION TO ASSESS THE PATHOLOGY AND PROVISIONAL DIAGNOSIS**

A 47-yr-old bank employee presented to the emergency room with chest pain for 1 h. Pain radiated to the left arm and was associated by epigastric pain and profuse sweating. The patient gave a history of dyslipidemia. You have been provided the ECG findings of this patient (Fig. A2).

After examining the ECG tracing provided, answer the following questions:

a. Explain the pathological findings in different ECG lead(s) of this patient.

b. What is your provisional diagnosis?

**QUESTIONNAIRE FOR PROVIDING FEEDBACK ABOUT THE ECG-ECE-6-STEP APPROACH**

Table A1 presents the questionnaire for providing student feedback about the ECG-ECE-6-Step approach.

**FOCUS GROUP DISCUSSION GUIDE**

Table A2 presents a guide for focus group discussions.

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Figure A1 shows the sinus rhythm rate of 56 beats/min. The PR interval, QRS axis, duration, voltage, and QT interval appear normal. The ST segment appears to be elevated in leads II, III, aVF, V5, and V6. The elevation in lead II is equal to lead III, along with reciprocal depression in leads I and aVL. Based on the findings, the answer key for the aforementioned MCQ is option 2 (inferior STEMI).

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ACKNOWLEDGMENTS

This study was done as a part of the curriculum innovation project for the Foundation for Advancement of International Medical Education and Research (FAIMER) Fellowship of the principal investigator. We acknowledge the contributions of Professors Samar Ahmed, Malak Shaheen, and Amel Hasheesh for their supervision. The role of Professor Ali Sabbour, Director of the Extended Modular Program (EMP), at Ain Shams University, Cairo for approval and guidance is also acknowledged.

DISCLOSURES

No conflicts of interest, financial or otherwise, are declared by the authors.

AUTHOR CONTRIBUTIONS

A.A.S. conceived and designed research; A.A.S., H.M.E., K.D., and N.B. performed experiments; D.N.K.B. analyzed data; D.N.K.B. prepared figures; A.A.S. drafted manuscript; A.M.C. and M.G.K. edited and revised manuscript; A.A.S., H.M.E., K.D., D.N.K.B., N.B., A.M.C., S.U.V., and M.G.K. approved final version of manuscript.

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Table A1. Questionnaire for providing feedback about the ECG-ECE-6-Step approach

| Question                                                                 | Rating |
|--------------------------------------------------------------------------|--------|
| 1. The overall ECG-ECE-6-Step approach was well organised.               |        |
| 2. The pre-module instructions on ECG delivered through the orientation session were clear. |        |
| 3. The pre-module instructions on ECG-ECE-6-Step approach delivered through e-mail was clear to me. |        |
| 4. The pre-module instructions on ECG delivered through Moodle were clearly understood by me. |        |
| 5. The orientation about ECG-ECE-6-Step approach was organised in a manner to prepare me for the actual clinical practice. |        |
| 6. Instructors/Tutors assigned for ECG-ECE-6-Step approach were committed to the schedule. |        |
| 7. Integrated case based sessions raised my skills of ECG interpretation. |        |
| 8. The hospital field visits enhanced my understanding of relevance of ECG concepts in clinical practice. |        |
| 9. The hospital field visits enhanced my understanding of relevance of ECG concepts in clinical practice. |        |
| 10. Integrated ECG lectures enhanced my understanding of ECG concepts.   |        |
| 11. Pre-instructional ECG videos enhanced my knowledge about the subject. |        |
| 12. The pre and post assessment questions helped me reflect on my understanding of the subject. |        |
| 13. ECG forum training facilitated my comprehension of ECG concepts.     |        |
| 14. ECG forum training improved my ECG interpretation skills.            |        |
| 15. ECG-ECE-6-Step approach is more efficient in helping me appreciate the clinical relevance of ECG when compared to the traditional lecturing. |        |
| 16. ECG-ECE-6-Step approach will help me apply ECG principles in real life situations in future. |        |
| 17. ECG-ECE-6-Step approach helped me gain a higher level of skills in ECG interpretation than I expected. |        |
| 18. ECG-ECE-6-Step approach helped me gain a higher level of subject knowledge in ECG interpretation than I expected. |        |
| 19. Overall, I am satisfied with the ECG-ECE-6-Step approach implemented during the present cardiovascular module. |        |
| 20. After having undergone ECG-ECE-6-Step approach, I feel more confident in interpreting ECGs. |        |
| 21. ECG-ECE-6-Step approach provided a safe learning environment.        |        |
| 22. In your opinion, what was the single most important factor that facilitated learning during the ECG-ECE-6-Step approach? Why do you think so? |        |
| 23. Your inputs are valuable. If you have any ideas/suggestions to make the ECG-ECE-6-Step approach better, please express it to us. |        |
Table A2. Focus group discussion guide

1. Ice breaker: Let me start by asking you what you would like to specialize in after finishing medical school? Why did you choose that? Is that related to disciplines you studied through your medical school so far, or a dream you have always wanted to accomplish?

2. Do you think ECG, as a medical diagnostic tool, is important to master? Why do you think so?

3. What is your perception of early clinical exposure for ECG interpretation as a teaching and learning strategy?

4. How were ECG integrated lectures? i.e., physiology followed cardiology lectures. How did they affect your ECG interpretation skills? How do you think they could be improved?

5. Did patient visits make any difference in your knowledge and interpretation skills of ECG? Why? Could you elaborate on your experience on that please.

6. What about the ECG forum and case studies, how did they affect your ECG reading skills? Why do you think so?

7. How could you rate the whole experience? Express your feelings after going through this learning experience. Do you have any further suggestions to improve ECG-ECE-6-Step approach as a teaching and learning strategy?

8. Would you like to share anything else about the ECG-ECE-6-Step approach? If we have missed anything, please do tell. Is there anything else you think we should have talked about?
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