Learning clinical skills through audiovisual aids embedded in electronic-PBL sessions in undergraduate medical curriculum: perception and performance

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Arain SA, Afsar NA, Rohra DK, Zafar M. Learning clinical skills through audiovisual aids embedded in electronic-PBL sessions in undergraduate medical curriculum: perception and performance. Adv Physiol Educ 43: 378–382, 2019; doi:10.1152/advan.00075.2019.—Learning clinical skills in a large group of undergraduate medical students is challenging. Innovative technology-based modalities are being evaluated to complement limited hospital rotations. We determined the effectiveness of clinical skills-related audiovisual (AV) aids embedded in electronic-problem-based learning (PBL) sessions, in terms of students’ feedback and formative Objective Structured Clinical Examinations (OSCE) grades. This mixed-method study was conducted during the Cardiovascular System module in year 3 of the Bachelor of Medicine, Bachelor of Surgery program. The AV aids, mainly consisting of abnormal chest auscultation sounds, were linked to the cases for the intervention group. The control group received only a description of clinical signs. Sessions were conducted using an intranet platform. At the end of the module, feedback was obtained from intervention group students and faculty using a self-administered questionnaire. The learning was compared between intervention and control groups through an OSCE. Finally, focus group interviews were conducted to explore factors underlying deviation from the expected results. Out of 110 intervention group students, 86 (78%) responded. The students appreciated the inclusion of AV aids, as suggested by a high average satisfaction score of 4.2 (SD 0.8). They agreed that, apart from being appropriate and relevant, the aids improved the learning environment and engagement in the process. The tutors also gave a similar feedback. However, no difference in the OSCE scores was found between control and intervention groups. The study indicates that inclusion of AV aids improved students’ engagement and classroom environment in electronic-PBL sessions, but did not improve diagnostic abilities based on the learned clinical skills.

INTRODUCTION

In undergraduate medical education, clinical training is challenging, especially in settings in which patients or volunteers are difficult to find, coupled with limited hospital rotations (13). To overcome the limitations associated with hospital rotations, medical schools are developing their in-house simulation centers. Simulation centers are based on examination of mannequins and standardized patients, with clinical training typically focused on performing the skills without significant emphasis on clinical reasoning.

The significance of context and relevance while learning scientific principles and clinical skills has been emphasized in the literature (2, 21). Furthermore, constructivist theory of learning highlighted the need for diversified training contexts, as it provides appreciation of, and experience in, different perspectives. Engagement in a variety of activities helps to enrich learner’s understanding. In addition, learning of the complex process of clinical reasoning should start early using multiple modalities, such as clinical case-based learning and practice of clinical skills (10). It has been reported that students have preferences for modes of learning, and a large number of them preferred a combination of learning styles (12).

At Alfaisal University College of Medicine, Riyadh, an organ system-based hybrid curriculum was adopted. Problem-based learning (PBL) remains a major learning strategy during the first 3 yr. PBL is a student-centered active learning method conducted in small groups. Group discussion is based on triggers in the life-like clinical scenarios designed to activate students’ prior knowledge and identification of knowledge gaps to formulate learning objectives. Students then learn independently for the identified learning issues and meet again as a group to share the acquired knowledge. Thus, in the PBL process, students use appropriate triggers from the clinical scenario to learn and improve understanding; it is not about problem solving by itself. During the PBL process, the role of the tutor is to guide learning by asking relevant questions if a need arises without providing information directly (20). Learning of clinical skills is carried out in a temporally coordinated fashion (7) at an in-house simulation center, along with limited hospital rotations.

Over the last few years, internal program evaluations and informal faculty feedback showed a declining interest and lack of engagement of the students in the PBL process. As reported previously, one possible reason could be the monotonous paper-based PBL cases (5, 14). Thus it was decided to conduct sessions in an electronic environment using an existing electronic learning system (intranet platform), and all of the cases were transformed into soft versions in the form of electronic-PBL (e-PBL). Introduction of the e-PBL provided the opportunity to embed audiovisual (AV) aids related to the clinical skills within the cases. We hypothesized that, including the relevant clinical skills in e-PBL sessions may foster engage-
ment of the students in the PBL process and may enhance contextual learning, thus moving up the ladder of integration (7).

Therefore, this study was conducted to determine the perception of the students and faculty regarding introduction of AV aids embedded in e-PBL. In addition, we assessed their effect on students’ diagnostic ability based on the learned clinical skills.

METHODS

Institutional context. The curriculum of the Bachelor of Medicine, Bachelor of Surgery (MBBS) course and its organization have been published previously (22). Briefly, the course is completed in 10 semesters spanning over 5 yr, designed in spiral fashion, and emphasizing a gradual “basic to clinical” shift in themes and training. The students are offered parallel running courses of clinical skills, temporally integrated with the system-based modules, and are evaluated through Objective Structured Clinical Examinations (OSCE).

Study design. This mixed-methods study was conducted during the fall semester of academic session 2017–18 at the College of Medicine, Alfaisal University, Riyadh, Saudi Arabia. The 5- wk-long Cardiovascular System (CVS) module offered in semester 5, year 3 was chosen for this study. Longitudinal clinical themes were identified to run over each week. Clinical cases in the form of e-PBL were introduced at the start of the week, with reporting or discussion sessions toward the end of week, covering major learning objectives related to the weekly themes. The clinical skills related to the CVS module were identified. The AV aids, mainly consisting of abnormal chest auscultation sounds, were linked to the e-PBL cases. These versions were offered to the selected student groups (intervention group) to complement the normal chest auscultation sounds learned in parallel-running clinical skills module. The others (control group) did not receive those AV files as part of their e-PBL cases and received only a soft copy of the description of clinical examination findings.

A total of 219 students (127 women, 58%) were enrolled in the CVS module. The students were randomly divided into 20 small groups, each consisting of 10–12 students. Male and female students were segregated into same-sex groups due to cultural reasons (12 female groups). Password-protected e-PBL cases were made available to all of the groups simultaneously each week using an intranet platform. Ten groups (6 female and 4 male groups; 64 and 46 students, respectively) received the specific AV files embedded in their e-PBL cases (intervention group), whereas the remaining 10 groups received only the description of clinical signs in e-PBL cases (control group). The AV files were available only during the PBL sessions for students to learn and reflect. Each group was supervised by a faculty member.

The study was approved by the Institutional Review Board (ref. no. IRB-59–17), and an informed consent was obtained from the participants.

Data collection. At the end of the course, the intervention group students and facilitating faculty were requested to respond to a self-administered questionnaire consisting of two components. The first part was related to the students’ perception for inclusion of AV files and designed as a 5-point Likert scale. The second component consisted of three open-text comments. The effect on learning the skills was assessed through an OSCE at the end of the module, which comprised stations pertaining to specific objectives and themes similar to those covered in e-PBL sessions.

Finally, focus group structured interviews were carried out for low-scoring students (at least 5 scorers) in the intervention group and high-scoring students (top 5 scorers) in the control group, to explore factors underlying the deviation from expected results.

Statistical analysis. The data were collected on a 5-point Likert scale as frequency (strongly disagree being 1; strongly agree being 5). Average satisfaction (AS) scores for both students and faculty were calculated based on the mean scores of all of the items in the Likert scale. In addition, we grouped “agree” and “strongly agree” into “agreement”, shown as percent frequency (%). Similarly, percent “disagreement” comprised all “disagree” and “strongly disagree” responses. Comparison of OSCE scores between the groups was made through Student’s *t*-test. Comparison of qualitative data, such as qualitative performance at each OSCE station between the groups, was made through *χ*² test. In all analyses, only a *P* value of <0.05 was considered significant. Qualitative data from open comments and focus group interviews were grouped on the basis of recurring themes and are reported as such.

RESULTS

In the intervention group, 86 out of 110 students (78%) completed the questionnaire. After excluding the inconsistent responses (through internal control question), 59 student responses were finally included in analysis (net 54% inclusion rate).

Rating on Likert scale. The feedback from students and their tutors is presented in Table 1. The students generally appreci-

| Item | Agree | Disagree | Neutral | Mean (SD) |
|------|-------|----------|---------|-----------|
| **Student feedback (n = 59)** |       |          |         |           |
| AV aids were appropriate for the cases. | 98.31 | 1.69 | 0.00 | 4.58 (0.53) |
| AV aids improved classroom environment. | 71.19 | 23.73 | 5.08 | 4.05 (0.92) |
| Compared with the text, AV aids were more helpful in learning clinical signs. | 77.97 | 8.47 | 11.86 | 4.10 (1.05) |
| AV aids improved engagement in the learning process. | 81.36 | 11.86 | 6.78 | 4.07 (0.91) |
| Overall, AV aids were helpful in learning. | 84.75 | 10.17 | 3.39 | 4.14 (0.80) |
| Average satisfaction score (maximum: 5) | | | | 4.19 (0.84) |
| **Tutor feedback (n = 8)** |       |          |         |           |
| AV aids were appropriate for the cases. | 100.00 | 0.00 | 0.00 | 4.50 (0.53) |
| AV aids improved classroom environment. | 50.00 | 37.50 | 12.50 | 3.75 (1.16) |
| Compared with the text, AV aids were more helpful in learning clinical signs. | 75.00 | 12.50 | 12.50 | 4.00 (1.07) |
| AV aids improved engagement of the students. | 62.50 | 37.50 | 0.00 | 3.88 (0.83) |
| AV aids helped me in facilitation of PBL sessions. | 50.00 | 37.50 | 12.50 | 3.38 (0.74) |
| Overall, AV aids were helpful in learning. | 62.50 | 37.50 | 0.00 | 3.75 (0.71) |
| Average satisfaction score (maximum: 5) | | | | 3.88 (0.84) |

Results are reported as percentages, and means (SD) values are of Likert scale score; *n*, no. of students. Data pertain to the intervention group students and tutors only. AV, audiovisual; PBL, problem-based learning.
ated the inclusion of AV aids, as suggested by a high AS score of 4.2 (SD 0.8) out of 5 and a high percent agreement with the questionnaire statements. They agreed that, apart from being appropriate and relevant, the aids improved learning, as well as promoted engagement in the task. The tutors also had a similar feedback, with an AS score of 3.9 (SD 0.8), and supported the inclusion of such aids in e-PBL sessions. The tutors showed highest agreement with the notion that AV aids were helpful in learning clinical skills.

Open comments and focus group interviews. The second component of the questionnaire consisted of open comments and suggestions regarding the intervention. Similar comments were grouped and are reported based on recurring themes in Table 2. In addition, a focus group assessment was conducted from low-scoring intervention group and high-scoring control group students to explore factors underlying deviation from expected results. The relevant responses are also included in Table 2. Interestingly, high-scoring control subjects rated themselves low (2–3/10) when asked about their confidence to perform the skills in an OSCE. On the other hand, the low-scoring intervention group tended to rate themselves higher (maximum 7/10) in this regard. This may suggest a higher level of confidence among the intervention group.

OSCE scores. Comparison of overall OSCE scores and performance at each OSCE station were made for control vs. intervention, and female vs. male groups. The OSCE scores are presented in Tables 3 and 4 and show no significant differences overall or stationwise.

DISCUSSION

The dearth of clinical training opportunities, on one hand, and advances like simulation technology, virtual patients, and e-learning environment, on the other hand, are compelling reasons for the implementation of innovative student-centered pedagogical strategies (16). Present-day learners have grown up immersed in a variety of technological advances and are less interested in traditional ways of learning. Introduction of e-PBL provided the opportunity to embed AV aids of the relevant clinical skills promoting contextual learning. AV aids have many advantages over paper-based cases, such as triggers to increase critical

Table 2. Indicative comments from questionnaire and focus group interviews

| Open comments from the intervention group |
|------------------------------------------|
| AV aids are useful; should be continued in e-PBL. (37)* |
| AV aids should also be included in other modules. (43) |
| Keep AV aids/e-PBL available all the time. (4) |
| Improve PBL room AV infrastructure. (4) |
| Intervention group |
| Aids were difficult to comprehend; normal should be given for comparison. |
| No curiosity/interest, as these sounds were perceived excluded from exams. |
| Control group |
| Learned these skills online out of curiosity as triggered by e-PBL and hospital rotations. |
| Received information about the AV files through peers in the intervention group. |

AV, audiovisual; e-PBL, electronic-problem-based learning. *Nos. in parentheses are the no. of similar comments that were combined as an indicative statement.

Table 3. Comparison of overall Objective Structured Clinical Examinations scores dichotomized by intervention and sex

| Group          | Exam Takers, n (%) | Mean Score (SD) | P Value |
|----------------|--------------------|-----------------|---------|
| Intervention   |                    |                 |         |
| Control        | 80 (49.38)         | 2.64 (1.20)     | 0.47    |
| e-PBL with AV  | 82 (50.62)         | 2.50 (1.19)     |         |
| Sex            |                    |                 |         |
| Women          | 95 (58.64)         | 2.44 (1.13)     | 0.11    |
| Men            | 67 (41.36)         | 2.75 (1.27)     |         |

n, No. of students. Comparison was made through Student’s t-test. Maximum possible Objective Structured Clinical Examinations (OSCE) score was 5. AV, audiovisual; e-PBL, electronic-problem-based learning.

observation and promote active listening (15). We determined the effectiveness of this educational environment in terms of perception of students and faculty and learning of clinical skills. This study enabled us to explore the utility and feasibility of integrating two different pedagogical strategies and moving up the ladder of coordination in local circumstances.

We chose the CVS module due to the clinical relevance of chest auscultation sounds, which remains a major focus of the simulation technology (19). In our institution, simulation sessions among year 3 MBBS students are planned with emphasis on adopting the right clinical method, for example, placement of the stethoscope in the appropriate areas for auscultation of heart or lung sounds. The appreciation of the actual physical sign or symptom remains secondary, primarily because the simulated patients are healthy adults. We included normal and adventitious heart and lung sounds in e-PBL cases to augment learning of clinical skills, to facilitate their correlation with disease pathophysiology, and to improve clinical reasoning in the context of the presented case, thus following a constructivist and contextual learning approach that lies at the heart of the modern practice of adult learning.

Findings of the present study confirmed our hypothesis regarding engagement of the students. Students appreciated the

Table 4. Comparison of performance at each Objective Structured Clinical Examinations station

| Station                  | Control Mean (SD) | Intervention Mean (SD) | P Value | Women Mean (SD) | Men Mean (SD) | P Value |
|--------------------------|-------------------|------------------------|---------|-----------------|---------------|---------|
| CCF, S3 gallop           | Incorrect         | 43 (38)                | 0.32    | 53 (28)         | 42 (39)       | 0.23    |
| Correct                  | 37 (44)           | 35 (18)                |         | 35 (18)         | 60 (49)       |         |
| Normal heart sounds      | Incorrect         | 43 (38)                | 0.43    | 53 (28)         | 42 (39)       | 0.08    |
| Correct                  | 37 (44)           | 28 (27)                |         | 27 (27)         | 40 (40)       |         |
| CCF, crepitation         | Incorrect         | 26 (28)                | 0.82    | 66 (42)         | 29 (25)       | 0.13    |
| Correct                  | 54 (54)           | 42 (40)                |         | 42 (40)         | 68 (40)       |         |
| Pericardial rub          | Incorrect         | 50 (58)                | 0.27    | 66 (42)         | 29 (25)       | 0.40    |
| Correct                  | 30 (24)           | 27 (27)                |         | 27 (27)         | 40 (40)       |         |
| Early diastolic murmur   | Incorrect         | 47 (51)                | 0.65    | 62 (36)         | 33 (31)       | 0.15    |
| Correct                  | 33 (31)           | 36 (36)                |         | 36 (36)         | 31 (31)       |         |
| Incorrect                | 47 (51)           | 42 (39)                |         | 42 (39)         | 60 (49)       |         |
| Correct                  | 33 (31)           | 31 (31)                |         | 31 (31)         | 40 (40)       |         |
| Incorrect                | 43 (38)           | 28 (27)                |         | 27 (27)         | 40 (40)       |         |
| Correct                  | 37 (44)           | 35 (18)                |         | 35 (18)         | 60 (49)       |         |
| Incorrect                | 26 (28)           | 27 (27)                |         | 27 (27)         | 40 (40)       |         |
| Correct                  | 54 (54)           | 42 (39)                |         | 42 (39)         | 68 (40)       |         |

n, No. of students. CCF, congestive cardiac failure. Comparisons were made through χ² test.
inclusion of AV aids, as reflected by a high AS score of 4.2 (SD 0.8). They agreed that AV aids improved the learning environment and engagement in the task. In open comments, students strongly favored the continued inclusion of AV files in other modules. Similarly, tutors also had a favorable AS score of 3.9 (SD 0.8) and supported the inclusion of such aids in e-PBL sessions.

The findings of our study are consistent with other reports (5, 11, 15, 17). In those studies, PBL consisted of a video of a patient-doctor encounter, followed by either a group discussion (5, 11), or the use of special software for e-PBL application (17), or the use of virtual animated patients (6, 15). In all of those studies, the AV version of the PBL was preferred by the students, and it improved their engagement.

On the other hand, it has been argued that video-based e-PBL sessions rich in sensory data may cause sensory saturation and cognitive overload (1, 9). In addition, excessive use of videos and multimedia may overwhelm and interfere with the group discussion process in a PBL session (3, 8). Musal et al. (17), who used e-PBL software, reported technical problems related to the infrastructure and a lesser depth of discussion. This could imply that the addition of AV aids may act as a distractor in the learning process. We used a combination of case description with the addition of limited AV clues, primarily chest auscultation sounds, to avoid cognitive overload, as well as to maintain group dynamics. Consequently, 50% of our participating faculty agreed that e-PBL improved the classroom environment. However, in informal discussions, few expressed their apprehension regarding the distraction caused by AV clues. One possible reason might be that students accessed e-PBL cases on their devices, watching and listening to AV clues individually, which affected group dynamics. In fact, in open-text comments, many students asked for improvements in PBL room AV infrastructure to be able to access AV clues as a group.

In this study, we explored the effect of our approach in terms of OSCE score. Comparison of OSCE scores between the intervention and the control groups did not show any significant differences. Furthermore, we could not observe any sex differences in the adoption of this learning style. There could be multiple reasons for a comparable OSCE score between groups. First, students knew that the assessment for the clinical skills learned during the e-PBL will be formative. In fact, in focus group interviews, low-scoring students of the intervention cohort admitted that they did not take an interest, as e-PBL-related AV content was excluded from examinations. On the other hand, high-scoring students of the control cohort learned those skill using online resources out of interest, as triggered by the PBL cases and clinical rotations. Second, clinical skills-related AV content was made available only for a limited time to avoid spill-over of the information as much as possible. However, such dissemination of information about AV aids and independent study by the control group students could not be restrained, as was evident from focus group interviews. In fact, our findings agree with some earlier reports showing e-PBL having no effect on the knowledge content or diagnostic ability of the students (11, 17, 18). On the other hand, Bintley et al. (4) reported improvement in students’ knowledge of physiology using case-based sessions combined with advanced simulation. However, they did not assess for clinical skills, and their case-based sessions followed a format of problem solving, unlike our study, in which we used e-PBL cases for trigger-based learning of clinical skills and reasoning.

Study limitations. Although the students and faculty strongly favored the inclusion of AV aids in other modules, this intervention in a single, 5-wk module is not enough to assess if the engagement and enthusiasm is maintained over time. This intervention should be continued in other modules to have a better perception of its efficacy. In addition, comparable OSCE scores may not be reflective of actual learning incurred through this process, as limited exposure, spill-over of the learning resources, and lack of extrinsic motivation in this study might have masked its effects. Therefore, further studies should be conducted over multiple modules with inclusion of learned clinical skills in summative assessment as an element of extrinsic motivation.

Conclusions. Our study showed that both students and faculty appreciated the inclusion of clinical skills-related AV aids in the e-PBL sessions. It improved students’ engagement in the learning process and classroom environment. Inclusion of AV aids did not improve diagnostic abilities, as assessed by OSCE scores. Educators can add AV aids in e-PBL to motivate students, but a significant improvement in diagnostic ability may not be predicted. Also, while using AV aids in e-PBL, their effect on group dynamics and PBL room infrastructure should be carefully considered.

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