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STUDENTS' CORNER
RESEARCH ARTICLE

Use of simulation based technology in pre-clinical years improves confidence and satisfaction among medical students

Muhammad Bilal Mirza,[1] Anjiya Sulaiman,[1] Satwat Hashmi,[3] Samar Zaki,[4] Rehana Rehman,[5] Rozmeen Akbar[6]

Abstract

Objective: To determine perception of medical students about learning from integrated simulated clinical skill sessions as part of the undergraduate curriculum.

Method: The cross-sectional study was conducted at the Centre for Innovation in Medical Education, Aga Khan University (AKU), Karachi, from July 2018 to February 2019, and comprised first year medical students undertaking the Respiration and Circulation module of the curriculum. Quantitative data was collected using a questionnaire and the responses were assessed on a five-point Likert scale. Data was analysed using SPSS 21. Qualitative data was gathered through focused group discussion with students and an in-depth interview with the facilitator conducting the sessions. The data was subjected to thematic analyses.

Results: Of the 161 subjects, 71(44%) participated in the session I and 90(56%) in the session II. Altogether 68(96%) students in session I and 81(90%) in session II believed integrated sessions to be effective in achieving learning objectives, and 65(92%) in session I and 79(88 %) in session II found them motivating, while 61(86%) in session I and 76(84%) in session II expressed the confidence that they had accomplished learning objectives and felt they had learned practical clinical skills; session I, 59(84%), session II, 73(81%). Qualitative analysis revealed that these sessions enhanced understanding of the subject matter and student engagement.

Conclusion: Integrated clinical skills sessions improved students' interest, engagement and confidence. It should be implemented in undergraduate medical teaching curriculum.

Keywords: Simulation, Clinical skills, Confidence, Satisfaction, Pre-clinical years. (JPMA 71: 1296; 2021)

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Introduction

Introduction of clinical skills education in preclinical years with early integration of clinical and basic sciences' knowledge has been shown to be effective in increasing students' confidence, improving performance and better preparing students for clinical rotations.[1-4] In recent years, simulation-based medical education (SBME) has emerged as an essential and effective method for supplementing and enhancing comprehensive clinical skills education in undergraduate medical curricula. In an SBME programme, clinical situations are simulated for teaching and learning purposes, creating opportunities for deliberate practice of new skills without involving real patients. Simulation takes many forms; from simple skills training models to computerised full-body mannequins.[5] While emerging evidence supports the value of simulation as an educational technique, it also cautions that simulation must be integrated into the curriculum in a way that promotes effective transfer of skills to clinical practice.[6]

SBME is particularly useful with changing trends in hospital management and increased medical accountability with emphasis on provision of patient safety and nominal margin for medical errors. The use of medical simulators has shown to have positive implications for both patient safety and training time.[7,8] Simulation provides facilitators with the ability to deliver training in controlled environments under a variety of conditions, including uncommon or high-risk scenarios.[1] With implementation of SBME, clinical skills sessions can become more standardised, allowing for better feedback and evaluation of performance.[9] SBME offers a defined metric for assessing competency, and permits the quantitative measurement of performance due to the objectively standard scenarios presented.[10]

The five-year Bachelor of Medicine, Bachelor of Surgery (MBBS) programme at the Aga Khan University (AKU) is structured with two years of basic science training, followed by three years of clinical training. Preclinical students participate in three-hour clinical skills sessions related to their ongoing preclinical module, like respiration and circulation, musculoskeletal etc., on a

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weekly basis. These sessions aim at introducing students to the basics of clinical history-taking and examinations to provide a strong foundation for clinical skills. Currently, each skill session is taught with the aid of a healthy, live simulated patient. While this approach allows students to practice their history-taking and examination skills, there are specific learning objectives which are difficult to meet on live simulated patients. Although there are mechanical simulators available for use at AKU which are commonly used in the clinical years, they had not previously been considered for use in preclinical education.

Clinical skills sessions may involve live simulated patients, like healthy volunteers who are present during teaching sessions for students to practice history-taking and examination skills, mechanical simulators, or a combination of the two during integrated sessions. The current study was planned to determine the effectiveness of integrated simulated clinical skills sessions by adding mechanical simulators to the curriculum and their effect on perception and attitudes of students towards their learning.

Subjects and Methods

This mixed-method cross-sectional pilot study was conducted at the Centre for Innovation in Medical Education (CIME), AKU, Karachi, from July 2018 to February 2019, and comprised both quantitative and qualitative components. After approval from the institutional ethics review committee, first year undergraduate medical students, mean age 20±2 years were enrolled during the Respiration and Circulation Module. Informed consent was obtained from the subjects prior to enrolment. Two mandatory clinical skills sessions were chosen for integration: examination of precordium / heart sounds and chest examination. A mechanical cardiopulmonary patient simulator was utilised during the integrated sessions (Harvey®) which was a life-sized model with the capability to replicate normal and abnormal cardiovascular and respiratory findings.[11]

Prior to the sessions, the faculty members facilitating first year clinical skills sessions were trained to use the simulator by the CIME technical staff. These sessions were mandatory for the facilitators and consisted of a basic, non-certificate session that gave an overview of the specific features of the simulator that were used in the two sessions. These included normal heart and lung sounds and selected abnormal heart and lung sounds, like palpable pulses, diastolic murmur, systolic murmur, crepitation, wheeze etc. The facilitators were provided a handout of the specific skills and objectives which were to be demonstrated in each session. These objectives were developed with input from facilitators with prior experience of teaching clinical skills sessions during the Respiration and Circulation Module and approved by the institutional clinical skills committee.

The integrated sessions were set up in three portions. The first portion consisted of a 30-minute didactic discussion with session facilitators about the clinical skills to be performed. Subsequently, live simulated patients were called into the rooms for practice. There were a total of nine student groups, with 10-11 students in each of them. As there was only one simulator available and multiple group sessions were simultaneously ongoing, the groups were scheduled to have 20 minutes with the simulator in between their practice with the live simulated patients (Annexure-A).

At the end of each session, the students were asked to complete a perception-related questionnaire (Annexure-B). Perception is defined as the organisation, identification and interpretation of sensory information in order to represent and understand the environment.[12] This helped determine whether the sessions had an impact on satisfaction and confidence of the students. At the end of the final session, a focused group discussion (FGD) with students was carried out. One student from each group was randomly selected to join the FGD for a total of nine participants (Annexure-C).

Confidentiality of the participants was maintained by seeking information without identification, and de-identifying which group each participant was part of.

Annexure-A: Schedule for preclinical integrated clinical skills session.

	Group 1	Group 2	Group 3	Group 4
1400-1430	Discussion based teaching session with clinical faculty	Discussion based teaching session with clinical faculty	Discussion based teaching session with clinical faculty	Discussion based teaching session with clinical faculty
1430-1450	Practice with Harvey®	Practice with simulated patient	Practice with simulated patient	Practice with simulated patient
1450-1510	Practice with simulated patient	Practice with Harvey®	Practice with simulated patient	Practice with simulated patient
1510-1530	Practice with simulated patient	Practice with simulated patient	Practice with Harvey®	Practice with simulated patient
1530-1550	Practice with simulated patient	Practice with simulated patient	Practice with simulated patient	Practice with Harvey®
1550-1600	Perception survey			

Annexure-B: Perceptions questionnaire.

Perception of Satisfaction about Simulation-based sessions:

I) Please respond in terms of usefulness of integrated clinical skills teaching method with simulation as SDA (Strongly Disagree), DA (Disagree), N (Neutral), A (Agree), and SA (Strongly Agree).

Statement	SDA	DA	N	A	SA
1. The integrated clinical skills teaching method with simulation was effective in achieving the learning objectives of the session	----	----	----	----	----
2. The integrated clinical skills teaching method with simulation was well integrated with the weekly topics of the R&C module	----	----	----	----	----
3. The integrated clinical skills teaching method with simulation was comprehensively organized in terms of scheduling and planning	----	----	----	----	----
4. The facilitators were well trained in using simulations	----	----	----	----	----
5. The facilitators gave me clear ideas of what is expected from me during this session	----	----	----	----	----
6. I enjoyed how my facilitator conducted the simulation sessions	----	----	----	----	----
7. The integrated clinical skills teaching method with simulation were motivating me to learn	----	----	----	----	----
8. The facilitator gave me sufficient guidance before I performed on simulation	----	----	----	----	----
9. The facilitators gave me feedback concerning my simulation experience	----	----	----	----	----
10. The integrated clinical skills teaching session provided me with enough opportunities for independent practice	----	----	----	----	----
11. The way my facilitators conducted the simulation was suitable to the way I learn	----	----	----	----	----
12. The integrated clinical skills teaching method with simulation helped me to link theory to practice	----	----	----	----	----
13. The quality of facilitation was consistent among different integrated clinical skills teaching sessions	----	----	----	----	----
14. Simulation sessions were standardized between different groups of students (in terms of objectives, facilitators, availability of resources, timings, etc.)	----	----	----	----	----

Perception of Confidence about Simulation-based sessions:

II) Please respond in terms of confidence gained by students after simulation-based sessions as SDA (Strongly Disagree), DA (Disagree), N (Neutral), A (Agree), and SA (Strongly Agree).

Statement	SDA	DA	N	A	SA
1. I am confident that I am obtaining the required knowledge from integrated clinical skills sessions with simulation to perform necessary tasks in a clinical practice	----	----	----	----	----
2. I am confident that I am developing the required skills from integrated clinical skills sessions with simulation to perform necessary tasks in a clinical practice	----	----	----	----	----
3. I am certain that I can accomplish my intended learning objectives for these sessions	----	----	----	----	----
4. I am confident that I am mastering the content of the simulation activity that my facilitators presented to me	----	----	----	----	----
5. I am confident that the integrated clinical skills sessions with simulation covered all the necessary content mentioned in the curriculum	----	----	----	----	----

Annexure-C: Focused group discussion questions.

- What is your opinion about use of simulation based technology as a teaching/learning tool?
- Do simulation based sessions promote student engagement in the class? If yes, how?
- Should this be continued to be used as a teaching/learning tool?
- What are your suggestions for other leaning pedagogies which could meet better the expectations and needs of 21st century learner?
- Please compare and contrast the usefulness of integrated simulation based teaching with the conventional session format
- In your opinion, what are/could be the short comings of this integrated medical simulator based teaching?

Once collected, physical copies of the questionnaire were kept in a locked cabinet when not in use by the researchers. Soft copies of data were saved as encrypted, password-protected files.

An in-depth interview with a senior faculty member conducting the clinical skills sessions was also arranged. The facilitator had been facilitating preclinical year clinical skills sessions for >5 years.

The questionnaire was designed to record the response of students, covering two main components: usefulness of integrated clinical skills teaching method with simulation (14 items) and confidence gained by students after simulation-based sessions (5 items). The questionnaire was developed after literature review and discussion among peers; the method being Delphi rounds. The items were devised, validated with content experts and then a preliminary testing with 20 students.[13]

The response acquired from the students on a set

criterion was assessed on a Likert scale ranging from 1-5, where 5 = strongly agree, 4 = agree, 3 = neutral, 2 = disagree, and 1 = strongly disagree. The 'strongly agree' and 'agree' responses were clustered as a 'positive response', whereas 'disagree' and 'strongly disagree' were grouped as a 'negative response'. The neutral responses were discarded. Quantitative data was analysed using SPSS 21.

Qualitative data was collected through the FGD and the interview. The interview guide was developed based on relevant literature on FGD and with reference to previous studies[14,15] considering the integration of SBME with the conventional clinical skills format. These sessions were facilitated by a trained teaching assistant. The FGD and interview lasted approximately 30 minutes and were audio-taped. For analysis, simple verbatim transcription of FGD recordings was carried out. The credibility of results were explored by member checking, or respondent validation, in which results were returned to the participants to check for accuracy and any mistakes.[16] Qualitative data was subjected to thematic analyses.

Results

Of the 161 subjects, 71(44%) participated in the first session (40 males and 31 females) and 90(56%) in the second (50 males and 40 females) (Table).

Altogether 68(96%) students in session I and 81(90%) in session II (Table-1) believed integrated sessions to be effective in achieving learning objectives. There were clear differences between positive and negative reactions to the various parameters testing the satisfaction of the students after the integrated sessions. The students overwhelmingly expressed their satisfaction after the sessions and considered them enjoyable and motivating; 65(92%) in session I and 79(88 %) in session II (Table).

The students expressed the confidence that the integrated sessions covered the necessary content mentioned in the curriculum; session I, 61(86%) session II, 76(84%) and that they felt confident about having acquired the required knowledge and having developed the required skills to perform necessary tasks in clinical practice; session I, 59(84%), session II, 73(81%) (Table).

The first of the themes that emerged from the FGD was enhanced understanding of subject matter. The students generally were of the opinion that the integrated clinical skills session was a useful modality

Table: Students' perception of integrated clinical skill sessions.

	Session I: Examination of precordium/ heart sounds (n=71: males 40, females 31)		Session II: Chest examination (n=90: males 50, females 40)	
	Positive responses*	Negative responses*	Positive responses	Negative responses
Student's perception of effectiveness of integrated clinical skills sessions				
The integrated clinical skills teaching method with simulation was:				
◆ Effective in achieving the learning objectives of the session	68 (96%)	1 (1%)	81 (90%)	2 (2%)
◆ Well integrated with the weekly topics of the R&C module	54 (76%)	5 (7%)	81 (90%)	1 (1%)
◆ Well organized in terms of scheduling and planning	51 (72%)	7 (9%)	80 (89%)	4 (4%)
◆ Helped students link theory to practice	61 (86%)	1 (1%)	81 (90%)	2 (2%)
◆ Provided opportunities for independent practice	48 (68%)	11 (16%)	61 (68%)	14 (15%)
◆ Motivating the students to learn	62 (87%)	1 (1%)	81 (90%)	2 (2%)
◆ Suitable to the way individual students learn	60 (85%)	3 (4%)	80 (89%)	3 (3%)
◆ Were standardized between different groups of students (in terms of objectives, facilitators, availability of resources, timings, etc.)	47 (66%)	4 (6%)	75 (83%)	4 (4%)
◆ Were enjoyable for the students	65 (92%)	0 (0%)	79 (88%)	1 (1%)
Facilitators for the integrated clinical skills sessions with simulation were:				
◆ Well trained in using simulations	69 (97%)	0 (0%)	82 (91%)	1 (1%)
◆ Gave students clear ideas of what is expected from the students	64 (90%)	0 (0%)	80 (89%)	4 (4%)
◆ Gave sufficient guidance before students performed on simulation	61 (86%)	3 (4%)	78 (87%)	5 (6%)
◆ Gave and received feedback about the simulation experience	39 (55%)	13 (18%)	61 (68%)	11 (12%)
Students' perception of confidence gained after integrated sessions				
◆ Acquiring the required knowledge to perform necessary tasks in a clinical practice	61 (86%)	2 (3%)	74 (82%)	3 (3%)
◆ Developing the required skills to perform necessary tasks in a clinical practice	59 (83%)	1 (1%)	73 (81%)	4 (4%)
◆ Accomplishing the intended learning objectives	59 (83%)	0 (0%)	70 (78%)	3 (3%)
◆ Mastering the content of the simulation activity	54 (76%)	3 (4%)	71 (79%)	5 (6%)
◆ Covering the necessary content mentioned in the curriculum	61 (86%)	2 (3%)	76 (84%)	1 (1%)

*The table shows positive and negative responses as total number of responses (percentage of responses).

for their learning. One participant commented, "It cemented whatever we learned".

The students emphasised that as preclinical students are not used to actual patients, it is easier for them to recognise the findings on the simulator that have much more obvious findings. This was evident in one participant's statement, "It is hard for the students to recognise findings on actual patients, so the simulator technology helps them to get used to it before actual hands-on".

They also added that students used to listen to recorded heart and lung sounds before the availability of simulators and that had variable quality. The ready availability of this technology was also a strong point in favour of using mechanical simulators. Students noted that they can come back to access the simulator if they want to practice further, which is not possible with a simulated patient. Furthermore, mechanical simulators provide the additional advantage of practicing placing the stethoscope on the right areas on the precordium to hear normal heart sounds and murmurs, and on the chest to hear normal and pathological breath sounds: "So it is more practical".

The simulator used in the study allowed as many as 10 students listen to the same sound at the same time. Conventionally, only one student examines and listens to heart and lung sounds at a time on a patient, while the other students observe.

The second theme was enhanced student engagement. The students' reaction echoed in one comment: "It makes it more interesting". Participants recalled being excited by having a chance to learn on the simulator. One student commented, "*When you see a you know like that Harvey® lying down over there so you kinda get impressed by it that you know we have something like this over here so you are more keen to get to do as much as you can about that*".

The moderator summarised the participants' comments: "*So basically the interest, the attention span increases when it comes to technology-based simulations*". The students agreed that the simulation technology was engaging, but the biggest factor that made the difference was the facilitator teaching the session — a good, engaged facilitator was important for maintaining student engagement.

Another theme was the pitfalls in simulation-based teaching methodologies. The participants were very cognizant of the pitfalls of over-dependence on SBME. They discussed how if sessions were done only on a simulator, it would 'dehumanise' the experience by removing interaction with real humans. "The personal level connection you have with that person is obviously not there", one student commented.

The group also added that one cannot judge if the patient is angry, sad or in pain when you are practicing on a simulator. Gauging the pain response is crucial when you are learning to examine a patient. On this aspect, one of the students remarked, "*So a lot of times when you might touch it, you might not be as considerate as you might be with touching a patient*".

Moreover, there were a number of examination procedures which could not be performed on a single simulator, leading to the need for a number of different simulators to cover a complete clinical skills session content without a live simulated patient. The fact that the findings are exaggerated for clear understanding also moves the experience further from real life experience. "You normally wouldn't hear those sounds that clearly on a patient so in a way it's making you used to something you will never see on an actual patient".

The next theme was a useful and effective addition to traditional teaching methods. The students were in unanimous agreement that SBME should not be adopted in totality, especially in the clinical skills sessions of the first two years of pre-clinical medical education. They serve best if integrated into the sessions where some aspects are covered by the simulation and others through the traditional patient interaction.

One participant said, "*I think we should have both of them because it's just a matter of experience*".

During the in-depth interview, the facilitator, while talking about the usefulness of SBME, noted that patients often do not want to be examined by students. Therefore, SBME can aid students in learning about perception and interpretation of different clinical examination findings, like example heart and lung sounds. As far as preclinical students are concerned, the facilitator pointed out: "*A second-year student or a first-year student who has studied basic sciences, it's very good for him if you teach him history and examination and clinical skills, basic things to exert a trickle-down effect in the clinical years*". He stressed the importance of communication with patients: "*this technology and the entire world's information is in your hands. But this will not replace patient interaction, — patient interaction and examining a patient comes first and then maybe they can go back further*".

In response to a question comparing integrated simulation-based teaching with the conventional session format, he added that although replacement of

traditional teaching is occurring at a rapid rate, computers cannot replace nurses and doctors -- "*but they can use these gadgets for facilitation of learning and clinical practice*". He also commented on expectations in clinical rotations, where students are expected to interact with and examine patients on a regular basis. With reference to use of the simulator, he reiterated that the "*satisfaction which a doctor acquires with 'human touch', in examination, on interaction, in a polite manner, in a soft manner, you are placing your hand on them, so that that they don't feel any pain, taking care of privacy is incomparable*". This satisfaction and bedside manner can be learned with the aid of live simulated patients, but not on mechanical simulators: "*You teach them everything on the SP [simulated patient] first and then expose them to real patients*". The facilitator concluded by stating that *"teaching on the simulator should be added, but supplemented with live simulated patients and real clinical experience"*.

Discussion

Adult learning works best through multimodal learning strategies[17]. Introduction of clinical skills in the preclinical years facilitates the integration of knowledge related to clinical and basic sciences.[3] It increases students' confidence, improves performance and better prepares them for actual patient interaction.[1,2] Clinical skills teaching, however, has been reported to be inadequate by many.[5,9] SBME utilisation in clinical skills teaching has proved helpful.[18] It is important, however, to be cognisant of the effects of removing human interaction from basic clinical skills education, which was a recurring topic in the qualitative analyses of the current study. A possible solution to this problem comes in the form of integrated sessions.[19-21] These allow for interaction with live simulated patients as well as opportunity to learn on mechanical simulators.

The current study found that students had positive perceptions regarding the effectiveness of integrated clinical skills sessions using SBME. Over 80% of the students found the sessions motivating and informative. This agrees with previous studies and demonstrates acceptance among the students.[21,22] An overwhelming majority of students in the current study felt confident with acquiring knowledge through the sessions and felt that they would be able to apply the essential skills learned in clinical practice. This observation is comparable to studies which found that realistic scenario-based simulation enhanced nursing students' competence and confidence[23] and improvement in student satisfaction scores with the addition of SBME.[24,25]

Studies have shown that most medical students were deficient in interviewing, history-taking and systemic examination skills.[6,26] A group on Educational Affairs Plenary of the Association of American Medical Colleges has also discussed clinical skills deficiencies of medical students.[1,26] SBME has emerged as an effective tool to deal with this problem. Students in the current study felt that integrated clinical skills sessions cemented their basic medical knowledge and improved their performance in the clinical setting with more hands-on experience readily available. A study conducted to teach the pharmacology of anaesthetic drugs to second year medical students using a 'MedSim-Eagle (Binghamton, NY) full-scale mannequin' showed that more >80% students considered the integrated clinically oriented sessions better than didactic teaching.[27] Sequential demonstration and practice using simulators during group sessions allows students to learn from each other's mistakes, leading to an overall improvement in students' performance. Furthermore, the interest garnered by adding novel modalities is more likely to engage students than traditional learning formats.

Whether the skills developed using mechanical simulators are worth the limited funding allocated to government-funded universities is an important concern to address when considering implementation of SBME in low-middle income countries (LMICs). Also, simulation-based training for faculty and staff is very resource-intensive.[28]

Although the results of the current study are promising, introducing expensive mechanical simulators in these settings, with the attached initial and maintenance costs, may not be possible for many institutions. However, a study carried out at a government-funded university in Pakistan with an intermediate-fidelity simulator as a teaching and learning tool found that students who had received training on the simulator performed significantly better on skills evaluation.[29]

With clear benefits with SBME, it is recommended that low-fidelity, cost-effective simulators that may be integrated into medical curricula in LMICs should be studied further.

The current pilot study has limitations as it was done at a single centre, and was carried out during a single curriculum module comprising only first year medical students. Studies with larger sample size are needed. Also, the reliability of the score on the questionnaire was not calculated.

Conclusion

Integrated clinical sessions improved students' interest,

engagement and confidence. With the positive feedback from students and faculty, it is proposed that SBME should be implemented in undergraduate medical teaching in an integrated format. It is important to consider feasibility of introducing mechanical simulators on a larger scale in LMICs and further research should be undertaken on the benefits of low-fidelity simulators in these environments.

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