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Large-scale trauma education for all? Learner perspective and implementation insights

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Abstract
Introduction: Trauma represents a significant global health burden, yet dedicated trauma education is frequently deficient in undergraduate medical curricula. Consequently, medical students often report lack of preparedness to manage trauma cases. The optimal approach to integrate trauma education in medical school curricula remains unclear.
Objective: To evaluate the feasibility of implementing large-scale simulation-based trauma education within the core medical curriculum and assess student perceptions.
Methods: An *Initial Trauma Management Course* was devised and implemented as part of the standard surgery clerkship. The course combined a lecture and case-based learning with three simulation-based hands-on stations. Small-group teaching was employed. Twelve course editions per year (up to 30 students each) accommodated an annual capacity of 360 students.
This was a mixed method cross-sectional study with a prospective component. Students completed a post-course survey with Likert-scale items and open-ended comments. Quantitative data were analyzed using descriptive statistics, and thematic content analysis was conducted on qualitative data from student commentary.
Results: Over a two-year period, 685 students attended the course and 622 completed the survey (91% participation rate). Over 90% of respondents rated all the course's components and stations *very relevant*. Qualitative analysis identified hands-on training, use of simulation/manikins, content relevance, quality of instructors and interactive learning as the most valued aspects.
Conclusion: The implementation of a simulation-based trauma course as part of the undergraduate core curriculum was feasible and highly valued by students. These findings support broader integration of structured trauma education and offer a scalable model for other institutions.

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PALABRAS CLAVE
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Educación en trauma para todos: Implementación y perspectiva del estudiante

Resumen
Introducción: El trauma representa una carga significativa para la salud global. Sin embargo, la educación dedicada al trauma es frecuentemente deficiente en los programas de pregrado en medicina. Como resultado, los estudiantes de medicina reportan a menudo falta de preparación para gestionar casos de trauma. El enfoque óptimo para integrar la formación sobre trauma en los currículos médicos sigue siendo incierto.
Objetivo: Evaluar la viabilidad de implementar educación sobre trauma basada en simulación a gran escala dentro del currículo estándar y evaluar las percepciones de los estudiantes.
Métodos: Se diseñó e implementó *un Curso Inicial de Manejo de Trauma* como parte de la enseñanza clínica de cirugía. El curso consistía en una sesión con aprendizaje basado en casos y tres estaciones prácticas de simulación. Se empleó enseñanza en grupos pequeños. Se realizaron 12 ediciones del curso al año (hasta 30 estudiantes cada una), con una capacidad anual de 360 estudiantes. Este fue un estudio transversal de métodos mixtos con un componente prospectivo. Los estudiantes completaron una encuesta posterior al curso con ítems de escala Likert y respuesta abierta. Los datos cuantitativos fueron analizados con estadísticas descriptivas y el análisis de contenido temático se llevó a cabo en los datos cualitativos.
Resultados: Durante dos años, 685 estudiantes asistieron al curso y 622 completaron la encuesta (tasa de participación del 91%). Más del 90% de los encuestados calificaron todos los componentes del curso y las estaciones prácticas como muy relevantes. El análisis cualitativo identificó la formación práctica, el uso de simulación/maniquíes, la relevancia del contenido, la calidad de los instructores y el aprendizaje interactivo como los aspectos más valorados.
Conclusión: La implementación de un curso de trauma basado en simulación como parte del currículo médico de pregrado fue viable y muy valorada por los estudiantes. Estos resultados respaldan una mayor integración de la educación estructurada sobre trauma y ofrecen un modelo escalable para otras instituciones.

Introduction

Trauma is a significant cause of emergency department admissions, and severe trauma is a leading cause of death among young patients, accounting for up to six million deaths per year worldwide.[1] Globally, it remains the main cause of death among youngsters, surpassing infectious diseases.[2] In the European Union, accidents caused 3.3% of all deaths and accounted for more than one-third of all deaths among people aged 15–24 years.[3]

Trauma systems and training programs are of utmost importance in the adequate management of trauma patients and in reducing mortality.[4–7] While postgraduate trauma care training is focused on medical specialties involved in the care of trauma patients, a general understanding of the principles of trauma management is key for any medical student upon completion of their degree.

Despite the global importance of trauma, dedicated trauma education is lacking[8] in many medical schools and the topic remains scattered among the curriculum of surgery, orthopedics, emergency or intensive care medicine.[8–11] Upon completion of their medical degrees, students report low rates of trauma teaching, both in knowledge and practical skills.[10] In a survey of final-year British medical students,[8] only 16% of participants reported that trauma education at their institution had been adequate, with 93% stating that it would have been useful for a short course to have been formally included in their medical school's curriculum.

While calls for the introduction of dedicated trauma education in medical schools have been made,[11] the optimal approach to undergraduate trauma education is yet to be defined. A review of the literature on trauma education for medical students yields a wide variety of teaching models, and most of the literature reports on smaller groups often composed of voluntary students.[12,13]

On the other hand, evidence on trauma education in the post-graduate setting is extensive. In particular, there is comprehensive evidence supporting the use of simulation-based education.[14–16]

Simulation allows for standardized educational opportunities, available on demand in a controlled environment.[17] A recent review of the literature has shown simulation-based education to be associated with increased performance and high appreciation by medical students.[10]

The aims of this study were to: (i) report on the implementation of a trauma course for a large cohort of

students as part of the standard curriculum of a medical school and assess its feasibility and (ii) to analyze students' perceptions regarding the course's relevance and utility.

Methods

Trauma course design

We planned and designed a course named *Initial Trauma Management Course (ITM)* consisting of (a) a lecture and case-based learning on the principles of trauma management (1 h), (b) three simulation-based hands-on stations. Students rotated in smaller groups through the hands-on stations and each student was given the opportunity to practice: (i) airway management (ii) shock management and venous accesses and (iii) immobilization of fractures. Each hands-on station had a duration of 1 h.

For the hands-on stations, a skills lab with three separate rooms, equipped with manikins (physical anatomic trainers) and materials, was prepared specifically for the course. Instructors were involved in activity planning and briefed on practical skills teaching.[18] Following explanation and demonstration by the instructors, students were encouraged to practice the skills under supervision allowing for personalized feedback from instructors as per zone 1 simulation design.[19] Learning outcomes for the course and each hands-on station were defined in line with the principles of simulation-based learning: remembering, understanding and applying the principles of initial management (ABCDE) of trauma patients. Learning Outcomes are detailed in Appendix A.

The course instructors in the various hands-on stations included general surgeons, orthopedic surgeons and anesthesiologists. They were all ATLS (Advanced Trauma Life Support) certified, and some were ATLS instructors themselves.

The course was delivered to all fourth-year medical students during their surgery clerkship as part of the standard curriculum.

Twelve editions of the course were run every academic year. Each of the twelve course editions had a maximum of 30 students, for a total annual capacity of 360 students.

Population and study design

The study population comprised all students who participated in the *ITM* course in the academic years of 2021/2022 and 2022/2023.

The design of the study included three components:

- Assessment of operational feasibility of implementing a trauma course to a large cohort of students as part of the standard curriculum.
- Cross-sectional mixed-methods survey to gather and analyze students' perceptions regarding the course's relevance and utility.
- Prospective sub-sample re-assessment of students' perception among a convenience sample of final year medical students attending a case-based revision course two years later (this component took place during the academic year of 2024/2025).

Outcome measures

To assess students' perception on the relevance and suitability of the *ITM* course, a survey with structured 5-point Likert scales was used. Students were asked to rate whether they had found the course contents and hands-on stations relevant/useful and whether they had found the course contents adequate/suitable to their level of medical studies.

In order to analyze students' input on the didactics and learning strategies of the course, students were also asked for open commentary/suggestions and requested to highlight the course's strengths and weaknesses.

The questionnaire had been developed by the Medical Education Department of the Medical School and was validated through expert review and pilot testing.

In the sub-sample analysis, to evaluate the course's perceived contribution to trauma knowledge, a convenience sample of final year medical students attending a revision course was invited to rate on a Likert scale the contribution of the course and each of its components to their level of knowledge upon completion of their medical degree.

Consistent with the study's focus on feasibility and student perception, objective measures of learning, such as post-course tests or Objective Structured Clinical Examinations (OSCEs), were not included in the outcome assessment.

Data analysis

All survey responses were included.

Descriptive statistics were performed to analyze data on the Likert scale rates for relevance/usefulness and adequacy of the course.

For the qualitative analysis, a thematic analysis was performed.[20] All comments were transcribed and reviewed. Secondly, comment fragments were grouped with similar comments and organized into common themes through an inductive approach.[20] Illustrative quotes were selected to exemplify each identified theme. These themes yielded a category scheme according to which all comments were then coded.

All analyses were performed with Microsoft Excel.

Results

Over two academic years, course attendance was 685 students (90% attendance rate). The median number of students per course was 28. Of the 685 students who attended the course, 622 students answered the survey (91% response rate).

Relevance of the course

Responses on students' perception of the relevance of the course showed that over 90% of students deemed all the course's components and stations **very relevant,** as detailed in Table 1.

Questioned on whether they found the course **adequate/suitable**, 86.8% of students deemed the lecture + case discussion to be very adequate while more than 90% rated the three **hands-on stations as very adequate** (Table 2).

Table 1 Likert scale rates for **relevance** of the course, n(%).

	5 (Very relevant)	4 (Relevant)	3 (Moderately relevant)	2 (Barely Relevant)	1 (Not relevant)
Lecture + Cases	558 (89.7%)	57 (9.1%)	5 (0.8%)	–	–
Airway	587 (94.4%)	24 (3.6%)	8 (1.3%)	1 (0.1%)	–
Shock venous accesses	589 (94.7%)	27 (4.3%)	2 (0.3%)	–	–
Immobilization	585 (94.1%)	30 (4.8%)	6 (0.9%)	1 (0.1%)	–

Thematic analysis

Qualitative analysis of the surveys yielded 2421 comment fragments provided by 622 students. These fragments were grouped into five major categories: (i) Hands-On and Applied Cognition; (ii) Learning Resources & Outcomes; (iii) Course Relevance; (iv) Teaching/Learning Environment; and (v) Logistics. Comments in these five categories were further grouped into 26 themes, as displayed in Appendix B.

The ***Hands-On and Applied Cognition*** was the most mentioned category (n = 685, 28.3%). Students highly valued the hands-on training (n = 348 comments) and the use of manikins and simulators (n = 145). Some students commented on the benefits of applied cognition: "unique opportunity to put theoretical knowledge into practice".

Regarding the ***Learning Resources and Outcomes*** category (263 comments, 10.9%), students highlighted the value of a clear framework for teaching and "clear explanations from the instructors" (n = 80 comments). Students valued the opportunity to discuss with instructors "Opportunity to discuss the contents" and as well as direct feedback on their performance "feedback on the practical gestures" (n = 34). The relevance of case-based teaching was noted in 40 comments, and 20 comments remarked that the course helped "train clinical reasoning". Students also commented on their chance to review previous knowledge and to learn new skills (n = 28). Some students (n = 38) suggested that the course should "include even more topics and encompass other relevant skills", and some suggested that "handouts for future reference" should be provided (n = 22).

The ***Course Relevance*** category was the focus of 463 comments (19%). Students praised the course (n = 92) and commented that they found the course to be "very relevant and useful for any medical student" (n = 265) and that it allowed them to fill in the gap in the curriculum (n = 29) as Trauma was a "topic that is not taught in the remaining curriculum". Students mentioned that the course should be kept a part of the core curriculum in the future (n = 41), and that refresher courses in the subsequent years of medical school would be welcome (n = 36).

Students often commented (n = 509) on the ***Teaching and Learning Environment*** of the course: 181 students praised the quality of instructors and 81 noted the "positive environment" and "friendly and relaxed learning space", allowing for ample discussion and questioning. Students highly valued Interactive Learning (n = 169) and small-group teaching (n = 78).

Comments on ***Logistics*** were returned by 473 students (19.5%) who noted that the course was "well organized" (n = 81) and offered suggestions such as a longer break (n = 80) and an earlier schedule (n = 116) and calendar (n = 44). Comments on duration of the course (n = 136) were evenly split among students who thought the duration was adequate, too long and too short.

Sub-sample analysis

For the sub-sample analysis, 53 **final year medical students** completed the survey, two years after taking the *Initial Trauma Management* course.

Responses on students' perception of the relevance of the *ITM* course to their final year knowledge on management of trauma showed that **over 80% of students deemed the course as quite or very relevant,** as detailed in Table 3.

Questioned to rate whether the ITM course's components had been useful to their current level of knowledge and skills, over **75% of the final year medical students considered that all of the ITM course's components had been very useful,** as detailed in Table 4.

Discussion

The effectiveness of dedicated trauma education has been well established in various institutions and settings.[8,21,22] One example of trauma education for the undergraduate setting is the Trauma Evaluation and Management (TEAM) course.[12] Downsides of the TEAM course are the associated cost and resources which limit its application. A literature review[10] of simulation-based trauma education demonstrated that a wide variety of trauma teaching models were effective, highly enjoyed by students and perceived as very useful.[23–30] It should be noted that most literature reports on teaching small groups of voluntary students.

Table 2 Likert scale rates for adequate/suitable content, n(%).

	5 (Very adequate)	4 (Adequate)	3 (Moderately adequate)	2 (Barely adequate)	1 (Not adequate)
Lecture + Cases	540 (86.8%)	72 (11.6%)	7 (1.1%)	1 (0.1%)	–
Airway	574 (92.3%)	39 (6.3%)	6 (0.9%)	–	–
Shock + venous accesses	569 (91.5%)	46 (7.4%)	4 (0.6%)	–	–
Immobilization	572 (92%)	44 (7.1%)	4 (0.6%)	1 (0.1%)	–

Table 3 Likert scale rate for **relevance** of the ITM course among final year students, n(%).

	5 (Very relevant)	4 (Quite Relevant)	3 (Relevant)	2 (Barely Relevant)	1 (Not relevant)
How relevant was the contribution of the ITM course to your current knowledge on trauma?	31 (58.5%)	12 (22.6%)	9 (17%)	1 (1.9%)	–

Another literature review[13] underscored the variability in undergraduate trauma education, the relevance of simulation-based learning and the lack of research on trauma education in undergraduate medical training.

In this study, a mixed methods approach was employed to evaluate student satisfaction with a newly implemented trauma course, which was integrated into the standard medical curriculum. Over a two-year period, quantitative and qualitative data were collected from a large cohort of more than 650 unselected students who attended the course. The results revealed exceptionally high levels of student satisfaction among this large sample. Consistent with literature highlighting the need for dedicated trauma education,[8,10] the vast majority of students (over 90%) considered the trauma course and its hands-on stations to be very relevant. Qualitative data further disclosed that the course addressed a significant gap in the existing curriculum.

Our results on student satisfaction are on par with the results of trauma courses taught to smaller samples of students described in the literature.[10,13,23–30] The design of the teaching sessions in the *ITM* course was carefully planned to allow similar hands-on opportunities to each attendee, which likely contributed to the satisfaction reported by students, despite the course being taught to many students. We were able to teach up to 360 students per academic year with a maximum of 30 students per course and 10 students per hands-on session with a suitable instructor/student ratio.

Qualitative analysis has allowed us a thorough understanding of the students' perspectives on the course, and to get an insight into which aspects were most appreciated by the attendants.

The use of simulation and hands-on stations to practice critical skills and procedures was highly valued by the students and is in line with the literature demonstrating that active learning[31] and simulation[32] lead to high satisfaction among students. It is worth noting that our students also valued the use of realistic manikins.

Students often commented on the profile of instructors whom they considered as friendly, approachable and knowledgeable. The interaction with the instructors in the learning environment favored feedback over the step-by-step explanation of the procedures, as well as during each student's attempt. Students valued the opportunity to discuss and receive feedback from experienced instructors. In our course, all instructors have relevant and ongoing experience in the management of trauma patients, are ATLS-certified, and some are ATLS instructors themselves. This is in line with the literature pointing out that students tend to rate classes higher when the teacher is an expert in the field.[33]

Furthermore, two years after taking the course, at the end of their medical degree, students still considered the course to have been very relevant and useful to their knowledge and skills on the management of trauma patients.

Prior to the introduction of this course, our students were exposed to trauma teaching as part of surgery, orthopedics and intensive care teaching. These results suggest that our students, on par with the findings documented on their international counterparts, felt an inadequacy in the previous trauma curriculum.

This study has some limitations: it was conducted at a single institution. We cannot exclude a halo effect or that the Likert scale ratings on relevance and adequacy that students were asked to fill could have influenced open commentary. A limitation of the sub-sample analysis is the use of a convenience sample of final year medical students, which introduces a potential for selection bias.

This study did not aim to analyze the impact or results of the course on the long-term knowledge and skills of the students. All fourth-year students were offered the course, and no data was available for a historical control group. As the students had no previous contact with trauma education at the time they took the course, it is expected that their knowledge level would increase after the course. It has been demonstrated that in the comparison between teaching and non-intervention groups among medical students, any form of training will lead to an improvement in skills favoring the training group.[10] Long-term assessment of knowledge retention was not performed.

Further research should focus on long-term knowledge retention and its impact on clinical performance.

In conclusion, this study demonstrates that implementing a mandatory, simulation-based trauma course for large cohorts of students is feasible and highly valued by students.

Table 4 Likert scale rates on ITM course's components among final year students, n(%).

	5 (Very useful)	4 (Quite Useful)	3 (Useful)	2 (Barely useful)	1 (Not useful)
Lecture + Cases	42 (79.2%)	6 (11.3%)	5 (9.4%)	–	–
Airway	45 (85%)	4 (7.5%)	4 (7.5%)	–	–
Shock + venous accesses	40 (75.5%)	6 (11.3%)	7 (13.2%)	–	–
Immobilization	41 (77.4%)	7 (13.2%)	5 (9.4%)	–	–

The findings in this report may provide a practical and effective model for other medical schools aiming to integrate trauma education into their core curriculum.

Conflict of interest

The authors report there are no competing interests to declare.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.edumed.2025.101117.

References

1. Cairns C, Kang K. National hospital ambulatory medical care survey: 2020 emergency department summary tables. National Center for Health Statistics (U.S.); 2022. doi:10.15620/cdc:121911.
2. Rossiter ND. Trauma-the forgotten pandemic? Int Orthop. 2022;46(1):3–11. doi:10.1007/s00264-021-05213-z.
3. Deaths from accidents, injuries and assault. Eurostat. Updated October 26, 2023. Accessed November 1, 2023. https://ec.europa.eu/eurostat/web/main/home.
4. Emergency and trauma care. WHO 72nd World Health Assembly (2019) agenda item 12.9.
5. Mock C, Joshipura M, Arreola-Risa C, Quansah R. An estimate of the number of lives that could be saved through improvements in trauma care globally. World J Surg. 2012;36(5):959–63. doi:10.1007/s00268-012-1459-6.
6. Choi J, Carlos G, Nassar AK, Knowlton LM, Spain DA. The impact of trauma systems on patient outcomes. Curr Probl Surg. 2021;58(1):100849. doi:10.1016/j.cpsurg.2020.100849.
7. Georgiou A, Lockey DJ. The performance and assessment of hospital trauma teams. Scand J Trauma Resusc Emerg Med. 2010;18:66. doi:10.1186/1757-7241-18-66.
8. Mastoridis S, Shanmugarajah K, Kneebone R. Undergraduate education in trauma medicine: the students' verdict on current teaching. Med Teach. 2011;33(7):585–7. doi:10.3109/0142159X.2011.576716.
9. Chen FG, Ti LK, Dong C. Call for a systematic approach to teaching trauma in medical schools. Med Teach. 2016;38(1):101. doi:10.3109/0142159X.2015.1045845.
10. Borggreve AS, Meijer JMR, Schreuder HWR, Ten Cate O. Simulation-based trauma education for medical students: a review of literature. Med Teach. 2017;39(6):631–8. doi:10.1080/0142159X.2017.1303135.
11. Hill DA. A model to teach trauma care to medical students. Med Teach. 1993;15(2–3):179–86. doi:10.3109/01421599309006712.
12. Ali J, Danne P, McColl G. Assessment of the trauma evaluation and management (TEAM) module in Australia. Injury. 2004;35(8):753–8. doi:10.1016/j.injury.2003.10.023.
13. Jouda M, Finn Y. Training in polytrauma management in medical curricula: a scoping review. Med Teach. 2020;42(12):1385–93. doi:10.1080/0142159X.2020.1811845.
14. Larraga-García B, Quintana-Díaz M, Gutiérrez Á. Simulation-based education in trauma management: a scoping review. IJERPH. 2022;19(20):13546. doi:10.3390/ijerph192013546.
15. Knudson MM, Khaw L, Bullard MK, Dicker R, Cohen MJ, Staudenmayer K. Trauma training in simulation: translating skills from SIM time to real time. J Trauma Injury Infect Crit Care. 2008;64(2):255–64. doi:10.1097/ta.0b013e31816275b0.
16. Barleycorn D, Lee GA. How effective is trauma simulation as an educational process for healthcare providers within the trauma networks? A systematic review. Int Emerg Nurs. 2018;40:37–45. doi:10.1016/j.ienj.2018.03.007.
17. Motola I, Devine LA, Chung HS, Sullivan JE, Issenberg SB. Simulation in healthcare education: A best evidence practical guide. AMEE guide no. 82. Med Teach. 2013;35(10):e1511–30. doi:10.3109/0142159x.2013.818632.
18. Da Costa M, Santos José, Rui Maio P. The role of a basic surgical skills laboratory as viewed by medical students (6th year). Med Teach. 2001;23(2):176–80. doi:10.1080/01421590120036565.
19. Roussin CJ, Weinstock P. SimZones: an organizational innovation for simulation programs and centers. Acad Med. 2017;92(8):1114–20. doi:10.1097/acm.0000000000001746.
20. Kiger ME, Varpio L. Thematic analysis of qualitative data: AMEE guide no. 131. Med Teach. 2020;42(8):846–54. doi:10.1080/0142159X.2020.1755030.
21. Hill KA, Johnson ED, Lutomia M, et al. Implementing the Trauma Evaluation and Management (TEAM) course in Kenya. J Surg Res. 2018;232:107–12. doi:10.1016/j.jss.2018.05.066.
22. Berndtson AE, Morna M, Debrah S, Coimbra R. The TEAM (Trauma Evaluation and Management) course: medical student knowledge gains and retention in the USA versus Ghana. Trauma Surg Acute Care Open. 2019;4(1):e000287. doi:10.1136/tsaco-2018-000287.
23. Pai DR, Ram S, Madan SS, Soe HH, Barua A. Causes of stress and their change with repeated sessions as perceived by undergraduate medical students during high-fidelity trauma simulation. Natl Med J India. 2014;27(4):192–7.
24. Brandão CF, Collares CF, Marin HF. Student perception on high-fidelity simulation during the medical clerkship. Stud Health Technol Inform. 2013;192:960.
25. Ruesseler M, Weinlich M, Müller MP, Byhahn C, Marzi I, Walcher F. Simulation training improves ability to manage medical emergencies. Emerg Med J. 2010;27(10):734–8. doi:10.1136/emj.2009.074518.
26. Ali J, Dunn J, Eason M, Drumm J. Comparing the standardized live trauma patient and the mechanical simulator models in the ATLS initial assessment station. J Surg Res. 2010;162(1):7–10. doi:10.1016/j.jss.2010.02.029.
27. Smolle J, Prause G, Smolle-Jüttner FM. Emergency treatment of chest trauma – an e-learning simulation model for undergraduate medical students. Eur J Cardiothorac Surg. 2007;32(4):644–7. doi:10.1016/j.ejcts.2007.06.042.
28. Shukla A, Kline D, Cherian A, Lescanec A, Rochman A, Plautz C, et al. A simulation course on lifesaving techniques for third-year medical students. Simul Healthc. 2007;2(1):11–5. doi:10.1097/01.SIH.0b013e31802ccf6c.
29. Takayesu JK, Farrell SE, Evans AJ, Sullivan JE, Pawlowski JB, Gordon JA. How do clinical clerkship students experience simulator-based teaching? A qualitative analysis. Simul Healthc. 2006;1(4):215–9. doi:10.1097/01.SIH.0000245787.40980.89.
30. Gilbart MK, Hutchison CR, Cusimano MD, Regehr G. A computer-based trauma simulator for teaching trauma management skills. Am J Surg. 2000;179(3):223–8. doi:10.1016/s0002-9610(00)00302-0.
31. McCoy L, Pettit RK, Kellar C, Morgan C. Tracking active learning in the medical school curriculum: a learning-centered approach. J Med Educ Curric Dev. 2018;5:2382120518765135. doi:10.1177/2382120518765135.
32. Theodoulou I, Nicolaides M, Athanasiou T, Papalois A, Sideris M. Simulation-based learning strategies to teach undergraduate students basic surgical skills: a systematic review. J Surg Educ. 2018;75(5):1374–88. doi:10.1016/j.jsurg.2018.01.013.
33. Aslam U, Rehman M, Imran MK, Muqadas F. The impact of teacher qualifications and experience on student satisfaction: a mediating and moderating research model. Pak J Commer Soc Sci. 2016;10(3):505–24.