RBEM
Revista Brasileira de Educação Médica

ORIGINAL ARTICLE

DOI: https://doi.org/10.1590/1981-5271v50.2-2025-0245.ING

Active methodologies in the development of surgical skills in medical students: a quali-quantitative study

Metodologias ativas no desenvolvimento de habilidades cirúrgicas em estudantes de Medicina: um estudo qualiquantitativo

Ana Gabriela Terencio de Sousa[1] anagsousa21.2@bahiana.edu.br
Maria Eduarda Lehubach Ferreira Prates[1] mariaferreira18.2@bahiana.edu.br
Luiza Tanajura de Araujo[2] luizatanajura2@gmail.com
André Luis Barbosa Romeo[1] andreromeo@bahiana.edu.br

ABSTRACT

Introduction: The history of medical, previously focused on teacher-centered methods that were essentially theoretical, has evolved into a theoretical-practical teaching approach. That highlighted the need for a reformulation of pedagogical methods became evident, especially in the teaching of surgical skills. The use of active methodologies aims to promote a more practical and engaging learning experience for medical students, responding to the demand for well-trained and adaptable physicians to the contemporary needs of medical practice.

Objective: To evaluate the factors that influenced students performance and cognitive development in the curricular component Surgical Skills 2 (HC2).

Methodology: This is a qualitative and quantitative study conducted with medical students enrolled in the HC2 course during the study period at a medical school in Salvador/BA. Data collection included the application of online forms with sociodemographic questions, 5-point Likert scale items, and open questions, at the beginning and end of the course. Responses were analyzed using statistical and qualitative methods.

Results: On average, 86 students participated in the study. Most students (86,2% at the beginning and 86,0% at the end) considered the hands-on classes and the case discussions complementary to their studies. Regarding time spent at practice stations, 65,5% initially agreed that it was sufficient, increasing to 68,6% at the end. Additionally, 58,1% of students indicated the need for more hands-on practice sessions. Concerning prior study of the subjects to be covered in class, 71,3% reported doing so at the beginning, dropping to 58,1% by the end. As for the use of additional materials beyond those provided, 56,3% initially reported not using them, and 51,1% also did not use them at the end. By the end of the course, 91,9% of students reported good performance.

Conclusion: Students evaluated the teaching methodologies applied in this course effective for learning surgical skills, contributing to an efficient medical training. They highlighted increased confidence and observed greater technical competence by the end. However, there was a noted need to encourage prior study and the use of complementary learning resources. Students also reported that more practice time would be desirable. The monitors involvement was a positive factor in the students learning process.

Keywords: Health education. Surgical skills. Surgical education. Medical students. Teaching.

RESUMO

Introdução: *A história da educação médica, anteriormente utilizando métodos unicamente centrados no professor, basicamente teóricos, evoluiu para o ensino teórico-prático. Assim, evidenciou-se a necessidade de reformulação dos métodos pedagógicos, especialmente no ensino das habilidades cirúrgicas. O uso de metodologias ativas visa promover a aprendizagem mais prática e envolvente para os estudantes de Medicina, como resposta à demanda por médicos capacitados e adaptáveis às necessidades contemporâneas da prática médica.*

Objetivo: *Este estudo teve como objetivo avaliar os fatores que influenciaram no desempenho e na evolução cognitiva dos alunos no componente curricular Habilidades Cirúrgicas 2 (HC2).*

Método: *Trata-se de um estudo qualiquantitativo realizado com discentes de Medicina em curso na disciplina HC2 durante o período estudado em uma escola médica de Salvador, na Bahia. A coleta de dados incluiu a aplicação de formulários online com questões sociodemográficas, itens em escala Likert de 5 pontos e perguntas discursivas, aplicadas ao início e ao final do componente curricular, com análise estatística e qualitativa das respostas.*

Resultado: *Em média, 86 discentes participaram do estudo. A maioria dos discentes (86,2% ao início e 86,0% ao final) considerou as aulas práticas e a discussão de casos clínicos complementares ao estudo. Quanto ao tempo nas bancadas, 65,5% concordaram que foi suficiente ao início, aumentando para 68,6% ao final. Ademais, 58,1% apontaram a necessidade de mais momentos práticos. Quanto ao estudo prévio das temáticas a serem abordadas em sala, 71,3% afirmaram tê-lo feito ao início, caindo para 58,1% ao final. Sobre a utilização de materiais didáticos adicionais além dos disponibilizados previamente, 56,3% afirmaram, ao início, que não os utilizaram e 51,1%, ao final, também não. Ao término do período da disciplina, 91,9% dos discentes relataram bom desempenho.*

Conclusão: *Os discentes avaliaram as metodologias de ensino utilizadas no componente estudado como eficientes para o aprendizado das habilidades cirúrgicas, contribuindo para uma formação médica mais eficaz. Destacaram o aumento da confiança e observaram maior competência técnica ao final. Apesar disso, observou-se a necessidade de incentivo ao estudo prévio e à busca por materiais complementares. Também foi mencionado que maior tempo de prática seria desejável. A atuação dos monitores destacou-se como elemento positivo no processo de aprendizado.*

Palavras-chave: *Educação em Saúde; Habilidades Cirúrgicas; Educação Cirúrgica; Estudantes de Medicina; Formação Acadêmica.*

[1] Escola Bahiana de Medicina e Saúde Pública, Salvador, Bahia, Brasil.
[2] Universidade Salvador, Salvador, Bahia, Brasil

Chief Editor: Rosiane Viana Zuza Diniz. | Associate Editor: Izabel Coelho.

Received on 08/18/25; Accepted on 05/10/26. | Evaluated by double blind review process.

INTRODUCTION

The training of medical students, intrinsic to the history of medicine, is defined by a journey full of developments, challenges and achievements over the centuries. Hippocrates, considered the father of medicine, left the production of academic books as part of his legacy. Consequently, the transition from oral and essentially practical medical teaching to theoretical teaching based on scientific literature began and was consolidated in the Middle Ages with the emergence of universities[1].

Since its inception, the methodology traditionally adopted in medical schools has tended to be based on didactic, teacher-centred methods, which often limits the students' practical experience, supporting the passive transmission of knowledge through expository and theoretical classes[1,2].

The growing demand for doctors who are trained and adaptable to the complexities of the contemporary world has generated the need to review and update the teaching methods used in medicine[3]. As noted by Barrows et al.[2], the traditional learning method may not be the most effective for promoting the comprehensive development of the skills needed by medical students. In this regard, it has become essential to consider the incorporation of new pedagogical approaches, such as Problem Based Learning (PBL), which encourages active student participation in knowledge construction, fosters the development of practical skills and improves problem-solving[4].

By adopting active methodologies in the teaching-learning process, medical students are provided with a more complete education in line with the contemporary demands of medical practice, covering the biological, psychological and social dimensions[5].

The integration of active teaching methods such as PBL and monitoring programmes not only allows for a more practical and contextualised approach to learning, but also promotes greater student autonomy and responsibility in their professional training[2-6]. Accordingly, rather than just absorbing theoretical knowledge, future doctors are enabled to develop practical skills from the earliest stages of their undergraduate training, preparing them more effectively for the challenges of the clinical and surgical environments[3,5].

This study aims to analyse the factors that influenced the performance and cognitive evolution of students in the Surgical Skills 2 (HC2) curriculum component, by identifying efficient teaching methods, promoting realistic learning environments and incorporating technologies into surgical training. Thus, by understanding the factors that affect students' surgical performance, it will be possible to create educational strategies that prepare them to deal with the challenges of the current surgical scenario, contributing toward a safer and more effective practice.

METHOD

This is a mixed-methods study, based on primary data collection, conducted at a private, philanthropic higher education institution located in Salvador, Bahia. The project was approved by the Research Ethics Committee (CEP) of the Bahiana School of Medicine and Public Health on 25 June 2024, report number 6.907.507, in compliance with the ethical principles of Resolution 466/12 on research with human beings, and the bioethical pillars for clinical practice: autonomy, beneficence, nonmaleficence and justice.

The research was carried out in the second half of 2024, between the months of July and December. The target population included students from the 8th semester of the medical course who took the HC2 module during the period studied. The sample was defined by convenience and consisted of approximately 150 students.

The inclusion criteria encompassed students who were regularly enrolled and attending HC2 during the study period and who agreed to take part by signing the Free and Informed Consent Form (FICF). Students who did not take the module in the semester under analysis and those who did not fully complete the forms provided were excluded.

Data was collected online using the Microsoft Forms® platform, using instruments developed by the researchers themselves based on the research question and available scientific literature[7,8], since no validated instrument with the necessary specificities had been identified at the time of the research. The questionnaires were administered at two different times: at the beginning and at the end of the course.

During the first and last lessons of the module, the researchers gave a brief presentation on the study as a way of encouraging student participation. Individualised invitations were then sent via institutional email and messaging application (WhatsApp®), containing a link to access the FICF and the questionnaires.

The students who agreed to take part were initially given a socio-demographic questionnaire with information such as gender, age group, class and subject rotation. They then responded via two specific tools: an initial questionnaire, applied in the first lessons of the module, containing 19 questions - 18 closed, on a 5-point Likert scale (ranging from "completely disagree" to "completely agree"), and 1 open-ended question; and a final questionnaire, applied at the end of the activities, made up of 25 questions – 21 closed and 4 open-ended.

The variables analysed included categorical data (gender, age in age groups, rotation, day of the week of the class) and

variables with a Likert scale, related to the students' perception of pedagogical aspects of the module, such as: clarity of the syllabus, organisation of the classes, relevance of the materials provided, structure of the practice on benches, performance of the monitors and supervisors, use of simulator materials, learning environment, number of class hours, compulsory clothing and confidence in the assessment method. The open-ended questions explored initial expectations, general experience with the module, suggestions or criticisms, as well as views on the practical and theoretical tests.

The quantitative analysis was conducted using Statistical Package for Social Sciences (SPSS®) software, version 25.0 for Windows. The data was initially organised in Microsoft Excel® spreadsheets and then analysed using descriptive statistics in SPSS®, calculating absolute frequency and proportion, to support visualisation and interpretation of the results presented in tables and graphs.

The answers to the open-ended questions were subjected to qualitative analysis using the Content Analysis technique proposed by Bardin[9]. This technique was applied with the aim of identifying thematic categories that expressed the participants' main perceptions and representations in order to understand their experience with the module and the factors that influenced their learning, following the stages of pre-analysis, categorisation and thematic interpretation.

RESULTS

The questionnaires were administered to a group of 142 medical students at the start and end of the course. In the initial questionnaire, 87 (61.2%) students responded, of whom 60 (69.0%) were female. The age group with the highest number of responses to the questionnaire was 20-22 year olds, 38 (43.7%), followed by 23-25 year olds, 36 (41.4%). Between the days on which the subject was taught, Wednesday and Thursday, there were more students on Thursdays, with 45 (51.7%). As for distribution by rotation, 49 (56.3%) were on the second rotation. In the final questionnaire, 86 (60.5%) students took part, with the same student profile as in the initial questionnaire, 53 (61.6%) of whom were female. It was observed that 38 (44.2%) students were in the 20-22 age group, followed by the 23-25 age group with 36 (41.9%). Regarding the days of classes, the number of students on Thursdays was 41 (47.7%). When it came to the division by rotation, there was an even split in the number of responses between the first and second rotation, each with 43 (50.0%) responses (Table 1).

In the initial questionnaire, the option "I completely agree with the statement" was the most frequently chosen for statements 10, 11 and 13, with 77 (88.5%), 75 (86.2%) and 76 (87.4%) responses respectively. The lowest frequencies of this option were for statements 1, 3 and 5, with 11 (12.6%), 18 (20.7%) and 6 (6.9%), respectively. The other statements showed a balanced distribution between the options (Table 2).

In the final questionnaire, the statements with the highest frequency of the option "I completely agree with the statement" were statements 10, 11 and 14, with 72 (83.7%), 71 (82.6%) and 67 (77.9%) responses respectively. The lowest values for this option were for statements 1, 3 and 5, with 11 (12.8%), 16 (18.6%) and 16 (18.6%) responses, respectively. The other statements showed an even distribution among the alternatives, as shown in Table 3. In addition, final questions 1 and 2 were answered "Yes" by 79 (91.9%) and 82 (95.3%) students respectively (Table 4).

As for the subjective responses, the initial questionnaire asked "What are your expectations of this module?" and identified the following categories: learning and practice, confidence/sense of security in procedures and preparation for internship and future medical practice. Of the total number of answers, 3 (3.4%) consisted of just a full stop, making it impossible to analyse this data.

Table 1. Number and percentage of medical students taking Surgical Skills 2 who answered the questionnaires according to their socio-demographic and academic characteristics.

Characteristics of the sample	Initial Questionnaire (n=87)		Final Questionnaire (n=86)	
	n	%	n	%
Gender				
Female	60	69.0	53	61.6
Male	27	31.0	33	38.4
Age Group				
20-22	38	43.7	38	44.2
23-25	36	41.4	36	41.9
26-28	9	10.3	7	8.1
29 Or over	4	4.6	5	5.8
Class				
Wednesday	42	48.3	45	52.3
Thursday	45	51.7	41	47.7
Rotation				
1st rotation	38	43.7	43	50.0
2nd rotation	49	56.3	43	50.0

Source: Developed by authors.

 DOI: https://doi.org/10.1590/1981-5271v50.2-2025-0245.ING

Table 2. Number and percentage of responses from medical students who studied Surgical Skills 2 to the questions in the initial questionnaire, according to statements.

Statement	Completely disagree with the statement		Partially disagree with the statement		Neither agree nor disagree with the statement		Partially agree with the statement		Completely agree with the statement	
	n	%	n	%	n	%	n	%	n	%
1. I have good prior knowledge of surgical skills to start this module.	2	2.3	12	13.8	14	16.1	48	55.2	11	12.6
2. The syllabus for the module is satisfactory and interesting.	-	-	1	1.1	6	6.9	26	29.9	54	62.1
3. I study all the content in advance of the classes.	2	2.3	10	11.5	13	14.9	44	50.6	18	20.7
4. The materials made available on AVA (video lessons, skills guides and study guides) are essential for my study.	-	-	2	2.3	6	6.9	19	21.8	60	69.0
5. I use other study materials in addition to those made available on AVA by the teachers.	24	27.6	25	28.7	11	12.6	21	24.1	6	6.9
6. Practical classes and discussions of clinical cases will complement previous study.	-	-	3	3.4	9	10.3	23	26.4	52	59.8
7. I learn a lot from the clinical rotations system.	-	-	-	-	8	9.2	26	29.9	53	60.9
8. The formation of small groups for the benches helps my learning.	1	1.1	-	-	4	4.6	15	17.2	67	77.0
9. The time provided on the benches (40 minutes) is sufficient for practising skills.	2	2.3	19	21.8	9	10.3	29	33.3	28	32.2
10. The presence of the teachers and supervisors, helping the monitors and clarifying doubts, is important for my learning.	-	-	-	-	1	1.1	9	10.3	77	88.5
11. The use of biological parts, prototypes and mannequins are indispensable for my surgical training.	1	1.1	-	-	2	2.3	9	10.3	75	86.2
12. It is important to wear compulsory standard clothing (full-length trousers without holes, closed shoes, lab coat, scrub caps and gloves).	-	-	2	2.3	2	2.3	10	11.5	73	83.9
13. The practice laboratory has an influence on learning (clean and organised spaces, with materials available).	-	-	-	-	1	1.1	10	11.5	76	87.4
14. I feel welcome and comfortable in the personal environment of the module.	-	-	-	-	6	6.9	11	12.6	70	80.5
15. The class hours for the module (40 hours per semester with weekly 2-hour classes for seven weeks) is sufficient for effective learning.	5	5.7	14	16.1	7	8.0	35	40.2	26	29.9

Continue...

Table 2. Continuation.

Statement	Completely disagree with the statement		Partially disagree with the statement		Neither agree nor disagree with the statement		Partially agree with the statement		Completely agree with the statement	
	n	%	n	%	n	%	n	%	n	%
16. I am comfortable and confident with the assessment method for this component (theoretical and practical tests at the end of the module).	2	2.3	8	9.2	18	20.7	28	32.2	31	35.6
17. A good performance in SS2 is fundamental for me to do well in the internship period.	-	-	1	1.1	4	4.6	26	29.9	56	64.4
18. I'm sure that at the end of the module I'll be better prepared to begin my internship.	2	2.3	2	2.3	6	6.9	31	35.6	46	52.9

Source: Developed by authors.

Table 3. Number and percentage of responses from medical students who studied Surgical Skills 2 to the questions in the final questionnaire, according to statements.

Judgment	Completely disagree with the statement		Partially disagree with the statement		Neither agree nor disagree with the statement		Partially agree with the statement		Completely agree with the statement	
	n	%	n	%	n	%	n	%	n	%
1. I had good prior knowledge of surgical skills when I started the module.	6	7.0	14	16.3	22	25.6	33	38.4	11	12.8
2. The syllabus was satisfactory and interesting.	1	1.2	2	2.3	1	1.2	30	34.9	52	60.5
3. I studied all content in advance of the classes.	6	7.0	11	12.8	19	22.1	34	39.5	16	18.6
4. The materials made available on AVA (video lessons, skills guides and study guides) were essential for my study.	1	1.2	2	2.3	3	3.5	25	29.1	55	64.0
5. I used other study materials in addition to those made available on AVA.	26	30.2	18	20.9	14	16.3	12	14.0	16	18.6
6. Practical classes and discussions of clinical cases complemented previous studies.	2	2.3	3	3.5	7	8.1	29	33.7	45	52.3
7. The clinical rotation system was essential to my learning.	2	2.3	-	-	8	9.3	30	34.9	46	53.5
8. The formation of small groups for the benches helped my learning.	1	1.2	1	1.2	6	7.0	18	20.9	60	69.8
9. The time provided on the benches (40 minutes) was sufficient for practice.	6	7.0	9	10.5	12	14.0	24	27.9	35	40.7
10. The presence of the teachers and supervisors, helping the monitors and clarifying doubts, was important for my learning.	1	1.2	1	1.2	4	4.7	8	9.3	72	83.7

Continue...

Table 3. Continuation.

Judgment	Completely disagree with the statement		Partially disagree with the statement		Neither agree nor disagree with the statement		Partially agree with the statement		Completely agree with the statement	
	n	%	n	%	n	%	n	%	n	%
11. The use of biological parts, prototypes and mannequins was indispensable in my surgical training.	1	1.2	1	1.2	1	1.2	12	14.0	71	82.6
12. It was important to wear compulsory standard clothing during classes (full-length trousers without holes, closed shoes, lab coat, scrub caps and gloves).	1	1.2	5	5.8	7	8.1	15	17.4	58	67.4
13. The practical laboratory had an influence on learning (clean and organised spaces, with materials available).	1	1.2	1	1.2	3	3.5	15	17.4	66	76.7
14. I felt welcome and comfortable in the personal environment of the module.	1	1.2	1	1.2	4	4.7	13	15.1	67	77.9
15. The class hours for the module (40 hours per semester with weekly 2-hour classes for seven weeks) was sufficient for effective learning.	5	5.8	7	8.1	13	15.1	23	26.7	38	44.2
16. I was comfortable and confident with the assessment method for this component (theoretical and practical tests).	2	2.3	8	9.3	8	9.3	27	31.4	41	47.7
17. A good performance in SS2 was fundamental for me to do well in the internship period.	1	1.2	2	2.3	8	9.3	18	20.9	57	66.3
18. I'm better prepared to begin my internship.	1	1.2	1	1.2	7	8.1	27	31.4	50	58.1

Source: Developed by authors.

Table 4. Number and percentage of answers given by medical students taking Surgical Skills 2 to the final questions in the final questionnaire.

Alternative	Yes		No	
	N	%	n	%
1. I absorbed well all the knowledge shared.	79	91.9	7	8.1
2. Did the module meet your expectations?	82	95.3	4	4.7
3. My experience with the subject encouraged me to take part in the competition to become a future HC2 tutor.	45	52.3	41	47.7

Source: Developed by authors.

In the field of learning and practice, there were 45 (51.7%) responses expressing the students' desire to broaden their knowledge and consolidate practical skills they began to develop in the previous semester. With regard to the theme of confidence/sense of security in the procedures, 25 (28.7%) of the students' responses reflected the expectation to feel more secure and confident at the end of the module, through classroom practice, to perform interventions they had learnt in the module on patients, both during internship and in real life, which connects to the other field identified, preparation for internship and future medical practice. Among the responses, 23 (26.4%) students emphasised the importance of the module for tackling practical situations in a medical career. Representative examples include:

> *"[...] In addition to the practical procedure, the module contributes to the development of clinical reasoning through case discussions, which make the component*

> *more interesting and raise expectations even more. The module therefore complements what was seen in SS1 and also allows interdisciplinarity with surgical clinic [...].*" – Form 44 of the initial questionnaire.

> *"I believe that this module will give me more confidence and prepare me for discussions and practice in my internship. As well as allowing me to learn basic general practice procedures.*" – Form 54 of the initial questionnaire.

In the final questionnaire, the students were asked four open-ended questions: "Comment on your experience in Surgical Skills 2", "Report your experience with the practical test at the end of the module", "Report your experience with the theoretical test at the end of the module" and "Do you have any suggestions or criticisms for this module?".

In the first question, the following categories were identified: positive experience, limited time and practice, and organisation of the module. Forty (46.5%) students reported having a good overall experience, learning a lot and feeling better prepared for the internship. Thirty (34.9%) student responses highlighted time constraints on the benches and the need for more practice opportunities. Twenty-one (24.4%) of the students praised the subjects covered in the course, emphasised the importance of clinical cases for developing clinical reasoning and highlighted the attention and dedication of the tutors and teachers throughout the lessons. Of the total number of answers, 4 (4.6%) consisted of just a full stop (".") or dash ("-"), making it impossible to analyse this data. Examples include:

> *"[...] contact with practice is very limited, training the procedure only once most of the time and without enough time on the benches, as they are made up of 6 students, often with not enough time or material."* – Form 1 of the final questionnaire.

> *"It was amazing! There were a lot of articles to read, so I didn't have time to go through all the content every week, but it was very useful and I enjoyed the practical experience. The standout feature of the module was the help from the teachers and the bonus of having the clinical cases before the practical, as well as the content of the articles, which were a way of providing updates on the week's topics."* – Form 18 of the final questionnaire.

> *"[...] The practical-theory-clinical relationship was extremely well executed, as I also learnt to think of conduct in a less static Diagnosis-Treatment way, and as something that can be interconnected."* – Form 54 of the final questionnaire.

As for the practical test, the categories identified were: nervousness, comfortable test environment and improvement suggestions. Twenty-five (29.1%) student responses reported initial nervousness and 35 (40.7%) responses praised the conduct of the monitors and teachers, who provided a calm atmosphere, reducing tension. Twenty-six (30.2%) responses suggested more frequent and spaced-out evaluations to improve the training. Of the total number of answers, 4 (4.6%) consisted of just a full stop (".") or dash ("-"), making it impossible to analyse this data. Some of the responses included:

> *"Like any assessment process, there is an associated component of stress. However, the practical test is consistent with the content of the texts provided and the practical lessons we studied during the rotation."* – Form 14 of the final questionnaire.

> *"I was very nervous before the practical test, but the process was super smooth! The conduct of the test by the monitors was essential for everything to go smoothly."* – Form 22 of the final questionnaire.

> *"It was a very light test that prioritised knowledge. I felt that the test was not too heavy (despite the fact that there was a lot of content) and that its aim was to prepare us and emphasise the content we had learnt, not to demoralise us for not memorising certain details."* – Form 54 of the final questionnaire.

The categories that stood out in the theory test were those regarding the difficulty and relevance of the test, and technical and logistical problems. Forty (46.5%) students reported coherence between the questions and the content studied, although others highlighted the difficulty and specificity of some questions, considering the test difficult. Twenty (23.3%) reported instability on the platform during the application of the test. Of the total number of answers, 5 (5.8%) consisted of just a full stop (".") or dash ("-"), making it impossible to analyse this data. For example:

> *"Completely meaningless questions, unrelated to the practical and theoretical content studied. A lot of questions focussed on extremely minute and irrelevant details."* – Form 5 of the final questionnaire.

> *"Very content-intensive test, full of many subjects, but at an acceptable level for what was proposed."* – Form 38 of the final questionnaire.

In the final question, about suggestions or criticisms, the main themes were the need for more practice opportunities, better resources and the restructuring of the benches. There were 50 (58.1%) responses from students suggesting extra opportunities to practise procedures and additional practice outside of class. Twenty-five (29.1%) answers showed the need for improvements in the materials used for practice. Sixteen (18.6%) of the responses suggested benches with fewer members or more monitors, as well as increasing the time available for each practice. Of the total number of answers, 3

(3.4%) consisted of just a full stop (".") or dash ("-"), making it impossible to analyse this data. Examples include:

> *"Improving time on the benches, having more training beyond the classroom, like 'practice time'."* – Form 6 of the final questionnaire.

> *"Trying to reduce the number of students on the benches or putting one more monitor on the bench, to provide attention for all the students."* – Form 16 of the final questionnaire.

> *"The mannequins, frankly, left a lot to be desired. It is very sad to realise [...]'s disregard for the preparation of their students, translated into extreme savings on the purchase of mannequins/prototypes/experimental models"* – Form 59 of the final questionnaire.

DISCUSSION

This study showed that the average student participation in the survey was approximately 60.0%. There was a predominance of women among those who answered the questionnaires, which may be associated with the gradual increase in women's access to higher education, as discussed in the study by Guedes[10].

This phenomenon is especially evident in medical courses, referred to as the "feminisation of medicine", according to the article by Scheffer and Cassenote[11]. However, as regards surgical specialities, there is still a disparity between the sexes, with men still the dominant majority[12]. The study by Scheffer et al.[13] confirms the trend that women have an increasing presence in the medical profession, reflecting a transformation in the demographic composition of the sector and greater female inclusion in academic and professional careers.

Organization of the module

The organisation of classes in clinical rotations arranged in small groups of approximately 4 to 5 students guided by monitors was considered very satisfactory at the start, but agreement reduced slightly at the end of the module. Studies by Noerholk[14] and Meyers[15] found that students developed more skills when participating in smaller groups, as in this study. In surgical skills training, therefore, this class arrangement can promote an informal and interactive teaching environment by learning with colleagues from other semesters (monitors), reducing stress and increasing participation and confidence during practice, resulting in better acquisition and retention of technical skills[6,14-19].

The time made available per bench during the rotation did not prove sufficient for the students to practice, with agreement below 70% in the initial and final questionnaires, which was also identified in the work by Noerholk[14]. In addition, the open-ended answers to the final questionnaire suggested restructuring the benches by reducing the number of students per group to improve personal performance, increasing time on the benches and extra practice opportunities, because, as indicated in the studies by Acton[20] and Reznick[21], repetition of the techniques promotes enhanced learning, associated with the immediate feedback provided by the monitors. However, despite the insufficient individual practice time, according to the students, studies show that this does not diminish the gain in knowledge[14,22].

On the other hand, when asked about the total workload of the course, almost three quarters of the students indicated, both at the beginning and at the end, that it was sufficient for effective learning, contradicting the result highlighted earlier regarding the limited practical training time. There is no precise information in the literature on the ideal duration of surgical skills practice for medical students, given that this can vary considerably between educational institutions[14,23].

The other active methodologies adopted in the module, aimed at practising surgical skills and discussing clinical cases, were appreciated by the students, with over 80% of responses in both questionnaires agreeing that they complemented and consolidated the knowledge acquired in their previous studies.

The research carried out by Hamstra[24] highlights the significant evolution in the technical performance of students at the University of Toronto, with the skills acquired being retained over the long term and transferred to clinical practice through the use of face-to-face simulations to develop surgical skills.

It can thus be seen that simulation-based learning brings multiple benefits to students by allowing them to experience surgical situations in a controlled environment, improving motor skills, communication, concentration, decision-making, teamwork, knowledge retention and confidence levels[20,21,25-28].

Studies produced during the COVID-19 pandemic have also highlighted the difference between studying surgical skills in person and virtually, revealing that although the virtual modality is effective and shows positive results, it does not replace face-to-face training for surgical learning[29-31].

Furthermore, approximately a quarter of the students in their discursive responses to the final questionnaire praised the topics covered in the module, underscored the importance of clinical cases for developing reasoning and highlighted the attention and commitment of the monitors and teachers during classes, which helped with learning; three-quarters of the students did not express any opinion.

As regards clinical case-based learning (CBL), this plays a key role in the development of surgical skills, especially when combined with other active methodologies, considerably strengthening students' theoretical knowledge and skills[32].

The students stressed in both questionnaires that the content studied was satisfactory and interesting, and almost all agreed that the presence of the teachers, who were always available to answer questions during classes, and the supervisors, who organised the dynamics of the day and helped the monitors in class, was important for learning, as observed in other studies[6,18].

Simulator materials

The use of biological materials, prototypes and mannequins are essential for surgical training[20,21,33-39]. Anatomical parts of animal origin offer realism and are more effective in preparing students for the technical and emotional demands of surgical practice[21,33,34,37-40]. Synthetic models can be divided into high-fidelity and low-fidelity, where high-fidelity models, with current technologies and higher costs, may not be so accessible. On the other hand, the low-fidelity ones, which can be built with easily accessible materials, also enable students to learn efficiently, are low-cost and their easy portability allows them to practise in non-laboratory settings[33,35,38,39].

In this study, the students had access to biological parts of animal origin, mannequins and low-fidelity models during the lessons, and almost 100% agreement was reported both at the beginning and end of the module that these materials were indispensable for learning. Teaching based on the use of various models, as occurs in this subject, brings more benefits in the education of surgical skills, by allowing practice on different models that more faithfully adapt to the technique studied[20,21,33-39].

However, in the open-ended answers to the final questionnaire, more than a quarter of the students pointed to the need for higher quality materials for practising these skills, while the rest failed to express any opinion on the issue. This indicates that, although it is important for the acquisition of knowledge, the lower quality of such equipment can jeopardise its effectiveness, due to it being difficult to use, also sometimes leading to reduced student interest in these moments[35].

Learning strategies

Classes in this subject are eminently practical, but there is also discussion of clinical cases to intellectually stimulate the students. They must work collaboratively to investigate, analyse and find solutions to a proposed problem, developing critical and teamwork skills.

Therefore, to make good use of these meetings, students are required to study beforehand, applying the PBL and CBL methods in this component[4,5,41,42]. The study by Peng[32] showed that the combination of case-based learning and simulations resulted in higher scores in theoretical knowledge and surgical skills compared to traditional teaching methods.

However, it was noted that, at the start of the course, less than three quarters of the students agreed that they studied all the content before classes and, by the end, this figure had dropped significantly by approximately ten per cent.

This tendency goes against the development of autonomy proposed by the teaching methodology of this subject, since by taking part in lessons without adequate prior preparation it is not possible to make effective use of them[2,4].

Studies have assessed that one of the challenges of this method is increased study pressure and reduced learning time perceived by students, since they become responsible for their own learning[43-45].

When preparing for sessions, it is essential that students use a variety of sources and resources[2]. Nonetheless, they showed little interest in looking for other sources of learning besides the teaching materials suggested by the lecturers on the institution's online learning platform. This is probably due to the reduction in the amount of time they have to study beforehand and because they have already learnt the materials recommended by their teachers[43-45]. Therefore, the search for theory through new sources of study should be encouraged in order to increase utilisation and knowledge.

Furthermore, when they started the course, the students pointed out that they had a moderate level of prior knowledge, possibly as a result of previous experience with surgical subjects. By the end, however, there was an understanding that prior knowledge was more limited than initially indicated.

This is probably due to the lack of contact with surgical components during the undergraduate course, a factor that does not reinforce learning over the semesters, and also due to the holiday period, when students take the opportunity to rest without getting involved in academic activities[46,47].

Module environment

When it comes to the teaching environment, physical safety is essential. Almost one hundred percent of the students agreed at the beginning of the module that the organisation of the laboratories would influence their learning. By the end, however, there was a decline in this understanding.

This trend also occurred with regard to the importance attributed to wearing standard clothing in practice environments, with a roughly ten per cent reduction by the end of the component. Lack of awareness of the importance of safety protocols, even in educational environments, can lead to inadequate biosafety attitudes in real-life situations[48,49].

In addition, psychological security is just as important for enhancing learning. The concept of "educational security" suggests that students feel comfortable learning and growing

professionally without fear of negative repercussions for mistakes or interpersonal risks[50]. This can be challenging in environments with constant evaluation and rigid hierarchies, especially in the surgical field.

Nevertheless, during the module in question, the students revealed that they felt welcome and comfortable in the personal environment – more than ninety per cent agreed – showing that a safe environment contributes to strengthening teaching.

Evaluation method

This curricular component is assessed by means of practical and theoretical multiple-choice tests. When asked if they felt comfortable and confident with this evaluation model, initially less than a quarter agreed, possibly because not everyone was aware of it. By the end of the course, this level of agreement had increased, indicating that they were prepared for the tests.

For the practical assessment, one of the most widely used methods is the Objective Structured Assessment of Technical Skills (OSATS), a validated tool for assessing technical skills in surgery, adopted by the module. OSATS uses structured checklists to assess technical performance in specific tasks by students at various practical stations[21,51-53]. According to Asif[54], this method can be applied by trained students, maintaining reliability comparable to that of expert assessors.

In the discursive questions of the final questionnaire, there were reports of nervousness when taking the practical test, an emotional state commonly associated with assessments[55]. On the other hand, this stress was mitigated due to the comfortable environment provided by the teachers and assessors, corroborating the proposition that "educational security" is valued in this module[50].

With regard to the theory test, the students complained about the meticulous detail of the content covered, although they recognised the coherence between the questions and the topics studied. This reinforces the hypothesis that students do not set out to seek more information than that offered by their teachers[43-45]. In addition, there were technical and logistical setbacks during the theoretical assessment, which can intensify stress and make it difficult to complete.

Initial expectations

At the beginning of the module, when asked about their expectations, the students reported an interest in deepening their understanding, consolidating their surgical knowledge and developing confidence in performing the techniques they had learnt, preparing themselves for their internship and future medical work. Previous research has shown that the active learning approaches applied in each study contributed to the students' academic training, achieving the objectives highlighted in this work[17,22,24,28,32,39,41].

When asked about the value of good performance in the module as a reflection of good performance for the internship, the majority of students agreed with the statement at the beginning of the course, but the level of agreement had decreased by the end.

The internship is divided into compulsory assignments in essential areas of medicine, including general surgery[56]. Therefore, a good performance in a surgical subject does not mean a good performance in the internship as a whole, because this period encompasses other segments.

Nevertheless, the students indicated from the start of this module that it would influence their preparation for entering the final period of their undergraduate medical training. At the end of the module, around two-fifths of the students commented that their experience had been broad and positive and had helped them learn and prepare for their internship. The rest failed to discuss the issue.

Development of skills

At the end of the module, 91.9% of the students indicated that they had efficiently absorbed the content covered, reinforcing that the integration of different teaching methods can enhance educational results and promote more satisfactory learning for students[17,22,24,28,32,39,41]. This was underlined by 95.3% of the students, who agreed that the subject had met their expectations.

During surgical training, many students become interested in a career in surgery, influenced by practical experiences and exposure to the speciality. The use of interactive methodologies and the confidence acquired during the surgical discipline play a significant role in motivating students to choose this speciality[25,46,57-59].

In this study, half of the students showed an interest in applying to monitor Surgical Skills 2, which may be due to their own performance in the module and/or their personal desire to work in a surgical speciality in the future and thus keep in touch with this area, gaining more experience.

Limitations

Although the results show that active teaching methods influence the development of students' surgical skills, they should not be considered absolute or interpreted outside the context of this research, which has limitations. The average number of students taking part was only 60.8%, possibly due to their heavy workload during the period studied. Furthermore, the questionnaires were long, time-consuming

and were administered twice, which may have discouraged students from taking part. Another limitation observed is the subjective nature of some variables, as their value depends on the experience and understanding of each participant and their level of comfort in answering the discursive questions. Thus, the study may present information bias, due to the individual dedication of each participant in answering the questionnaire and uninformative discursive answers.

CONCLUSION

This study showed the effectiveness of active methodologies in developing students' surgical skills in the module investigated, focusing on realistic simulations and discussion of clinical cases, with the monitoring programme contributing to the long-term retention of skills. The practical training, conducted in smaller groups and associated with the use of simulators, supported learning, although the time allocated to individual practice was insufficient. The guidance given to students by the monitors in the clinical rotations was identified as a positive factor in creating a comfortable environment, including in terms of assessment methods. However, the students failed to commit to their preparatory studies.

The major challenge identified is how to make students believe that it is important to study the topics of the lessons beforehand, not only using the materials provided by the curricular component, but also other sources of information.

Analysis of the teaching methods applied in surgical training described in this study offers an important insight for medical schools by broadening the understanding of factors that influence the learning of technical skills and collaborating in the improvement of medical curricula.

CONTRIBUTION OF THE AUTHORS

Ana Gabriela Terencio de Sousa participated in the research design and supervision, data collection, analysis and interpretation, and writing and critical review of the manuscript. Maria Eduarda Lehubach Ferreira Prates participated in the research design and writing and critical review of the manuscript. Luiza Tanajura de Araujo participated in the critical review of the manuscript. André Luis Barbosa Romeo participated in the research design and critical review of the manuscript.

CONFLICT OF INTEREST

We declare no conflict of interest.

FUNDING

We declare that there is no funding.

STATEMENT OF DATA AVAILABILITY

Research data is available in the body of the document.

REFERENCES

1. Rocha SR, Romão GS. A história da educação médica na Europa, no Brasil e nos Estados Unidos. Femina. 2021;49(10):602-7.
2. Barrows HS, Tamblyn RM. Problem-based learning: an approach to medical education. New York: Springer Publishing Company; 1980.
3. Machado CD, Wuo A, Heinzle M. Educação médica no Brasil: uma análise histórica sobre a formação acadêmica e pedagógica. Rev Bras Educ Med. 2018;42(4):66-73.
4. Zheng QM, Li YY, Yin Q, Zhang N, Wang YP, Li GX, et al. The effectiveness of problem-based learning compared with lecture-based learning in surgical education: a systematic review and meta-analysis. BMC Med Educ. 2023;23:546.
5. Abreu JR. Contexto atual do ensino médico: metodologias tradicionais e ativas – necessidades pedagógicas dos professores e da estrutura das escolas [dissertação]. Porto Alegre: Universidade Federal do Rio Grande do Sul; 2009.
6. Frison LM. Monitoria: uma modalidade de ensino que potencializa a aprendizagem colaborativa e autorregulada. Pro-Posições. 2016;27(1):133-53.
7. Ryan JF, Istl AC, Luhoway JA, Davidson J, Christakis N, Butter A, et al. Gender disparities in medical student surgical skills education. J Surg Educ. 2020;00(00):1-10.
8. McKinley SK, Kochis M, Cooper CM, Saillant N, Haynes AB, Petrusa E, et al. Medical students' perceptions and motivations prior to their surgery clerkship. Am J Surg. 2019;218(3):424-
9. Bardin L. Análise de conteúdo. São Paulo: Edições 70; 2016.
10. Guedes MC. A presença feminina nos cursos universitários e nas pós-graduações: desconstruindo a ideia da universidade como espaço masculino. Hist Cienc Saude Manguinhos. 2008;15(1):117-32.
11. Scheffer MC, Cassenote AJF. A feminização da medicina no Brasil. Rev Bioét. 2013;21(2):268-77.
12. Quadros e Silva FP. Feminização da medicina x dominação masculina nas áreas cirúrgicas [trabalho de conclusão de curso]. Manhuaçu: Centro Universitário UniFACIG; 2022.
13. Scheffer M, Guilloux AGA, Miotto BA, Almeida CJ, Guerra A, Cassenote A, et al. Demografia médica no Brasil 2023. São Paulo: FMUSP; 2023.
14. Noerholk LM, Morcke AM, Kulasegaram K, Nørgaard LN, Harmsen L, Andreasen LA, et al. Does group size matter during collaborative skills learning? A randomised study. Med Educ. 2022;56(6):680-9.
15. Meyers MO, Meyer AA, Stewart RD, Dreesen EB, Barrick J, Lange PA, et al. Teaching technical skills to medical students during a surgery clerkship: results of a small group curriculum. J Surg Res. 2011;166(2):171-5.
16. Bennett SR, Morris SR, Mirza S. Medical students teaching medical students surgical skills: the benefits of peer-assisted learning. J Surg Educ. 2018;75(6):1471-4.
17. Pintér Z, Kardos D, Varga P, Kopjár E, Kovács A, Than P, et al. Effectivity of near-peer teaching in training of basic surgical skills: a randomized controlled trial. BMC Med Educ. 2021;21(1):156-63.
18. Saleh M, Sinha Y, Weinberg D. Using peer-assisted learning to teach basic surgical skills: medical students' experiences. Med Educ Online. 2013;18:21065.
19. Akinla O, Hagan P, Atiomo W. A systematic review of the literature describing the outcomes of near-peer mentoring programs for first year medical students. BMC Med Educ. 2018;18(1):98.
20. Acton RD. The evolving role of simulation in teaching surgery in undergraduate medical education. Surg Clin North Am. 2015;95(4):739-50.
21. Reznick RK, MacRae H. Teaching surgical skills: changes in the wind. N Engl J Med. 2006;355(25):2664-9.

22. Shebilske WL, Jordan JA, Goettl BP, Paulus LE. Observation versus hands-on practice of complex skills in dyadic, triadic, and tetradic training-teams. Hum Factors. 1998;40(4):525-40.
23. Rufai SR, Holland LC, Dimovska EO, Bing Chuo C, Tilley S, Ellis H. A national survey of undergraduate suture and local anesthetic training in the United Kingdom. J Surg Educ. 2016;73(2):181-4.
24. Hamstra SJ, Dubrowski A. Effective training and assessment of surgical skills, and the correlates of performance. Surg Innov. 2005;12(1):71-7.
25. Glossop SC, Bhachoo H, Murray TM, Cherif RA, Helo JY, Morgan E, et al. Undergraduate teaching of surgical skills in the UK: systematic review. BJS Open. 2023;7(5):zrad083.
26. McCarrick CA, Moynihan A, Khan MF, Lennon F, Stokes M, Donnelly S, et al. Impact of simulation training on core skill competency of undergraduate medical students. J Surg Educ. 2024;81(9):1-10.
27. 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.
28. Shahrezaei A, Sohani M, Taherkhani S, Zarghami SY. The impact of surgical simulation and training technologies on general surgery education. BMC Med Educ. 2024;24(1):1297.
29. Hernandez S, Song S, Nnamani Silva ON, Anderson C, Kim AS, Campbell AR, et al. Third year medical student knowledge gaps after a virtual surgical rotation. Am J Surg. 2022;224(1 Pt B):366-70.
30. Fu MZ, Islam R, Singer EA, Tabakin AL. The impact of COVID-19 on surgical training and education. Cancers. 2023;15(4):1267.
31. Kowal S, Kolasky O, Winthrop A, Mann S. Impact of COVID-19 on confidence and anxiety in medical students related to procedural skills. J Surg Educ. 2024;81(12):103290.
32. Peng Y, Yang L, Qi A, Zhang L, Xiong R, Chen G. Simulation-based learning combined with case and problem-based learning in the clinical education of joint surgery. J Surg Educ. 2023;80(6):892-9.
33. Radzi S, Chandrasekaran R, Peh ZK, Rajalingam P, Yeong WY, Mogali SR. Students' learning experiences of three-dimensional printed models and plastinated specimens: a qualitative analysis. BMC Med Educ. 2022;22(1):695.
34. Bergmeister KD, Aman M, Kramer A, Schenck TL, Riedl O, Daeschler SC, et al. Simulating surgical skills in animals: systematic review, costs & acceptance analyses. Front Vet Sci. 2020;7:570852.
35. Denadai R, Saad-Hossne R, Todelo AP, Kirylko L, Souto LRM. Low-fidelity bench models for basic surgical skills training during undergraduate medical education. Rev Col Bras Cir. 2014;41(2):137-45.
36. Burgess A, McGregor D, Mellis C. Medical students as peer tutors: a systematic review. BMC Med Educ. 2014;14:115.
37. Cho J, Kang GH, Kim EC, Oh YM, Choi HJ, Im TH, et al. Comparison of manikin versus porcine models in cricothyrotomy procedure training. Emerg Med J. 2008;25(11):732-4.
38. Guimarães PJ, Oliveira DL, Oliveira TA, Pontes AC, Souza CS. Análise comparativa de habilidades adquiridas no treinamento de drenagem torácica: um estudo descritivo e prospectivo entre um modelo de simulação sintético de baixo custo e um modelo de origem animal. Rev Contemp. 2024;4(6):e4848.
39. Daly SC, Wilson NA, Rinewalt DE, Bines SD, Luu MB, Myers JA. A subjective assessment of medical student perceptions on animal models in medical education. J Surg Educ. 2014;71(1):61-4.
40. De Sá VH, Pazin GS, Elias PE, Achar E, Pereira Filho GV. How to do it: teaching surgical skills to medical undergraduates. Ann Med Surg. 2022;82:104617.
41. Schwartz RW, Burgett JE, Blue AV, Donnelly MB, Sloan DA. Problem-based learning and performance-based testing: effective alternatives for undergraduate surgical education and assessment of student performance. Med Teach. 1997;19(1):19-23.
42. Davari FV, Teymouri F, Amoli HA, Mojtabavi H, Sharifi A, Alaeddini F, et al. Problem-based learning as an effective method for teaching theoretical surgery courses to medical students. J Educ Health Promot. 2021;10(1):477.
43. Li T, Song R, Zhong W, Liao W, Hu J, Liu X, et al. Use of problem-based learning in orthopaedics education: a systematic review and meta-analysis of randomized controlled trials. BMC Med Educ. 2024;24(1):253.
44. Ribeiro LR, Mizukami MG. Uma implementação da aprendizagem baseada em problemas (PBL) na pós-graduação em engenharia sob a ótica dos alunos. Semin Cienc Soc Hum. 2004;25(1):89-102.
45. Frezatti F, Silva SC. Prática versus incerteza: como gerenciar o estudante nessa tensão na implementação de disciplina sob o prisma do método PBL? Rev Univ Contab. 2014;10(1):28-46.
46. McAnena PF, O'Halloran N, Moloney BM, Courtney D, Waldron RM, Flaherty G, et al. Undergraduate basic surgical skills education: impact on attitudes to a career in surgery and surgical skills acquisition. Ir J Med Sci. 2018;187(2):479-84.
47. Marquardt MD, Fischer F, Quatman-Yates C, Rutter C, Quatman CE. A mixed-methods needs assessment for a longitudinal surgical preparation course in undergraduate medical education. J Surg Educ. 2023;80(4):537-46.
48. Barratt R, Wyer M, Hor SY, Gilbert GL. Medical interns' reflections on their training in use of personal protective equipment. BMC Med Educ. 2020;20(1):328.
49. Abu-Siniyeh A, Al-Shehri SS. Safety in medical laboratories: perception and practice of university students and laboratory workers. Appl Biosaf. 2021;26(Suppl 1):S34-42.
50. Williamson AJ, Jensen RM, Smith BK. Educational safety for the surgical learner. J Surg Educ. 2022;79(5):1083-7.
51. Hatala R, Cook DA, Brydges R, Hawkins R. Constructing a validity argument for the objective structured assessment of technical skills (OSATS): a systematic review of validity evidence. Adv Health Sci Educ Theory Pract. 2015;20(5):1149-75.
52. Campos ME, Oliveira MM, Assis LB, Reis AB, Gonçalves FB. Validation of the objective structured assessment of technical skill in Brasil. Rev Assoc Med Bras. 2020;66(3):328-33.
53. Niitsu H, Hirabayashi N, Yoshimitsu M, Mimura T, Taomoto J, Sugiyama Y, et al. Using the objective structured assessment of technical skills (OSATS) global rating scale to evaluate the skills of surgical trainees in the operating room. Surg Today. 2013;43(3):271-5.
54. Asif H, McInnis C, Dang F, Ajzenberg H, Wang PL, Mosa A, et al. Objective structured assessment of technical skill (OSATS) in the surgical skills and technology elective program (SSTEP): comparison of peer and expert raters. Am J Surg. 2022;223(2):276-9.
55. LeBlanc V, Woodrow SI, Sidhu R, Dubrowski A. Examination stress leads to improvements on fundamental technical skills for surgery. Am J Surg. 2008;196(1):114-9.
56. Brasil. Resolução nº 3, de 20 de junho de 2014. Diretrizes Curriculares Nacionais do Curso de Graduação em Medicina. Brasília: Ministério da Educação; 2014.
57. Sutton PA, Mason J, Vimalachandran D, McNally S. Attitudes, motivators, and barriers to a career in surgery: a national study of U.K. undergraduate medical students. J Surg Educ. 2014;71(5):662-7.
58. Glynn RW, Kerin MJ. Factors influencing medical students and junior doctors in choosing a career in surgery. Surgeon. 2010;8(4):187-91.
59. Rouhani M, Gelder C, Selwyn-Gotha J, Rufai S. Which factors influence the pursuit of a career in surgery? A national undergraduate survey. Br J Healthc Manag. 2017;23(12):581-7.