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Simulation-based instruction: student enjoyment of a computer-based practical activity

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Abstract

Background & Objective: Computer-based simulations are increasingly used in medical education to enhance practical learning. They allow flexible interaction with physiological processes while providing structured, engaging experiences. However, student perspectives on enjoyment, stress, and perceived learning remain underexplored. The aim of this study is to evaluate medical students' perceptions and experiences of a simulation-based physiology practical session.

Materials & Methods: A descriptive cross-sectional questionnaire-based study was conducted among 94 third-year medical students who completed a physiology practical session via computer-based simulation using the Lt platform (ADInstruments, Australia). A structured questionnaire was used to collect data on students' experience, covering perceived enjoyment, content comprehension, teacher effectiveness, perceived stress, and skills acquisition. The questionnaire demonstrated excellent internal consistency (Cronbach's alpha = 0.97). Data were analysed using descriptive statistics and Chi-square tests in SPSS version 28. A p-value < 0.05 was considered statistically significant.

Results: Students reported high levels of enjoyment (92.6%), with significant associations with instructor effectiveness ($p < 0.001$), student participation ($p < 0.001$), skill acquisition ($p < 0.001$), and low perceived stress ($p < 0.001$). Most students agreed that the learning objectives were met and that the session content was clearly understood.

Conclusion: The findings showed that computer-based practical simulations provide a positive and effective learning environment. Beyond enhancing enjoyment and reducing stress, these platforms support active participation and reinforce skill acquisition. Given the observed advantages, we strongly recommend integrating simulation-based platforms into physiology curricula.

Keywords: computer simulation; physiology; medical education; students, medical

Introduction

Computer-based simulation has become an innovative modality in medical education over recent years, especially for practical and laboratory-based training [1, 2]. These interactive online modules simulate real-life clinical scenarios so that students can study complex physiological signs in a well-organized, educational, and student-oriented learning process [3]. Unlike traditional practical sessions, which may be limited by time, space, or resources, computer-based simulations offer innovative solutions that accommodate a large number of students while maintaining educational integrity [4, 5]. Simulation also provides opportunities for independent learning, prolonged practice, and immediate feedback, which are critical to the development of competence and confidence in undergraduate learners [6]. In addition to the limited access to patients, the recent shift toward simulation-based learning in practical sessions is driven by the need to integrate theory with practice in ways that are flexible, reproducible, and accessible [7, 8]. In physiology education, for instance, simulations of techniques such as electromyography, electrocardiogram recording, and respiratory assessments provide students with exposure to essential clinical tools, without the logistical or ethical constraints of real patient interactions [9, 10]. It is worth noting that these platforms are suitable for diverse learning styles, as they combine multimedia elements, self-directed progression, and data-driven experimentation with opportunities for multiple repetitions and immediate feedback, thereby deepening conceptual understanding and supporting the development of practical skills [11, 12]. Effective practical training is essential for both medical and paramedical students, as their professional needs require more than just textbooks. They should develop the capacity to react skilfully in actual medical contexts. Through simulation, hands-on experience can be well developed in a safe, controlled environment to bridge the gap between knowledge and action. Students can acquire fundamental skills without endangering their patients. Computer-based simulation is central to improving student outcomes, as it allows repetition until skills and confidence are gained before transfer to the actual clinical setting [13]. Although the existing literature has extensively documented the benefits of simulation-based education for knowledge acquisition and skills development, fewer studies have addressed students' perceptions of its use in practical physiology. Factors such as learner enjoyment, perceived instructional quality, opportunities for student participation, and emotional engagement are found to influence students' motivation and long-term educational outcomes [14–16]. Enjoyment, in particular, has been shown to enhance cognitive engagement, reduce anxiety, and promote sustained interest, which are especially important in early clinical training [17–19]. In the context of computer-based simulations, enjoyment plays a pivotal role in sustaining learner attention, promoting deeper interaction with the material, and reducing the monotony often associated with traditional practical classes. When students perceive the activity as enjoyable, they are more likely to demonstrate persistence, creativity, and self-directed learning, which ultimately strengthen both conceptual understanding and practical competence [20]. Computer-based simulations are increasingly used in medical education to supplement traditional practical instruction because they overcome the limitations of resource constraints, time constraints, and limited access to patients. The interactive nature of such platforms enables students to engage with the experiments, repeat steps, and receive instant feedback, thereby developing their skills. Although past studies have reported the advantages of simulation-based education for knowledge acquisition and skills training, there is a paucity of data on students' perceptions and overall enjoyment during physiology practical sessions. In addition, the association between students' enjoyment of such platforms and knowledge gain, skills development, the instructor's skill, and perceived stress was not investigated. The aim of this study is to explore medical students' perceptions of a computer-based physiology practical session, with special emphasis on enjoyment as a key aspect of the learning experience.

Materials & Methods

Design and setting(s)

A descriptive cross-sectional study was conducted in the Physiology laboratory during the period from 9 October 2024 to 15 April 2025 to assess medical students' perceptions of a computer-based practical session delivered via the ADInstruments Learning Tool (Lt) platform. The session included interactive simulations that allowed students to explore physiological principles, such as electromyography and grip force measurement, in a controlled digital environment. The study was designed to capture students' immediate reflections on their learning experience, focusing on active participation, enjoyment, instructor effectiveness, perceived stress, and perceived skill acquisition.

Participants and sampling

The study included all 94 third-year medical students enrolled in the physiology course during the 2024–2025 academic year, representing a 100% participation rate. All participants had completed at least one computer-based simulation session using the Lt platform. Lt by ADInstruments (Australia) is a computer-based simulation platform that enables students to conduct physiology experiments using interactive digital tools. It provides engaging modules that replicate traditional laboratory activities to enhance skill acquisition and conceptual understanding. The questionnaire was administered immediately after the simulation session while students remained inside the Physiology laboratory. Although the survey was distributed via a Google Forms link sent to students' university emails, it was opened and completed on their personal mobile phones or iPads before leaving the session. The process was conducted under the instructor's direct supervision to ensure independent completion and prevent students from collaborating while responding to the questionnaire. Participation was voluntary, anonymity was assured, no incentives or reminders were provided, and written informed consent was obtained prior to survey administration. To minimize bias, the instructor was present only to offer technical support and to ensure that students completed the questionnaire individually; students were instructed not to discuss their responses until all submissions were finalized.

Tools/Instruments

Data were collected using a structured questionnaire "the Learning Enjoyment Scale", which was designed previously by the researchers to measure students' enjoyment of a learning experience and its relation to various dimensions of teaching [15, 21]. The final instrument consisted of 12 items in two sections. The first section included six items assessing knowledge, comprehension, application, analysis, concentration, and enjoyment, each rated on a five-point Likert scale (1 = strongly disagree to 5 = strongly agree). The second section evaluated the impact of various factors on students' enjoyment, including teacher proficiency, topic complexity, student participation, objective fulfilment, perceived stress, and skill acquisition. This allowed direct analysis of how each factor contributed to overall enjoyment, providing a detailed understanding of the learning experience [15, 21]. The scale used in this study is a previously validated instrument with established content and construct validity in undergraduate health-professions students [21]. To ensure alignment with the current educational context, three experts in physiology and medical education reviewed the items for clarity, representativeness, and relevance.

Their consensus supported the appropriateness of the scale without the need for item modification. Construct validity was not reassessed in this study because the LES has undergone factor-analytic validation in earlier publications [21], and our study aimed to apply rather than redevelop the scale. Internal consistency was evaluated in our sample and demonstrated high reliability (Cronbach's $\alpha = 0.97$).

Data collection methods

A professor of Physiology, with strong experience in teaching the subject, conducted the computer-based practical session. The session was delivered using the Lt simulation platform (ADInstruments, Australia), which provides interactive modules for laboratory-based learning. Students were exposed to computer simulations of fundamental physiological principles, including electromyography and grip-force measurement, in a well-organized, well-regulated environment. Immediately after completing the teaching session, students were asked to fill out the survey before leaving the laboratory.

Data analysis

All responses were recorded using a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). Data analysis was performed using SPSS Version 28 (IBM Corp., Armonk, NY). Descriptive statistics, including frequencies, percentages, means, and standard deviations, were calculated to summarize students' responses. Chi-square tests were used to examine associations between students' enjoyment of the teaching activity and various teaching dimensions. Fisher–Freeman–Halton exact tests were used as a sensitivity check for tables with small cell counts. A p-value of < 0.05 was considered statistically significant. A post-hoc power analysis was conducted using G*Power 3.1 for the chi-square tests of independence performed in this study. For the 2×3 contingency tables analyzed ($df = 2$, $\alpha = 0.05$, $n = 94$), the observed chi-square statistics corresponded to large to very large effect sizes (Cohen's $w = 0.67–0.85$). Based on these values, the achieved statistical power exceeded 0.99 across all associations, indicating that the sample size was fully adequate to detect the effects observed.

Results

Table 1 presents students' responses to the survey statements evaluating their perceptions about the learning experience during the practical activity. Overall, the responses indicate a high level of satisfaction and perceived effectiveness. A substantial majority of participants either agreed or strongly agreed that they remembered most of the new information presented (91.5%), and 88.3% expressed confidence in applying what they had learned.

Notably, 92.6% also agreed or strongly agreed that they enjoyed the activity. Additionally, 93.6% perceived the teacher as effective / highly competent in delivering the content. Confidence in analysing and evaluating problems was 91.5%, affirming analysis and evaluation capabilities. Importantly, 90.4% of students reported being relaxed and not stressed during the session, and over 92% expressed satisfaction with the skills acquisition during the practical component.

Table 1. Summary of student responses to survey statements (n = 94)

Question	Strongly agree (%)	Agree (%)	Disagree / Strongly disagree (%)	Unsure (%)
1. I remember most of the new information taught in the teaching activity	38 (40.4)	48 (51.1)	6 (6.4)	2 (2.1)
2. I understand most of the information given during this teaching activity	33 (35.1)	53 (56.4)	6 (6.4)	2 (2.1)
3. I feel confident to apply the information I learned in this activity	33 (35.1)	50 (53.2)	5 (5.3)	6 (6.4)
4. I feel confident to analyze and evaluate problems related to the information	34 (36.2)	52 (55.3)	5 (5.3)	3 (3.2)
5. I followed most of the teaching activity with interest	38 (40.4)	46 (48.9)	5 (5.3)	5 (5.3)
6. I enjoyed the teaching activity	46 (49.0)	41 (43.6)	7 (7.4)	0 (0.0)
7. The teacher is talented in teaching	46 (49.0)	42 (44.6)	4 (4.3)	2 (2.1)
8. The topic contents are easy	36 (38.3)	47 (50.0)	8 (8.5)	3 (3.2)
9. I was able to participate	45 (47.9)	38 (40.4)	5 (5.4)	6 (6.4)
10. The learning objectives were fulfilled	41 (43.6)	45 (47.9)	5 (5.3)	3 (3.2)
11. I was relaxed and not stressed	44 (46.8)	41 (43.6)	5 (5.3)	4 (4.3)
12. I am satisfied with the skills I acquired during the practical part of this activity	47 (50.0)	40 (42.6)	6 (6.4)	1 (1.1)

Note: Data are presented as number (percentage). The survey assessed students' perceptions across cognitive, affective, and behavioral domains of the learning experience.
Abbreviations: n, number of participants.

Table 2 displays the association between students' perceived ability to remember new information and their reported enjoyment of the computer-based physiology practical session. A statistically significant association was observed ($\chi^2_{(2,\ n = 94)} = 60.31$, $p < 0.001$), indicating that students who reported greater enjoyment were also more likely to affirm that they remembered the new content delivered during the session.

Table 2. Association between students' enjoyment of the computer-based session and content recall (n = 94)

	I remember most of the new information taught in the teaching activity.			
I enjoyed the teaching activity.	Agree (%)	Disagree (%)	Unsure(%)	**Total (%)**
Agree	85 (90.4)	1 (1.1)	1 (1.1)	87 (92.6)
Disagree	1 (1.1)	5 (5.3)	1 (1.1)	7 (7.4)
Total	86 (91.5)	6 (6.4)	2 (2.1)	94 (100)

Note: The Chi-square test was used to assess the association between students' enjoyment of the teaching activity and their recall of new information. In addition, the Fisher–Freeman–Halton exact test was performed as a sensitivity analysis, and it yielded consistent results. $\chi^2_{(2,\ n = 94)} = 60.31$, $p < 0.001$.

Table 3 presents a cross-tabulation of student responses comparing their enjoyment of the teaching activity with their perceptions of the instructor's teaching effectiveness.

Most students who reported high enjoyment (98%) also perceived the instructor as talented. In contrast, those expressing lower levels of enjoyment were more likely to provide neutral or negative evaluations of teaching effectiveness. The association between these two variables was statistically significant ($\chi^2_{(2,\ n = 94)} = 51.96$, $p < 0.001$), indicating a strong link between instructional quality and students' enjoyment of the teaching activity.

Table 3. Association between students' enjoyment of the computer-based session and quality of instructor (n = 94)

	The teacher is talented in teaching.			
I enjoyed the teaching activity.	Agree (%)	Disagree (%)	Unsure (%)	**Total** (%)
Agree	85 (90.4)	0 (0.0)	2 (2.1)	87 (92.6)
Disagree	3 (3.2)	4 (4.3)	0 (0.0)	7 (7.4)
Total	88 (93.6)	4 (4.3)	2 (2.1)	94 (100)

Note: The Chi-square test was employed to assess the association between students' enjoyment of the teaching activity and their perception of the instructor's teaching talent. In addition, the Fisher–Freeman–Halton exact test was performed as a sensitivity analysis, and it yielded consistent results. $\chi^2_{(2,\ n = 94)} = 51.96$, $p < 0.001$.

Table 4 describes the association between students' enjoyment of the teaching activity and their perceived active participation during the practical session. The majority of students who reported enjoying the session also participated actively. A statistically significant relationship was observed ($\chi^2_{(2,\ n = 94)} = 41.98$, $p < 0.001$), highlighting a strong association between enjoyment and active involvement.

Table 4. Association between students' enjoyment of the computer-based session and active participation (n = 94)

	I was able to participate.			
I enjoyed the teaching activity.	Agree (%)	Disagree (%)	Unsure (%)	**Total** (%)
Agree	81 (86.2)	1 (1.1)	5 (5.3)	87 (92.6)
Disagree	2 (2.1)	4 (4.3)	1 (1.1)	7 (7.4)
Total	83 (88.3)	5 (5.3)	6 (6.4)	94 (100)

Note: The Chi-square test was used to determine the association between students' enjoyment of the teaching activity and their ability to participate. In addition, the Fisher–Freeman–Halton exact test was performed as a sensitivity analysis, and it yielded consistent results. $\chi^2_{(2,\ n = 94)} = 41.98$, $p < 0.001$.

Table 5 illustrates the relation between students' enjoyment of the computer-based physiology teaching activity and their satisfaction with the skill acquisition during the activity. Among those who enjoyed the session, nearly all (99%) were satisfied with the skills acquisition. A statistically significant association was observed ($\chi^2_{(2, n = 94)} = 67.57$, $p < 0.001$), indicating that students who enjoyed the session were more likely to report high satisfaction with their skill acquisition.

Table 5. Association between students' enjoyment of the computer-based session and skills development (n = 94)

	I am satisfied with the skills I acquired during the practical part of this activity.			
I enjoyed the teaching activity.	Agree (%)	Disagree (%)	Unsure (%)	**Total** (%)
Agree	86 (91.5)	1 (1.1)	0 (0.0)	87 (92.6)
Disagree	1 (1.1)	5 (5.3)	1 (1.1)	7 (7.4)
Total	87 (92.6)	6 (6.4)	1 (1.1)	94 (100)

Note: The Chi-square test was applied to assess the association between students' enjoyment of the teaching activity and their satisfaction with the skills acquisition during the practical part. In addition, the Fisher–Freeman–Halton exact test was performed as a sensitivity analysis, and it yielded consistent results. $\chi^2_{(2, n = 94)} = 67.57$, $p < 0.001$.

Discussion

The current study analysed the experiences of medical students during a computer-based practical physiology session provided on the Lt platform. The study investigated enjoyment as an indicator of active engagement, the quality of teaching, skill development, and perceived stress. The findings indicate a high level of student satisfaction with this computer-based simulation, reinforcing its pedagogical value in medical education. One of the most important findings is the instructor's effectiveness being endorsed. The majority of students rated the teacher as talented at delivering practical content, and this perception was strongly associated with higher levels of enjoyment. This aligns with findings of previous studies that identified instructor competence as a core determinant of learner satisfaction, especially in interactive or digitally mediated learning environments [22, 23]. While teacher effectiveness is clearly influential, it is important to acknowledge other factors that contribute to the overall success of a teaching experience, such as the educational environment, the nature of the topic, the types of tasks, and the quality of the educational technology used during the activity [24–27]. Student enjoyment is a positive emotional state during learning that supports motivation and engagement. It creates a favorable atmosphere for concentration and knowledge retention and helps students persist with challenging tasks [28]. In simulation-based settings, enjoyment reduces frustration and makes interaction with complex material easier [29]. Studies have shown that enjoyment is positively related to academic achievement, partly by increasing motivation and active participation [28, 30]. Enjoyment was further found to enhance focus and social interaction. The high enjoyment levels observed in our study, therefore, likely played an important role in supporting both satisfaction and learning outcomes.

Student involvement during the practical session and active participation are critical for enhancing overall satisfaction [31]. Many students reported active participation during the practical session, suggesting that the LT simulation, which included procedures such as EMG and grip force measurements, successfully translated theoretical knowledge into practice. Practical activities have always played a crucial role in studying physiology, as they help go beyond abstract knowledge and facilitate application, a crucial process for deep learning [32, 33].

Moreover, the literature indicates that interactive assignments encourage critical thinking and reinforce memory, especially when students engage with materials in a self-directed, technology-rich manner [34].

Consistent with our findings, the majority of students perceived the sessions as low stress [35]. They provide a supportive, psychologically safe learning environment, which is recommended in medical education, particularly during practical sessions when students may feel apprehensive about making mistakes [36]. These findings align with the notion that reduced performance pressure can increase learner confidence and engagement [37]. However, some scholars suggest that moderate levels of cognitive stress (by controlling teaching activity) may enhance focus and resilience, underscoring the importance of an optimal balance between support and challenge [38, 39]. The session's perceived success was further demonstrated by students' satisfaction with their skill acquisition and with achieving the learning objectives.

Most students agreed that the activity enabled them to acquire relevant skills, validating the role of simulation platforms in supporting procedural learning alongside theoretical understanding. These outcomes support the use of computer-based simulations for skill acquisition in health education, particularly when they are accompanied by real-time feedback, the option to repeat, and individualized pacing [40, 41]. In terms of content comprehension, students described the practical topic as well-structured and clearly organized, facilitating understanding of key physiological principles. It is worth noting that a few participants reported difficulty, which may reflect variation in prior experience with digital tools, different learning styles, or individual preferences in instructional delivery. Although computer-based platforms are designed to enhance understanding through multimedia and interactivity, some students may benefit from additional orientation or technical support to navigate digital learning environments effectively [42, 43]. Collectively, these results align with established educational theories.

The high engagement and reported satisfaction are supported by Constructivist Learning Theory, which emphasizes hands-on, student-centered experiences that promote meaningful learning [44, 45].

The findings also resonate with Self-Determination Theory, which holds that student motivation is enhanced through feelings of autonomy, competence, and relatedness, all of which are fostered during computer-based practical sessions [46, 47]. Motivational teaching activities are important tools in education because they enhance student engagement by drawing students' attention and developing their interest in learning. Moreover, the positive outcomes align with principles of Cognitive Load Theory, suggesting that the Lt platform may have provided an optimal balance between challenge and cognitive processing, thereby facilitating deeper learning [48].

Our findings should be interpreted in the light of the following limitations.

The study was conducted at a single institution, limiting the external generalisability of the results, and the sample size is relatively small, further limiting generalisability. Furthermore, the use of a self-administered survey increases the possibility of reporting bias.

Although the instructor's presence in the lab for supervising data collection minimized collaboration and ensured response independence, it may have influenced students' responses through social desirability effects. In addition, the cross-sectional design of the study does not allow for making conclusions about long-term knowledge retention or skill durability.

Other possible confounding factors, including prior simulation experience, baseline digital literacy, and variation in students' learning styles, may affect the findings. Because of the small sample size, the relationship between demographic variables and questionnaire outcomes was not analyzed; however, this will be addressed in future studies with larger, more diverse participants.

Conclusion

Despite these limitations, the present study clearly highlights the value of integrating computer-based simulations into physiology education.

Results support a statistically significant association between computer-based simulation sessions and students' overall enjoyment, positive perceptions of instructor efficacy and skill improvement, and low perceived stress. The strong alignment between enjoyment, learning outcomes, and instructional quality underscores the pedagogical strength of such digital platforms. Future research is recommended to examine long-term knowledge retention, sustained skill acquisition, and the scalability of these methods across diverse educational contexts.

Ethical considerations

Ethical approval was obtained from the Institutional Research Ethics Committee under reference number HEC-10-2023/24-F-M. All participants provided informed consent before participating in the study. Responses were anonymized, and confidentiality was maintained throughout, in accordance with the Declaration of Helsinki.

Artificial intelligence utilization for article writing

The authors declare that no AI-based tools were used in conducting the research or preparing this manuscript.

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Conflict of interest statement

The authors declare that they have no conflicts of interest.

Author contributions

TM conceptualized the study, developed the simulation-based practical activity, supervised data collection, and

drafted the manuscript. NAK coordinated the teaching session, assisted with data collection and interpretation, and critically reviewed the manuscript.
HT contributed to the literature review, data collection, data interpretation, and critically reviewed the manuscript.
AOA contributed to the literature review, questionnaire refinement, statistical analysis, and contributed to manuscript drafting and review. All authors reviewed and approved the final version of the manuscript.

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Data availability statement

The datasets used and analysed in this study are available from the corresponding author upon reasonable request.

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