Analysis of Acceptance of Simulated Practices in Respiratory Therapy Students

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Abstract: *Simulated clinical practices are an innovative tool designed to improve interdisciplinary collaboration in health education, as well as assertive communication and decision-making based on critical thinking, clinical reasoning, and ethics. These practices offer students controlled; real-world scenarios led by instructors. This study aimed to assess the acceptance of simulated practices among Respiratory Therapy students at a university in Bogotá, Colombia. A quantitative, cross-sectional study was conducted with 243 students who completed a Technology Acceptance Model (TAM) questionnaire via Google Forms. Data were collected from March to May 2024, following ethical guidelines. Results: The questionnaire showed high internal reliability, with a Cronbach's Alpha of 0.97. Median scores above 4 in all TAM categories indicated strong interrelationships.: The TAM was effective in evaluating students' learning conditions and identifying strategies to improve the use of simulation laboratories by both students and instructors.*

Keywords: Respiratory therapy simulated clinical practices, technology acceptance model, university students, clinical education, transdisciplinary.

1 Introduction

The respiratory therapist is a healthcare professional with both scientific and humanistic training, educated at the university level. They are equipped to design, implement, and evaluate plans for analyzing, assessing, preventing, treating, and rehabilitating cardiorespiratory disorders in individuals, considering them as biopsychosocial beings, along with their families and communities. Respiratory therapists utilize various techniques and modalities tailored to both basic and advanced cardiorespiratory care, and they are skilled in health promotion and disease prevention initiatives, aiming to improve the quality of life for vulnerable populations (González, 2017).

In Latin America, respiratory therapy accreditation is managed by the Latin American Council for Professional Certification in Respiratory Therapy (CLACPTER), which includes delegates from four key scientific organizations: the National Board for Respiratory Care Inc. (NBRC), the American Association for Respiratory Care (AARC), and the Latin American Society for Respiratory Care (SOLACUR) (González, 2017).

Nationally, the field of respiratory therapy was established in 1947 in Bogotá, Colombia, at the Franklin Institute of Roosevelt, under the leadership of Dr. Carlos Salinas and Sister Rosa Karels, who introduced the first practices in respiratory therapy (González, 2017). Over the years, Respiratory Therapy has evolved from a technology-focused curriculum into a professional discipline incorporating foundational, disciplinary, and socio-humanistic components.

According to the Colombian Association of Respiratory Therapy Faculties (ACOLFATER), by 2024, there will be five authorized programs nationwide, with a total of 5,890 respiratory therapy graduates (Republic of Colombia, Ministry of National Education, 2003). Fundación Universitaria del Área Andina began technological training in respiratory therapy in 1984, becoming a pioneer in the academic preparation of respiratory therapists. By 1990, the institution shifted to offering professional-level programs in response to increasing demands (González, 2017).

In recent years, respiratory therapists have taken on diverse roles and responsibilities across different levels of care, leading to increased demand in healthcare, administrative management, research, teaching, public health, and commercial sectors such as pharmaceuticals and medical equipment companies. This expansion has integrated respiratory therapy services into hospitals, clinics, and both commercial and research sectors nationwide (Ministry of Health and Social Protection, 2014).

In response to this growth, Respiratory Therapy programs in Colombia have adapted their curricula to meet the evolving needs of the health sector. Their goal is to train professionals capable of addressing respiratory health challenges within multidisciplinary teams, equipped to solve problems and make informed decisions (González, 2017).

Traditionally, education for health professionals in universities has focused on declarative (theoretical) and procedural (practical) knowledge, often delivered through methods that emphasize memorization and repetition. As a result, a gap has emerged between academic learning and clinical practice, as students often struggle to apply their knowledge in real-world clinical settings. Fortunately, the technological revolution of the 21st century has influenced education, presenting both challenges and opportunities for educators and learners alike (Juguera Rodríguez, 2014). One transdisciplinary area of interest is Psychosociology, which examines the relationship between individuals and their environment, particularly in clinical simulation laboratories (Gouveia, Delaunay, & Morais, 2022).

One of the most innovative strategies in the education and training of healthcare professionals is the adoption of simulated clinical practices. These allow students to participate in controlled interventions within safe, technology-mediated environments, fostering meaningful learning experiences that prepare them for real-world clinical contexts (Niño Herrera C., 2014). As biomedical research increasingly relies on interdisciplinary collaboration, these methods are becoming essential (Gehlert et al., 2017).

However, continuous evaluation of technology use in clinical simulation is crucial. The Technology Acceptance Model (TAM), developed by computer engineer and University of Michigan professor Fred Davis in 1989, was introduced to explain the factors that influence technology acceptance. TAM explores how external factors affect users' perceptions, attitudes, and intentions to use technology (Davis, 1989).

According to TAM, technology adoption is shaped by users' intentions to use (BI), which are influenced by their attitudes (A) and perceptions of usefulness (U) towards the technology. TAM offers valuable insights for analyzing the comprehensive training of healthcare professionals, particularly respiratory therapists, who frequently engage in simulation practices throughout their education. Furthermore, the model helps address the challenges of implementing transdisciplinary education and provides recommendations for successful transdisciplinary programs in healthcare (Gehlert, 2012).

Due to the lack of quantitative and qualitative evidence in national literature regarding these practices, this study explores students' perceptions of the equipment and simulation strategies used in laboratory settings, aiming to identify areas for improvement. Thus, this research seeks to analyze the acceptance of simulated practices among respiratory therapy students at a private university in Bogotá, Colombia.

2 Methodology

2.1 Study Design

This study utilizes a quantitative, descriptive, cross-sectional design to analyze the status and acceptance of simulated practices among respiratory therapy students during a specified data collection period. The study follows the STROBE guidelines.

The research explores the integration of technology as a learning and preparation tool within the health sector, aligning with technological trends and strategic planning for the 21st century and the Fourth Industrial Revolution. It incorporates a transdisciplinary approach, combining biomedical advancements with the application of simulated clinical practice in healthcare. This approach serves as a key strategy for developing essential clinical skills and competencies in students.

2.2 Population

The study population consists of undergraduate students enrolled in the respiratory therapy program at a private university in Bogotá, Colombia, ranging from the first to the eighth academic semester. As of the first semester of 2024, the total student population was 243. The sample size was estimated using simple random sampling with a 95% confidence level, an alpha of 0.05, an 8% margin of error, and a 9% non-response rate, following Otzen's equation (2017).

$$n_{finito} = \frac{p * q * {z_{a/2}}^2}{\epsilon^2} * \frac{N-1}{N} \tag{1}$$

2.3 Procedure

A Technology Acceptance Model (TAM) questionnaire was created using Google Forms, and a QR code was generated and shared with students enrolled in the respiratory therapy program.

Students were informed of the voluntary nature of their participation, and they were assured that all data collected would remain anonymous and be used solely for the study's objectives. Each participant signed an informed consent form before completing the questionnaire in full.

As previously mentioned, the TAM was designed to explain the factors that influence technology adoption. Specifically, it aims to predict the adoption of technologies or services based on two key dimensions:

- **Perceived Usefulness**: The extent to which an individual believes that using a specific system will improve their job performance.
- **Perceived Ease of Use**: The degree to which an individual believes that using a particular system will require minimal effort (Yong Varela, 2004).

According to TAM, technology adoption is driven by the user's intention to use (BI), which is influenced by their attitude toward (A) the technology and their perception of its usefulness (U), as expressed in Equation 2.

$$(BI=A+U) \quad (2)$$

Depicting the estimated regression with relative weights, and is visualized in Figure 1 (Davis, 1989).

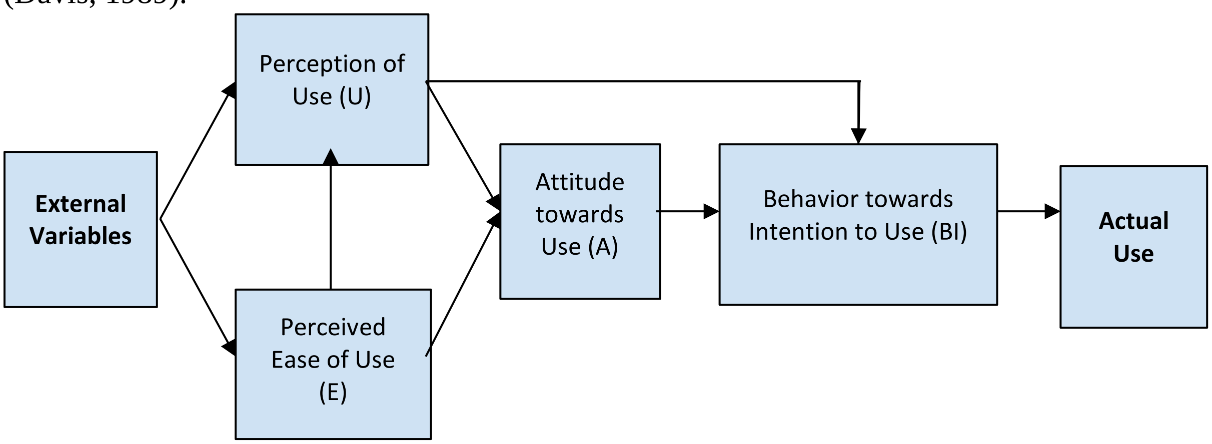

Figure 1. Technology Acceptance Model (TAM)

The model suggests that the relationship between attitude (A) and intention to use (BI) indicates that, all else being equal, individuals tend to have a positive attitude toward usage behavior. Conversely, the relationship between perceived usefulness (U) and intention to use (BI) implies that individuals form intentions toward behaviors that they believe will enhance their job performance, regardless of their sentiments (Davis, 1989).

The TAM model includes statements designed to address the categories of attitude (A), perceived usefulness (U), and intention to use (BI). For this study, these statements are categorized as follows:

Perceived Usefulness (U)

- **U1**: The equipment, technology, and resources in the respiratory therapy program's laboratories are useful for enhancing my understanding of theoretical and practical concepts relevant to my field.

- **U2**: The equipment, technology, and resources in the respiratory therapy program's laboratories help me perform assigned tasks more effectively and efficiently.
- **U3**: Participation in classes increases with the use of equipment, technology, and resources in the respiratory therapy program's laboratories.
- **U4**: The equipment, technology, and resources in the respiratory therapy program's laboratories facilitate the acquisition of practical skills relevant to my field of study.
- **U5**: The equipment, technology, and resources in the respiratory therapy program's laboratories contribute to improving my performance in practical activities related to my field of study.

Perceived Ease of Use (E)

- **E1**: Learning to use the equipment, technology, and resources in the respiratory therapy program's laboratories is straightforward.
- **E2**: Operating the equipment, technology, and resources in the respiratory therapy program's laboratories is clear and understandable.
- **E3**: The equipment, technology, and resources in the respiratory therapy program's laboratories are easier to use compared to other available tools or methods (e.g., presentations, lectures, videos, practical exercises).
- **E4**: Acquiring the skills to use the equipment, technology, and resources in the respiratory therapy program's laboratories requires specialized technical knowledge.
- **E5**: Interacting with the equipment, technology, and resources in the respiratory therapy program's laboratories is straightforward.

Attitude Towards Use (A)

- **A1**: I view the equipment, technology, and resources in the respiratory therapy program's laboratories as an improvement over traditional teaching and learning methods.
- **A2**: I have a positive attitude toward integrating technology into academic settings.
- **A3**: I am willing to use the equipment, technology, and resources in the respiratory therapy program's laboratories in my studies or professional practice.

Behavioral Intention to Use (BI)

- **BI1**: How confident are you in using the technologies, simulators, and equipment in the respiratory therapy program's laboratories to develop skills relevant to your field of study?
- **BI2**: Do you believe the equipment, technology, and resources in the respiratory therapy program's laboratories reflect current innovations in the field?
- **BI3**: Will using the equipment, technology, and resources in the respiratory therapy program's laboratories during your academic training help improve your academic performance and prepare you for professional life?
- **BI4**: I consider the use of the equipment, technology, and resources in the respiratory therapy program's laboratories as a distinguishing factor in my professional academic training.

2.4 Statistical Analysis

The survey data were initially processed using Microsoft Excel, and subsequent statistical analyses were conducted in RStudio. The analysis utilized the readxl, psych, corrplot, lavaan, and semPlot packages for data management, descriptive statistics, correlation analysis, confirmatory factor analysis (CFA), and model visualization.

Descriptive statistics were computed by averaging variables within each category, and boxplot graphs were created for each semester to examine category behaviors over time.

Confirmatory Factor Analysis (CFA) was performed using the Lavaan package in R. Additional R packages, such as psych (Revelle, 2023) for item analysis and MVN (Selcuk Korkmaz, 2022) for multivariate normality assessment, were also used.

The structured model analysis was conducted with the lavaan library, using model validation indices: Comparative Fit Index (CFI $\geq$ .95), Tucker-Lewis Index (TLI $\geq$ .95), Root Mean Square Error of Approximation (RMSEA $\leq$ .05), and Standardized Root Mean Square Residual (SRMR $\leq$ .06).

The performance of the TAM model in predicting the acceptance of simulated practices among respiratory therapy students was visually represented using the semPlot library, which provided graphical insights into the model's relationships and dynamics.

2.5 Ethical Considerations

This study adhered to national ethical regulations outlined in Resolution 8430 of 1993 from the Ministry of Social Protection, which establishes technical, scientific, and administrative standards for health research. The research was classified as minimal risk (Minsalud, 1993).

At the institutional level, the study followed the guidelines set forth in Resolution 0314 of 2018, which addresses ethical policies on research, bioethics, and scientific integrity. The study protocol was submitted to the ethics committee of Fundación Universitaria del Área Andina. The committee reviewed the protocol to assess and manage risks (Colciencias, 2018). Approval was granted on October 25, 2023, under reference number 18/2023.

Students were informed that their participation was voluntary and would have no academic consequences. They provided informed consent, and their confidentiality and anonymity were assured. Researchers committed to maintaining professional secrecy and not disclosing participants' identities or personal information (Minsalud, 1993; Colciencias, 2018).

3 Results and Discussions

3.1 Descriptive Analysis

Table 1 presents the overall results of the categories assessed using the TAM questionnaire, along with the cumulative values for each category.

Table 1. Overall results of the categories

Variable	Q1	Median	Q3	CV
A	4	5	5	0.14
BI	4	4.75	5	0.15
E	4	4.4	5	0.15
U	4	5	5	0.15

According to the responses obtained for each semester, the behavior within each category can be observed in Figure 2.

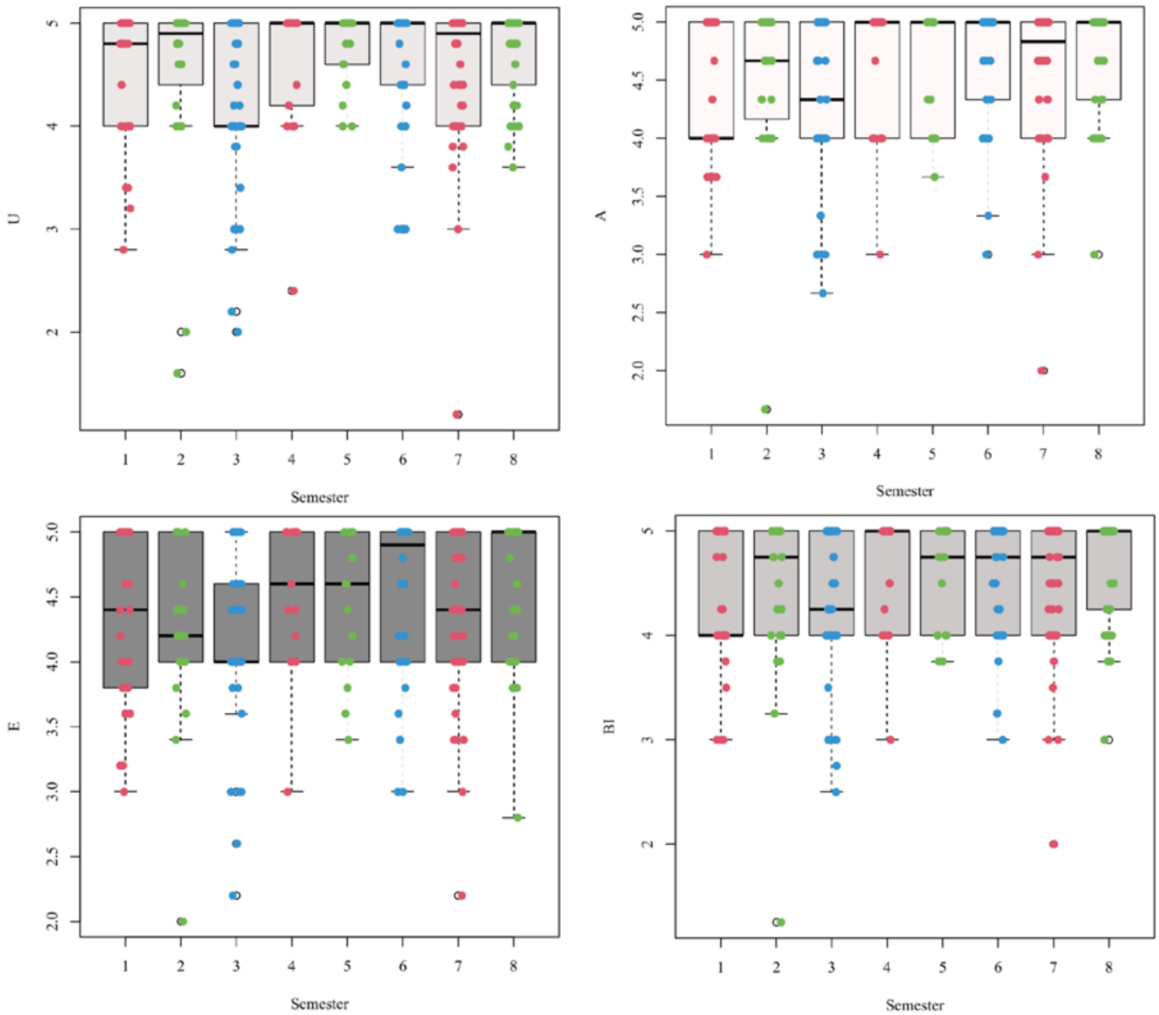

Figure 2. Behavior of TAM Variables According to Semester of Study

3.2 Questionnaire Reliability

The Cronbach's alpha analysis results demonstrate a high level of internal reliability for the questionnaire. This suggests that the questions consistently measure the same underlying construct, ensuring accurate and reliable scores. The reliability analysis yielded the following results for Cronbach's Alpha estimation: raw_alpha: 0.97, std.alpha: 0.97, G6(smc): 0.98, average_r: 0.69, S/N: 38, ase: 0.0025, mean: 4.5, sd: 0.62, and median_r: 0.7.

A Cronbach's Alpha of 0.97 indicates excellent internal consistency according to standard reliability interpretations. Table 2 presents the reliability analysis for each question.

Table 2. Reliability by Question

Question	raw_alpha	std.alpha	G6(smc)	average_r	S/N	alpha se	var.r	med.r
U1	0.97	0.97	0.98	0.69	36	0.0027	0.0061	0.7
U2	0.97	0.97	0.98	0.69	36	0.0027	0.0065	0.7
U3	0.97	0.97	0.98	0.69	36	0.0026	0.006	0.7
U4	0.97	0.97	0.98	0.69	35	0.0027	0.0062	0.7
U5	0.97	0.97	0.98	0.69	35	0.0027	0.0067	0.69
E1	0.97	0.97	0.98	0.7	37	0.0026	0.0068	0.71
E2	0.97	0.97	0.98	0.69	36	0.0027	0.007	0.7
E3	0.97	0.97	0.98	0.69	35	0.0027	0.0069	0.69
E4	0.97	0.98	0.98	0.71	40	0.0024	0.0035	0.71
E5	0.97	0.97	0.98	0.69	36	0.0026	0.0066	0.7
A1	0.97	0.97	0.98	0.69	36	0.0027	0.0066	0.7
A2	0.97	0.97	0.98	0.69	36	0.0027	0.0062	0.7
A3	0.97	0.97	0.98	0.69	36	0.0027	0.0063	0.7
BI1	0.97	0.97	0.98	0.69	36	0.0027	0.0067	0.7
BI2	0.97	0.97	0.98	0.7	36	0.0026	0.0069	0.7
BI3	0.97	0.97	0.98	0.69	35	0.0027	0.0064	0.69
BI4	0.97	0.97	0.98	0.69	35	0.0027	0.0064	0.69

3.3 Structural Equations Model

Based on the confirmatory factor analysis (CFA), a structural equation model (SEM) is proposed as shown in Equation 3.

$$(TAM= U + E + A + BI) \quad (3)$$

Where:

- (U) Perceived Usefulness composed of = (U1 + U2 + U3 + U4)
- (E) Perceived Ease of Use composed of = (E1 + E2 + E3 + E4 + E5)
- (A) Attitude Towards Use composed of = (A1 + A2 + A3)
- (BI) Behavioral Intention to Use composed of = (BI1 + BI2 + BI3 + BI4)

When calculating the indices for model fit, the following results were obtained:

- Root Mean Square Error of Approximation (RMSEA) = 0.086 (reference value <= 0.05),
- Comparative Fit Index (CFI) = 0.96 (reference value >= 0.95),
- Tucker-Lewis Index (TLI) = 0.951 (reference value >= 0.95),
- Standardized Root Mean Square Residual (SRMR) = 0.032 (reference value <= 0.06).

The Figure 3 depicts the SEM model illustrating the behavior of the TAM questionnaire as evaluated in the study:

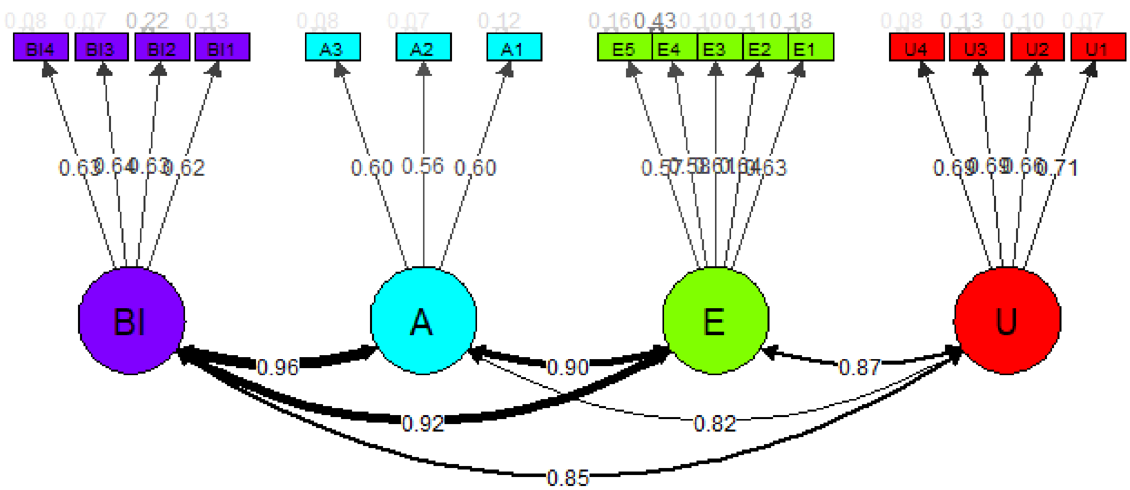

Figure 3. SEM Model for the Present Study

4 Conclusion

The university's simulation laboratories, where this study was conducted, enjoy both national and international acclaim, boasting over twenty years of experience and featuring cutting-edge technology for the comprehensive training of students and continuous professional development of school of health sciences programs. This robust infrastructure prompted an investigation into the perception of technology use in simulated clinical practices, specifically among students enrolled in the respiratory therapy program.

The results of the reliability analysis indicate a very high internal consistency of the survey, as all questions exceeded a Cronbach's alpha value of 0.97. This suggests that all items effectively measure the same underlying construct. Therefore, the responses to the instrument's items are highly consistent and coherent throughout (Campo-Arias, 2005).

Analysis of the results reveals that the variable E (Usability) demonstrates the lowest value relative to the median. This disparity suggests that the technology utilized in these laboratories requires a higher degree of proficiency compared to other technologies. This finding aligns with the educational objectives of the program, which employs high-fidelity simulators for scenarios

involving obstetrics, critical care patients, and advanced medical equipment such as ventilators, videolaryngoscopes, PIM-PEM devices, T-pieces, Sectra tables, and spirometers, among others.
Bektas, in his study on interprofessional simulation experiences in respiratory therapy, nursing, and radiology, affirmed that such simulations foster teamwork, leadership, and communication skills among students. This enriches their competencies and enhances safety in the utilization of advanced medical technologies (Bektas, 2023).

The second category with the lowest value relative to others is BI (Intention to Use), which pertains to technological innovation, level of trust, contribution, and its role as a differential factor in professional training. A mean score of 4.75 was observed, indicating a moderate impact but falling slightly below 5. This prompted an exploration into the underlying reasons for these responses. Students across all semesters noted that a single laboratory session is insufficient for mastering equipment and tasks. This finding is consistent with Meza Cano (2022), who asserts that perceptions regarding Usefulness, Ease of Use, Attitude, and Intention are favorable, averaging close to four on a five-point scale. However, perceptions of Perceived Risk and Trust scored less favorably, averaging between 2.6 and 2.7 on the same scale.

Regarding U (Utility), semesters I, III, and VII displayed the greatest variation and lowest results. Further inquiry revealed that lower semester students (I and III) cited limited exposure to laboratories, hindering their ability to assess the equipment's utility. Conversely, senior students mentioned appreciating the lab resources but expressed reservations about their future applicability in certain fields, thus perceiving less utility.

An additional noteworthy finding is that some faculty members still favor traditional teaching methods and may encounter challenges in adopting simulation-based approaches. Nevertheless, at the institutional level, strides have been made towards active methodologies centered on student engagement, complemented by simulation and the integration of Artificial Intelligence (AI) in classrooms.

Walker (2013) underscores this trend, arguing that team-based simulation offers a learning environment conducive to developing teamwork skills and enhancing learning outcomes within a controlled setting, despite challenges posed by contextual factors, distractions, and practical complexities.

Regarding E (Usability), semesters I, VI, VII, and VIII indicate that students utilize specific high-fidelity equipment, such as the neonatal delivery simulator in respiratory care practices but perceive its limited use in intramural settings.

An identified opportunity for improvement in this study pertains to students in the VIII semester, who primarily approach polysomnography in a theoretical manner. Therefore, the study proposes the integration of simulation laboratories to reinforce these topics and expose students to realistic, controlled scenarios, which have gained prominence in recent years. This proposal aligns with Bektas (2023), who underscores the value of simulated scenarios resembling real-world environments and advocates for their integration into health curricula.

Regarding A (Attitude of Use), the results from semesters I, III, and VII may indicate a lack of interest or confusion. Some students perceive that simulations do not accurately replicate clinical reality, raising doubts about their efficacy in learning. However, the analysis suggests that simulations provide students with professional practice adhering to quality standards and continuous updates. In contrast, real-world practice environments, whether private or public, offer limited resources available at the time, fostering creativity in students' decision-making processes.

The Structural Equation Model (SEM) reveals a positive effect of Attitude (A) on Usability (E), and Usability (E) in turn positively influences Usefulness (U). Specifically, the direct effects indicate a significant positive relationship between A and E (coefficient of 0.64), and between E and U (coefficient of 0.87). Moreover, there is an indirect effect of A on U mediated through E, calculated as the product of these coefficients (0.64 x 0.87 = 0.56). Higher levels of Attitude towards Use are associated with greater Usability, and higher Usability is linked to increased perceived Usefulness. Teachers' willingness and non-punitiveness contribute significantly to both attitude towards use and usability of technology, with feedback playing a crucial role in enhancing student confidence and usefulness (Ayala, 2019).

Simulation plays a crucial role in advancing technological improvements and teaching techniques, complementing clinical activities with teachers acting as facilitators, role models, and providers of resources and information. A study conducted at the University of Murcia, Spain, used a semi-structured questionnaire to explore nursing students' perceptions of clinical simulation. The findings highlighted positive perceptions, emphasizing the acquisition of competencies such as prioritization, knowledge reinforcement, confidence building, teamwork, communication, error management, and readiness for real-world practice. However, students expressed dissatisfaction with the evaluation system and suggested greater flexibility in attendance. Both programs utilize clinical simulation as an educational tool focusing on practical competencies and soft skills development (Juguera Rodríguez et al., 2014).

At the institutional level, a noteworthy strategy is the implementation of the Objective Structured Clinical Examination (OSCE) as a comprehensive formative evaluation in respiratory care courses from the second to eighth semester. Each session includes standardized guides for practical activities across various stations, addressing simulated clinical cases and evaluating competencies. This structured approach incorporates feedback, self-assessment, and evaluation, aiming to enhance students' communication skills and ability to manage analytical situations under time constraints. Aligned with Miller's pyramid (1990), the evaluation framework progresses through "knows, knows how, shows how, does" levels using appropriate instruments and combining diverse assessment tools.

As a strategy for improvement, it is crucial to train teachers in clinical simulation to facilitate their involvement in simulated practices with small groups of students. This approach allows dedicated time for individualized attention to each student. Another notable strength lies in the availability of practical tutorials in laboratories, accessible to students both with and without direct supervision from teachers. According to Ayala (2019), simulated practice enables the evaluation of clinical competencies, knowledge application, interpersonal attributes, clinical judgment, technical skills, and the development of personality traits in an ongoing manner.

At the institutional level, there is a growing emphasis on integrating emerging AI technologies across all programs, particularly in respiratory therapy and healthcare at large. The university has established virtual, 3D, and augmented reality facilities that enable immersive training for students. This initiative aligns with advancements in rehabilitation processes at the National Research Institute in Washington, D.C., where AI tools such as 24-hour virtual assistants (chatbots), robotics, telemedicine, and nanotechnology are being employed to drive future improvements (Lanotte, 2023). The overarching goal of integrating AI in healthcare is to support rather than replace healthcare professionals, focusing on tasks like administrative support, clinical documentation, patient care, and specialized tasks such as image analysis, medical device automation, and patient monitoring (Bohr & Memarzadeh, 2020).

Alnagrat (2023) underscores that aligning specific laboratory learning objectives enhances the credibility and authenticity of simulation tools, thereby optimizing learning processes and improving student outcomes. The Technology Acceptance Model (TAM) offers valuable insights into the factors influencing user acceptance of laboratory simulations, providing practical guidance for educators and instructional designers aiming to create more effective virtual laboratory environments in educational settings.

In summary, this study offers preliminary insights into the acceptance of simulated practices among respiratory therapy students at a university in Bogotá. However, further research is warranted to delve deeper into the benefits, limitations, and impacts on clinical performance and patient care outcomes within healthcare education.

In general, academia does not adequately handle transdisciplinary, wasting the opportunity to improve and mitigate health disparities. We must leverage other health disciplines in the faculty and conduct simulations that integrate and improve communication, conflict resolution skills, and other determinants of health education among faculty.

A transdisciplinary attitude in simulation laboratories allows respiratory therapy students to interact with professionals from other areas, such as medicine, nursing, and psychology. This collaborative approach encourages comprehensive learning, where students acquire not only technical skills but also communication and teamwork skills essential to face the complex challenges of clinical practice.

Authors' Contribution: Claudia P. Vélez García: Methodology, data collection, statistical analysis, data interpretation, draft and original writing, review and editing. Carlos A. Castillo Daza: Methodology, data collection, statistical analysis, data interpretation, draft and original writing, review and editing. Nathalya Casallas Hernandez: Methodology, data collection, statistical analysis, data interpretation, draft and original writing, review and editing. Methodology, data collection, statistical analysis, data interpretation, draft and original writing, review and editing.

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