CLINICAL SIMULATIONS IN THE DEVELOPMENT OF CLINICAL REASONING IN PHYSIOTHERAPY STUDENTS: A LITERATURE REVIEW

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Abstract

Background: Clinical reasoning is one of the main foundations for developing skills that students must strengthen physical therapy. Multiple methodologies exist to foster this skill, one of which is the use of designed and controlled simulations. It was wanted to analyze the effectiveness of clinical simulations for developing clinical reasoning in physical therapy students. **Method**: A bibliographic search was conducted using MeSH and DeCS terms, as well as the Boolean operators AND and OR, to analyze the effectiveness of the clinical simulations described by the authors in each of the included articles. **Results:** In experimental studies, it was found that beginning students use pain as a hypothesis and apply strategies such as trial and error, protocols, and rule-in/rule- out, while advanced students stand out for their use of deduction and pattern recognition. In observational studies, students primarily used hypothetical-deductive reasoning and protocols, demonstrating high acceptance of simulations as an effective strategy for developing clinical reasoning. **Conclusion**: It was determined that clinical simulations have high effectiveness and acceptance in the development of new clinical reasoning strategies.

Keywords: Clinical simulation, Clinical reasoning, Learning, Physical therapy.

Resumen

Introducción: El razonamiento clínico es una de las principales bases del desarrollo de destrezas que debe fortalecer un estudiante que cursa la carrera de Terapia Física. Ahora bien, existen múltiples metodologías por medio de las cuales se puede fomentar y una de ellas es el uso de la simulaciones diseñadas y controladas. En estudio se buscó analizar la efectividad de las simulaciones clínicas para el desarrollo del razonamiento clínico en estudiantes de fisioterapia. **Método:** Mediante una cadena de búsqueda bibliográfica que incluyó términos MeSH y DeCS, así como los operadores booleanos AND y OR, se analizó la efectividad de las simulaciones clínicas que los autores describieron en cada uno de los artículos incluidos. **Resultados:** En estudios experimentales, se encontró que los estudiantes iniciales usan el dolor como hipótesis y aplican estrategias como prueba-error, protocolos y rule-in/rule-out, mientras que, los estudiantes avanzados destacan por el uso de deducción y reconocimiento de patrones. En estudios observacionales, los estudiantes usaron

principalmente el razonamiento hipotético-deductivo y protocolos, mostrando alta aceptación de las simulaciones como una estrategia eficaz para desarrollar el razonamiento clínico. **Conclusión:** Se logró determinar que las simulaciones clínicas tienen una alta efectividad y aceptación en el desarrollo de nuevas estrategias del razonamiento clínico.

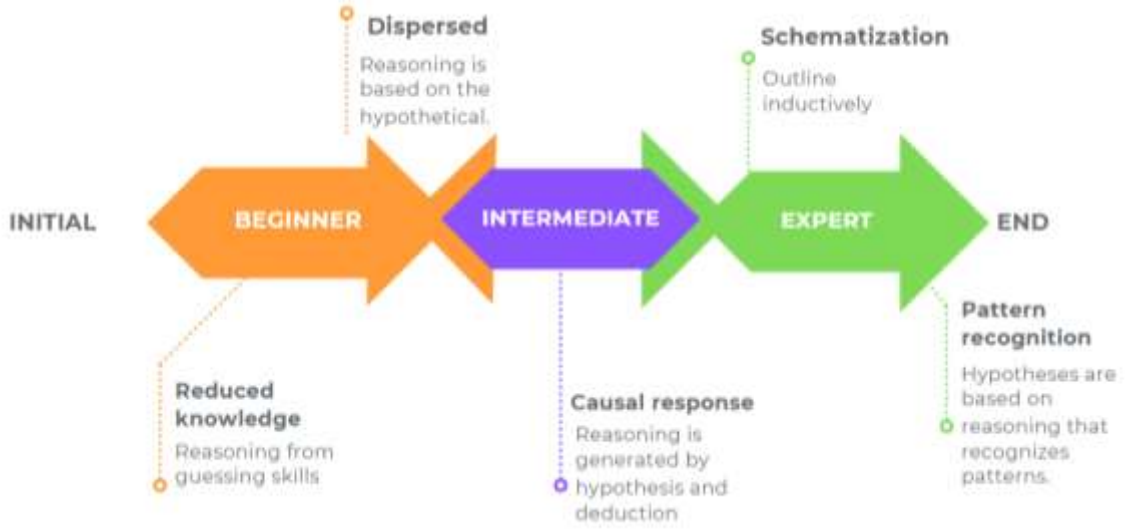
Palabras clave: simulación clínica, razonamiento clínico, aprendizaje, Terapia Física.

1. Introduction

The development of clinical reasoning is a key element in the learning curves of health science students and is related to each individual's abilities (Rodríguez De Castro et al., 2017). The quality of service a patient receives depends on a professional's knowledge and ability to reason clinically. This, in turn, will have implications for the accuracy of a diagnosis and for recovery from illness (Gilliland, 2014).

Figure 1 describes the strategies used in the development of clinical reasoning, which are characterized by diverse forms of knowledge organization. Furthermore, these strategies are directly proportional to each student's learning level. Rodríguez et al. (2017) state that when students use a clinical reasoning strategy based on hypothetical-deductive logic and pattern recognition, their disease recognition and timely diagnosis improve.

Figure 1: Developing clinical reasoning according to the student's level of knowledge



Note. Own elaboration, adapted from Rodríguez et al. (2017) .

On the other hand, Barrows and Feltovich (1987) proposed a model of clinical reasoning that suggests professionals should generate multiple hypotheses when providing care. This aims to create a clinically relevant line of thought that addresses the needs related to a patient's illness. In this way, a mental representation of the patient's pathology is internalized, leading to a final intervention hypothesis.

Health-related professions such as physical therapy involve the need to provide clinical care to patients (APTA, 2023). The APTA (American Physical Therapy Association) establishes the core competencies of physical therapy as those related to the integumentary, cardiovascular, pulmonary, musculoskeletal, and neuromuscular domains. Addressing diverse health conditions requires considering the process of clinical reasoning. For this reason, teaching strategies that foster its development are fundamental and should be included in the curriculum design of the program. However, there is still limited information available to identify the most effective strategies for promoting this process (Mora et al., 2018).

In 2018, the American Council of Academic Physical Therapy established the Clinical Reasoning Curriculum Assessment Agreement to guide and develop cognitive skills in both educators and healthcare professionals (Cencetti, 2019) . Tools have also been established to guide students in describing and understanding the characteristics of a patient's illness. One such tool is the International Classification of Functioning, Disability and Health (ICF), which allows for a theoretical description of a person's functionality.

Furze et al. (2015), through the application of the The Clinical Reasoning Questionnaire (CRRQ) and the Clinical Performance Instrument (CPI) were used to assess clinical reasoning ability over one year in two cohorts of physical therapy students. The instrument was applied at different stages of the clinical practice course, and the results showed that the strategies used to promote clinical reasoning allow for: self-focus, phased thinking, working on the initial stages of context recognition and use, improved reflection on performance, and dynamic interaction with the patient that integrates situational awareness.

A widely used teaching method for developing clinical reasoning skills in students is the use of simulated environments and cases (simulations). This strategy involves trained individuals taking roles with specific clinical characteristics in a designed and structured environment with defined conditions. It has been highly successful and has yielded positive results for each student (Phillips et al., 2017) .

Clinical simulation has emerged as an innovative educational tool for acquiring knowledge and enhancing skills. This activity is typically divided into three phases: the *pre-briefing* , the *briefing* , and the *debriefing* (León & Maestre, 2019) . The pre-briefing phase is *used* to present the topic to be addressed in the session and detail the goals to be achieved. Its objective is to create a safe environment to reassure and comfort the students, who should feel free to express themselves without fear of making mistakes and learning from them. The *briefing phase* is based on the simulation activity itself, through the use of paper cases, videos, or even video games (Henricksen & Altenbur, 2017). Finally, in the reflective debate or *debriefing* , a dialogue is carried out between the students, led by a teacher or instructor, with the aim of understanding, investigating, examining the events, actions, thoughts and results (Díaz and Cimadevilla, 2019) .

These simulations allow future professionals to develop skills in a controlled environment that guides them in making appropriate decisions when intervening with a person, without incurring potential errors with real users (Phillips et al., 2017) . For this reason, this teaching method has become one of the main learning tools in Health Sciences degrees (Villca, 2023). Cazzell and Anderson (2016) found that, following a clinical simulation, students reported experiencing greater satisfaction and self-confidence in this type of learning methodology.

The value of simulations in the academic field of physiotherapy lies in the teacher's ability to select and prepare the content of a specific course in a sequential and organized manner, according to the time and resources available. The *debriefing stage* is the one that most allows transferring opportunities for improvement in patient care into routine practice (Johnston et al., 2017) .

Considering the approaches presented above, this research aims to analyze the effectiveness of clinical simulations as a methodological strategy used to promote the development of clinical reasoning in Physical Therapy students.

2. Method

A qualitative literature review of a descriptive observational type was carried out, where the articles published in the period from 2014 to 2024 were considered. The search was carried out in the databases: Google Scholar, Scopus, EBSCO, Pubmed, Elsevier, Scielo and Proquest.

A review and analysis of articles in Spanish and English was carried out, with a publication date from the chosen period and that had the keywords suggested in the methodology for using the Descriptors

in Health Sciences (DeCS) and Medical Subject Headings (MeSH) (BIREME, 2024) . These sought to answer the research questions posed, as shown in Table 1.

The selected keywords were clinical simulation, clinical reasoning, learning, students, physical therapy, and physiotherapy. Two Boolean operators, "AND" and "OR" were used as the search strategy. This resulted in the following search structures: [(clinical simulation AND clinical reasoning AND strategy AND health AND health AND students AND physical therapy OR physiotherapy)], [(clinical simulation AND clinical reasoning AND strategy AND health AND learning AND physical therapy OR physiotherapy)], and [(clinical simulation AND clinical reasoning AND students OR learning AND physical therapy OR physiotherapy)].

Table 1: Structure of possible search strategies, according to operationalization of research questions

ID	Research question	Keywords	Structure
TO	What is the effectiveness of simulations in clinical reasoning in physiotherapy students?	Simulation, clinical reasoning, strategy, health, students, physical therapy, physiotherapy.	[(Clinical simulation AND clinical reasoning AND strategy AND health AND students AND physical therapy OR physiotherapy)] .
B	What are the clinical reasoning strategies of physical therapy students?	Clinical simulation, clinical reasoning, strategy, health, learning, physical therapy, physiotherapy.	[(Clinical simulation AND clinical reasoning AND strategy AND health AND learning AND physical therapy OR physiotherapy)].
C	How effective are clinical simulations in the learning and reasoning of physical therapy students?	Clinical simulation, clinical reasoning, strategy, health, students, learning, physical therapy, physiotherapy.	[(Clinical simulation AND clinical reasoning AND strategy AND health AND students OR learning AND physical therapy OR physiotherapy)].

Those same search structures translated into Spanish were established as: [(simulación clínica AND razonamiento clínico AND estrategia AND salud AND estudiantes AND terapia física OR fisioterapia)], [(Simulación clínica AND razonamiento clínico AND estrategia AND salud AND aprendizaje AND terapia física OR fisioterapia)] and [(Simulación clínica AND razonamiento clínico AND estrategia AND salud AND estudiantes OR aprendizaje AND terapia física OR fisioterapia)].

3.1 Inclusion and exclusion criteria

Only articles published or received between 2014 and 2024 were considered, and they corresponded to experimental or observational studies (exploratory, meta-analyses and systematic reviews), where conclusions were provided on the effectiveness of the use of clinical simulations as a method of promoting clinical reasoning in students of the Physical Therapy degree.

3.2 Article selection and data analysis

After the searches were carried out, a total of 137 were obtained. publications. Of these, only 88 were extracted for an initial review, the articles were selected based on their relevance to the study's objective. Of the selected articles, 19 were experimental studies, 19 were systematic reviews, 1 was a meta-analysis, and 20 were exploratory studies from primary sources.

The researchers' contributions were analyzed using a pre-established classification based on year, study type (experimental studies, meta-analyses, systematic reviews, or exploratory studies using primary sources), country of origin, effectiveness criteria, and opinions regarding the use of clinical simulations by students and faculty. Additionally, contributions on clinical reasoning strategies were considered based on conclusions and by sex when data processing by sex or gender was required.

3. Results

One hundred and thirty-seven studies were identified in the databases. Of these, 49 records were excluded due to duplication, leaving 88 eligibles for full-text review. Seventy-four articles were excluded based on thematic specificity, study type, and methodological quality, resulting in 8 remaining studies for final analysis.

Table 2 describes the publications that corresponded to interventional studies. In these studies, participants performed a simulation, resulting in high acceptance and effectiveness of this methodology for promoting clinical reasoning (Gilliland, 2014; Phillips et al., 2017 ; Mackaulie, 2018 ; Bermejo , 2023). authors stand out that the groups They used the pain phase as reasoning hypotheses and within the strategies for developing reasoning Clinical, they highlighted the *trial-and-error* protocols learned *and Rule-in/Rule-out* in the students of years Initial. However, the *deduction and pattern recognition strategy* was mostly evident in advanced students.

As shown in Table 3, corresponding to the observational studies, students mostly used the hypothetical-deductive reasoning strategy and followed protocols. Furthermore, simulations were deemed acceptable by the students and identified as an optimal way to generate hypotheses for clinical reasoning (Gilliland & Wainwright, 2017 ; Sanchez et al., 2019).

Table 4, dedicated to meta-analyses and *scoping.* Reviewed studies do not necessarily fully implement standards; furthermore, the design of simulations using *pre-briefing* and *debriefing* has increased since 2016. It was also found that simulations improve students' clinical skills, as well as promote empathy, informed decision-making, and multidisciplinarity (Stockert et al., 2022 ; Becerra, 2024).

Table 2: Description of the included reviews: interventional studies

Revision	Methodology used	Main results/conclusions	Limitations
Gilliland, 2014 Origin: USA	The implementation of a clinical simulation as a method of formulating clinical hypotheses was evaluated in 12 first and third year students. The students were analyzed in two phases of a simulated scenario with a patient with adhesive capsulitis: in the first phase, the student had to analyze the patient based on Barrows and Feltovich's clinical reasoning model. In the second phase, their ability to analyze the information collected in the previous phase was evaluated in combination with the methodology established by the International Classification of Functioning, Disability and Health (ICF). of Function in English). Subsequently, the analysis strategies and clinical	Students at both levels formulated hypotheses based on the various categories of clinical reasoning (medical reasoning, the injured structure, biomechanical function of the structure, anatomical, user activities, phase of symptoms, and mechanism of injury). The most used clinical reasoning development methodologies by first-grade students were trial and error, learned protocols, and Rule-in/Rule- out, while in third-grade students, the reasoning strategy was based on	Since this is a comparative study of 2 different career levels, the information regarding the student's knowledge-based clinical reasoning ability could be biased. Non-randomized

	hypothesis formulation of each student were determined (trial and error, learned protocols, Rule-in/Rule- out, deduction, pattern recognition, pain description).	deduction and pattern recognition. Both groups used the pain phase as a reasoning hypothesis.	
Phillips et al., 2017 Origin: Australia	The group was divided into 3 subgroups according to the hospital where each student was assigned to rotate: Condition A: Standardized patient scenario session without video *feedback* during *diebriefing.* Condition B: Standardized patient scenario session with optional video of *feedback* during the *diebriefing.* Condition C: Peer role-playing scenario session. Interviews were conducted before and after the simulation, using a 10-item instrument, evaluated on a scale from 1 to 10, with 10 being the highest acceptance of a clinical simulation.	All three participating groups reported improvements in confidence and perceived preparedness for clinical reasoning, and high levels of satisfaction with the interactions experienced in each scenario. The item that showed the greatest change in acceptance between the pre- and post-interview was " *I am aware of my strengths in my role* " *of my strengths in this role-playing activity),* where there was a change from 4.6(±1.6) to 7.6(±1.5). Realism, self-evaluation, the opportunity to learn from others, and practice are the categories mentioned by students regarding the perceived value of clinical simulation.	It was not randomized There is no evidence of the use of validated instruments.
Mackaulie, 2018	Two cohorts of first- and second-year physical therapy students were followed up. Initially, they were given the *Clinical Decision test.* The Clinical Decision *Making (CDM) Tools , created by Beudvukg and Macauley* (Mackaulie, 2018) , are based on the APTA Clinical Performance Instrument (APTA, 2023) . A total of 71 students participated in a randomized simulation, while 51 were in the control group.	Those who participated in the simulation reported a higher level in the second evaluation with the *CDM Tools* compared to the first. Furthermore, the study allowed for the validation of the *CDM Tools,* as the second-year students had better results than the first-year students.	
Bermejo, 2023 Origin: Spain	The students were grouped into 10-12 groups and shown a video of a real-life case of shoulder pain (over 3 hours) to promote clinical reasoning. The relationship between clinical data, complementary tests, and	It was found that 59.3% of students and teachers consider simulations appropriate; furthermore, 28.1% considered them to contribute to prior	Since it is an evaluation done in an academic setting, there could be fear

	communication as a key strategy in physiotherapy care was analyzed. The activity was structured in three parts: presentation (*prebriefing*), development (briefing), and reflective discussion (*debriefing*). Subsequently, student satisfaction was explored using a Likert scale survey. A total of 32 students' opinions were gathered.	knowledge, 68.8% considered the objectives of a simulation to be realistic, 65.6% said that simulations encourage clinical reflection, 53.1% said that they provide security, and 79% consider the *debriefing phase* to be a moment of reflective learning.	in the student's answers. No validated methodologies are used.

Note . APTA (American Physical Therapy Association)

Table 3: Description of the reviews included: observational studies

Revision	**Methodology used**	**Main results/conclusions**	**Limitations**
Gilliland and Wainwright, 2017 Origin: United States	The main clinical reasoning strategies were evaluated in the Clinical Practice courses (real cases) of second-year students from two different universities. The author based his work on the methodology established by the International Classification of Functioning, Disability and Health (ICF) . *of Function (in* English), as well as in the APTA practice guide.	Participants based their clinical reasoning on the formulation of hypotheses primarily based on the injured anatomical structure (22.5%). In addition, considering the function of the structure and the factors influencing the injury were also reasoning strategies employed. The students used the hypothetical-deductive development strategy and the following protocols as a reasoning methodology.	None
Sanchez et al., 2019 Origin: Colombia	Through a structured survey, the aim was to describe the perception of 23 students from the third to sixth semester of the physical therapy career at the University of La Sabana during 2018.	It was found that students find great value in clinical simulations, since through this learning methodology there are highly complex metacognitive processes, in which the student is involved in the analysis, the design of the scenario, and the role-playing of the person who interprets. Students understand the importance of clinical simulations in their career and in learning, mostly as a tool to increase *Know-How, Knowledge, Being, Communication Skills, Interaction and Integration of Knowledge and Physiotherapeutic Skills.*	When evaluating the perceptions of students of different levels, the information could be biased, since it analyzes different levels of knowledge in this group of students.

Table 4: Description of the included reviews: scoping review and meta-analysis

Revision	Methodology used	Main results/conclusions
Stockert et al., 2022 Origin: USA	Scoping *review review)* to examine the existing literature on the use of scenario-based simulation in physical therapy students.	It was determined that clinical simulations contribute to clinical reasoning in aspects such as 1. Diversity in simulation settings: Most of the reviewed studies focused on acute care and outpatient settings. 2. Most common educational objectives: The most frequent objectives of the simulation scenarios were patient communication and clinical reasoning. Objectives related to the ability to enhance skills were also frequently reported (31%). Most of the reviewed studies did not fully implement these standards, although there was an increase in the use of *pre-briefing* and *debriefing* after the standards were published in 2016. The urgency of standardizing the design, delivery, and evaluation of simulations in physiotherapy education was determined, as well as the need to use validated assessment tools that allow for more effective measurement of long-term outcomes and changes in students' clinical behavior.
Becerra, 2024 Origin: Spain	Meta-analysis with a time window between 2012 and 2024, related to the level of impact that clinical simulations have on the clinical reasoning of students in the physical therapy career. The databases used were Scopus, Science Direct and Pubmed, and the PRISMA analysis methodology was used.	The results highlight that simulation not only improves clinical skills but also promotes empathy, informed decision-making, and multidisciplinarity. Furthermore, improvements in students' self-confidence and professional identity were identified. The authors conclude that, in an increasingly interdisciplinary healthcare environment, clinical simulation is essential for preparing future physiotherapists through realistic cognition, helping them develop a deep understanding of their professional practice and improve the quality of healthcare.

4. Discussion

In a reality where healthcare is increasingly interdisciplinary, the ability to integrate technical, reflective, and communicative knowledge is essential for providing quality care. Clinical simulation, by offering a controlled and realistic environment, fosters technical learning as well as informed decision-making in dynamic and complex situations (Ortiz-Rivas et al., 2021). According to Bezanilla et al. (2023), contextual factors influence students' clinical reasoning performance, and their actions will be linked to the clinical task or the objective of the scenario, the context, and the patients' needs.

Formulating hypotheses based on the various categories of clinical reasoning indicates an increasing ability among students to integrate knowledge holistically, supported by reflective and critical thinking skills, which are essential for clinical decision-making. The process of reflection is inherent to clinical

decision-making and allows students to evaluate the actions taken, identify areas for improvement, and discern whether a decision could have been made more effectively (Bezanilla et al., 2023). These expressions are common during *debriefing,* a fundamental phase of the clinical simulation scenario, where instructors guide reasoning throughout the process of reflection, decision-making, and the rationale behind those decisions (Stephenson & Poore, 2016).

According to the WCPT Physiotherapist Training Framework (2021), academic programs should facilitate reflection on clinical experiences to promote deep learning, reinforcing clinical decision-making and reasoning. Therefore, alternating phases of academic experience with phases of clinical experience constitute an effective model for training physiotherapists prepared for professional practice.

The students are taking an initial and fundamental approach to identifying the injury, which is consistent with early-year learning, when anatomy and injury localization are central to their training. This focus on the injured anatomical structure may indicate that the students are still in the process of consolidating their basic knowledge of anatomy and pathophysiology.

However, it is important that, as students progress in their training, they broaden their reasoning to a more holistic approach that considers the interaction of other factors. For example, the function of the structure, biomechanical factors, and the patient's activities are all essential elements for decision-making in clinical practice.

These findings offer several implications for teaching clinical reasoning in physical therapy. First, it is crucial that educational programs continue to foster the learning and practice of hypothetico-deductive reasoning (Gilliland & Wainwright, 2017) , as it is a powerful approach for generating hypotheses and making informed clinical decisions. It is also necessary for students to develop skills to more broadly integrate clinical information. Instructors should encourage students to think critically and consider diverse perspectives when formulating a diagnosis and treatment plan.

The evolution of clinical reasoning observed among students in the initial and more advanced stages highlights the importance of adapting teaching methodologies to the students' level of training. For students in the initial stages of the curriculum, it is relevant to continue using structured methodologies, such as the use of protocols and *rule-in/rule- out strategies* (Gilliland, 2014), as these provide them with a solid foundation for addressing initial clinical situations. These approaches, although basic, allow students to develop a fundamental understanding of clinical processes.

Students beyond their third year of study typically possess greater experience and knowledge. Therefore, the focus should shift to more complex decision-making (Gilliland, 2014), deduction, critical analysis, and pattern recognition. These additional strategies demonstrate a greater mastery of complex clinical reasoning.

Clinical placements are often associated with high levels of emotional stress, which in turn is linked to poor performance, as it diminishes working memory. Repeatedly subjecting students to clinical simulation scenarios that generate repetitive stress can consolidate long-term memory and improve performance (Fraser et al., 2015). Challenging scenarios allow students to apply theories and confront situations that require the integration of various aspects of clinical reasoning, thus facilitating deeper and more contextualized learning.

Furthermore, the realism of the simulations is essential for students to experience situations like those they will encounter in their actual clinical practice. According to Rudolph et al. (2006), authenticity in simulation scenarios improves the transfer of knowledge and skills to real-life situations, allowing for the effective application of clinical reasoning.

When students encounter situations as close as possible to real-world clinical practice, they can effectively put their clinical reasoning skills and strategies into practice. The realism of simulations

allows students to confront complex and diverse situations (Bermejo, 2023) , which is crucial for the development of clinical competencies. Furthermore, it provides them with a space to practice decision-making, time management, and problem-solving in an environment that simulates the real-world context.

A crucial aspect of clinical simulation is the interaction during the *debriefing process* , which has been perceived as a valuable tool by students (Bermejo, 2023) . This feedback process allows students to reflect on their decisions, identify areas for improvement, and learn from the experiences of others. The *debriefing phase,* along with ongoing feedback, fosters critical reflection and self-evaluation. Furthermore, by involving collaboration between students and instructors, it also reinforces the importance of collaborative learning, where different perspectives contribute to enriching the understanding of the clinical process.

To foster learning within the degree program, students should have time to interact with professors and peers to develop their intellectual, practical, and clinical skills. These are also spaces for questioning, deepening thinking (to incorporate broader experience into case-based discussions), and providing and receiving feedback (WCPT, 2021).

5. Conclusions

Clinical simulation has proven to be a fundamental tool in developing the clinical reasoning skills of physical therapy students. This educational methodology provides a safe and controlled environment in which students can apply and refine their technical skills while improving their ability to make decisions in complex situations. Simulations allow students to address dynamic and realistic scenarios that foster comprehensive learning, preparing future physical therapists to confidently meet the demands of clinical practice.

It is especially important that, from the third year of the program onward, the educational focus shifts toward developing more advanced clinical reasoning skills. This includes complex decision-making, critical analysis, and pattern recognition, all of which are essential for addressing the challenges of professional practice. This progressive approach fosters deeper learning and facilitates the acquisition of key competencies for clinical practice.

The realism of simulation scenarios is another crucial aspect that enhances learning. By facing situations that closely mimic clinical reality, students can more effectively transfer acquired knowledge to professional practice. This realism improves skill transfer and strengthens clinical reasoning, allowing students to confront challenges like those they will experience in their future careers.

Finally, the debriefing and continuous feedback process is positioned as an essential component for reflective learning and self-assessment. The opportunity to reflect on the decisions made during the simulation, identify areas for improvement, and receive feedback from peers and instructors fosters collaborative learning and the development of communication skills. This space for critical reflection reinforces the understanding of clinical processes and contributes to more effective and meaningful learning.

In summary, clinical simulation, by integrating realism, complex challenges, and feedback processes, is essential in the training of physiotherapists, improving both their technical skills and their clinical reasoning ability in a controlled environment that is close to real-life practice.

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