

Physiotherapy Students' Perceptions of Systemic Anatomy Practical Teaching Using the Problematization with Maguerez's Arc

[Jennyfer Klissya Ferreira Sousa](#) , Isabelle Guedes do Nascimento , Maria Eduarda dos Santos Oliveira , [Ana Carla Sousa Rodrigues](#) , Ricardo Freitas Dias , [Michela Caroline Macêdo](#) , [Edivaldo Xavier da Silva Júnior](#) *

Posted Date: 29 January 2026

doi: 10.20944/preprints202601.2252.v1

Keywords: human anatomy; Maguerez arch; teaching-learning; health education; active methodologies; anatomy education; practical learning; human anatomy learning; higher education; active learning



Preprints.org is a free multidisciplinary platform providing preprint service that is dedicated to making early versions of research outputs permanently available and citable. Preprints posted at Preprints.org appear in Web of Science, Crossref, Google Scholar, Scilit, Europe PMC.

Copyright: This open access article is published under a [Creative Commons CC BY 4.0 license](#), which permit the free download, distribution, and reuse, provided that the author and preprint are cited in any reuse.

Disclaimer/Publisher's Note: The statements, opinions, and data contained in all publications are solely those of the individual author(s) and contributor(s) and not of MDPI and/or the editor(s). MDPI and/or the editor(s) disclaim responsibility for any injury to people or property resulting from any ideas, methods, instructions, or products referred to in the content.

Article

Physiotherapy Students' Perceptions of Systemic Anatomy Practical Teaching Using the Problematization with Maguerez's Arc

Jennyfer Klissya Ferreira Sousa ¹, Isabelle Guedes do Nascimento ¹,
Maria Eduarda dos Santos Oliveira ¹, Ana Carla Souza Rodrigues ¹,
Ricardo Freitas Dias ², Michela Caroline Macêdo ³ and Edivaldo Xavier da Silva Júnior ^{4,*}

¹ Teaching and Research of Human Anatomy Laboratory, University of Pernambuco

² Physiotherapy Department, University of Pernambuco

³ Pedagogy Department, University of Pernambuco

⁴ Teaching and Research of Human Anatomy Laboratory, University of Pernambuco

* Correspondence: edivaldo.junior@upe.br; Tel.: +55-81-99146-4955

Abstract

Teaching human anatomy represents a significant challenge in health education, given the complexity and breadth of its content. Active methodologies, such as the Problematization Methodology (PM) based on Maguerez's Arc, have proven to be effective strategies for promoting meaningful learning. However, there is still a gap in its effectiveness in the practical classes of this curricular component. Thus, this study aimed to analyze students' perceptions of the teaching-learning process in practical classes of Systemic Anatomy, with the application of PM, in the Physiotherapy course at a public state university of Pernambuco, Brazil. This is a qualitative, descriptive, and exploratory study conducted with 16 first-semester students, based on a guiding question applied at the end of the academic semester. Data analysis was performed based on content analysis, from which six thematic categories emerged. The findings showed that the PM contributed to student engagement, the integration of theory and practice, the development of critical and reflective thinking, and the consolidation of more autonomous learning. However, difficulties were reported, such as fatigue due to the workload, adaptation to the method, and organizational challenges. Thus, it can be inferred that the PM has significant educational potential in the practical teaching of Systemic Anatomy, provided it is applied under appropriate structural and pedagogical conditions, representing a strategy that promotes the critical and reflective training of future health professionals.

Keywords: human anatomy; Maguerez arch; teaching-learning; health education; active methodologies; anatomy education; practical learning; human anatomy learning; higher education; active learning

1. Introduction

Systemic Anatomy constitutes a cornerstone in the education of health professionals, providing the structural and functional basis necessary for understanding the human body and supporting subsequent disciplinary learning in curricula such as Physiotherapy. Beyond its disciplinary relevance, the quality of Anatomy education has direct implications for health workforce training, clinical competence, and, ultimately, population health outcomes, as insufficient anatomical knowledge may compromise diagnostic accuracy and patient safety. Mastery of anatomical knowledge is essential for clinical reasoning and professional practice; however, the inherent complexity and volume of content pose persistent challenges to the teaching-learning process,

particularly when instruction relies predominantly on memorization and traditional lecture-based approaches [1].

Anatomy has been broadly defined as the science that studies the structures and development of living beings at both micro- and macroscopic levels, aiming to promote understanding of nomenclature, spatial organization, and functional relationships within the human body [2]. In Human Anatomy education, practical activities play a decisive role in consolidating theoretical knowledge. Nevertheless, limitations such as scarcity of instructional resources, reduced access to anatomical specimens, and bureaucratic barriers to acquiring didactic materials negatively affect the quality of learning, with potential downstream effects on the standardization and effectiveness of health professional training at an institutional and systemic level [1,2].

From a pedagogical perspective, traditional models of education have been critically examined for positioning students as passive recipients of knowledge. Freire's critique of the "banking" model of education highlights how the unidirectional transmission of content undermines critical thinking, autonomy, and meaningful learning [3]. In health education, where the integration of theory and practice is indispensable for safe and effective care delivery, such limitations become particularly evident, reinforcing the need for pedagogical strategies that align educational processes with contemporary demands for competent and reflective health professionals.

In response to these challenges, active learning methodologies have gained prominence in recent years. These approaches emphasize student protagonism, autonomy, and critical engagement, encouraging learners to take responsibility for their own educational processes [4–6]. Within the health sciences, there is a growing consensus that active methodologies contribute to deeper learning by decentralizing the instructor's role and repositioning them as a facilitator of learning experiences, thereby fostering collaborative, reflective, and interdisciplinary learning environments [7,8].

Among these strategies, the Problematicization Methodology (PM), operationalized through the Maguerez Arc, stands out for its grounding in real or simulated realities that are meaningful to students. This method promotes observation of reality, identification of key problems, theoretical reflection, formulation of hypotheses, and application of solutions, enabling learners to link scientific knowledge to concrete situations and to develop critical and transformative competencies [9,10]. Such characteristics make this methodology particularly relevant for practical Anatomy teaching, where contextualization and applied reasoning are essential for meaningful learning and professional transfer.

The introduction of the PM in practical Systemic Anatomy classes within the Physiotherapy program at the University of Pernambuco, Petrolina campus, represents an intentional shift away from traditional, content-centered instruction toward a student-centered pedagogical model. This initiative seeks to enhance learning outcomes, stimulate critical-reflective thinking, and improve the quality of practical classes through greater integration between theory and practice. However, despite its theoretical plausibility and documented benefits in other educational contexts, the effectiveness of this methodology in practical Anatomy teaching remains insufficiently explored in the literature, especially from the perspective of students' experiences and perceptions.

Although previous studies have documented the benefits of the PM primarily in theoretical or classroom-based contexts, there is a clear lack of empirical evidence—both quantitative and qualitative—regarding its application in practical Systemic Anatomy activities. This gap underscores the relevance of investigating how students perceive this pedagogical strategy and how it influences engagement, autonomy, and learning outcomes in a foundational discipline for health professional training. Accordingly, the present study addresses the following research question: *What are the perceptions of Physiotherapy students regarding the use of the Problematicization Methodology in practical Systemic Anatomy classes, and how do these perceptions relate to the teaching–learning process?* Thus, this study aims to analyze the perceptions of Physiotherapy students regarding the teaching–learning process in practical sessions of the Systemic Anatomy course, with a specific focus on the pedagogical impact and effectiveness of the Problematicization Methodology within the educational context in Brazilian Northeast.

2. Materials and Methods

2.1. Study Design and Ethical Aspects

This study adopted a qualitative, exploratory, and descriptive design, grounded in principles of action research. Exploratory research enables close engagement with the phenomenon under investigation, facilitating the clarification of problems and the generation of interpretative insights, whereas descriptive research seeks to characterize experiences and meanings attributed by participants to a given phenomenon [11]. Action research was incorporated insofar as researchers and participants were jointly involved in a pedagogical process aimed at reflecting upon and improving teaching–learning practices in Systemic Anatomy [12]. The study was conducted in accordance with the ethical principles established by Resolution No. 510/2016 of the Brazilian National Health Council, which governs research involving human and social sciences in Brazil.

Voluntary participation, anonymity, and confidentiality of information were ensured throughout all stages of the research. Participation or non-participation had no academic, evaluative, or institutional consequences for the students. The research protocol was reviewed and approved by the Research Ethics Committee of the institution responsible (Approval No. 794,237). All participants received detailed information regarding the study objectives, procedures, potential risks, and benefits, and provided written informed consent before data collection. Eligibility criteria included undergraduate students who were duly enrolled in the Systemic Anatomy course and who agreed to participate in the study. Students who were not enrolled in the course, declined participation, or withdrew at any stage of data collection were excluded, without any academic or personal prejudice.

2.2. Study Context and Participants

The study was conducted with students enrolled in the Systemic Anatomy lecture of the Physiotherapy undergraduate program at a state public university located in Petrolina, Pernambuco, Brazil. The course comprises 45 hours of theoretical instruction and 30 hours of practical activities and is offered during the first academic year of the program.

Data collection took place between August 2024 and September 2025 in which the PM was systematically adopted as the pedagogical strategy for all practical classes. Participant selection followed a purposive sampling strategy, based on students' effective participation in the practical activities mediated by Methodology.

The final sample consisted of 16 students, a number considered adequate for in-depth qualitative analysis aimed at capturing meanings, perceptions, and experiences related to the pedagogical intervention. Data saturation was achieved when no new themes or meanings emerged from successive responses, indicating sufficient depth and redundancy of information. Confidentiality and anonymity were preserved through alphanumeric identification of participants.

2.3. Characterization of Participants

Participants were undergraduate students in the first year of the Physiotherapy program, aged between 17 and 22 years, characterizing a predominantly young cohort at an early stage of academic training. The majority were female (58.8%). Most students (88.2%) reported not engaging in paid employment, dedicating themselves exclusively to academic activities. Regarding place of residence, most participants lived in Petrolina, Pernambuco (52.9%), while others resided in neighboring municipalities in the state of Bahia, including Juazeiro (17.6%) and Remanso (5.9%), reflecting the regional reach of the institution.

The systematization of students' narratives enabled the identification of the following thematic categories: Importance of Tutoring; Meaningful Learning Processes; Development of Critical–Reflective Reasoning; Teamwork; Integration of Theory and Practice; and Limitations and Obstacles of Pedagogical Practice, which are presented in the Results section.

2.4. Pedagogical Intervention: Problematization Methodology

The PM, operationalized through the Maguerez's Arc, was applied throughout all practical classes of the Systemic Anatomy course during the 2025.1 academic year. The method was implemented by the course instructors and teaching assistants, who received prior pedagogical orientation to ensure consistency in the application of the Methodology, following its five sequential stages: (i) observation of reality; (ii) identification of key points; (iii) theorization; (iv) formulation of solution hypotheses; and (v) application to reality.

In the first stage, students were presented with professionally contextualized problem situations, including clinical scenarios and case studies related to the anatomical systems addressed in each class. Guided questions were used to stimulate reflection and initial discussion. Subsequently, students identified key terms and concepts related to the problem, which guided the theorization phase. During theorization, students engaged in autonomous and collaborative research using textbooks, scientific articles, and digital resources to deepen their understanding of the anatomical structures and functional relationships involved. Based on this theoretical grounding, students formulated hypotheses for solving the proposed problem, drawing connections between anatomical knowledge and practical application.

In the final stages, students proposed intervention strategies aimed at resolving the initial problem and discussed their applicability to real professional contexts. At the conclusion of each learning cycle, students presented their solutions to the instructors and teaching assistants, who provided feedback, clarification, and conceptual corrections, when necessary, without attributing grades or summative evaluations to these activities.

2.5. Data Collection

Data were collected at the end of the academic year through a single open-ended guiding question, designed to elicit students' perceptions of the pedagogical experience: *"How did the Problematization Methodology impact my understanding and participation in practical Systemic Anatomy classes, considering its positive and negative aspects?"* The use of a single open-ended question was intentional, as it allowed participants to provide comprehensive, reflective narratives aligned with the exploratory objectives of the study. When necessary, implicit cognitive prompts embedded in the question encouraged elaboration without directing responses. Responses were collected in digital format using Google Forms, ensuring accessibility, anonymity, and confidentiality.

2.6. Data Analysis

Qualitative data were analyzed using Content Analysis, following the methodological framework proposed by Bardin [13]. The analysis was conducted in three interrelated phases: pre-analysis, material exploration, and treatment and interpretation of results. During the pre-analysis phase, a floating reading of all responses was performed to gain familiarity with the material and to identify recurrent themes related to students' experiences with the PM. In the material exploration phase, responses were systematically coded, segmented, and grouped into thematic categories representing shared meanings and patterns. Coding was performed independently by two researchers, and discrepancies were resolved through consensus discussions, enhancing analytical reliability.

In the final phase, treatment and interpretation of results were conducted through analytical inference and triangulation, considering students' narratives, the theoretical framework of active learning methodologies, and the researchers' interpretative perspectives. An audit trail was maintained throughout the analytical process to enhance transparency and trustworthiness. This process enabled the identification of emerging tensions, convergences, and contradictions within the pedagogical experience, ensuring analytical rigor and coherence with the study objectives [13,14].

3. Results

3.1. Descriptive Characteristics of Participants

Sixteen first-year Physiotherapy students participated in the study. The demographic characteristics of the participants are summarized in Table 1. As shown, the sample was predominantly composed of female students, most of whom reported no engagement in paid employment, enabling them to devote themselves exclusively to their academic pursuits. It is also noteworthy that the participants exhibited religious diversity, although the majority identified as Catholic.

Table 1. Demographic characteristics of the participants.

Variable	Category	Percentage (%)
Sex	Female	58.8
	Male	41.2
Work situation	Not employed	88.2
	Employed	11.8
Religion	Catholic	47.1
	Evangelical	29.4
	Unspecified Christian	11.8
	Atheist	5.9
	Agnostic	5.9
Place of residence	Residents in Petrolina	52.9
	Residents of other municipalities	47.1

3.2. Emerging Categories with Content Analysis

The systematization of students’ perceptions regarding the application of the PM in practical classes of Systemic Anatomy enabled the identification of the meanings constructed, the tensions and contradictions that emerged, as well as the pedagogical repercussions arising from this formative experience within the context of Anatomy education. In this process, it was possible to identify the following word categories: *Importance of Peer Tutoring; Integration of Theory and Practice; Development of Critical-Reflective Reasoning; Facilitation of Learning; Teamwork; and Limitations and Challenges of Pedagogical Practice*. These categories reflect both the elements considered positive by the students and the difficulties encountered during the implementation of the methodology in practical classes.

In accordance with the content analysis framework proposed by Bardin [13], the emergent categories were organized based on thematic recurrence and on the meanings attributed by participants to their experiences. Table 2 synthesizes the distribution of these categories across the students’ narratives, highlighting both the aspects that supported the teaching–learning process and

those that emerged as challenges within the pedagogical practice. In the following sections, each category is presented and examined in detail, illustrated by representative excerpts from the students’ accounts, thereby providing a deeper understanding of the methodology adopted.

Table 2. Frequency and percentage of categories.

Category / Subtheme	Number of students (n)	Percentage (%)
Importance of Monitoring	4	25
Integration Between Theory and Practice	7	44
Training in Critical and Reflective Thinking	8	50
Learning Facilitation	7	44
Teamwork	3	19
Limitations and Obstacles in Teaching Practice	5	31

3.2.1. Importance of Monitoring

The support provided by the peer monitors was recognized by the students as a facilitator of learning, particularly due to their ability to use accessible language and address the actual difficulties experienced by the class. Several accounts emphasized the monitors’ approachability, their assistance in resolving questions, and their role in mediating clinical case activities during the practical sessions, as evidenced in the participants’ statements below.

“It was very helpful because the interaction with the peer monitors supported us greatly. Since they were closer to us and had gone through the same experience, they were able to assist us extensively and share a great deal of knowledge.” (Student 1).

“In addition, the monitoring sessions served as an essential support for consolidating this knowledge, providing a more informal space to review content, clarify doubts, and strengthen my theoretical foundation.” (Student 4).

“I would like to conclude by expressing my appreciation for our peer monitors, who, despite the challenges faced throughout the semester, remained committed to sustaining the regularity and quality of their activities.” (Student 3).

“As the peer monitors mentioned, there will be moments in our professional practice when we will need to improvise, study, and seek additional knowledge.” (Student 5).

Thus, it becomes evident that monitoring functioned as a key support mechanism for the PM, narrowing the gap between theory and practice and fostering meaningful student engagement. This process contributed not only to a solid academic education but also to the development of future professionals who are better prepared and more qualified to navigate complex real-world social contexts.

3.2.2. Integration Between Theory and Practice

Several student accounts portrayed PM as a bridge to real-world practice and as preparation for the challenges inherent in the professional field. Another recurring theme was the perceived alignment between theoretically studied content and actual situations encountered in healthcare

practice, which enabled students to recognize the practical applicability of their knowledge in future professional contexts—particularly using clinical cases and case studies.

“The application of the Problematicization Methodology in the practical classes of Systemic Anatomy provided me with a unique and enriching learning experience [...] Together, these complementary activities made my studies more comprehensive and effective, better preparing me for clinical practice in Physiotherapy.” (Student 4).

“The Problematicization Methodology encouraged my active participation in the Systemic Anatomy classes, facilitating my understanding and promoting the exchange of ideas.” (Student 14).

“We will encounter challenges that, as professionals, we must be prepared to address [...]” (Student 5).

Based on the students’ reports, it was observed that PM promotes a closer alignment between theoretical content and professional context. The analysis indicates that this approach contributes to narrowing the gap between theory and practice, functioning as preparation for clinical experience and fostering the development of critical thinking—an essential component of health education. By encouraging students to reflect on real cases and problem situations, the methodology serves as a formative exercise for professional clinical practice, cultivating not only technical competencies but also critical analysis and decision-making skills, which are central to health professional training.

3.2.3. Training in Critical and Reflective Thinking

The students’ testimonials indicated that the methodology fostered the development of critical-reflective thinking. Through the PM, learners were encouraged to formulate hypotheses, devise problem-solving strategies, and build autonomy in addressing the situations presented.

“[...] the methodology helped me adapt to the different situations I will encounter. It allowed me to apply knowledge in practice and to assess whether I had studied effectively [...]” (Student 2).

“[...] it promotes clinical reasoning through problem-solving processes, including the identification and analysis of hypotheses and the development of appropriate solutions [...]” (Student 7).

In this context, the production of new knowledge presupposes the belief that transformation is possible, coupled with the continuous exercise of curiosity, intuition, emotional engagement, and accountability, as well as the cultivation of critical capacities to observe, delimit, and systematically pursue the object of study. This process requires a methodical approach that enables confrontation, questioning, comprehension, intervention, and critical appraisal of the reality under investigation. The findings of the present study indicate that the PM not only enhanced students’ understanding of course content but also promoted the development of higher-order cognitive skills—such as analysis, synthesis, and clinical judgment—particularly in relation to the problem situations presented.

3.2.4. Learning Facilitation

Most students reported that the PM contributed to a clearer, deeper, and more meaningful understanding of the content, particularly using clinical cases and the practical approach adopted. Moreover, elements such as the dynamics of the activities, effective time management, and the structured organization of the stages of the Maguerez’s Arc were highlighted as fundamental to the learning process, as illustrated in the reports presented below.

“[...] by employing strategies such as activities in which the class collaboratively solved clinical cases, the methodology effectively stimulated our learning.” (Student 1)

“[...] it (the Problematicization Methodology) enabled us to apply the content taught in theoretical classes in a more practical and engaging manner [...] I did not perceive any negative aspects in relation to my learning.” (Student 3)

“It had a positive impact on my understanding of the subject matter [...]” (Student 10)

"It was highly beneficial due to the clear and accessible teaching strategies, as well as the dynamic activities, which substantially enhanced my learning." (Student 11)

From this perspective, it can be inferred that the PM, when applied in practical anatomy classes through hands-on and engaging approaches, constitutes a privileged strategy for the learning process. Such problem-centered activities not only foster concrete experiential learning but also deepen the internalization of knowledge, ultimately resulting in more meaningful and enduring learning outcomes.

3.2.5. Teamwork

The students demonstrated recognition of the importance of teamwork, social interaction, and cooperation through their active engagement in the implementation of the proposal, emphasizing the development of relational and collaborative skills that are essential to the educational process.

"[...] encouraging collaborative work by bringing together different perspectives and opinions to construct a shared response [...]" (Student 7)

"[...] fostering greater social interaction among the groups [...]" (Student 3)

Drawing on Maguerez's Arch, it becomes evident that teamwork entails reconciling not only ideas, experiences, and knowledge, but also a wide range of perspectives in the pursuit of solutions to a shared problem. In this sense, collaborative work facilitated the distribution of responsibilities, the negotiation of meanings, and the joint construction of explanations for the problems presented.

3.2.6. Limitations and Obstacles in Teaching Practice

The students highlighted several aspects related to the time available for completing the activities, physical fatigue, cognitive overload, and the size of the groups—factors that can directly influence engagement, active participation, and the overall effectiveness of the learning process.

"[...] the practical classes take place immediately after the theoretical sessions. After lengthy theoretical classes, I am usually fatigued and tend to retain little of the content, often having to rely on them later as a study guide through repetition at home. As a result, the same difficulty occurs during problem-solving activities and practical classes, since I am unable to retain enough from the theoretical sessions to apply it effectively, given their close scheduling [...]" (Student 3)

"[...] being accustomed to linear learning processes, feelings of uncertainty and fear of making mistakes when solving problems sometimes create an impasse [...]" (Student 7)

"[...] the Problematicization Methodology often becomes tiring, as it requires sustained attention to every statement made by the instructor [...]" (Student 9)

These factors, as reported by the students, compromised both full participation and the overall quality of the experience with the PM. Such observations underscore the need for methodological refinements that consider students' individual learning pace, appropriate class organization, and the alignment of the pedagogical proposal with the workload available for its implementation. In this regard, the students' critiques and contributions provide valuable insights into the teaching process of Systemic Anatomy, from which key elements for enhancing teaching and learning practices can be inferred.

Overall, it can be inferred that PM was perceived as a facilitating strategy in the teaching and learning of Systemic Anatomy, fostering content comprehension, critical development, and the integration of theory and practice. Nonetheless, certain limitations emerged which, rather than being inherent to the methodology itself, stemmed from adverse conditions surrounding its implementations such as planning, group organization, and instructional mediation. These aspects are essential to observe, interpret, and analyze to understand students' perceptions and to inform possible improvements for future pedagogical practices.

4. Discussion

The demographic profile identified in this study reflects patterns commonly described in health sciences education. The predominance of female students aligns with national and global evidence showing the progressive feminization of the health workforce, particularly in Physiotherapy and allied health courses [15–18]. The high proportion of students not engaged in paid work may indicate greater availability for academic activities, a factor relevant in anatomy learning due to its high cognitive and practical demands, as can be seen in studies de Silva Júnior, Souza Santos e Silva Neto Border [18] e Border [19]. Evidence suggests that working students often experience increased stress and reduced study time, which can negatively affect performance in content-heavy disciplines such as Human Anatomy [20]. Additionally, the coexistence of different religious identities—predominantly Catholic—echoes the broader Brazilian cultural landscape [18,21] and has been shown to influence students' perceptions of body-related ethical issues, cadaveric dissection, and body donation practices [22,23].

The almost equal distribution of students residing in the host city and in surrounding municipalities highlights the regional role of the institution and is consistent with evidence showing that commuting can affect academic engagement and access to campus resources [24]. These sociodemographic characteristics, taken together, help contextualize how learners experience Human Anatomy—a discipline recognized for its intensity and reliance on practical, hands-on components [25]. Understanding students' backgrounds therefore contributes to a more accurate interpretation of their learning conditions and supports the development of pedagogy that is sensitive to diverse academic, cultural, and logistical realities within contemporary anatomy education [26].

The results of this study demonstrate that the application of the PM in practical Systemic Anatomy classes favored more active, contextualized, and meaningful learning, contributing to overcoming the traditional teaching model centered on memorization of anatomical structures. These findings are consistent with the perspective of problematizing education, in which students take on a leading role in the process of knowledge construction, breaking with the logic of banking education and promoting critical and reflective learning [3]. In the context of health education, this approach is particularly relevant, as it encourages the integration of theoretical knowledge and real-life professional practice situations.

The active participation of students observed in this study corroborates evidence that active methodologies promote greater engagement, intrinsic motivation, and knowledge retention in morphological disciplines, traditionally recognized for their complexity and high degree of abstraction [27–30]. Relevant studies indicate that student-centered strategies, such as problematization and problem-based learning, favor the development of critical thinking and clinical decision-making skills from the early stages of health undergraduate education [27,28].

In this scenario, academic monitoring, highlighted by participants as a support element during practical classes, plays a strategic role in the teaching-learning process. By acting as a mediator between teachers, content, and students, monitoring contributes to reducing conceptual difficulties, strengthens collaborative learning, and expands opportunities for dialogue and clarification of doubts. Evidence shows that structured peer monitoring and monitoring programs positively impact academic performance, self-confidence, and student adaptation to the curricular demands of health courses [31–34].

The approximation between theory and practice, emphasized by students, reinforces the need for pedagogical strategies that articulate anatomical knowledge with clinical and functional contexts. The literature highlights that the teaching of anatomy becomes more meaningful when associated with real or simulated scenarios of professional practice, promoting deep and lasting learning [2,26,35]. Recent studies indicate that practical activities based on active methodologies result in better academic performance, greater ability to integrate content, and the development of skills such as creativity, teamwork, and problem solving [37–40].

The development of critical-reflective thinking identified in the students' reports is aligned with the assumptions of active methodologies, whose central objective is to train autonomous, critical

professionals capable of analyzing and intervening in a well-founded manner in the reality in which they operate. In this sense, learning ceases to be a merely reproductive process and begins to involve analysis, synthesis, judgment, and decision-making, which are essential skills for health training [27,41]. The results of this study suggest that PM favored not only the understanding of anatomical content but also the development of higher cognitive skills, which are fundamental for clinical and professional reasoning.

Teamwork, widely evidenced in the results, is another central aspect of health training, as it encourages the exchange of knowledge, respect for different perspectives, and the development of interpersonal skills. Cooperative learning allows students to alternate between the roles of learners and facilitators, promoting greater engagement and conceptual understanding [42]. Systematic reviews indicate that collaborative and interprofessional activities provide superior learning experiences when compared to individualized strategies, especially in health education contexts [43].

From a professional practice perspective, the experience of teamwork during undergraduate studies contributes to the training of professionals who are better prepared to work in interdisciplinary contexts, reducing fragmentation of care and strengthening the comprehensiveness of health actions. Teams that value communication, cooperation, and shared responsibility tend to have better care and organizational outcomes [43,44]. Thus, the PM favored the distribution of roles, the negotiation of meanings, and the collective construction of solutions to the proposed problems, as evidenced by the students' accounts presented in this study.

However, the limitations pointed out by our students—such as heavy workloads, physical and mental fatigue, and organizational conditions—show that the effectiveness of the PM is directly related to pedagogical planning and institutional conditions. The literature indicates that, although active methodologies promote significant benefits, their application in extensive and highly demanding curricula can generate cognitive overload and academic fatigue, negatively impacting students' attention and performance [45,46].

Studies on contemporary trends in the teaching of Human Anatomy report that students often express the need for a better balance between theoretical and practical workloads, as well as diversified assessments and pedagogical strategies that respect the cognitive and emotional limits of learners [26,47]. These findings reinforce that the transition from traditional models to active methodologies does not occur homogeneously, requiring continuous monitoring and pedagogical adjustments [48].

In addition, the academic environment of health courses is characterized by high cognitive, emotional, and organizational demands, which can intensify levels of stress and anxiety among students. The need to develop autonomy, articulate theory and practice, and deal with constant evaluations often occurs in competitive contexts, potentially leading to conflicts and emotional exhaustion [49,50]. Thus, pedagogical strategies should consider not only cognitive aspects but also the well-being of students.

Given the above, the results show that PM is a relevant and promising pedagogical strategy for the practical teaching of Systemic Anatomy. However, its effectiveness depends on careful didactic planning, teacher training, and adaptation to the specificities of the institution and the subjects involved, to maximize its benefits and minimize limitations in the teaching-learning process.

5. Conclusions

The results indicate that the integration of the Problematic Methodology into the practical activities of Systemic Anatomy was positively received by students. This was evidenced by their reports highlighting strengthened group interactions, closer alignment between theory and practice, and increased student engagement in the learning process. Additionally, the methodology was shown to foster the development of critical and reflective thinking, as well as essential competencies for comprehensive training in the health sciences.

Despite these benefits, students also identified challenges and limitations, primarily associated with the high curricular workload and difficulties in adapting to the cognitive and operational

demands inherent to active learning methodologies. These findings underscore the importance of pedagogical planning that incorporates gradual implementation strategies, ensuring a balance between methodological innovation and practical feasibility within health education contexts.

In this regard, examining student perceptions is crucial, as they provide valuable insights into both the strengths and limitations of the methodology, offering guidance for its refinement and supporting the feasibility of future applications across different courses and educational settings. Overall, the findings suggest that the Problematicization Methodology, grounded in Maguerez's Arc, holds substantial educational potential within the teaching-learning process. However, its effectiveness is contingent upon adequate structural and pedagogical conditions, as well as continuous adjustments that consider the demands and constraints of the student population. This highlights the need for further research that prioritizes students' perspectives, fostering dialogue and active participation in the co-construction of their learning experiences.

Author Contributions: Conceptualization, Edivaldo Xavier da Silva Júnior and Jennyfer Klissya Ferreira Sousa; Methodology, Edivaldo Xavier da Silva Júnior, Michela Caroline Macêdo, Ricardo Freitas Dias and Jennyfer Klissya Ferreira Sousa; Formal Analysis, Jennyfer Klissya Ferreira Sousa, Isabelle Guedes do Nascimento; Maria Eduarda dos Santos Oliveira and Ana Carla Souza Rodrigues; Investigation, Jennyfer Klissya Ferreira Sousa, Isabelle Guedes do Nascimento, Ana Carla Souza Rodrigues and Maria Eduarda dos Santos Oliveira; Resources, Jennyfer Klissya Ferreira Sousa, Isabelle Guedes do Nascimento; Maria Eduarda dos Santos Oliveira; Writing – original draft preparation, Jennyfer Klissya Ferreira Sousa, Isabelle Guedes do Nascimento; Maria Eduarda dos Santos Oliveira and Edivaldo Xavier da Silva Júnior; Writing—Review and Editing, Edivaldo Xavier da Silva Júnior; Michela Caroline Macêdo; Ricardo Freitas Dias and Jennyfer Klissya Ferreira Sousa; Supervision, Edivaldo Xavier da Silva Júnior; Project Administration, Edivaldo Xavier da Silva Júnior; Financial Support through Scholarships, Edivaldo Xavier da Silva Júnior.

Funding: Pro-Rectorate for Graduate Studies, Research and Innovation, University of Pernambuco.

Institutional Review Board Statement: The study was conducted in accordance with the Declaration of Helsinki, and approved by the Research Ethics Committee of the University of Pernambuco, Brazil (protocol code 794,237 at 17th September, 2014).

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Acknowledgments: The researchers would like to thank all the students who volunteered to participate in this study, both in the participatory phase and in responding to the guiding question, which was necessary for the construction of the study. We would also like to thank the University of Pernambuco for its financial support through scholarships granted under the Pro-Rectorate for Graduate Studies, Research and Innovation.

Conflicts of Interest: The authors declare no conflicts of interest.

References

1. Mourthé Filho A, Dos Santos Borges MA, De Figueiredo IPR, De Oliveira MI, Taitson PF. Refletindo o ensino da Anatomia Humana. *Enferm Rev.* 2016;19(2):169–175.
2. Moraes GNB, Falcão JGB, Sandes AAG, Rodrigues BR, Nascimento IYM, Schwingel, PA, Silva Júnior EX. Cadaveric dissection by students-monitors in human anatomy discipline: experience report. *J Morphol Sci.* 2016;33(2):68-72.
3. Freire P. *Pedagogia do oprimido*. 17th ed.; Paz e Terra: Rio de Janeiro, Brazil, 1987.
4. De Moura Carlos LB, Bastos FSA, Bandeira HRF, Claudino LRF, Ferreira MUF, Nascimento Lameira AP. Metodologias Ativas no Ensino e Aprendizagem de Anatomia Humana: Uma Revisão Integrativa. *Braz J Dev.* 2021;7(9):90030-90047.
5. Raposo Neto LT, Costa RO, Morano DACMS, Cerqueira GS. Problematicization with Maguerez's Arc for health teaching: an integrative review. *Holos.* 2025;41(7):1-15.
6. Nascimento AAP, Silva Santos L, Silva Júnior EX. Estudantes de ciências biológicas e o uso da pintura corporal no ensino de anatomia: um estudo perceptivo. *O Anatomista.* 2025;3:60-71.

7. Costa RRO, Medeiros SMD, Martins JCA, Menezes RMPD, Araújo MSD. O uso da simulação no contexto da educação e formação em saúde e enfermagem: uma reflexão acadêmica. *Rev Esp Saúde*. 2015;16(1):59–65.
8. Strini PJSA, Srin PJS, Júnior RB. Metodologia ativa em aulas práticas de anatomia humana: a conjunta elaboração de roteiros. *Ensino Rev*. 2020;27(2):680–697.
9. Bordenave JD, Pereira AM. *Estratégias de ensino-aprendizagem*, 28th ed.; Vozes: Petrópolis, Brazil, 2007.
10. Berbel NAN, Gamboa SAS. A metodologia da problematização com o Arco de Magueres: uma perspectiva teórica e epistemológica. *Rev Filos Educ*. 2012;3(2):264–287.
11. Gil AC. *Como elaborar projetos de pesquisa*. 5th ed.; Atlas: São Paulo, Brazil, 2010.
12. Tripp D. Pesquisa-ação: uma introdução metodológica. *Educ Pesqui*. 2005;31(3):443–466.
13. Bardin L. *Análise de conteúdo*. Edições 70: São Paulo, 2016.
14. Valle PRD, Ferreira JL. Análise de conteúdo na perspectiva de Bardin: contribuições e limitações para a pesquisa qualitativa em educação. *Educ Rev*. 2025;41:e49377.
15. Maquini GV, Oliveira LMD, Takano CC, Dias MM, Silva EV, Nunes ABA, Jármey-Di Bella ZIK, Sartori MGF. Feminization of science: female pioneering in the healthcare area. *Rev Assoc Med Bras*. 2023;69(6):1-4.
16. Quironga-Garza A, Reyes-Hernández CG, Zarate-Garza PP, Esparza-Hernández CN, Gutierrez-De La O J, De La Fuente-Villarreal D, Elizondo-Omaña RE, Guzman-Lopez S. Willingness Toward Organ and Body Donation Among Anatomy Professors and Students in Mexico. *Anat Sci Edu*. 2017;10:589-97.
17. Likus W, Janiszewska P. Would you donate your body? Attitudes of students of nursing and physiotherapy towards body donation for education and scientific purposes. *Folia Morphol*. 2023;82:921-931.
18. Silva Júnior EX, Souza Santos JVM, Silva Neto JC. Perspective of a group of students on voluntary body donation for academic and scientific purposes in Pernambuco, Brazil. *J Morphol Sci*. 2025;42:46-53.
19. Border S. Working with students as partners in anatomy education. *Anat Sci Edu*. 2017;10(6):613-614.
20. Darolia, R. Working (and studying) day and night: heterogeneous effects of working on the academic performance of full-time and part-time students. *Econ Educ Rev*. 2014;38:38-50.
21. Ciliberti R, Gulino M, Gazzaniga V, Gallo F, Vellone VG, De Steano F, Santi P, Baldelli I. A survey on the knowledge and attitudes of Italian medical students toward donation: ethical and scientific considerations. *J Clin Med*. 2018;7:01-09.
22. McLachlan JC, Patten D. Anatomy teaching: ghosts of the past, present and future. *Med Educ*. 2006;3:243-253.
23. Ang WC, Doyle T, Stringer MD. Left-sided and duplicate inferior vena cava: A case series and review. *Clin Anat*. 2013;26(8):990-1001.
24. Credé M, Kuncel NR. Study habits, skills, and attitudes: the third pillar supporting collegiate academic performance. *Perspect Psychol Sci*. 2008;3(6):425-453.
25. Estai M, Stuart B. Best teaching practices in anatomy education: a critical review. *Ann Anat*. 2016;208:151-157.
26. Turney BW. Anatomy in a modern medical curriculum. *Ann R Coll Surg Engl*. 2007;89:104-107.
27. Dolmans DHJM, Loyens SMM, Marcq H, Gijbels D. Deep and surface learning in problem-based learning: a review of the literature. *Adv Health Sci Educ Theory Pract*. 2016;21(5):1087–1112.
28. Jiang Z, Wu H, Cheng H, Wang H, Xie AN, Fitzgerald SR. Twelve tips for teaching medical students online under COVID-19. *Med Educ Online*. 2021;26(1):1–10.
29. Estevez ME, Lindgren KA, Bergethon PR. A novel three-dimensional tool for teaching human neuroanatomy. *Anat Sci Educ*. 2010;3(6):309-317.
30. Singh K, Srivastav S, Bhardwaj A, Dixit A, Misra S. Medical education during the COVID-19 pandemic: a single institution experience. *Indian Pediatr*. 2020;57(7):678-679.
31. Ferreira T, et al. Formação de monitores do museu de ciências dá dica: preparo além da prática. In XI Encontro de Pesquisa em Ensino de Física, Curitiba, Brazil, 2008. (October 21rs, 2008).
32. Moraes GNB, Falcão JGB, Sandes AAG, Rodrigues BR, Nascimento IYM, Shiosaki RK, Schwingel PA, Silva Júnior EX. Vivência na monitoria de anatomia humana: relato de experiência de discentes-monitores do curso de fisioterapia. *Travessias*. 2016;10(3):67-79.

33. Burgess A, McGregor D, Mellis C. Medical students as peer tutors: a systematic review. *BMC Med Educ.* 2014;14(1):115.
34. Rees EL, Quinn PJ, Davies B, Fotheringham V. How does peer teaching compare to faculty teaching? A systematic review and meta-analysis. *Med Teach.* 2016;38(8):829–837.
35. Drake RL, Pawlina W. Multimodal education in anatomy: the perfect opportunity. *Anat Sci Educ.* 2014;7(1):1–2.
36. Turney BW. Anatomy in a modern medical curriculum. *Ann R Coll Surg Engl.* 2007;89(2):104–107.
37. Colares MAM, Mello JD, Vidotti AP, Sant’Ana DMG. Metodologias de ensino de anatomia humana: estratégias para diminuir as dificuldades e proporcionar um melhor processo de ensino-aprendizagem. *Arq MUDI.* 2019;23(3):140–160.
38. Soares BO, Ribeiro FS, Santos IF, Silva ACAA, Amorim M, Shiosaki MA, Bettencourt Pires MA, Schwingel PA, Silva Júnior EX. Are corpses the best method for practical anatomy assessment, according to health course students? *J Morphol Sci.* 2018;35(1):70–79.
39. Lemos GA, Monteiro JG, Lima FJC. Ensino de anatomia humana baseado em aprendizagem ativa. *Diversitas J.* 2021;6(2):2335–2350.
40. Silva Júnior EX, Nascimento RSCF, Oliveira TNFC, Brito MIC, Schwingel PA. Entre saberes e descobertas: metodologia da problematização na construção do conhecimento sobre o corpo humano na educação básica. *O Anatomista.* 2025;3:31–39.
41. Schmidt HG, Rotgans JI, Yew EHJ. The process of problem-based learning: what works and why. *Med Educ.* 2011;45(8):792–806.
42. Piazza BL, Chassot AI. Anatomia humana, uma disciplina que causa evasão e exclusão: quando a hipótese principal não se confirma. *Ciênc Mov.* 2011;14(28):45–59.
43. Reeves S, Fletcher S, Barr H, Birch I, Boet S, Davies N, McFadyen A, Rivera J, Kitto S. A BEME systematic review of the effects of interprofessional education: BEME Guide No. 39. *Med Teach.* 2016;38(7):656–668.
44. Laccort AA, Oliveira GB. A importância do trabalho em equipe no contexto da enfermagem. *UNINGÁ Rev.* 2017;29(3):6–10.
45. Young JQ, Van Merriënboer J, Durning S, Ten Cate O. Cognitive load theory: implications for medical education. *Med Teach.* 2014;36(5):371–384.
46. Sweller J. Cognitive load theory and educational technology. *Educ Technol Res Dev.* 2019;68(1):1–16.
47. Papa V, Vaccarezza M. Teaching anatomy in the XXI century: new aspects and pitfalls. *Sci World J.* 2013;2013(1):310348.
48. Cyrino EG, Toralles-Pereira ML. Trabalhando com estratégias de ensino-aprendizado por descoberta na área da saúde: a problematização e a aprendizagem baseada em problemas. *Cad Saúde Públ.* 2004;20(3):780–788.
49. Souza MR, Caldas TCG, De Antoni C. Fatores de adoecimento dos estudantes da área da saúde: uma revisão sistemática. *Psicol Saúde em Debate.* 2017;39(1):99–126.
50. Dyrbye LN, Thomas MR, Shanafelt TD. Medical student distress: causes, consequences, and proposed solutions. *Mayo Clin Proc.* 2005;80(12):1613–1622.

Disclaimer/Publisher’s Note: The statements, opinions and data contained in all publications are solely those of the individual author(s) and contributor(s) and not of MDPI and/or the editor(s). MDPI and/or the editor(s) disclaim responsibility for any injury to people or property resulting from any ideas, methods, instructions or products referred to in the content.