

Effectiveness of Pedagogical Strategies in Teaching Medical Semiology for the Development of Clinical Skills: A Systematic Review.

Eficacia de las Estrategias Pedagógicas en la Enseñanza de la Semiología Médica para el Desarrollo de Habilidades Clínicas: Una Revisión Sistemática.

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Summary.

Introduction: Medical semiology is a fundamental pillar in the clinical training of medical students. In recent decades, various pedagogical strategies have been incorporated to optimize the development of clinical skills, the effectiveness of which requires systematic evaluation. **Objective:** To evaluate and compare the effectiveness of various pedagogical strategies in the development of clinical skills in medical students. **Methods:** A systematic review was conducted following the PRISMA 2020 guidelines. The search was carried out in PubMed, Scopus, and Web of Science, including studies published between 2010 and June 2025. Randomized controlled trials, quasi-experimental studies, and descriptive studies that evaluated pedagogical interventions in undergraduate medical students with quantitative and qualitative results were included. The risk of bias was assessed using validated tools according to the study type. Results: Sixteen studies were analyzed. Active methodologies such as Problem-Based Learning (PBL) combined with lectures and Team-Based Learning (TBL) showed significant improvements in clinical performance and satisfaction. Educational videos and hybrid simulations improved procedural skills and self-confidence, especially when combined with face-to-face practice. Near-peer teaching and blended learning showed positive effects on OSCE scores. **Conclusions:** Pedagogical strategies that integrate practice, feedback, and multimedia resources appear more effective than isolated traditional methods for developing clinical skills in medical semiology.

Keywords: Medical semiology, medical education, clinical skills, problem-based learning, clinical simulation.

Resumen.

Introducción: la semiología médica constituye un pilar fundamental en la formación clínica del estudiante de medicina. En las últimas décadas, se han incorporado diversas estrategias pedagógicas con el objetivo de optimizar el desarrollo de habilidades clínicas, cuya efectividad requiere ser evaluada de manera sistemática. **Objetivo:** evaluar y comparar la eficacia de diversas estrategias pedagógicas en el desarrollo de habilidades clínicas en estudiantes de medicina. **Métodos:** se realizó una revisión sistemática siguiendo las directrices PRISMA 2020. La búsqueda se llevó a cabo en PubMed, Scopus y Web of Science, incluyendo estudios publicados entre 2010 y junio de 2025. Se incluyeron ensayos clínicos aleatorizados, estudios cuasiexperimentales y descriptivos que evaluaran intervenciones pedagógicas en estudiantes de medicina de pregrado con resultados cuantitativos y cualitativos. El riesgo de sesgo fue evaluado mediante herramientas validadas según tipo de estudio. **Resultados:** se analizaron 16 estudios. Las metodologías activas como ABP combinado con clases magistrales y TBL mostraron mejoras significativas en rendimiento clínico y satisfacción. Los videos educativos y simulaciones híbridas mejoraron habilidades procedimentales y autoconfianza, especialmente cuando se combinaron con práctica presencial. El near-peer teaching (enseñanza entre pares) y el aprendizaje mixto mostraron efectos positivos en puntuaciones de OSCE. **Conclusiones:** las estrategias pedagógicas que integran práctica, retroalimentación y recursos multimedia parecen más efectivas que los métodos tradicionales aislados para el desarrollo de habilidades clínicas en semiología médica.

Palabras clave: Semiología médica, educación médica, habilidades clínicas, aprendizaje basado en problemas, simulación clínica.

1. Introduction

Medical semiology represents the fundamental pillar of clinical practice and the doctor-patient relationship. It is not only a technique for collecting signs and symptoms, but also the grammar of medicine that allows us to interpret the language of disease (1). In undergraduate training, mastery of these skills transcends theoretical knowledge; it requires the development of complex communication skills (2) and keen clinical reasoning that allows us to integrate physical findings with the patient's history (3). This teaching of semiology has constantly evolved in the search for more effective methods.

Historically, teaching was based almost exclusively on bedside instruction. However, today, pedagogical strategies have diversified to meet the needs of patient safety and optimized learning (4). The current landscape includes the extensive use of simulation laboratories (5) and workshops with phantoms and interactive technology (6), which provide a safe environment before real-life contact. Strategies such as the use of standardized or simulated patients have proven to be valuable tools for comprehensive training (7), while innovative techniques such as role-playing (8) and gamification have introduced playful components to facilitate learning in complex areas such as neurological semiology (9).

In addition to these practical tools, methodologies focused on the cognitive process are also employed. The use of clinical case studies has become a key tactic for fostering clinical reasoning (10), and the implementation of peer-to-peer and faculty-to-faculty clinical mentoring programs has opened new avenues for skills transfer (11). However, the implementation of these strategies requires ongoing validation. Recent studies suggest that clinical simulation not only improves technique but is also vital for the development of critical thinking (12), and that the quality of feedback is crucial in determining students' perception of its usefulness (13).

Despite the abundant literature on the influence of new technologies (14) and various active methodologies, there is a continuing need to synthesize the evidence on which of these interventions offers the best objective results. Therefore, the aim of this study is to evaluate the effectiveness of different pedagogical strategies used in teaching medical semiology to medical students, compared with traditional methods, in relation to the development of clinical skills, through a systematic literature review based on a research question structured according to the PICO model.

2. Methods

Studio design

A systematic review was conducted following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA 2020) protocol guidelines to evaluate and compare the effectiveness of various pedagogical strategies in teaching medical semiology for the development of clinical skills in undergraduate medical students. The PubMed, Scopus, and Web of Science databases were searched.

Review protocol

No prior protocol for this systematic review was registered in PROSPERO or any other platform. It is explicitly acknowledged that omitting this procedure compromises the auditability and methodological traceability of the review, inherently increasing susceptibility to bias in the selective reporting of outcomes and the risk of undocumented empirical deviations in the eligibility criteria. However, in an effort to safeguard the internal validity of the synthesized evidence and mitigate these systematic threats, the inclusion and exclusion criteria and analysis strategies were strictly defined a priori and consistently applied throughout the review process.

Search strategies

The literature search was conducted on June 4, 2025. A systematic search was performed in the PubMed, Scopus, and Web of Science databases, including studies published between January 2010 and June 2025. These sources were chosen due to their high impact factor and the compatibility of their search algorithms. Filters were applied to limit the results to original articles published in the last 15 years (2010–2025), including documents in English and Spanish according to the authors' language proficiency. The Rayyan collaborative platform was used for reference management and duplicate removal. Search terms included combinations of keywords and MeSH headings related to: Clinical Skills: ("Clinical Skills" OR "Physical Examination" OR "Clinical Assessment"); Undergraduate Medical Education: ("Medical Education" OR "Undergraduate Medical Education"); and Teaching Methods: ("Teaching Methods" OR "Educational Strategies" OR "Active Learning"). The same search strategy was used in both databases.

Pre-selection, selection and screening process

Following the initial search of the databases, 216 articles were retrieved. Duplicates were removed, reducing the total to 203 records (13 duplicates removed). These 203 articles then proceeded to the selection stage. Articles whose titles and abstracts did not address the research question were excluded. The review was conducted in pairs, dividing the 203 articles into three equal parts. In cases of doubt, articles were discussed in a joint group meeting, where their inclusion or exclusion was decided. Study selection was carried out in two phases: screening of titles and abstracts, followed by full-text review. This process was performed independently by two reviewers using the Rayyan® platform. Discrepancies were resolved by consensus. Inter-rater reliability (kappa index) was not calculated. From this stage, 159 articles were excluded based on title/abstract, and the 44 selected articles were reviewed in full text by all members of the group. After evaluating their compliance with the inclusion criteria, 36 articles were unanimously selected for further evaluation.

Data extraction

The following data were systematically extracted: author, year of publication, country, study design, sample size, type of educational intervention, comparator, outcomes evaluated, and main results. This data extraction was performed by all reviewers.

Bias assessment and final selection

The 36 articles that advanced to this stage were evaluated considering methodological quality and risk of bias, using criteria previously defined by the team. Each study was reviewed independently by the team members, and any discrepancies were resolved by consensus. Risk of bias was assessed independently by two reviewers using validated tools according to the study type: RoB 2 for randomized controlled trials, ROBINS-I for non-randomized studies, the Newcastle–Ottawa Scale (NOS) for observational studies, and the NIH Quality Assessment Tool for descriptive studies. Discrepancies were resolved by consensus among all reviewers. Artificial intelligence was used solely to support the organization of methodological domains, without replacing the reviewers' critical judgment. From this evaluation, 16 articles that met the necessary quality and relevance standards were selected for inclusion in the review (Figure 1).

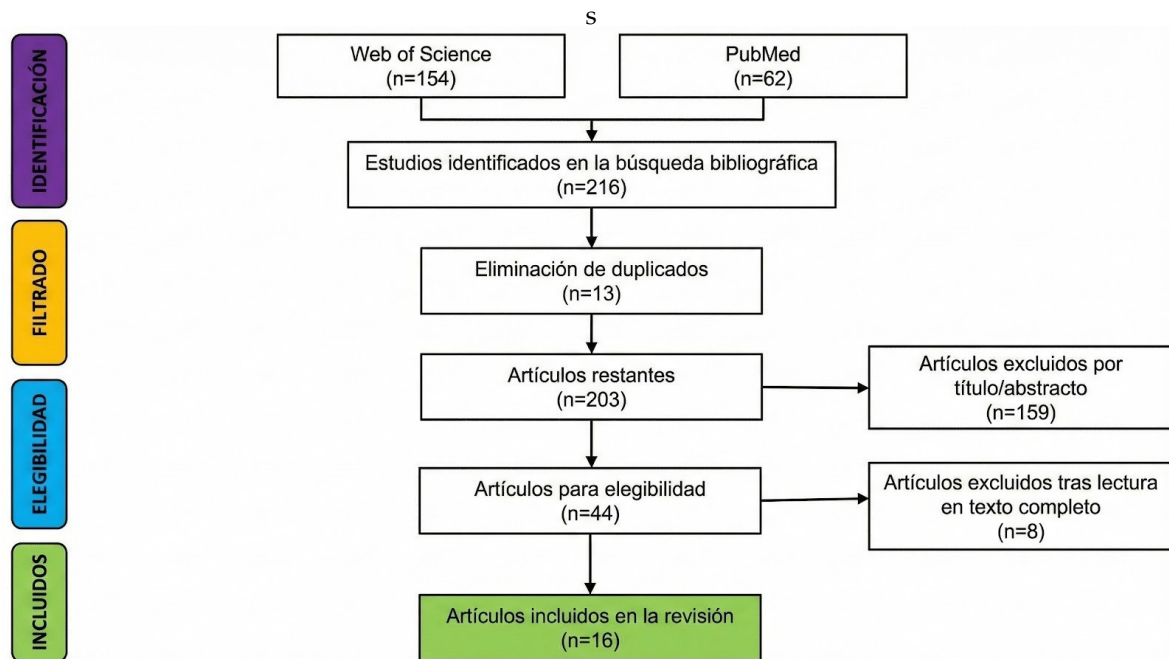


Figura 1. Flowchart of the process of selection of articles.

Summary of included studies

The 16 selected articles were analyzed considering their objectives, methodologies, pedagogical strategies evaluated, and main findings. The information was organized comparatively to identify similarities, differences, and general patterns among the studies. This synthesis allowed us to describe how different pedagogical strategies influence the teaching of medical semiology and the development of clinical skills.

Meta-analysis

Due to the clinical, methodological, and outcome heterogeneity among the included studies, a meta-analysis was not considered appropriate. The studies presented substantial differences in the populations analyzed (ranging from first-year to advanced students), in the types of pedagogical

interventions implemented (including hybrid simulation, problem-based learning, virtual reality, near-peer teaching, and blended learning models), as well as in the duration of the interventions and the instruments used to assess the outcomes (OSCE, Mini-CEX, perception scales, and proprietary questionnaires). In this context, the statistical combination of the results could have generated artificial or clinically uninterpretable overall estimates, compromising the validity of the conclusions. For this reason, a structured narrative synthesis was chosen, considered the most appropriate methodological approach to preserve the contextual interpretation of the findings and more accurately describe the differences between the pedagogical strategies evaluated. Furthermore, the narrative synthesis allowed for the organization and comparison of the findings according to the specific characteristics of each pedagogical intervention and the different outcomes assessed. This approach facilitated the identification of general trends among the included studies, while maintaining the contextual interpretation of the results and avoiding potentially simplistic conclusions derived from a statistical combination of highly heterogeneous studies. This decision is consistent with methodological recommendations for systematic reviews with high educational heterogeneity and diverse outcomes.

Inclusion and exclusion criteria

The articles had to base their research on the implementation of various pedagogical strategies aimed at teaching medical semiology and developing clinical skills in the context of undergraduate medical education. Teaching strategies considered included clinical simulation (with actors or mannequins), Problem-Based Learning (PBL), gamification, early practice in Primary Health Care (PHC), *near-peer teaching*, the use of interactive technologies, and hybrid models (*blended learning*). Studies with randomized controlled trials (RCTs), quasi-experimental, cohort, and descriptive designs with pre-post intervention assessment were included. Priority was given to comparative designs between an experimental group subjected to the teaching strategy and a control group using traditional methods (such as lectures) or another active strategy. Finally, the studies had to report structured quantitative or qualitative results. Regarding quantitative data, objective measurements of clinical skills (such as OSCE or Mini-CEX scores) and validated perception scales were considered; as for qualitative results, those related to satisfaction, self-confidence, and communication skills were considered. It is important to clarify that, although the primary focus was on experimental evidence, the methodological decision was made to exceptionally include structured and descriptive qualitative studies. This decision is based on the fact that these designs provide highly valuable methodological information for the narrative synthesis, offering a critical context on student perceptions, communication skills, levels of self-confidence, and empirical barriers to implementation—essential elements for understanding the feasibility and actual receptiveness of educational interventions in practice. Table 1 shows the inclusion and exclusion criteria.

Use of Artificial Intelligence

An artificial intelligence tool was used to assist in the preliminary data synthesis and risk-of-bias analysis of the included studies, following the Cochrane RoB 2 tool domains. All AI-generated analyses were manually verified by the authors to ensure methodological accuracy. The AI was used solely to support the preliminary organization of information, without making methodological judgments or replacing the critical appraisal of the reviewers.

Table 1. Inclusion and exclusion criteria.

Inclusion Criteria		Exclusion Criteria
Context and Participants	Undergraduate medical students in semiology courses or basic clinical skills.	Residents, medical graduates, or students in other health-related fields. Studies not focused on

		medical education.
Intervention	Teaching strategies with an explicit focus on semiological skills: Simulation, PBL, Gamification, Near-Peer, Blended Learning, Educational Videos, Early Practice.	Teaching strategies without a focus on semiological skills or non-teaching interventions.
Studio design	Randomized controlled trials (RCTs), quasi-experimental studies, cohorts, and pre-post intervention studies.	Literature reviews, editorials, letters, single case reports, and purely qualitative studies. Samples of fewer than 20 participants.
Results	Objective (OSCE, Mini-CEX) or structured subjective (validated scales) measurement of clinical skills: anamnesis, physical examination, diagnostic reasoning and communication.	Results based exclusively on theory or rote memorization. Lack of measurable quantitative or qualitative data.
Comparator	Explicit comparison between strategies (e.g., active vs. traditional) or temporal measurement (pre-post).	Studies without a comparator group or pre-post intervention measurement.

Table 2. Selected studies.

Author, country, year, reference	Design	Participants	Technique/Intervention implemented	Findings
Zhan HQ, China; 2023, 15	Randomized controlled trial	118 undergraduate medical students	Combination of (problem-based learning) with LBL (lecture)	The experimental group (integrated + LBC) scored significantly higher than the control group (LBC only) in Clinical Skills. Improvements were also observed in self-directed learning, problem analysis, problem-solving, and humanistic skills.
Flatt E. United Kingdom, 2023, 16	Randomized controlled trial	42 first and second year medical students	In-person clinical exam session + online educational video (F2FV) vs in-person only (F2F)	Both groups improved in exam skills. The F2FV group obtained significantly higher scores post-intervention (M=23.6 vs M=18.6 in F2F, p=0.005), showing that the supplementary educational video increased learning effectiveness.
Blank, Hannes, Germany, 2013, 17	Randomized controlled trial	53 third-year medical students	Additional near-peer teaching course: small groups supervised by advanced students, peer practice and practice with simulated patients	Students in the intervention group (additional course with close peer instruction) obtained significantly higher scores at each station of the OSCE. 18 received "very good", 6 "good", and 1 "satisfactory"; in the control group, no student received "very good".
Camille DiLullo, 18	Cross-sectional qualitative study	270 first-year medical students	Online tutorials based on clinical cases that include medical histories and physical examination, doctor-patient interaction videos, questioning, and image support.	Students who used the tutorials found them helpful in understanding the clinical relevance of the content. Those who did not use them cited a lack of time and the perception of the content as extracurricular.
Cuisle Forde, 19	Randomized controlled post-test only trial	47 undergraduate medical students	Face-to-face group: 2-hour session with instructor (1 hour theory + 1 hour practice). Blended group: Online material + 1 hour of face-to-face practice with instructor. Online group: Online material only (videos, forums, quizzes), no face-to-face	The combination of online material with face-to-face practice (mixed group) was the most effective for acquiring practical skills, followed by the face-to-face group, while the online-only group was significantly less effective.

practice.				
Deborah Murdoch 1999, United Kingdom, 26	Non- randomized controlled trial with parallel groups	172 fourth-year medical students from a 5-year course.	Structured teaching method called "silent run through": breaking down complex tasks into smaller steps, demonstrating the skill with explanation of fundamentals, practicing in pairs by speaking the steps aloud, and practicing individually by silently repeating the steps mentally.	Students who received structured instruction (silent run-through) significantly improved their ability to reproduce a complex, sequential clinical skill (strabismus examination, $P = 0.007$). However, there was no demonstrable improvement in problem-solving skills assessed in X-ray interpretation; in fact, these students scored lower ($P = 0.03$). Students expressed high levels of satisfaction and increased confidence in performing the skills thanks to the structured teaching method.
Merel JC Martens, 2009, Netherlands, 27	Cross- sectional qualitative study	First- to third- year undergraduate medical students.	Students' perceptions of effective teaching skills for acquiring physical examination skills were explored using focus group discussions as the methodology. Students identified interpersonal and communication skills as the most facilitating skills, followed by various teaching interventions and several preconditions.	Students perceived that the most effective teaching skills for acquiring physical examination skills are interpersonal and communication skills, followed by specific didactic interventions. These skills must be supported by preconditions such as curriculum integration, structured sessions, and good time management. Negative experiences had a short-lived impact, primarily affecting short-term motivation.
Zhicheng He, 2024, China, 28	Prospective, randomized, controlled study	48 fifth-year medical students.	Blended learning.	Students in the blended learning group achieved significantly higher scores across all OSCE stations compared to the traditional offline learning group. Furthermore, the majority perceived the blended learning methodology as superior and expressed a willingness to adopt it in other courses, highlighting improvements in procedural understanding, independent learning, and exam preparation.
Wanjun Zhao (2020), China, 29	Prospective, randomized, controlled study	354 fourth-year clinical medical students and 232 residents enrolled; 276	Pre- and post-class quizzes with 32 multiple-choice questions about thyroid nodules. The quizzes consisted of basic theoretical questions (50 points) and clinical case analyses (50 points).	The -CBL method significantly improved performance, clinical skills and motivation of students and residents ($P < 0.001$), enhancing communication, clinical thinking, self-learning, teamwork and creativity in case analysis.

participants in the -CBL group and 293 in the traditional group completed the study.

Abdulaziz Z Alomar (2022), Kingdom of Saudi Arabia, 30

Cross-sectional qualitative study

242 fifth-year medical students.

Online educational video.

Video-based learning (VBL) improved students' understanding and retention of musculoskeletal physical examination skills, making it preferable to traditional methods. It facilitated preparation for practical sessions and clinical exams, increased confidence, and promoted more practice. Its limitations include the need to supplement it with in-person practice and reinforce theoretical foundations and clinical anatomy.

3. Results

After applying the eligibility criteria and assessing methodological quality, 16 studies were selected for the final synthesis (Table 2). Analysis of these studies allows us to break down the impact of pedagogical interventions into five broad categories, revealing not only which methods work, but also in which specific contexts they showed favorable results compared to traditional teaching. Although many of the included studies reported positive associations between active pedagogical strategies and the development of clinical skills, these findings should be interpreted with caution due to the methodological, clinical, and outcome heterogeneity present among the analyzed studies. Furthermore, the included studies presented considerably different objectives, pedagogical interventions, and assessment methods, making it difficult to establish direct comparisons between the results. Additionally, some studies presented limitations related to risk of bias, lack of blinding, and variability in the assessment instruments used— aspects that could influence the magnitude and interpretation of the reported results.

3.1 Evaluation of methodological quality and risk of bias

To ensure the transparency and rigor of this systematic review, a detailed risk-of-bias assessment was conducted for the 16 selected studies. The domains assessed included, for randomized controlled trials (RoB 2): randomization process, deviations from planned interventions, missing outcome data, outcome measurement, and selection of reported outcome. For non-randomized and descriptive studies: selection bias, confounding, classification of interventions, and validity of measurement instruments (Table 3).

Table 3. Summary of Risk of Bias Assessment.

Reference	Type of Study	Tool	Global Judgment (Risk of Bias)
15	ECA	RoB 2	Low risk
16	ECA	RoB 2	Low risk
17	ECA	RoB 2	Some concerns (Blinding)
18	Descriptive	NIH Tool	Good quality
19	ECA	RoB 2	Low risk
20	ECA	RoB 2	Low risk
21	ECA	RoB 2	Low risk
22	ECA	RoB 2	Some concerns
23	ECA	RoB 2	Moderate risk
24	ECA	RoB 2	Low risk
25	ECA	RoB 2	Some concerns (Temporality)
26	Non-Randomized	ROBINS-I	Moderate risk
27	Qualitative	NIH Tool	Good quality
28	ECA	RoB 2	Low risk

29	ECA	RoB 2	Low risk
30	Descriptive	NIH Tool	Acceptable Quality

3.2 The impact of active methodologies: Problem-Based Learning (PBL) and Team-Based Learning (TBL).

The evidence gathered strongly suggests that abandoning the passive role of the student in favor of active methodologies transforms the acquisition of clinical skills. First, the integration of models such as Problem-Based Learning (PBL) proved to be an effective catalyst. Zhan et al. (15) observed that combining PBL with the traditional Lecture (LBC) not only raised academic performance but also fostered greater autonomy in learning. Along the same lines, Zhao et al. (29) explored the use of PBL combined with Case-Based Learning (CBL) for thyroid pathologies. Their findings were revealing: the experimental group showed significantly greater improvement on post-class questionnaires ($p < 0.001$), which integrated theory and analysis of real cases, far surpassing the traditional approach. On the other hand, Team-Based Learning (TBL) was particularly effective in complex clinical settings such as pediatrics. Gong et al. (21) implemented bedside TBL and the results were remarkable: students not only obtained better scores on computer simulations (85.73 vs. 80.13, $p = 0.0033$), but their performance in real-life situations (measured with Mini-CEX) was superior in critical areas such as clinical judgment ($p = 0.0020$) and the medical interview ($p = 0.0254$). This suggests that discussion and team collaboration refine clinical judgment much more effectively than solitary instruction.

3.3 Use of Educational Videos and Multimedia

The role of audiovisual resources is as a complement, not a substitute. Analysis of studies on educational videos yields a nuanced conclusion: they are excellent tools for enhancing practice, but insufficient on their own for teaching manual skills. The study by Flatt et al. (16) in the United Kingdom illustrates the positive potential of this approach. By adding personalized videos to face-to-face instruction of the shoulder examination, student scores increased significantly (23.6 points compared to 18.6 for the face-to-face-only group, $p = 0.005$). However, the research by Forde et al. (19) serves as a necessary cautionary note. Comparing modalities for teaching anthropometric measurements, they found that the group that learned exclusively online had an alarmingly low success rate of 17%, in contrast to the 89% success rate of the group that combined online theory with face-to-face practice (blended learning). The purely online students struggled with sensory and tactile aspects, such as the correct placement of instruments. Furthermore, the context in which knowledge is acquired is crucial. Ott et al. (20) found that viewing the video before self-directed practice improved skill retention at 7 days, indicating that the video cognitively prepares the individual for subsequent motor execution. Although students appreciate these resources for sequentially organizing the physical examination, they agree that the hands-on experience is irreplaceable.

3.4 Hybrid Simulation and Virtual Reality: Safe environments for error.

New technologies and advanced simulation are emerging as the ideal bridge between theory and real patients, allowing students to gain confidence safely. Nassif et al. (22) provided very positive data on hybrid simulation in breast examination. Its use dramatically improved students' ability to identify lesions ($p < 0.001$) compared to standard training. A crucial finding of this study is that the increased sensitivity did not lead to an increase in false positives, validating the method's clinical accuracy. Looking to the future, Virtual Reality (VR) has shown lasting benefits. Gan et al. (24) conducted a one-year follow-up and found that students trained with VR not only performed better in the immediate OSCE (especially in suturing and physical examination) but also maintained superior performance during their actual orthopedic surgical rotations. Beyond technique, these students reported stronger professional motivation and determination.

3.5 The human factor and structure: Near-peer teaching and Structured Methods.

Human interaction and the way teaching is structured play a crucial role, sometimes with surprising results. The Near-peer teaching strategy proved extraordinarily effective in the study by Blank et al. (17). The qualitative difference was substantial: in the Objective Structured Clinical Examination (OSCE), 18 students in the peer-instructed group achieved a "very good" rating, while no students in the control group achieved this distinction. This highlights how proximity to the tutor can facilitate understanding and reduce anxiety. However, the rigid structure of structured methods is a double-edged sword. Murdoch Eaton et al. (26) evaluated the "silent run-through" method. While this was excellent for improving sequential motor skills, such as those in the strabismus examination ($p = 0.007$), it proved counterproductive for complex diagnostic reasoning. In fact, students trained under this rigid method obtained worse results in the interpretation of x-rays ($p = 0.03$), suggesting that over-mechanizing learning may inhibit creative problem-solving.

3.6 The ideal synthesis: Blended teaching

Finally, blended learning emerges as the most balanced and powerful strategy, leveraging the best of both the digital and face-to-face worlds. The study by He et al. (28) in 2024 provides perhaps the most robust evidence in favor of this model. When comparing groups in the OSCE, students in the blended learning model outperformed those in traditional instruction at all stations. The differences were notable in chronic skills such as physical examination (with an average of 90.04 vs. 63.83, $p < 0.05$) and disinfection procedures (82.79 vs. 61.42). Interestingly, this improvement in performance was not perceived as an extra burden; on the contrary, 70.8% of students felt that the blended format facilitated faster mastery of skills and promoted more effective independent learning. This positions blended learning not only as a viable alternative but also as a potential new gold standard for teaching semiotics.

Table 4 shows a summary of findings by thematic category and Figure 2 integrates the interconnections observed between the evaluated pedagogical strategies, their underlying theoretical foundations and the clinical outcomes identified in the analyzed literature.

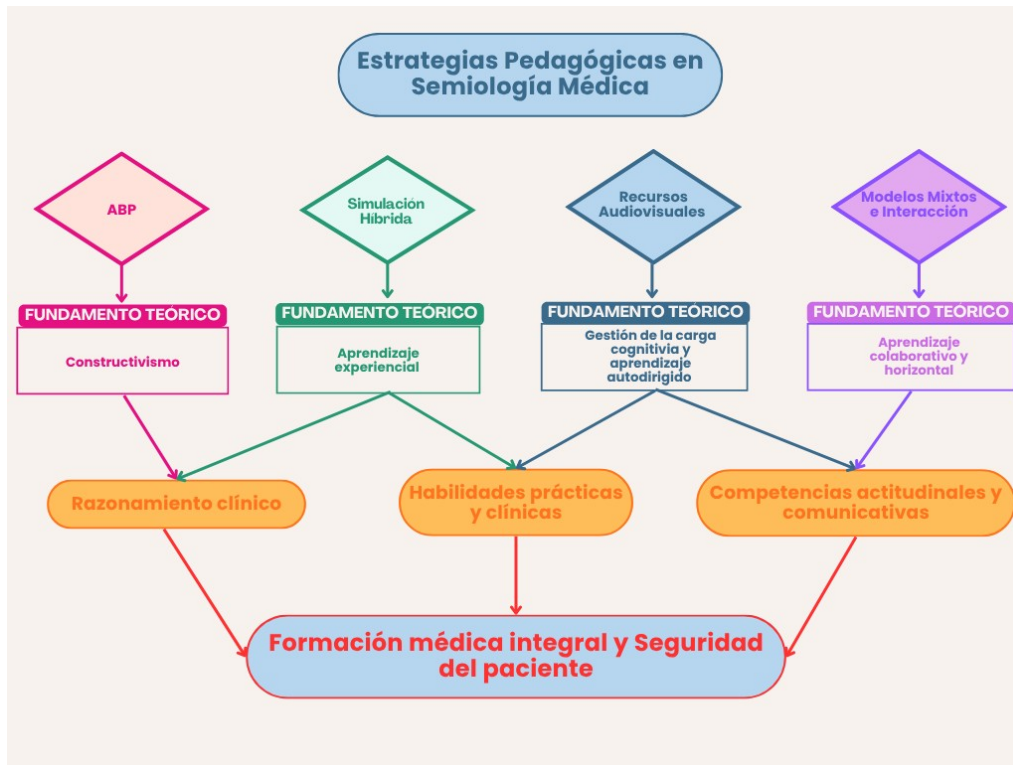
Table 4. Unified synthesis of findings by thematic category.

Author, country, year and (Ref. No.)	Technique / Intervention Implemented	Main Findings
Zhan HQ, China, 2023 (15)	Combination of Problem-Based Learning (PBL) with traditional lecture (LBC).	It significantly improved clinical skills, self-directed learning, problem-solving ability, and humanistic competencies compared to the traditional method.
Flatt E, United Kingdom, 2023 (16)	Use of complementary online educational video resources combined with a short face-to-face session, as opposed to traditional face-to-face teaching alone.	The use of supplemental video significantly increased the scores of novice medical students on the clinical exam assessment.
Blank WA, Germany, 2013 (17)	Implementation of a physical examination training program taught by upper-year students (near-peer teaching).	The peer-trained students demonstrated excellent performance in the OSCE-type practical assessment; most received a "very good" rating and none failed in the intervention group.
DiLullo C, USA, 2009 (18)	Introduction of online tutorials based on clinical cases integrated with tools and video demonstrations.	Students rated the tutorials' usefulness in understanding clinical relevance very positively, although it was identified that time and the extracurricular nature of the content may limit its widespread use.
Forde C, Ireland, 2020 (19)	Comparison of three methodological branches for the	The blended learning model proved to be the most effective for the lasting acquisition of practical skills,

	acquisition of practical skills: Face-to-face format, blended format and 100% online format.	while the purely online format was the least effective.
Ott T, Germany, 2023 (20)	Viewing a 10-minute instructional video as a standalone tool, followed by a self-directed practice session.	Watching the detailed video before moving on to practice significantly improved both immediate performance and retention of clinical skill at 7 days.
Gong J, China, 2019 (21)	Team-Based Learning (TBL) application directly at the patient's bedside (bedside TBL), incorporating assigned roles and immediate feedback.	A significant increase was observed in the scores of the clinical competencies (CCS) and the Mini-CEX assessments, also reporting higher levels of student satisfaction, team cohesion and communication skills.
Nassif J, Lebanon, 2017 (22)	Use of a hybrid simulation model (use of anatomical simulators in conjunction with standardized patients) for teaching breast physical examination.	Hybrid simulation significantly increased the accuracy of students in identifying critical breast lesions, reducing the false positive rate compared to conventional methods.
Masser BA, USA, 2005 (23)	Evaluation of the use and integration of technological tools and multimedia resources applied to medical education within the emergency service.	The study provided key data on the pedagogical flexibility of visual aids, although methodologically it was categorized as having a moderate risk of bias in the overall analysis.
Gan Y, China, 2023 (24)	Incorporation of a high-fidelity interactive Virtual Reality (VR) simulator focused on training and active review of suturing techniques.	The VR group showed superior long-term technical performance during their surgical rotations and OSCE assessments, in addition to demonstrating higher levels of motivation and self-evaluation.
McGraw RC, Canada, 1999 (25)	Intensive use of standardized patients (actors) combined with a smaller number of teaching tutors during the early stages of semiology.	No statistically significant differences were found in the results of the practical OSCE or in the overall satisfaction surveys compared to the traditional tutored scheme.
Murdoch-Eaton D, UK, 1999 (26)	Implementation of a highly structured teaching methodology based on silent run-through visual demonstration by the teacher.	The method was highly effective in enabling students to accurately reproduce motor skills and complex clinical steps, but it showed no impact on the development of abstract problem-solving abilities (such as independent interpretation of X-rays).
Martens J, Netherlands, 2009 (27)	Qualitative analysis using focus groups to explore student perspectives on what factors make physical exam teaching effective.	The students identified that the tutor's interpersonal skills, structured communication, and a clear sequence within the curriculum design are the fundamental pillars for successful learning.
He Z, China, 2024 (28)	Design and implementation of a blended teaching program that combines virtual platforms with face-to-face practical skills workshops.	The intervention group achieved significantly higher scores in all stations evaluated using the OSCE format, being rated by the students as a superior pedagogical environment.
Zhao W, China, 2020 (29)	A combined pedagogical approach that unites the strengths of Problem-Based Learning (PBL) and Case-Based Learning (CBL) to address the clinical practice of thyroid pathologies.	This synergistic strategy raised theoretical and practical academic performance, promoting in a coordinated manner intrinsic motivation, critical analysis of clinical cases, medical communication, and collaborative work.
Alomar AZ, Saudi Arabia, 2022 (30)	Evaluation of the perception of a fully audiovisual and online	Students reported subjective improvements in theoretical understanding, step retention, and pre-

module focused exclusively on musculoskeletal physical examination techniques.

assessment confidence, emphasizing that it requires mandatory complementation with face-to-face practical workshops to consolidate the skill.



4. Discussion

This systematic review analyzed the effectiveness of various pedagogical strategies implemented in the teaching of medical semiology, with the aim of evaluating their impact on the development of clinical skills in medical students. The results showed positive trends regarding certain active methodologies compared to traditional approaches in the development of key clinical skills, such as history taking, physical examination, and interpretation of clinical signs. The most relevant findings are then contextualized and integrated with the existing literature.

Before analyzing the results, it is important to consider the contribution of the descriptive and qualitative studies included in this review, such as that by Martens et al. (27). Although the methodological design prioritized experimental studies and excluded purely qualitative research, these studies provide relevant information on students' perceptions, implementation barriers, and the educational experience. While they do not allow for quantitative measurement of effectiveness, they do help to understand aspects that controlled studies often overlook, such as the importance of communication skills and interpersonal dynamics in the clinical setting.

ABP + LBC:

The combination of problem-based learning (PBL) with lectures (LBC) was associated with improved performance on clinical skills assessments, consistent with findings in previous studies (15, 29). PBL, as a student-centered approach, aims to facilitate the development of analytical and problem-solving skills, while lectures provide the necessary theoretical foundation for understanding the underlying concepts. Integrating both methods could complement the learning process, promoting the application of theoretical knowledge in real-world clinical contexts. These results are consistent with evidence suggesting that PBL may offer advantages over traditional teaching for the development of clinical reasoning (15, 29).

ABP + LBC:

The combination of problem-based learning (PBL) with lectures (LBC) was associated with improved performance on clinical skills assessments, consistent with findings in previous studies (15, 29). From a theoretical perspective, the effectiveness of PBL is based on constructivism, a model in which students actively construct their own knowledge and mental frameworks by interacting with meaningful clinical problems. PBL, as a student-centered approach, aims to facilitate the development of analytical and problem-solving skills, while lectures provide the necessary theoretical foundation for understanding the underlying concepts. Integrating both methods could complement the learning process, promoting the application of theoretical knowledge in real-world clinical contexts. These results are consistent with evidence suggesting that PBL may offer advantages over traditional teaching for the development of clinical reasoning (15, 29).

Hybrid Simulations:

Hybrid simulations, which combine face-to-face instruction with clinical simulation, have been associated with improved performance in practical skills without increasing false positives. This observation is consistent with the premise that they provide a controlled environment for technical training, allowing students to identify and correct potential procedural errors without compromising patient safety (22, 33). The report that this approach does not appear to increase the error rate is a methodological factor to consider compared to other strategies, suggesting that it could contribute to a more structured execution of acquired skills. Hybrid simulations, which combine face-to-face instruction with clinical simulation, have been associated with improved performance in practical skills without increasing false positives. This approach finds strong support in experiential learning

theory, as it allows students to safely transition from concrete clinical experience to reflective observation and conceptualization. This observation provides a controlled environment for technical training, allowing students to identify and correct potential procedural errors without compromising patient safety (22, 33). The report that this approach does not appear to increase the error rate is a methodological factor to consider compared to other strategies, suggesting that it could contribute to a more structured execution of the acquired skills.

Use of educational videos:

The use of educational videos as a supplement to face-to-face instruction resulted in a significant improvement in practical exam scores (OSCE), consistent with previous research demonstrating that videos help students review and consolidate knowledge before practical sessions (16, 20, 30). From an instructional design perspective, these asynchronous tools optimize cognitive load management, allowing students to process the complexity of semiotics at their own pace and fostering self-directed learning prior to clinical exposure. The improved knowledge retention and increased student confidence in performing clinical procedures reflect the potential of educational videos as an additional learning tool, which also promotes motivation and autonomous learning. The findings reported by Alomar et al. (30), Ott et al. (20), and Flatt et al. (16) showed consistent results regarding the contribution of audiovisual resources to teaching clinical skills. Although their designs and interventions differed, all three studies showed that the use of educational videos was associated with better preparation for practical activities, greater skill retention, and improved results in clinical assessments, especially when these resources were combined with in-person practice. In Spanish-speaking contexts and in educational communities with more limited access to teaching resources or frequent practical opportunities, these types of tools could facilitate access to educational materials developed by various universities and international academic teams, complementing local instruction through repeated observation of physical examination techniques and clinical demonstrations.

Near-Peer Teaching:

Near-peer teaching, a model in which upper-level students guide those in lower levels, was positively associated with performance on clinical skills assessments. This instructional design facilitates collaboration and horizontal feedback, elements that, according to the literature, can contribute to the consolidation of learning (32). Participants in these interventions reported higher levels of self-confidence and obtained higher scores on clinical measures. These findings suggest that peer instruction could operate as a bidirectional mechanism, offering student tutors an opportunity to strengthen their own theoretical and procedural competencies by assuming the role of facilitator. Near-peer teaching, a model in which upper-level students guide those in lower levels, was positively associated with performance on clinical skills assessments. This instructional design facilitates collaboration and horizontal feedback, elements that, according to the literature, can contribute to the consolidation of learning (32). Participants in these interventions reported higher levels of self-confidence and scored higher on clinical assessments. These findings suggest that peer instruction could operate as a bidirectional mechanism, offering student tutors an opportunity to strengthen their own theoretical and procedural skills by assuming the role of facilitator.

Mixed education:

The blended learning model, which integrates online components with face-to-face instruction, was associated with higher performance on practical skills assessments and clinical exam preparation compared to purely traditional approaches. The structure of this model could facilitate students managing their theoretical progression individually, while preserving direct interaction with instructors and peers during face-to-face sessions. Furthermore, this methodological configuration appears to promote self-directed learning and could positively influence the time required to acquire

procedural skills, findings that are consistent with previous evidence on hybrid learning environments (31).

Strengths and limitations

One of the main strengths of this work is its commitment to methodological transparency, having rigorously followed the PRISMA 2020 international standards. We sought not only to compile articles but also to construct a comparative and critical perspective that would be useful for designing future medical programs. By structuring our search using the PICO model and focusing on objective assessment tools such as the OSCE, we ensured that the results went beyond theory and had direct application in real-world clinical training. However, as researchers, we recognize that this study is not without its challenges. The most significant limitation is the marked heterogeneity among the analyzed studies. With such varied designs and mostly short-term follow-up periods, it becomes difficult to establish a direct statistical comparison or conduct a truly representative meta-analysis.

Furthermore, we must be cautious in interpreting positive results. While the results consistently favor active learning strategies, the risk of bias detected in selection and measurement domains in some of the included studies suggests that the magnitude of the positive effect may be overestimated. For example, the lack of blinding in outcome assessment in certain simulation and PBL trials could introduce compliance bias that must be considered when attempting to replicate these models in other curricula. Moreover, although instruments such as the OSCE and Mini-CEX are widely used and recognized in international medical education, their implementation can vary depending on the institutional, curricular, and educational context of each country, an aspect that must be considered when interpreting and extrapolating the results of the included studies. Additionally, the absence of statistical calculations of inter-rater agreement (such as the Kappa index) during critical stages of the study constitutes a substantial methodological limitation. It is explicitly acknowledged that omitting this quantitative metric of inter-rater agreement diminishes the robustness, objectivity, and reproducibility of the processes of literature screening and selection, data extraction, and bias risk assessment. Consequently, the inability to statistically verify inter-rater consistency increases the vulnerability of the systematic review to individual subjectivity and potential errors in classification or interpretation during the critical appraisal of the evidence.

In addition to the methodological limitations inherent in this review, the included studies also had their own limitations, such as a lack of blinding, variability in assessment instruments, and differences in intervention design, which could have influenced the magnitude of the reported effects. Finally, while the exclusion of qualitative studies allowed us to maintain quantitative rigor, we acknowledge that we may have overlooked nuances regarding the human experience and the everyday barriers faced by both teachers and students when implementing these new technologies.

Future research

Based on the findings of this review, further studies with more robust designs are needed to directly compare different active and blended methodologies for teaching medical semiology with traditional approaches, ideally using standardized clinical performance outcomes. Longitudinal studies that follow students beyond the course are also necessary to assess the retention of acquired skills and their impact on clinical practice and patient care. Furthermore, future research could incorporate mixed-methods approaches that explore the experiences of students and teachers, implementation barriers, and the institutional conditions that promote the sustainability of these strategies. Finally, the inclusion of cost-effectiveness analyses would allow for an assessment of their feasibility in resource-limited settings.

Recommendations

It is suggested that formal near-peer teaching programs be incorporated, with training and supervision of tutors, to leverage their potential to reinforce clinical skills, foster collaborative learning, and strengthen the formative role of advanced students. Likewise, it is recommended that faculties adopt blended learning models, focusing face-to-face activities primarily on supervised practice, case discussions, and structured feedback, while theoretical content is addressed through asynchronous resources. Regarding assessment, it is proposed that objective and standardized instruments, aligned with the competencies defined in the curriculum, be used consistently, and that results be systematically monitored to inform course design and contribute to the generation of local evidence in medical education.

5. Conclusions

- This systematic review suggests that active and combined methodologies, such as problem-based learning integrated into lectures, hybrid simulations, near-peer teaching, educational videos as a supplement, and mixed models, are associated with better outcomes in the development of clinical skills in medical students, compared to traditional methods used in isolation.
- These strategies seem to particularly favor the acquisition of practical skills, clinical reasoning, and self-confidence when they incorporate structured feedback and supervised practice spaces.
- These findings should be interpreted with caution due to the methodological heterogeneity of the included studies, the differences in the outcomes assessed, and the risk of bias present in some designs.
- While the available evidence supports the use of active and integrated pedagogical approaches in the teaching of medical semiology, future studies with more robust designs, standardized outcomes, and long-term follow-up are required to establish conclusive recommendations.

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