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ORIGINAL ARTICLE

Didactic conception for the development of imaging diagnostic skills in Family Medicine residents

Miguel Angel Amaró-Garrido [1], Andel Pérez-González [2], Carlos Lázaro Jiménez-Puerto [2], Eliecer González-Valdéz [3], Jim Alex González-Consuegra [1], Tatiana Hernández-González [1]

[1]University of Medical Sciences of Sancti Spíritus. Faustino Pérez Hernández Faculty of Medical Sciences. Juana Naranjo León University Polyclinic of Sancti Spíritus, Cuba.
[2]José Martí Pérez University. Sancti Spíritus, Cuba.
[3]University of Medical Sciences of Sancti Spíritus. Faustino Pérez Hernández Faculty of Medical Sciences. Camilo Cienfuegos Provincial General Hospital. Sancti Spíritus, Cuba.

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ABSTRACT

Introduction: the specialty of Family Medicine lacks a specific curricular space for the development of imaging diagnostic skills.
Objective: to evaluate the effectiveness of the didactic conception for the transversal development of imaging diagnostic skills in Family Medicine residents, using problem-based learning as the central pedagogical method.
Methods: the research consisted of two stages. First, a didactic conception based on the socio-critical paradigm was validated by 15 experts. Second, a quasi-experimental single-group study with pre-post design and repeated measures was implemented at the Juana Naranjo León University Polyclinic (September 2024–June 2025). Of 42 residents, 30 were selected through stratified sampling; 28 completed the intervention. The conception was applied over 42 weeks in a blended modality, structured in four phases. The three-dimensional evaluation (cognitive, procedural, affective-motivational) employed theoretical, empirical, and statistical methods (t-tests, repeated measures ANOVA, Wilcoxon, Pearson correlations).
Results: significant improvements ($p<0,001$) were observed in all dimensions: cognition increased from 48,3 to 82,4 points; 78,6 % reached advanced level in procedural skills; self-efficacy rose from 2,1 to 4,3. Critical self-reflection was shown by 85,7 %, and a correlation between procedural skills and metacognition was found ($p<0,01$). At one-month follow-up, 71,4 % applied the protocols. Sensitivity analysis confirmed the findings.
Conclusions: the results suggest that the didactic conception is effective for integrating the transversal development of imaging diagnostic skills in Family Medicine residency.

Keywords: Problem-Based Learning; Imaging Diagnosis; Family Medicine.

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INTRODUCTION

Family Medicine faces the permanent challenge of preparing professionals with comprehensive skills to solve health problems in the community.[1] Within this professional profile, the ability to request, interpret, and integrate imaging diagnostic studies constitutes an essential clinical capacity, as most diagnostic decisions in primary care require imaging support.[1,2]

A critical discrepancy is evident between practice and curriculum: while the daily clinical practice of family physicians demands skills for imaging diagnosis, Family Medicine residency curricula in Latin America, including Cuba, lack an explicit space, topic, course, or module specifically dedicated to its systematic teaching.[2,3] This skill is conceptualized as a complex integrated system that includes cognitive dimensions (technical and semiological knowledge), procedural dimensions (systematic interpretation, clinical correlation, report emission), and affective-motivational dimensions (self-efficacy, attitude toward diagnostic challenge).[4]

The absence of formal curriculum does not imply irrelevance, but rather generates a gap where the development of this skill is relegated to opportunity, self-management, or informal transfer during rotations.[3,4] Previous studies in the Cuban national context have evidenced significant deficiencies in family physicians and residents, manifested in difficulties interpreting basic studies, emitting coherent reports, and correlating radiological findings with patient clinical presentation.[5,6] The problem, therefore, transcends the mere individual lack of knowledge; it is situated at a didactic-curricular level: the lack of a proposal that defines how this transversal and complex skill should be developed intentionally, progressively, and contextualized throughout residency.[5]

Faced with this gap, it becomes imperative not only to implement isolated didactic strategies, but to propose and validate a didactic conception that contributes to the development of imaging diagnostic skills in Family Medicine residents from an integrative and contextual perspective. This is understood as a theoretical-methodological system that coherently establishes theoretical foundations, guiding principles, teaching objectives, contents, methods, organizational forms, means, and evaluation system to guide a specific teaching-learning process.[6,7] Unlike a punctual strategy, a conception offers a holistic framework to analyze complex educational problems in real curricular scenarios, especially if the content to be taught is not delimited in a conventional subject.[7,8]

In this framework, problem-based learning (PBL) emerges as an alternative to articulate this conception. PBL, by promoting the analysis of real or simulated situations, clinical reasoning, collaborative work, and autonomous decision-making, positions itself as the optimal methodological pathway to develop complex skills in authentic professional scenarios, which surpasses the traditional memoristic model.[8] Systematic integration within a valid didactic conception would allow transforming this deficiency in curricular design (absence of an imaging module) into an opportunity for integrated and meaningful learning.[8,9]

In correspondence with the above, the objective of the study was to evaluate the effectiveness of a didactic conception for the transversal development of imaging diagnostic skills in Family Medicine residents, through problem-based learning.

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METHODS

A quasi-experimental single-group study was conducted, with pre-post design and repeated measures. A baseline evaluation (T0), three intermediate measurements during the intervention (T1, T2, T3), and a final evaluation (T4) were included. This design allowed comparing each subject's performance with themselves and analyzing the trend of change over time. Although it did not substitute a controlled trial, repeated measures strengthened internal validity by reducing the effect of interindividual variability and allowing analysis of temporal progression. The research was developed at the Juana Naranjo León University Polyclinic of Sancti Spíritus, Cuba, between September 2024 and June 2025.

The study was directed at residents with insufficient performance in imaging diagnostic skills. Of the 42 active residents during the period, 34 met this condition after baseline evaluation (score below 60 points in the cognitive test or Incipient level in the procedural rubric) and constituted the intervention population. From this population, a sample of 30 participants was selected through stratified random sampling by year of residence. This sampling decision allowed forming small working groups with an expert facilitator per group, a pedagogical requirement of the intervention. Two participants withdrew from the residency program after randomization, so 28 residents completed all phases (retention rate: 93,3 %).

The conception was implemented by trained facilitators (imaging specialists and family physicians with teaching experience), trained in PBL and in the use of didactic resources. Their role consisted of guiding sessions, promoting reflection, and providing structured feedback, without substituting the institutional clinical tutor, in order to complement and enhance learning in daily clinical practice.

The study was structured in two stages: the first, of theoretical design and validation of the didactic conception by a panel of 15 experts; the second, of practical implementation and evaluation of results through a pre-post design with repeated measures.

Selection criteria were established to guarantee participant suitability and study integrity:

Inclusion criteria:
- Being an active Family Medicine resident throughout the entire period.
- Providing written informed consent.
- Committing to attend at least 80 % of activities.
- Presenting insufficient performance in baseline evaluation (score <60 in the objective knowledge test or level 1 in the procedural rubric).

Exclusion criteria:
- Having prior formal work experience in imaging services exceeding six months.
- Participating concurrently in other studies or educational interventions that could affect the dependent variables of this research.
- Presenting documented medical or personal conditions that limited continued participation in face-to-face and virtual sessions.
- Having scheduled external clinical rotations that covered more than 30 % of the total intervention period.

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Elimination criteria:
- Demonstrably failing to comply with established research protocols.
- Voluntarily abandoning the residency program during the course of the study.
- Accumulating unjustified absences to more than 20 % of scheduled activities.

Study variables:
- Independent variable: The Didactic Conception, operationalized through its 42-week implementation strategy, whose characteristics of intensity, modality, sequencing, and resources have already been specified.
- Dependent variable: The level of development of imaging diagnostic skills. This variable was operationalized and measured through a three-dimensional system:
  - Cognitive Dimension: Measured through continuous score (0-100) in the objective knowledge test.
  - Procedural Dimension: Measured through ordinal level (1-4) in the global structured observation rubric, with differentiated cut-off points for each year of residence.
  - Affective-Motivational Dimension: Measured through score on the Likert-type scale (transformed to a 1 to 5 scale) of the self-efficacy and attitudes questionnaire.

Design and validation of the Didactic Conception

The conception was designed on three fundamental theoretical-didactic pillars. First, a socio-critical approach that promotes knowledge construction through reflection on practice and transformation of the educational context. Second, a principle of meaningful learning that seeks to anchor new knowledge in the resident's prior cognitive structure, which guaranteed deep and applicable understanding. Third, a professional skills approach that holistically integrates knowledge, skills, and attitudes for effective performance in real scenarios.

Based on these foundations, five guiding principles were derived that guided design and implementation:

1. **Transversality and Curricular Integration:** The imaging diagnostic skill should be developed in an integrated and contextual manner within the resolution of clinical problems inherent to rotations and activities of the residency program, overcoming the fragmented approach. This implied articulating imaging core contents with clinical, diagnostic, and syndromic scenarios that residents faced in their training, without creating a parallel subject. The conception acted as a didactic scaffold that overlaid the existing curriculum, which enriched learning opportunities in real and simulated contexts.
2. **Contextualization:** The teaching-learning process would be anchored in prevalent health problems and characteristics of the first level of care, to ensure its relevance to family physician practice.
3. **Progressiveness:** The complexity of contents and activities would follow a gradual sequence, aligned with the level of development and expected responsibilities for each year of residence.
4. **Active and collaborative participation:** Residents would assume the leading role in constructing their knowledge, fostering dialogue, teamwork, and co-construction of solutions.
5. **Metacognitive reflectivity:** Explicit strategies would be incorporated to promote residents planning, monitoring, and evaluating their own diagnostic thinking process, fostering learning self-regulation.

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Three-dimensional structure of the didactic conception

The conception was articulated around three essential dimensions of professional skill, oriented so that residents integrate imaging study interpretation into their clinical reasoning in a grounded, efficient, and contextualized manner to primary care:

- Cognitive dimension: Acquisition and understanding of basic technical knowledge of main imaging methods and fundamental radiological semiology of most frequent diseases in primary care.
- Procedural dimension: Development of practical skills for systematic image interpretation, clinical-imaging correlation, emission of orienting diagnostic reports, and adequate selection of complementary studies.
- Affective-motivational dimension: Strengthening of diagnostic self-efficacy, fostering a proactive attitude toward autonomous learning, and reducing anxiety associated with image interpretation.

Transversal core contents

Given that the formal curriculum of the specialty does not contemplate an imaging subject, a set of transversal core contents was defined, selected for their relevance to Family Medicine practice. These contents were not organized in an independent course, but served as a continuous thematic base that was developed progressively and with different depth levels throughout the four implementation phases of the conception.

The core contents were:

1. Principles of pertinent selection of imaging studies, based on clinical suspicion, diagnostic efficacy, risk-benefit, and resources available at the first level of care.
2. Basic radiological semiology of thorax, abdomen, and osteomyoarticular system, with emphasis on identification of normal findings and elementary disease patterns in prevalent conditions.
3. Methodology for systematic image interpretation, through application of standardized reading protocols (such as the ABCDE method for chest radiography) that ensure exhaustiveness and rigor.
4. Principles for writing orienting diagnostic reports, including structure, expository clarity, correct use of terminology, and explicit correlation with patient clinical data.

Central pedagogical method and implementation strategy

Problem-Based Learning (PBL) was selected as the didactic strategy for its suitability to develop clinical reasoning and problem-solving skills in simulated practice contexts. To operationalize this method within the conception, a detailed implementation strategy was designed, also denominated, with the following specific characteristics:

• **Duration and scheduling:** The intervention extended over 42 weeks, from September 2024 to June 2025.

• **Intensity and modality:** It comprised a total of 120 teaching hours, delivered in blended modality. 60 % of activities were face-to-face (72 hours) and 40 % were developed virtually (48 hours) through the Moodle platform, which allowed flexibility and access to digital resources.

• **Frequency:** During the 30 weeks of intensive activity, two weekly sessions of two hours each were held. The remaining 12 weeks were dedicated to consolidation and follow-up activities.

• **Didactic resources:** An operational manual for facilitators was prepared, a bank of 25 anonymized real clinical cases was compiled, an interactive digital atlas of normal and pathological images was developed, and standardized reading and interpretation protocols were established.

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The strategy was organized in four sequential and interdependent phases:

• **Phase I: Integral Diagnosis (6 weeks, September-October 2024).** This initial phase had as purpose characterizing residents' starting point. It included multidimensional baseline evaluation, analysis of individual and group needs through a SWOT matrix, formation of heterogeneous collaborative groups, and signing of learning contracts with personalized goals.

• **Phase II: Progressive Immersion (12 weeks, October-December 2024).** Oriented to building necessary foundations, this phase sequentially analyzed three content nuclei, always through PBL activities linked to simulated clinical problems of the first level of care: 1) Physical and Technical Fundamentals (12 hours). 2) Systematic Radiological Semiology (16 hours). 3) Principles of Contextualized Interpretation (12 hours). These nuclei did not constitute independent modules, but content axes that were integrated horizontally in case-based work sessions. Strategies such as collaborative learning and guided case study were used to guarantee that knowledge acquisition was at the service of diagnostic application in context.

• **Phase III: Application in Real Context (18 weeks, January-April 2025).** As the central phase of the conception, it focused on knowledge transfer through resolution of 8 problem scenarios of increasing complexity. Main activities were critical image reading sessions, clinical-imaging correlation workshops, and laboratories for emission of diagnostic reports, always with mentorship and structured feedback.

• **Phase IV: Consolidation and Transfer (6 weeks, May-June 2025).** The final phase sought to consolidate learnings and promote their application in professional practice. An integrative evaluation was conducted through objective structured clinical examination stations (OSCEs), residents prepared an electronic portfolio of evidence, guided metacognitive reflection sessions were conducted, and each participant designed a continuous professional development plan.

Three-dimensional evaluation system

An evaluation system coherent with the three-dimensional objectives of the conception was designed, of both formative and summative character.

1. **Evaluation of Cognitive Dimension:** An objective evaluation instrument was used: a written multiple-choice knowledge test (test type), composed of 50 items with a single correct answer. This format allowed objective and standardized measurement of declarative knowledge, unlike instruments based on appreciation or perception used in other dimensions. The test, with a maximum score of 100 points, evaluated in a balanced manner three domains: conceptual knowledge of physical and technical principles (16 items), knowledge of basic and advanced radiological semiology (22 items), and understanding of criteria for selection of diagnostic studies (12 items).

2. **Evaluation of Procedural Dimension:** A structured observation rubric was used, which integrated 12 specific criteria grouped in four key domains: capacity for systematic interpretation (3 criteria), clinical-imaging correlation skill (3 criteria), skill in emission of diagnostic reports (4 criteria), and appropriateness in selection of complementary studies (2 criteria). Each criterion was scored on a four-level mastery scale: 1 (Incipient), 2 (Developing), 3 (Advanced), and 4 (Expert). Differentiated and realistic performance expectations were established for each year of residence.

3. **Evaluation of Affective-Motivational Dimension**: A self-efficacy and attitudes questionnaire composed of 20 Likert-type items with a five-point response scale (1 = Totally disagree to 5 = Totally agree) was applied. The instrument, with prior validation, measured four constructs: perceived self-efficacy in imaging diagnosis (6 items), attitude toward autonomous learning (5 items), valuation of collaborative work (5 items), and level of anxiety facing interpretation (4 items, with inverted scoring).

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4. **Evaluation of Metacognition and Transfer:** Self-reflection capacity was evaluated through a specific rubric applied to residents' electronic portfolios. Transfer of learnings to real clinical practice was assessed through a follow-up survey applied one month after completion of the intervention and through review of a sampling of clinical records.

The cognitive test obtained a Kuder-Richardson 20 internal consistency index of 0,88 and a content validity ratio of 0,81, according to expert validation. The procedural rubric showed a Cronbach's alpha of 0,86 and an inter-rater agreement (Cohen's Kappa) of 0,78. The self-efficacy and attitudes questionnaire presented a global Cronbach's alpha of 0,89, with adequate factorial adjustment in confirmatory analysis (CFI = 0,93; RMSEA = 0,05).

Expert validation
The didactic conception in its entirety, including its foundations, structure, methods, and evaluation instruments, was subjected to a rigorous validation process by a panel of 15 experts. Experts were selected through calculation of their competence coefficient (K), taking into account professional experience (≥15 years), scientific degree (Doctor of Sciences), and indexed academic production on the topic. The panel was composed in a multidisciplinary manner by specialists in Medical Education, Imaging, Educational Research Methodology, and Family Medicine.

The validation process was developed in three iterative rounds. The first round evaluated theoretical and contextual pertinence through a Likert scale. The second round analyzed internal coherence and construct validity through the Delphi method. The third round, through the nominal group technique, established definitive agreements. The resulting quality indicators confirmed the validity and reliability of the conception: an inter-judge concordance index of 0,82, internal consistency coefficients (Cronbach's Alpha) above 0,84 for all instruments, and a global content validity ratio of 0,78, which exceeded the established cut-off point. The process culminated with a unanimous favorable opinion.

Data collection and analysis procedures
Data collection was organized in several moments to capture process evolution: a baseline evaluation (T0, September 2024), evaluations during implementation (T1, T2, T3), and a final summative evaluation (T4, June 2025). One month after completion of the intervention, follow-up was conducted to evaluate transfer (T5, July 2025).

Analysis of data integrated quantitative and qualitative methods in a methodological triangulation process.

For quantitative data analysis, the following statistical techniques were employed:
- Descriptive statistics (means, standard deviations, frequencies, percentages) to characterize the sample and results.
- Student's t-test for related samples, to compare pre and post intervention scores in continuous variables with normal distribution, complemented with calculation of effect size (Cohen's d).
- Wilcoxon signed-rank test for one sample, to evaluate improvement in ordinal scores of the procedural rubric. The effect size for this test was reported through the Wilcoxon r statistic, calculated as $Z/\sqrt{N}$.
- Kruskal-Wallis test to compare baseline distributions between different years of residence.
- Repeated measures analysis of variance (ANOVA), to analyze the trend of change throughout different evaluation moments.
- Pearson correlation coefficient, to examine bivariate relationships between different dimensions of the dependent variable.

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- A sensitivity analysis was performed through the conservative worst-case imputation approach, in order to evaluate the possible impact of losses during follow-up and verify consistency of findings.

For qualitative data analysis from focus groups, interviews, and portfolios, the thematic analysis method was used. Two researchers performed coding independently, and discrepancies were resolved through discussion and consensus until reaching thematic saturation.

Processing of quantitative data was performed with SPSS software (version 25), with establishment of a statistical significance level of $p < 0.050$ for all tests.

The research was governed by recognized international ethical principles, enshrined in the Declaration of Helsinki.[10] The study protocol received formal and written approval from the Research Ethics Committee of the corresponding health institution. Prior to study initiation, written informed consent was obtained from each participating resident, after explaining objectives, procedures, potential benefits, minimal risks, and guarantees of confidentiality and anonymity in data handling. Strict protocols were established to ensure that personal and professional information was used for scientific purposes only.

RESULTS

Of the initial cohort of 30 residents, 28 completed all phases (retention rate: 93,3 %). The final distribution was 9 first-year, 9 second-year, and 10 third-year residents. Baseline evaluation confirmed insufficient performance in the skill. The mean cognitive score was 48,3 points (SD = 8,7; range 32-67). 76,7 % of the initial sample was positioned below 60 points. Analysis by year of residence showed significant differences (Kruskal-Wallis: $\chi^2(2) = 8,45$; $p = 0,001$), with higher scores in third-year residents (mean = 54,6; SD = 7,1) compared to first-year (mean = 43,1; SD = 6,8) and second-year (mean = 46,4; SD = 8.3).

In the procedural dimension, 76,7 % was positioned at level 1 (Incipient). 40 % of third-year residents reached level 2 (Developing), while this level was only observed in 22,2 % of first-year and 33,3 % of second-year residents.

In the affective-motivational dimension, 73,3 % recognized the importance of the skill, but perceived self-efficacy was low (mean = 2,1; SD = 0,6) and anxiety facing interpretation was high (mean = 1,8; SD = 0,5).

During Phase III, analysis of the eight clinical cases showed progressive improvement in all indicators. The number of relevant findings per case increased from 2,1 (SD = 0,9) in the first quartile of cases to 5.4 (SD = 1.1) in the last. The percentage of grounded hypotheses increased from 41,3 % to 88,7 %. Clinical-imaging correlations per case increased from 1,4 (SD = 0,7) to 4,8 (SD = 1,0), and report quality score from 4.2 to 8,9 out of 10. Interpretation time decreased from 18,5 to 9,2 minutes per case. Repeated measures ANOVA confirmed a main effect of evaluation moment ($F(3,81) = 45,23$; $p < 0,001$; $\eta^2 = 0,63$).

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Final evaluation showed significant improvements in all three dimensions. Cognitive score rose to 82,4 points (SD = 7,2; t(27) = 18,45; p < 0,001; d = 2,34). The median of global procedural level increased from 1 (IQR = 1-1) to 3 (IQR = 3-4) (Z = 4,68; p < 0,001; r = 0,88), and 78,6 % reached an Advanced or higher level. Perceived self-efficacy increased to 4,3 (SD = 0,5; t(27) = 14,21; p < 0,001; d = 1,87).

By specific procedural domains, no resident remained at Incipient level. In systematic interpretation, 82,1 % reached Advanced or Expert level; in clinical-imaging correlation, 75,0 %; in report emission, 78,6 %; and in study selection, 71,4%. Concordance in final evaluation was high (ICC = 0,84; 95% CI: 0,79-0,88).

92,9 % rated the intervention as satisfactory or very satisfactory. Regression analysis identified post-intervention self-efficacy as a predictor of final procedural performance (β = 0,52; p < 0,001). 85,7% of residents evidenced critical self-reflection in their portfolios. Correlations between dimensions were positive and significant (p < 0,01). The highest was observed between procedural dimension and metacognition (r = 0,74), followed by procedural-affective-motivational (r = 0,72). Other correlations are presented in Table 1.

Table 1. Bivariate correlation matrix (Pearson) post-intervention (n = 28).

Dimensions	Cognitive	Procedural	Affective-Motivational	Metacognition
Cognitive	1,00	0,68**	0,59**	0,63**
Procedural	0	1,00	0,72**	0,74**
Affective-Motivational	0	0	1,00	0,66**
Metacognition	0	0	0	1,00

Source: Integrated analysis of post-intervention data (June 2025). **p < 0,01

One month later, 71,4 % applied protocols in clinical practice. This proportion was higher in third-year residents (90,0 %) than in second-year (77,8%) and first-year (55,6 %).

Sensitivity analysis

Under the most unfavorable scenario (worst-case imputation), pre-post differences remained significant in all three dimensions: cognitive (t(29) = 15,32; p < 0,001), procedural (Z = 4,45; p < 0,001), and affective-motivational (t(29) = 10,21; p < 0,001). Multiple imputation analysis showed consistent results.

DISCUSSION

Results suggest that the didactic conception is effective for developing imaging diagnostic skills in Family Medicine residents without need to create a specific subject or module within the study plan. The intervention operated as a system of PBL-based activities, articulated in phases and overlapped transversally to the existing curriculum, which responds to the curricular gap already noted in previous studies[4,5,8] and supports the transversality principle that sustains it.

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Improvement in the cognitive dimension, particularly in clinical-imaging correlation, transcended isolated memorization. This suggests that sequential and contextualized articulation of contents within PBL scenarios facilitated applicable mental schemes to link imaging findings with clinical contexts. This finding coincides with what Laguna and Matuz[7] noted about knowledge organization in applicable networks through PBL, and with the challenge posed by Motta,[8] of integrating imaging findings in contextualized clinical reasoning.

In the procedural dimension, significant and large-magnitude improvement was observed, with generalized advancement from initial elementary levels to advanced performances. This result supports the hypothesis that the progressive structure of the conception (Immersion and Application phases) through PBL favors hypothetical-deductive reasoning in technical skills, coinciding with what was documented by Bisbee et al.[3] and Arruzza et al.,[11] in radiological education. The contrast with difficulties reported in previous research[5,12] could be explained by the longitudinal sequence and guided, repetitive practice inherent to this intervention, aspects highlighted by Pedraza[13] and Lozano et al.[14]

On the other hand, in the affective-motivational sphere, the notable increase in perceived self-efficacy and decrease in anxiety constitute a fundamental pillar for learning sustainability. This attitudinal change suggests that the conception not only provided cognitive and procedural tools, but also managed to impact the affective-motivational dimension, with strengthening of autonomy and clinical confidence of residents. This aspect is crucial according to self-efficacy theory and concurs with previous experiences with PBL in medical education that report similar improvements in student confidence.[2,15]

The correlation between procedural skill and metacognitive capacity, evaluated through portfolios, supports the reflexivity principle incorporated in the Consolidation phase and suggests that development of a complex diagnostic skill requires, in addition to practice, explicit scaffolding for self-reflection that facilitates learning transfer, coinciding with Ge et al.,[16] and innovative experiences in radiological education.[17,18]

The effectiveness of the conception can be attributed, at least in part, to materialization of the operational transversality principle. The intervention provided a system of activities (cases, protocols, correlation sessions) directly applicable to clinical problems of rotations, in which the facilitator acted as catalyst of imaging reasoning and the clinical tutor maintained their role of general supervision. This dual didactic-clinical articulation could explain the integration achieved without modifying the formal curricular structure and supports the viability of the approach to close skill gaps in primary care.[15,16,17]

It is necessary to recognize study design limitations. The absence of control group restricts causal inference, despite support from repeated measures and sensitivity analysis. External validity is limited by single-center sampling and by exclusive inclusion of residents with insufficient performance, a criterion congruent with the objective of closing gaps, but which limits generalization. These limitations, shared by other authors,[3,11] raise the need for replications with broader and more diverse samples.

Theoretical validation by experts and methodological rigor strengthen the study's internal validity, although positive transfer to practice would require longer follow-up to evaluate sustainability, as suggested in recent reviews on PBL.[11,19] An essential projection would be adapting the principles of this conception to other transversal skills of the Family Medicine curriculum, in consonance with the precedent of similar pedagogical designs.[6,20]

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Ultimately, this study makes a relevant contribution to postgraduate medical education by offering, more than a strategy, a didactic conception. Results suggest that it is possible to overcome theory-practice fragmentation and develop complex skills transversally, even in absence of specific curricular spaces.[1,21]

Thus, a contextualized and replicable solution is configured for primary care settings, where optimization of educational resources is crucial,[4,5] and a precedent is set for designing similar conceptions directed to other integrative skills in specialist training.

CONCLUSIONS

Results of this study suggest that the didactic conception, articulated through PBL, is associated with significant improvements in the cognitive, procedural, and affective-motivational dimensions of imaging diagnostic skills, as well as with strengthening of self-efficacy and metacognition. Articulation of core contents in a progressive sequence integrated to clinical rotations offers a pathway to address curricular fragmentation without creating a specific module.

Conflict of Interest

The authors declare that they have no conflicts of interest.

Authorship Declaration

MAAG: Conceptualization, Data curation, Formal analysis, Project administration, Investigation, Methodology, Resources, Supervision, Validation, Visualization, Writing – original draft, Writing – review and editing.
APG: Formal analysis, Investigation, Methodology, Supervision, Validation, Writing – original draft, Writing – review and editing.
CLJP: Data curation, Formal analysis, Investigation, Methodology, Resources, Supervision, Validation, Visualization, Writing – original draft, Writing – review and editing.
EGV: Investigation, Methodology, Supervision, Writing – original draft, Writing – review and editing.
JAGC: Investigation, Methodology, Supervision, Writing – original draft, Writing – review and editing.
THG: Investigation, Methodology, Supervision, Writing – original draft, Writing – review and editing.

BIBLIOGRAPHIC REFERENCES

1. Vilanova JC. La enseñanza de la radiología en los programas docentes integrados. Radiologia [Internet]. 2024 [citado 20/11/2025]; 66(2): 189-195. Disponible en: https://doi.org/10.1016/j.rx.2023.05.005

2. García Cárdenas N, Vázquez Villavicencio M, Heredia Cabrera G, Galán Avecillas E. Impacto del aprendizaje basado en problemas (ABP) en educación médica: habilidades clínicas y pensamiento crítico. Rev Soc Front [Internet]. 2025 [citado 03/08/2025]; 5(2): e–655. Disponible en: https://doi.org/10.59814/resofro.2025.5(2)655

ISSN: 1561-3194 **RNPS:** 1877
Rev Ciencias Médicas. 2026; 30(2026): e7093

3. Bisbee CA, Vaccaro MJ, Awan OA. Problem based learning in radiology education: benefits and applications. Acad Radiol [Internet]. 2023 [citado 20/05/2025]; 30(9): p2092-2094. Disponible en: https://doi.org/10.1016/j.acra.2022.08.015

4. Amaró Garrido MA, Díaz Quintanilla CL, Hernández González T, Nápoles Valdés MB, Morales Tamayo NM, Rodríguez Expósito AE. La habilidad diagnóstico imagenológico de médicos en la Atención Primaria de Salud. Gac méd espirit [Internet]. 2024 [citado 26/10/2024]; 26. Disponible en: https://revgmespirituana.sld.cu/index.php/gme/article/view/2627

5. Amaró-Garrido M, Díaz-Quintanilla C, Hernández-González T, Solenzal-Álvarez Y. Intervención educativa para el diagnóstico imagenológico en médicos del primer nivel de atención. Revista Cubana de Medicina [Internet]. 2024 [citado 16/02/2024]; 63 Disponible en: https://revmedicina.sld.cu/index.php/med/article/view/3428

6. Cabrales Fuentes J, Mendoza Tauler LL, Leyva Figueredo PA, Velázquez González VA. Concepción pedagógica de una intervención educativa en residentes de Imagenología Hospital Clínico Quirúrgico Holguín 2021-2022. CCM [Internet]. 2022 [citado 09/12/2025]; 26(4). Disponible en: https://revcocmed.sld.cu/index.php/cocmed/article/view/4510

7. Laguna Maldonado KD, Matuz Mares D. El aprendizaje basado en problemas como una estrategia didáctica para la educación médica. Rev Fac Med [Internet]. 2020 [citado el 10 de noviembre de 2025]; 63(1): 42-7. Disponible en: https://doi.org/10.22201/fm.24484865e.2020.63.1.07

8. Motta-Ramírez GA. Aprendizaje radiológico basado en problema clínico específico: parte 1, ¿qué y cómo se debe describir cualquier imagen radiológica? Rev An Radiol Mex [Internet]. 2021 [citado 10/11/2025]; 20(1): 38-45. Disponible en: https://doi.org/10.24875/arm.20000113

9. Calderón Jiménez CL. Aprendizaje basado en problemas en la docencia médica. Acta Medica Grupo Angeles [Internet]. 2024 [citado 17/08/2025]; 22(5): 359-60. Disponible en: https://doi.org/10.35366/118810

10. World Medical Association Declaration of Helsinki. JAMA [Internet]. 2024 [citado 15/10/025]; 333(1): 71-74. Disponible en: https://doi.org/10.1001/jama.2024.21972

11. Arruzza E, Chau M, Kilgour A. Problem-based learning in medical radiation science education: a scoping review. Radiography [Internet]. 2023 [consultado 23/11/2025]; 29(3): 564-72. Disponible en: https://doi.org/10.1016/j.radi.2023.03.008

12. Patil NS, Lee SY, Larocque N, Fong C, Leung V, Walker D. Revamping undergraduate radiology education in a problem-based learning driven institution: successes, challenges, and lessons learned. Acad Radiol [Internet]. 2024 [citado 05/06/2025]; 31(9): 3864-3871. Disponible en: https://doi.org/10.1016/j.acra.2024.06.024

13. Pedraza S. Estrategia de mejora del aprendizaje universitario del diagnóstico por la imagen. An Ranm [Internet]. 2023 [citado 01/10/2025];140(02):99-101. Disponible en: https://doi.org/10.32440/ar.2023.140.02.ed01

ISSN: 1561-3194 **RNPS:** 1877
Rev Ciencias Médicas. 2026; 30(2026): e7093

14. Lozano Terrón C, Lorenzo Álvarez R, Sendra Portero F. Una experiencia de aprendizaje basado en problemas en un rotatorio de radiología para estudiantes de sexto curso de Medicina. Radiologia [Internet]. 2023 [citado el 24 de julio de 2025]; 66(3): 207-218. Disponible en: https://doi.org/10.1016/j.rx.2022.10.012

15. Chávez Saavedra G, González Sandoval BV, Hidalgo Valadez C. Aprendizaje Basado en Problemas (ABP) a través del m-learning para el abordaje de casos clínicos. Una propuesta innovadora en educación médica. Innov Educ [Internet]. 2016 [citado 13/03/2025]; 16(72): 95-112. Disponible en: http://www.scielo.org.mx/scielo.php?script=sci_arttext&pid=S1665-26732016000300095&lng=es&tlng=es

16. Ge WL, Zhu XY, Lin JB, Jiang JJ, Li T, Lu YF. Critical thinking and clinical skills by problem-based learning educational methods: an umbrella systematic review. BMC Med Educ [Internet]. 2025 [citado 25/07/2025]; 25(455). Disponible en: https://doi.org/10.1186/s12909-025-06951-z

17. Rudolphi-Solero T, Bajos-Ariza F, Lorenzo-Álvarez R, Domínguez-Pinos D, Ruiz-Gómez MJ, Sendra-Portero F. Problem-based learning in radiology achieves similar results in classroom and metaverse settings. Insights Imaging [Internet]. 2025 [citado 20/11/2025]; 16(121). Disponible en: https://doi.org/10.1186/s13244-025-01987-7

18. Aquerreta Beola JD, Arbea Moreno L. Metodologías docentes en la enseñanza de la radiología pregrado. Radiologia [Internet]. 2023 [citado 22/04/2025]; 66(4): 390-397. Disponible en: https://doi.org/10.1016/j.rx.2023.04.009

19. Lawal O, Ramlaul A, Murphy F. Problem based learning in radiography education: a narrative review. Radiography [Internet]. 2020 [citado 10/02/2025]; 27(2): 727-732. Disponible en: https://doi.org/10.1016/j.radi.2020.11.001

20. Bastidas B, Vicente W. Estrategias para la enseñanza y el aprendizaje de la radiología en estudiantes de pregrado de la carrera de medicina: Revisión narrativa de la literatura. [Internet]. Bogotá, Colombia; 2024. [citado 02/09/2025] Disponible en: https://repositorio.unal.edu.co/handle/unal/87575

21. Amaró Garrido MA, González Valdéz E, González Consuegra JA, Jiménez Puerto CL, Hernández González T. Teleradiología para el desarrollo de la habilidad diagnóstica. Arch Hosp Univ Gen Calixto Garcia [Internet]. 2025 [citado 01/10/2025];13(3). Disponible en: https://revcalixto.sld.cu/index.php/ahcg/article/view/1598