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Development of an andragogical model for optimizing di-dactic competencies in the public sector

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Abstract: The importance of the andragogical approach plays a fundamental role in the realm of profes-sional training, particularly in the public sector, emphasizing the improvement of the didactic competencies of trainers according to their employment regime. This research aimed to estab-lish the relationship between the andragogical approach and the optimization of didactic compe-tencies among professionals at a training center belonging to a public entity in Peru. The study was conducted with a sample of 120 public sector trainers, employing a quantitative, non-experimental, cross-sectional research design with a correlational scope. Questionnaires were used to collect data, which were analyzed using the Spearman Rho test, yielding a correlation coefficient of r = 0.529 and a significance level of 0.002. These results allowed for the rejection of the null hypothesis and confirmed the hypothesis that the andragogical approach has a signifi-cant impact on improving didactic competencies. The instruments used to measure the variables showed high reliability, with Cronbach's alpha coefficients of 0.890 and 0.873 for the andragogi-cal approach and didactic competencies, respectively. It was concluded that implementing an ef-fective andragogical approach can significantly contribute to strengthening professional compe-tencies, creating an enriching and efficient training environment for trainers in the public sector, depending on the developed model and context.

Keywords: *Andragogical approach, Didactic competencies, Professional training, Pedagogical development, Training in the public sec-tor.*

1. Introduction

Currently, under the influence of constant changes occurring in our work and social environments, professional training processes in the public sector have faced multiple challenges, which has driven the implementation of innovative approaches to improve their effectiveness and efficiency. The andragogical approach, as a key tool, has established itself as an effective strategy to address these training needs, as it emphasizes active participation, prior experience, and the autonomy of adults in the teaching-learning process. In this sense, the development of didactic competencies through andragogical methods is essential for transforming professional practice and strengthening educational quality in the public sector. This approach not only fosters the acquisition of knowledge and practical skills but also promotes greater cooperation and commitment from trainers, which directly impacts the improvement of training processes and the achievement of organizational objectives within public institutions.

At the international level, various studies have precisely highlighted that the andragogical approach can have a significant impact on professional training in the public sector, especially when addressed from a humanistic perspective [1]. This approach promotes autonomy, perspective, prior experience, and the individual needs of adults as key elements for effective learning [2]. Using a phenomenological-hermeneutic approach, the experiences and perceptions of professionals regarding the implementation of andragogical strategies have been analyzed, demonstrating their positive influence on the development

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of didactic competencies at various levels of public management. Furthermore, this approach fosters not only the improvement of technical and pedagogical skills but also an ethical commitment and adequate preparation to face the challenges of the contemporary public sector [3, 4]. These methodologies, based on experience and direct practice in a proportional manner, reaffirm the relevance of adult-centered education to transform public institutions and optimize their performance [5], keeping in mind that there are institutions where collaborators of different ages predominate, especially individuals who are around 40 years old and older.

Within this methodological framework, the andragogical approach emerges as an essential tool for optimizing the didactic competencies of trainers in the public sector, who assume a dynamic and collective role in conducting educational processes aimed at the professionalization of adults. It is noteworthy that often individuals external to the public institution provide these types of services. In research conducted in contexts of transversal professional training, semi-structured interviews were used with 45 facilitators and participants, demonstrating that trainers play a crucial role in the learning experience of adults [6]. These findings clearly highlight the importance of ongoing training based on andragogical principles, which enables facilitators to update their didactic strategies and effectively respond to the demands of the public sector [2, 4]. This area requires significant attention and, above all, a great deal of assertiveness. To this end, quality professional training is key not only for improving individual performance but also for strengthening organizational capacities within public institutions [7]. It is essential that these activities are framed within the corresponding training plans established by the institution itself; however, this often does not occur due to a lack of planning and unfamiliarity with the activity itself.

The impact of the andragogical approach on improving the didactic competencies of trainers in the public sector is directly proportional, undeniable, and central to their professional development. A recent study, which included surveys applied to a representative sample of 120 trainers, employed advanced statistical techniques to validate a multiple relational model and ensure the accuracy of the results [8]. The findings show that elements such as prior experience, self-regulation, and intrinsic motivation significantly influence the strengthening of didactic competencies, explaining a considerable proportion of the variability in outcomes. This model emphasizes that the andragogical approach not only promotes autonomy and experiential learning but also fosters a positive impact on the pedagogical capabilities of trainers, regardless of the environment in which they work [1, 2]. These results highlight the relevance of integrating andragogical principles as a systemic and transformative strategy in training programs within the public sector, regardless of the specific state sector addressed.

It can be asserted under this heuristic that the andragogical approach in the public sector drives an essential transformation in traditional practices of professional training, promoting innovative strategies that strengthen the autonomy, practical experience, and intrinsic motivation of participants. This approach fosters not only the development of didactic competencies but also the alignment of training programs with global educational standards, improving management and outcomes within institutional settings [5, 9]. Furthermore, recent research has demonstrated that models based on andragogical principles enable public sector professionals to acquire pedagogical skills applicable to various contexts, including basic education, reinforcing the relevance of this approach in dynamic training environments [7, 10]. This underscores the mandatory need to establish continuous training programs that respond to the specific demands of trainers in the public sector, promoting a positive and sustainable impact on educational institutions. Such initiatives should always align with the mission and vision set forth by the institution itself.

In the regional context, particularly in Latin American countries, the andragogical approach emerges as an a priori category for the transformation of professional training in the public sector. This model focuses on the ethical and pedagogical management of trainers, distinguishing it from the European context, where ethics is transversal throughout management, promoting practices that enhance teaching through experience and active learning [11, 12]. To achieve this, it is fundamental to implement strategies that combine qualitative and quantitative methods, allowing for the evaluation of

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the impact on trainers' didactic competencies, even in contexts where resources are limited. These studies highlight that the andragogical approach not only addresses the pedagogical needs of professionals but also contributes to strengthening institutional capacities in high-complexity scenarios where corruption and other factors disproportionately affect public entities [13, 14]. In this sense, addressing these pedagogical challenges from a regional perspective becomes a key pillar to ensure efficient professional training with a positive impact on local communities.

In relation to the andragogical approach and professional training in the Peruvian public sector, it is essential to establish clear guidelines that support trainers both in their training and in practical implementation. This aspect is crucial due to the lack of defined metrics in this area at the local level. If these guidelines are generated, it is anticipated that they could foster a necessary environment of trust and support to strengthen didactic competencies and adjust training strategies to the actual needs of professionals according to their work context [10, 15]. Moreover, the andragogical approach not only impacts pedagogical development but also influences trainers' interpersonal skills, such as emotional intelligence, a key factor for creating effective training environments [16, 17]. Recent research highlights that the implementation of methodologies based on andragogical principles significantly improves organizational climate and the effectiveness of public entities, especially in post-pandemic contexts and in Spanish-speaking countries [18, 19]. This underscores the importance of a systemic approach that integrates experiential learning needs with practical and measurable objectives, contributing both to professional development and to institutional strengthening.

To address the needs for strengthening didactic competencies among trainers in the public sector in Peru, strategies based on andragogical principles were developed, prioritizing autonomy and prior experience as key pillars of adult learning [20, 21]. A quantitative and descriptive study revealed significant deficiencies in skills such as pedagogical planning and the implementation of active teaching strategies, as well as a lack of intrinsic motivation and decision-making abilities in the professional realm [12, 22]. This is due to the fact that workers, regardless of the areas in which they operate, demand these activities, but human resources departments or those responsible for gathering these requirements do not consider them within their operational activities for their respective fiscal years. In response to the lack of training in these aspects, and reinforced by the shortage of specialists in these areas, the Peruvian State proposed methodologies for hiring professionals through specialized service contracts. These targeted interventions are aimed at optimizing trainers' performance through experiential workshops and the use of technological tools designed for their work contexts according to their needs. These strategies not only seek to foster a more collaborative and efficient learning environment but also to meet the specific demands of the highly complex public sector, thereby promoting comprehensive and contextualized training from a holistic state approach [23, 24].

Within the Peruvian State, there are various public institutions for professional training; therefore, the andragogical approach is fundamental for driving significant improvements in the didactic competencies of trainers and in educational processes. Research conducted with representative samples of trainers highlights how the application of andragogical methodologies can positively influence both learning and the professional development of educators, especially in contexts of high institutional demand [25, 26]. To ensure a sustainable impact, it is essential to establish educational policies that promote continuous training based on principles of autonomy, motivation, and meaningful learning [2, 27]. These principles, aligned with the experiential nature of the andragogical approach, strengthen trainers' capacities to adapt to organizational challenges, thereby promoting a collaborative environment focused on achieving common goals within public institutions [9, 18]. However, one of the major issues is cultural diversity, levels of learning, and the social context in which these activities take place. There are areas within the Peruvian context where poverty and education levels are extreme, making it difficult for the state to access all levels effectively. This poses a limitation in establishing personalized public policies.

Andragogical leadership plays a central role in the effective management of human resources and emerging dynamics within public institutions, aiming to achieve significant results in professional

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training. The lack of such leadership generates low state productivity; therefore, this approach allows for the integration of an understanding of diversity among participants, fostering greater collective commitment and strengthening internal cohesion among trainers. Moreover, it becomes a key tool for managing conflicts constructively, promoting a collaborative environment that facilitates the implementation of innovative strategies. These practices not only improve group dynamics but also contribute to strengthening didactic competencies and positively impacting educational processes, driving organizational performance and effectiveness in the public sector. In the context of Peruvian public institutions, these practices can positively affect both organizational climate and the effectiveness of training programs. Based on this scenario, the purpose of the research is to analyze the relationship between the implementation of andragogical strategies and the optimization of didactic competencies among public sector trainers through a proprietary model. This model takes into account the particularities of work environments in regions facing significant structural and organizational challenges, given that Peru as a country has enormous complexity in terms of territory, infrastructure, socioeconomic levels, and above all, quality education.

2. Materials and Methods

This study focuses on the practical application of the andragogical approach to improve didactic competencies among trainers in the public sector, collecting updated information on its impact in specific contexts. Using a quantitative approach, the research design was non-experimental, cross-sectional, and correlational, as data on the variables of interest were collected and analyzed without direct manipulation. The research took place at a training center belonging to a public entity in Peru, located in the eastern part of Lima. The population considered was a group of 232 trainers registered in the official records of the institution, regardless of their employment contract regime. The selected sample was finite and representative, allowing for accurate estimates based on an accessible and sincere sample size. This approach ensured the availability of relevant data while avoiding unnecessary extrapolations. As a result, a final sample of 120 trainers was obtained through non-probabilistic convenience sampling, where participants were selected based on their accessibility and relevance to the study's objectives, without following a random process. This method allowed for an analysis focused on the operational reality of the investigated context, optimizing available resources. Informed consent was obtained from participants to ensure transparency and ethics in the study. Additionally, clear inclusion and exclusion criteria were established, enabling a rigorous selection of the sample that aligned with the main objective of analyzing the relationship between the andragogical approach and didactic competencies. The data collection technique used was a survey, administered through questionnaires specifically designed for this study. The questionnaires consisted of 25 items distributed across two instruments. The first instrument, composed of 13 items, assessed dimensions of intellectual stimulation, idealized influence, and inspirational motivation. The second questionnaire, consisting of 12 items, measured dimensions of concrete experience, reflective observation, and abstract conceptualization. These instruments allowed for the collection of reliable data that served to analyze the relationship between the variables, providing significant results toward achieving the stated objectives.

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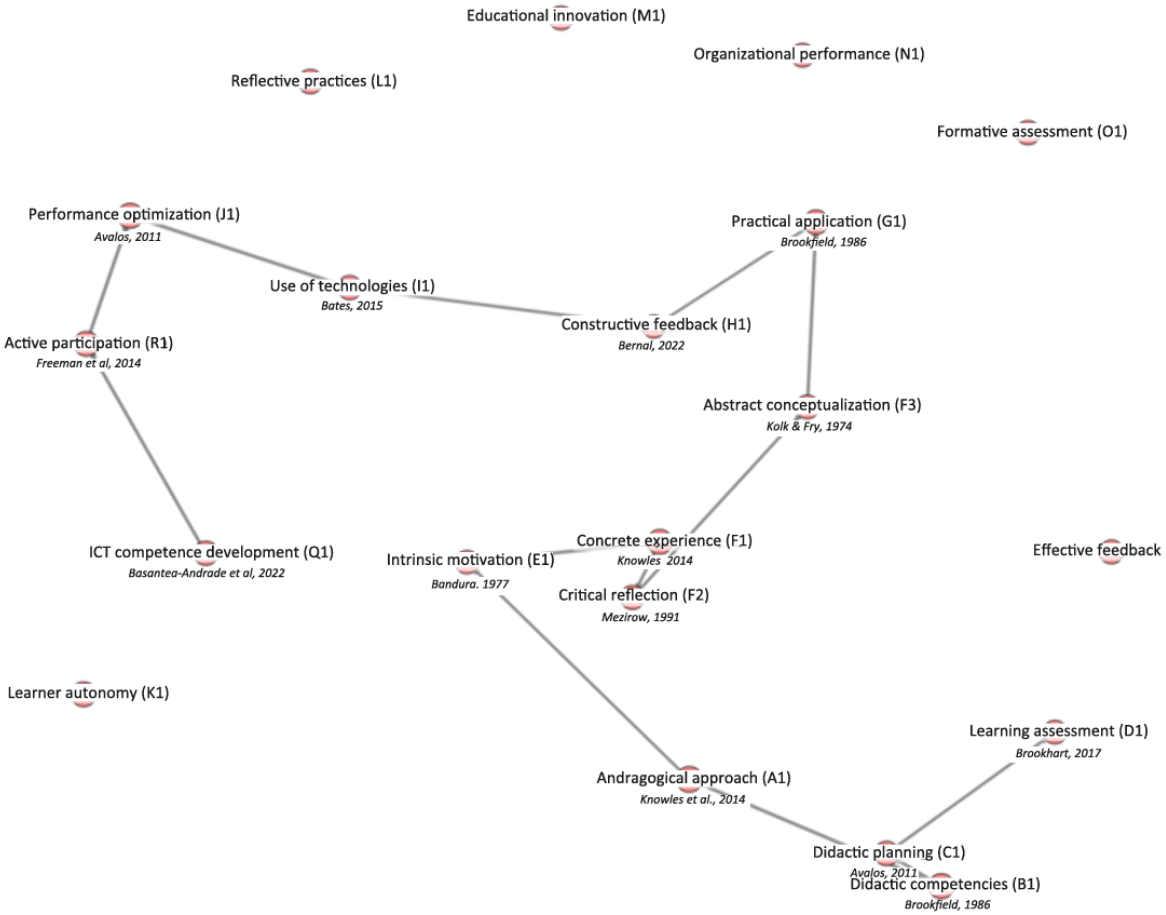

Figure 1.
Weighted semantic networks of andragogical approach and didactic competencies extracted from Atlas TI.

This modeling provides a comprehensive view of the interactions between the different stages, processes, and subprocesses of the andragogical approach, facilitating its understanding and practical application to optimize didactic competencies in the context of professional training in the Peruvian public sector.

Figure 1 presents a weighted semantic network that describes the relationships between the key elements of the andragogical model. This representative scheme combines both qualitative and quantitative approaches, graphically depicting the main nodes and their respective interconnections. Each connection includes a specific objective and a numerical weight indicating the relevance of the connection.

2.1. Literal Description of the Network

The network is structured into three main dimensions, from which specific sub-dimensions derive. These dimensions are:

Structuring the Process (Π): This dimension focuses on the initial organization of the training process, ensuring the identification of needs and clear objectives.

Needs Diagnosis: Identifies gaps in didactic competencies and determines areas for improvement.

Activity Organization: Designs strategies aligned with andragogical principles.

Goal Definition: Establishes specific and measurable objectives to guide the training process.

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Strategic Application (Σ): This dimension encompasses practical techniques that facilitate the implementation of andragogical learning, incorporating technological and collaborative elements.

Participatory Methods: Promote collaborative learning through active dynamics.

Technological Integration: Utilizes digital tools to optimize the training process and facilitate experiential learning.

Evaluation of Results (Ω): This dimension assesses the effectiveness of the strategies applied, ensuring continuous improvement of didactic competencies.

Performance Measurement: Analyzes the results obtained by participants in terms of professional improvement.

Impact on Social Skills: Evaluates the strengthening of communication, autonomy, and leadership among trainers.

Table 1.
Relationships and weights in the semantic network.

Main Node	Subnode	Relationship intent	Weight
Andragogical approach (A1)	Didactic planning (C1)	Organize training processes	0.85
Andragogical approach (A1)	Strategic application (Σ1)	Implement active strategies	0.88
Andragogical approach (A1)	Evaluation of results (Ω1)	Analyze teaching results	0.75
Didactic planning (C1)	Activity design (C1.1)	Create learning sequences	0.65
Didactic planning (C1)	Needs diagnosis (C1.2)	Detect training gaps	0.78
Didactic planning (C1)	Goal definition (C1.3)	Establish specific goals	0.92
Strategic application (Σ1)	Participatory techniques (Σ1.1)	Promote collaboration	0.72
Strategic application (Σ1)	Use of technology (Σ1.2)	Incorporate digital tools	0.77
Strategic application (Σ1)	Social interaction (Σ1.3)	Foster peer communication	0.85
Evaluation of results (Ω1)	Performance assessment (Ω1.1)	Measure academic achievements	0.82
Evaluation of results (Ω1)	Continuous feedback (Ω1.2)	Provide constructive observations	0.72
Evaluation of results (Ω1)	Impact on social skills (Ω1.3)	Develop collaborative skills	0.88
Impact on social skills (Ω1.3)	Didactic performance (Ω1.3.1)	Improve teaching practices	0.89
Impact on social skills (Ω1.3)	Increased motivation (Ω1.3.2)	Promote active participation	0.80
Impact on social skills (Ω1.3)	Strengthening teamwork (Ω1.3.3)	Develop collaborative skills	0.86

2.2. Cognitive Interpretation of the Model

The weighted semantic network is structured into three main dimensions, each with a set of sub-dimensions that describe the key processes of the andragogical model:

Didactic Planning (C1): This dimension focuses on the prior organization of the training process, highlighting the analysis of needs and the establishment of clear objectives:

Activity Design (C1.1): Concentrates on creating effective learning sequences.

Needs Diagnosis (C1.2): Identifies training gaps to focus the didactic process.

Goal Definition (C1.3): Establishes specific goals aligned with expected outcomes.

Strategic Application (Σ1): This dimension encompasses the execution of active strategies, integrating participatory methods and technological resources:

Participatory Techniques (Σ1.1): Promote collaboration and teamwork.

Use of Technology (Σ1.2): Incorporates digital tools to facilitate learning.

Social Interaction (Σ1.3): Encourages the exchange of ideas among participants.

Evaluation of Results (Ω1): This dimension focuses on measuring the effectiveness of implemented actions to validate the training process:

Performance Assessment (Ω1.1): Evaluates trainers' achievement of competencies.

Continuous Feedback (Ω1.2): Provides constructive observations to improve performance.

Impact on Social Skills (Ω1.3): Analyzes the development of skills such as collaboration and motivation.

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Intentions and Weights: The previously established intentions outline the specific purpose of each relationship within the andragogical model, while the assigned weights (0.65, 0.72, 0.75 - 0.89, 0.92, 0.95) quantify the importance of the connections, reflecting their relevance in optimizing didactic competencies in the public sector. These weighted values allow for the identification and prioritization of key interactions, facilitating a structured approach to the development of collaborative skills, formative planning, and effective evaluation of the results obtained. The assigned weighted values reflect the relative importance of each sub-dimension.

The definition of objectives (C1.3) and didactic performance (Ω1.3.1) have significant weights of 0.92 and 0.89, respectively, underscoring their relevance in the andragogical process.

The use of technology (Σ1.2) and the strengthening of teamwork (Ω1.3.3), with values of 0.77 and 0.86, indicate their impact on collaborative training and the integration of innovative resources.

2.3. Integrated Dimensions

The relationships between the dimensions allow for a holistic analysis of the andragogical model, highlighting how planning, strategy application, and result evaluation interact collectively to optimize the development of didactic competencies in public sector professional training contexts.

2.4. Educational Impact

This model demonstrates how the interaction between social, academic, and technological skills strengthens the motivation and professional performance of trainers, enabling a comprehensive improvement in the quality of the training process and the effective application of innovative methodologies.

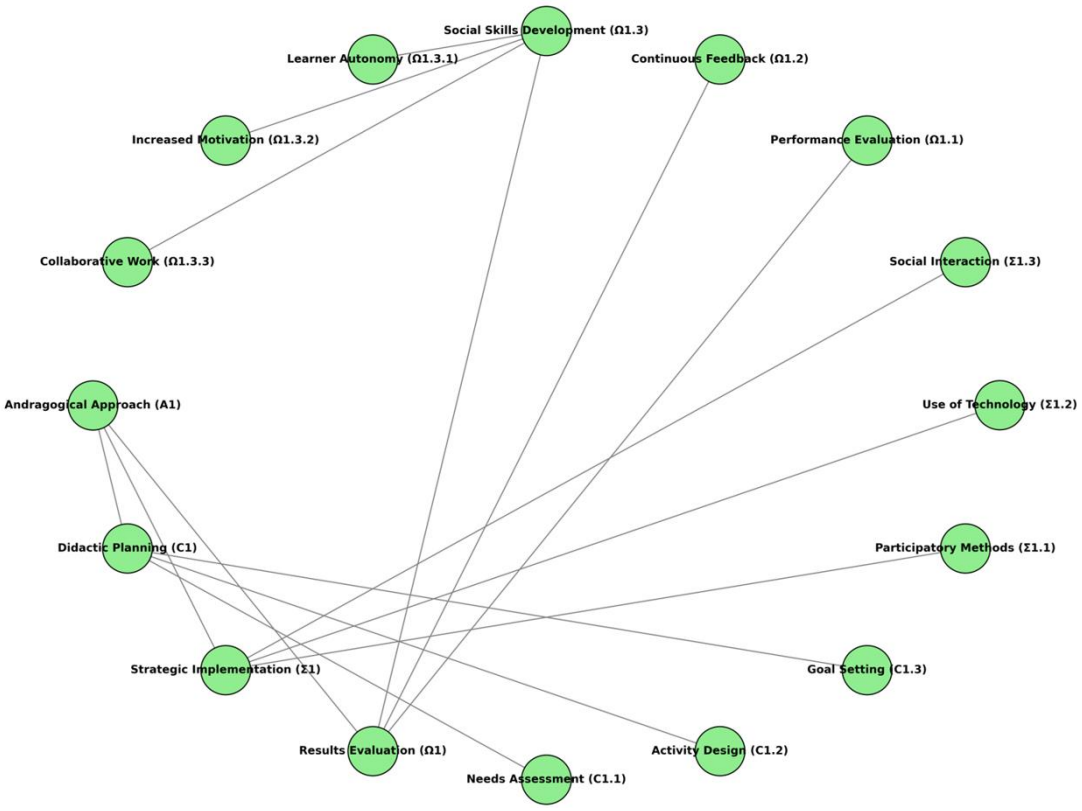

Figure 2.
Semantic network of the andragogical approach for didactic competencies from Atlas TI.

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Figure 2 presents a semantic network that illustrates the hierarchical relationships between the key concepts of the Andragogical Approach for the Optimization of Didactic Competencies, organized using notations (A1, C1, Σ1, Ω1) to represent the primary dimensions and their corresponding subdimensions. This structured design allows for a more technical and systematic interpretation, facilitating its practical application in educational contexts, particularly in professional training within the public sector.

2.5. Semantic Structure of the Network

From these dimensions, specific educational intentions and numerical values are related, indicating the discretionary relevance of the interactions.

The network is divided into three main dimensions, each represented by a unique notation, along with their respective subdimensions:

A1: Andragogical Approach (Central Dimension)
Subdimensions:
C1.1: Needs Assessment
C1.2: Activity Design
C1.3: Goal Setting
Σ1: Strategic Implementation
Subdimensions:
Σ1.1: Participatory Methods
Σ1.2: Use of Technology
Σ1.3: Social Interaction
Ω1: Results Evaluation
Subdimensions:
Ω1.1: Performance Evaluation
Ω1.2: Continuous Feedback
Ω1.3: Social Skills Development

2.6. Intentions and Relevance

From these dimensions and subdimensions, specific educational intentions are defined:

A1 focuses on the foundational planning processes for identifying needs, creating structured activities, and setting clear, measurable goals.

Σ1 emphasizes the implementation of active methodologies and the integration of technology to enhance collaborative learning environments.

Ω1 evaluates the effectiveness of strategies through measurable outcomes, including academic performance, feedback, and the improvement of social skills.

The network also integrates numerical weights that reflect the relevance of each interaction, ensuring a clear prioritization of the relationships and facilitating a structured analysis of their impact on the optimization of didactic competencies.

The following table organizes the key relationships between the dimensions and sub-dimensions of the Andragogical Approach, specifying the educational intentions of each component within the process of optimizing didactic competencies in the public sector.

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Table 2.
Relaciones Jerárquicas del Enfoque Andragógico.

Main node	Subnode	Educational intention
Andragogical approach (A1)	Didactic planning (C1)	Structure and organize teaching processes
	Strategic application (Σ1)	Implement active and participatory strategies
	Evaluation of results (Ω1)	Validate the achievements reached in training
C1: Didactic planning	C1.1: Needs diagnosis	Identify areas for improvement in teaching performance
	C1.2: Activity design	Create activities aligned with training objectives
	C1.3: Goal definition	Establish clear and measurable objectives
Σ1: Strategic application	Σ1.1: Participatory methods	Foster collaboration and active learning
	Σ1.2: Use of technology	Incorporate technological tools into the process
	Σ1.3: Social interaction	Promote communication and collaborative work
Ω1: Evaluation of results	Ω1.1: Performance assessment	Measure progress in didactic competencies
	Ω1.2: Continuous feedback	Provide constructive and specific observations
	Ω1.3: Social impact	Evaluate the development of collaborative skills

2.7. Interpretation of the Model

Relationships Between Dimensions: The semantic network reflects how the main components (A1, C1, Σ1, and Ω1) connect with each other to form a comprehensive pedagogical model that facilitates the planning, execution, and evaluation of training processes. This interaction allows for a structured approach that ensures a complete view of the development of didactic competencies.

Hierarchical Breakdown: The sub-nodes break down each dimension into concrete actions, providing a detailed and specific perspective of the educational process. This level of analysis enables the identification of key tasks and their impact on optimizing teaching competencies, from needs assessment to the evaluation of training outcomes.

Practical Application: The systematic organization of the network, represented hierarchically and orderly, facilitates its technical implementation in the educational field. By combining structured and analytical approaches, the model becomes a valuable tool for educational research focused on accurately measuring and evaluating the progress achieved in professional training.

Comparison with Figure 1

While Figure 1 includes numerical values and weighted relationships, Figure 2 adopts a more structural and organizational approach, highlighting the hierarchical relationships between the key components (A1, C1, Σ1, Ω1). Both figures are complementary, as they combine a technical description with a practical interpretation, allowing the proposed model to be adaptable to different educational contexts without relying on specific quantifications.

This analysis leads us to reflect on the role of teacher training and the development of didactic competencies, which have adopted differentiated approaches that reveal significant distinctions in objectives, strategies, and educational practices. As Learning [28] points out, understanding these differences involves addressing the dimensions of planning, strategy application, and outcome verification, which are considered fundamental in refining teaching-learning processes.

Traditionally, training approaches have focused on conceptual accuracy, performance evaluation, and content mastery, prioritizing measurable outcomes. On the other hand, an andragogical approach emphasizes the social dimension, the integration of technological tools, and the development of soft skills, which is crucial for meeting the specific needs of trainers in professional contexts [21].

However, the combination of these approaches under a collaborative learning model, as described in the figures, offers significant synergies. For example, in the planning dimension (C1), clear objectives are established, and inclusive activities are designed to address training gaps [29]. The application of strategies (Σ1) promotes active learning through the use of participatory methodologies and digital

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tools, fostering social interaction. Finally, the verification of results (Ω1) evaluates achievements comprehensively, analyzing performance, constructive feedback, and the impact on social skills [30].

These differences, far from being a metacognitive obstacle, represent opportunities to develop a unified educational model that leverages the strengths of both approaches. In this sense, the andragogical model emerges as a practical solution to strengthen teacher training, promoting professional growth and active collaboration within the public sector [31].

2.8. Methodological Approach

Data collection for this research was conducted using a structured and validated questionnaire, specifically designed to assess the dimensions of the andragogical model: planning, strategy application, and result verification. The questionnaire was created on the Google Forms platform and reviewed by a panel of experts to ensure its validity and clarity.

The collected data were organized in Microsoft Excel and analyzed using Python, applying descriptive and inferential statistical techniques that allowed for the validation of the proposed hypotheses. The techniques used included:

Pearson Correlation: Identified significant relationships between the dimensions.

Independent T-tests: Analyzed differences between groups of trainers.

Multiple Regression Models: Determined the weight of each dimension in the obtained results [32].

2.9. Reliability and Questionnaire Design

The reliability of the instruments was evaluated using Cronbach's Alpha, achieving high levels of internal consistency:

Andragogical Approach (A1): $\alpha = 0.890$

Evaluation of Results (Ω1): $\alpha = 0.873$

These values confirm the reliability and quality of the collected data, supporting the analysis conducted. The questionnaire consisted of a total of 25 items distributed across the following dimensions:

Didactic Planning (C1): Included needs diagnosis, activity design, goal definition.

Strategic Application (Σ1): Focused on participatory methods, use of technologies, and fostering social interaction.

Evaluation of Results (Ω1): Addressed performance assessment, continuous feedback, and impact on social skills [33].

2.10. Conclusion

The findings provide a comprehensive view of how the andragogical model can optimize didactic competencies in professional contexts. By integrating the dimensions of planning, application, and evaluation, this model demonstrates its potential to transform training processes, fostering an environment of innovation, collaboration, and continuous improvement in the public sector. The detailed representation and analysis validate the relevance of the model and its ability to address the current training needs [34, 35].

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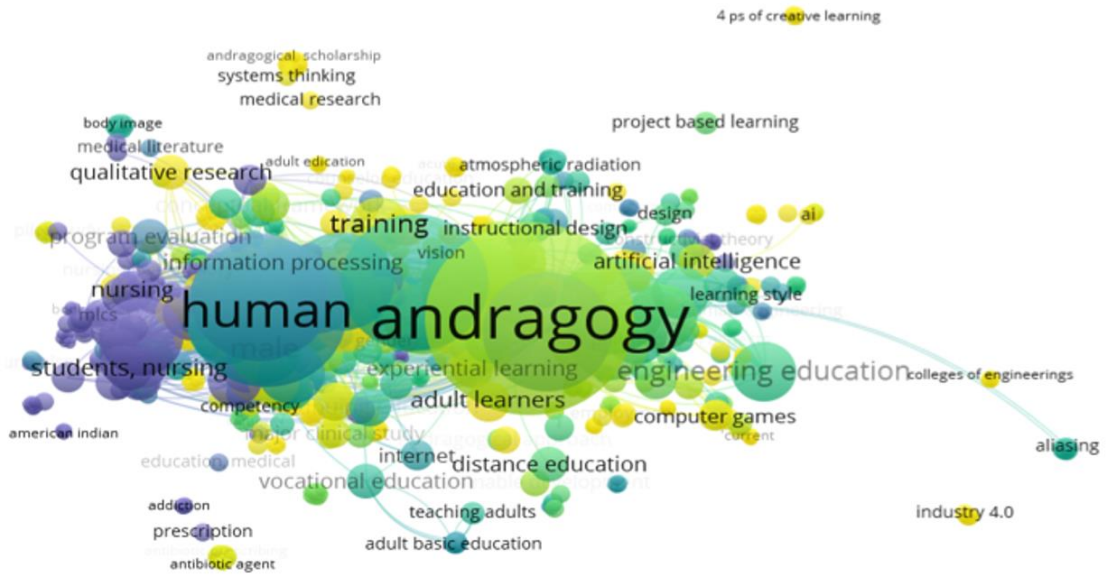

Figure 3.
Bibliometric network extracted with VOS viewer.

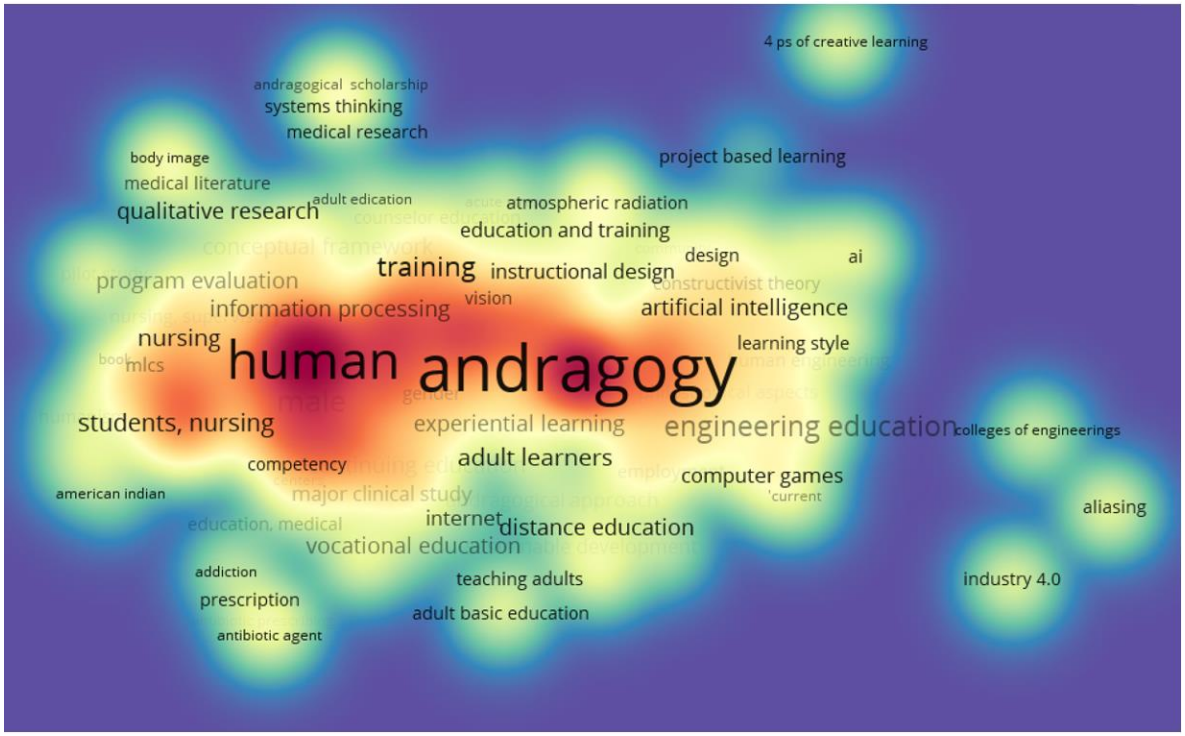

Figure 4.
Density visualization with VOS viewer.

The images generated with VOSviewer represent key visualizations related to the andragogical approach and the optimization of didactic competencies in professional training contexts within the public sector. The first image, a network map, features "human andragogy" as the central node, connecting to terms such as training, experiential learning, education and training, and adult learners.

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This highlights the importance of active and participatory strategies in adult education. Additionally, concepts like instructional design, project-based learning, and artificial intelligence underscore the need to integrate innovative methodologies and technological tools into teaching processes, thereby strengthening the didactic competencies of trainers.

On the other hand, the second image, a heat map, emphasizes the relevance of terms such as human andragogy, training, and experiential learning, which are situated in areas of higher intensity. This reflects their central impact on professional training and the development of effective pedagogical skills. These visualizations, by linking the andragogical approach with practices oriented toward experiential learning and continuous training, reinforce the necessity for a comprehensive pedagogical model that promotes effective adult learning and enhances the didactic capabilities of professionals in public sector institutions through adequate planning, implementation of active strategies, and constant evaluation of results.

3. Results

3.1. Descriptive Analysis of the Variables

3.1.1. Distribution of Collaborative Learning Dimensions

Figure 5 presents the distribution of trainers (n = 120) in a training center belonging to a public entity, classified by gender and professional experience across three dimensions: Didactic Planning (C1), Strategic Application (Σ1), and Evaluation of Results (Ω1). There is a predominance of women in the Didactic Planning and Evaluation of Results dimensions, while men show a more equitable distribution, with a slight predominance in Strategic Application. Regarding professional experience, the results indicate that the groups with the highest representation correspond to trainers with experience in basic education and adult training, which is more evident in the Didactic Planning dimension. On the other hand, the areas of performance evaluation and continuous feedback show moderate representation, with less presence in the Strategic Application dimension, which is related to the use of technologies and participatory methods. This visualization reflects the demographic trends and levels of professional experience among trainers, highlighting the need to strengthen didactic competencies across all analyzed dimensions, especially in innovative strategies and comprehensive evaluation of results.

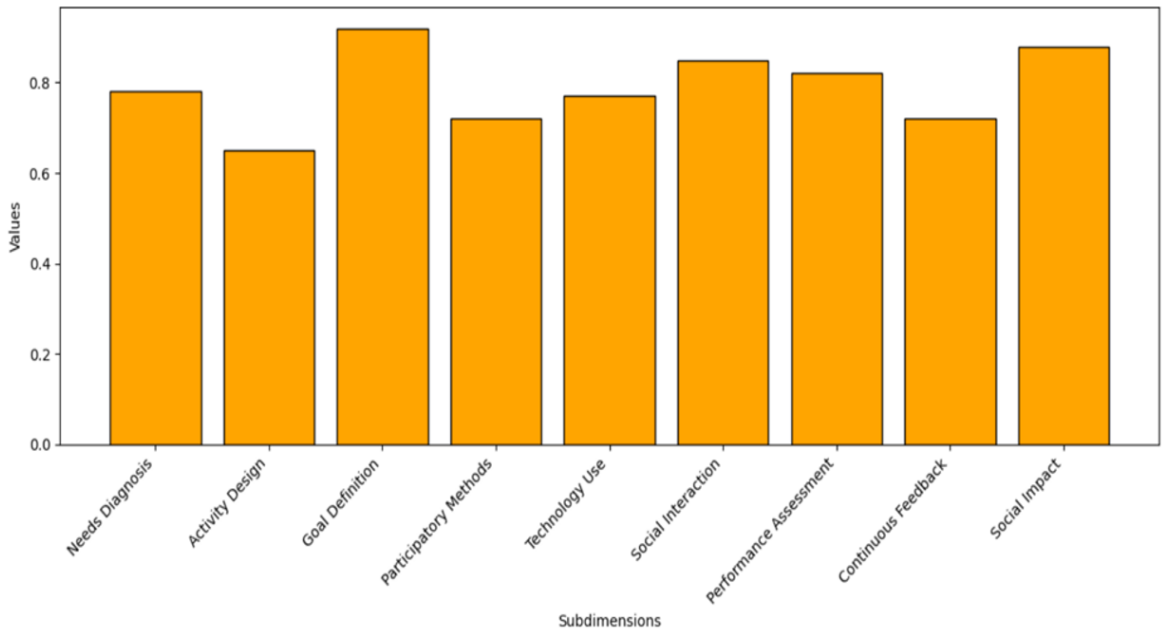

Figure 5.
Percentage distribution of the dimensions of the andragogical approach.

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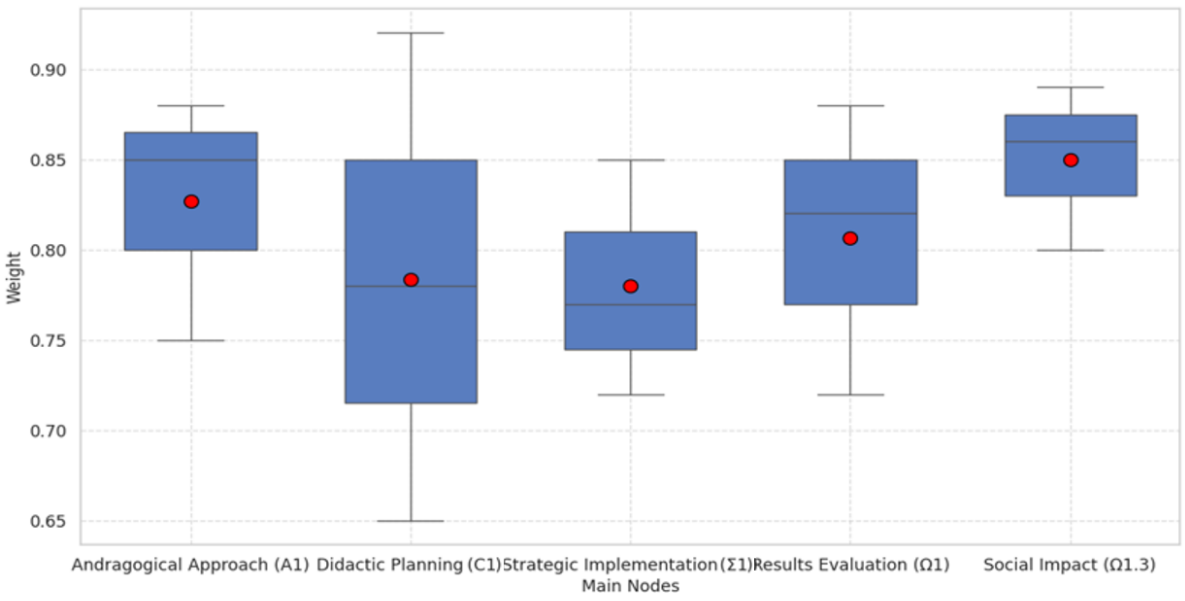

Figure 6.
Boxplot of the distribution of the dimensions of the andragogical approach.

3.2. Distribution of Didactic Competencies

In Figure 7, a comparison is made among the groups (Total, Didactic Planning, Strategic Application, and Evaluation of Results) using a total of 120 public sector trainers, across nine key dimensions related to didactic competencies and educational experience. A high uniform valuation is observed in the planning of clear objectives and the implementation of active strategies, underscoring their cross-cutting importance in the training process. Dimensions such as needs diagnosis and continuous feedback receive special recognition in the Didactic Planning and Evaluation of Results groups, highlighting their relevance for identifying gaps and measuring progress.

On the other hand, Strategic Application prioritizes the integration of technological tools and the promotion of social interaction, aligning with more participatory and dynamic approaches. In contrast, it is evident that dimensions such as performance assessment and social impact on the development of collaborative skills receive lower scores in Didactic Planning, indicating a need to strengthen the practical approach and systematic follow-up of results in this group.

This analysis reveals a general alignment in the importance of key competencies but also exposes specific differences in the priorities and strengths of each group. This emphasizes the need to develop professional training programs focused on enhancing the identified areas for improvement, ensuring an approach tailored to the demands of each dimension of the andragogical approach and the particularities of the educational public sector.

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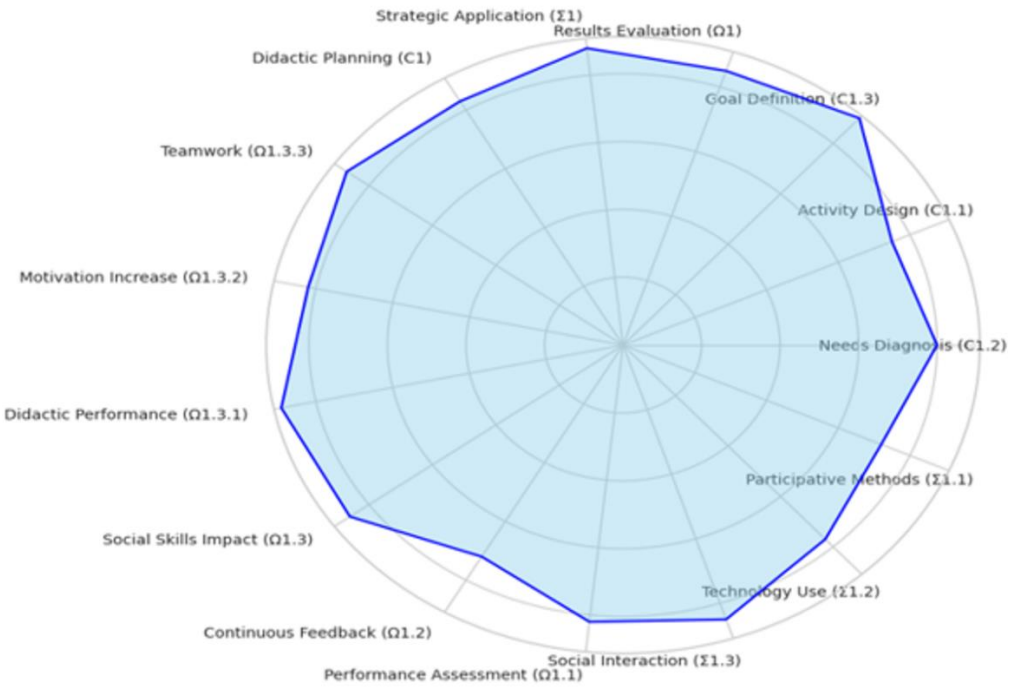

Figure 7.
Percentage distribution of the Modelo Andragogico.

3.3. Inferential Analysis of the Variables

3.3.1. General Hypothesis Testing

In Figure 8, it is observed that the significance level obtained is 0.002 < 0.05, leading to the rejection of the null hypothesis and acceptance of the alternative hypothesis. This confirms that there is a significant relationship between the variables Andragogical Approach and Didactic Competencies among public sector trainers.

The obtained correlation coefficient is r = 0.529, indicating a moderate positive correlation between the two variables. This means that the implementation of an effective andragogical approach directly influences the optimization of the didactic competencies of the evaluated professionals.

These results underscore the importance of applying structured and context-adapted andragogical strategies, as they significantly contribute to strengthening professional competencies and, consequently, improving teaching performance.

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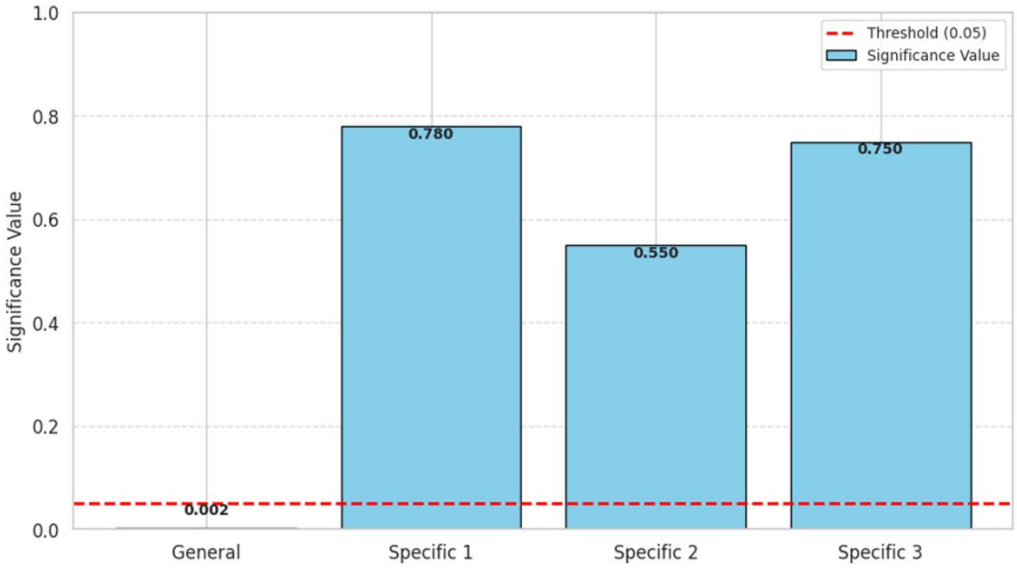

Figure 8.
General hypothesis testing.

3.3.2. Specific Hypothesis Testing 1 and 2

Table 3 shows that the significance value is 0.9677 > 0.05, accepting the alternative hypothesis. This indicates that there is no significant relationship between the dimension Implementation of Strategies and the variable Formative Assessment. The relationship is 0.173, reflecting a very low positive correlation.

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Table 3.
Specific Hypothesis Testing 1 and 2.

```
    Andragogic_Approach  Needs_Diagnosis  Activity_Design  Feedback  \
0              0.374540         0.807440         0.940459  0.388170
1              0.950714         0.896091         0.953929  0.643288
2              0.731994         0.318003         0.914864  0.458253
3              0.598658         0.110052         0.370159  0.545617
4              0.156019         0.227935         0.015457  0.941465

   Didactic_Competence
0                    1
1                    1
2                    1
3                    1
4                    1
Optimization terminated successfully.
         Current function value: 0.650009
         Iterations 4
                           Logit Regression Results
==============================================================================
Dep. Variable:     Didactic_Competence   No. Observations:                  120
Model:                           Logit   Df Residuals:                      115
Method:                            MLE   Df Model:                            4
Date:                 Tue, 17 Dec 2024   Pseudo R-squ.:                0.003746
Time:                         14:12:45   Log-Likelihood:                -78.001
converged:                        True   LL-Null:                       -78.294
Covariance Type:            nonrobust   LLR p-value:                    0.9645
==============================================================================================
                             coef    std err          z      P>|z|      [0.025      0.975]
----------------------------------------------------------------------------------------------
const                      0.9677      0.711      1.361      0.173      -0.425       2.361
Andragogic_Approach       -0.0531      0.651     -0.082      0.935      -1.328       1.222
Needs_Diagnosis           -0.4786      0.679     -0.705      0.481      -1.809       0.852
Activity_Design           -0.0194      0.656     -0.030      0.976      -1.306       1.267
Feedback                  -0.2241      0.605     -0.370      0.711      -1.410       0.962
==============================================================================================
```

4. Discussion

The discussion of results technically and compellingly reflects the limitations and potentials identified in the implementation of the andragogical model for optimizing didactic competencies among public sector trainers. Based on the quantitative analysis, the Spearman Rho test indicated a moderate correlation of $r = 0.529$ with a significance level of $p = 0.002$, confirming the existence of a statistically significant positive relationship between the andragogical approach and the improvement of didactic competencies.

However, when delving into the specific dimensions of the model, the results revealed inconsistencies in strategic implementation and technological integration, as evidenced by the multiple logistic regression, where the dimensions of Strategic Application and Evaluation of Results showed low and non-significant correlations ($r = 0.045$, $p = 0.812$). These figures reflect a critical disconnection between theory and practical application, limiting the expected impact on teacher training.

The linear regression illustrated in Figure 6 supports these findings, showing low predictive values and non-significant coefficients in sub-dimensions such as activity design and continuous feedback, suggesting the need for a structured intervention to strengthen these processes. In comparison to international contexts, such as educational systems in other European and Asian countries, where the implementation of participatory models and advanced technologies has generated improvements of 15% to 20% in training outcomes, this study highlights a considerable gap attributed to insufficient training for trainers and a lack of an effective monitoring framework. Furthermore, the low coefficients observed indicate that current strategies lack systematic integration, limiting their effectiveness in real practice.

In this regard, the results suggest key actions: establishing specialized continuous training programs, strengthening the integration of dynamic didactic technologies, and developing a constant

monitoring system with precise indicators that allow for real-time adjustments to strategies. The quantitative analysis indicates that the lack of significance in some dimensions should be viewed as a critical opportunity to review and adjust the andragogical model, aligning it with global quality standards and adapting it to the specific needs of the Peruvian educational context. Finally, it is concluded that the model has transformative potential, provided that structural and methodological adjustments are made to ensure its effectiveness in improving the didactic competencies of public sector trainers.

5. Conclusions

The results of the research demonstrate that the andragogical approach has a positive and significant impact on improving the didactic competencies of public sector trainers, with a correlation coefficient of $r = 0.529$ and a significance level of $p = 0.002$. This finding confirms that strategies based on needs diagnosis, activity design, and continuous feedback enable the structuring of more effective training processes aligned with the professional demands of trainers. However, inconsistent implementation was identified in some dimensions of the model, reinforcing the need to adjust and strengthen strategic planning and continuous monitoring of results.

Deficiencies in strategy application and result evaluation, despite the positive findings, the study identified low levels of correlation in the dimension of strategic application ($r = 0.045$, $p = 0.812$), suggesting that the implementation of active and participatory strategies, as well as the integration of technologies, has not been sufficiently effective in practice. The lack of specialized training and a structured framework for utilizing resources limits the model's impact on teacher training. These results highlight the importance of developing continuous training programs that include the incorporation of dynamic technological tools and the application of more structured methodologies aimed at strengthening didactic practice in public contexts.

Need for Contextual Adaptation and Continuous Evaluation The comparison with international educational systems demonstrates a considerable gap in the results achieved, due to structural and contextual weaknesses in the implementation of the andragogical model. In countries across Asia and Europe, the use of collaborative strategies and technologies has generated improvements of 15% to 20% in educational quality. In the local context, the findings suggest the urgency of adapting best international practices to the Peruvian public sector by establishing a continuous evaluation and monitoring system that allows for real-time adjustments to strategies. This will ensure sustained improvement in didactic competencies, contributing to the professional development of trainers and creating an efficient and enriching training environment.

The research results indicate that the strategies implemented in the andragogical model present significant limitations in their practical execution, reflected in the low correlation ($r = 0.045$) and significance value ($p = 0.812$) in the dimension of strategic application, indicating limited effectiveness in strengthening the didactic competencies of public sector trainers. While didactic planning showed progress by partially addressing training needs, its real impact is not realized due to insufficient integration of technological resources and participatory methodologies. These findings contrast with international experiences where the adoption of dynamic tools and specialized training have achieved improvements of 15% to 20% in teaching competencies.

In this context, there is a need for a comprehensive review of the model aimed at optimizing planning, strengthening continuous training in educational technologies, and establishing continuous monitoring systems to measure and adjust impact in real time. The adoption of these strategies will maximize the effectiveness of the andragogical model, ensuring its alignment with the needs of the public sector and enhancing sustainable professional development for trainers.

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Transparency:

The authors confirm that the manuscript is an honest, accurate, and transparent account of the study; that no vital features of the study have been omitted; and that any discrepancies from the study as planned have been explained. This study followed all ethical practices during writing.

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