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Development of the teaching, scientific research and public engagement model in the physical education pedagogy program at the Universidad de Las Américas, Chile

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The convergence of the mission functions of an academic program must enable learning objects to be graspable, situated in the reality of professional teaching, foster bi-directionality, and respond assertively to the demands of a constantly changing society. The main objective of this study was to design a model for articulating teaching, research, and engagement with the environment for the Physical Education Pedagogy program. We position ourselves from a qualitative perspective; its design is non-experimental, with a phenomenological-hermeneutic methodological approach and an exploratory-comprehensive scope. Its depth is also applicative and prospective, allowing for the unification of procedures and simultaneous impact on the objects and subjects of reality during initial teacher training. The tools used were documentary analysis and the design of analytical matrices. The results show that the integration of these functions strengthens students' professional development, promotes pedagogical reflection, and generates a bidirectional and meaningful connection with school communities. It would be a new way of integrating mission functions that were previously seen as separate or only incipiently articulated. In this way, it contributes to situated and transformative initial teacher training. The model is designed as a replicable and adaptable tool to strengthen training coherence in initial teacher training programs.

KEYWORDS

investigation, physical education, public engagement, teacher training, teaching

1 Introduction

The University is an institution of higher education associated with a space that trains professionals through the delivery of undergraduate and/or graduate programs leading to an academic degree and a professional qualification (Bernasconi, 2019; Navarrete, 2013; Pach et al., 2025; Ruiz-Corbella and López-Gómez, 2019). In turn, institutions of higher education have a responsibility to universalize knowledge through teaching, research, and engagement with the community. On numerous occasions, such statements do not translate into effective practices due to the lack of tools that enable their proper implementation (Irarrázaval, 2020; Serrano-Moreno et al., 2025).

Any attempt to disseminate knowledge through research or application must take into account the recurring historical, political, and epistemological context. Otherwise, it would skew the projective meaning of knowledge itself, which translates into the cognitive transformation produced by the change of state, from ignorance to the appropriation of a new linguistic code and meaning in thought (Popper, 2001).

Research is a systematic process characterized by the development of orderly and rigorous procedures that enable the obtaining of valid and reliable results (Ikrami, 2018; Manterola and Otzen, 2013). In turn, the development of research in universities is crucial, as it enables students to connect the content they receive during their professional training with real-world social contexts through the identification of a problem (Manterola and Otzen, 2013; Trinh, 2023). As part of this training process, students, guided by their teachers, can consolidate their critical, analytical, and reflective thinking, information search skills, communication skills, and collaborative and autonomous work skills (Rueda et al., 2022). In this way, another key function of the university is articulated, which is public engagement (Irarrázaval, 2020).

Public Engagement is a set of reciprocal and bidirectional actions and relationships that an institution establishes with its social, cultural, economic, educational, productive, multicultural, and intercultural environment, allowing these interactions to improve the institution's work, such as teaching and research (Araya, 2025; Irarrázaval, 2020). Following this logic, public engagement allows both teaching and research to be not isolated actions in the university environment, but rather a reflective dialogue between scientific knowledge and the knowledge of communities, in simple terms: from the territory (González B. et al., 2017; González-Weil et al., 2012; Osorio, 2018; Tommasino, 2018).

The intricate relationship between teaching, research, and public engagement can be analyzed in terms of the relationships that may develop during the continuum of initial training. In this sense, the preparation of all future professionals must consider this continuum with pedagogical criteria; this implies that academic status will only be recognized when the student is considered as an object of pedagogy. Finally, the objective of this research is to present the development of the Teaching, Research, and Public Engagement Model in the Physical Education Pedagogy program at the Universidad de Las Américas.

2 Methods and context

2.1 Type of study and methodological design of MADIV

The development of the Teaching, Research, and Public Engagement Model (in Spanish Modelo de Articulación Docencia, Investigación Científica y Vinculación con el Medio "MADIV") has the central purpose of systematizing these core functions in the context of initial teacher training in physical education.

This study is part of an applied qualitative paradigm, aimed at proposing a situated model that responds to the training needs of the Physical Education Teaching degree program at the Universidad de Las Américas (UDLA). In particular, a phenomenological-hermeneutic approach (Alsaigh and Coyne, 2021; Moustakas, 1994). is used, which allowed for the interpretation of meanings extracted through documentary analysis (bibliographic, newspaper, and archival) regarding university functions and their unification in the training process. For this reason, it is important to consider the guiding and fundamental principles of phenomenological studies, which are detailed below:

- It is necessary to eradicate everything one believes one knows about external and objective reality to focus on how something is experienced from one's own consciousness.
- The object-subject itself is analyzed not as a source of information with history and body, but as a consciousness capable of giving meaning to experiences (Ortiz, 2019; Rosental and Ludin, 1965).

This is a key component of teacher training, as future generations of graduates must know, know how to do, and know how to behave, using phenomenology as a guiding principle for contextual decision-making, as it opens up knowledge of objective reality (context and school population). Bearing in mind that experiences in the environment and institutional and public policy requirements form a frame of reference that shapes reality.

2.2 Methodological design

The design is non-experimental and exploratory-comprehensive (Ditroilo et al., 2025; Manterola et al., 2019; Selltiz et al., 1965), given that variables are not manipulated, but rather the aim is to understand and interpret the meanings, dynamics, and scope of the articulation of university mission functions in a specific educational context (Table 1). At the same time, it seeks to explore a little-known phenomenon and deepen the subjective or contextual understanding of it. It is based on the practice-based curriculum (PBC) framework, especially in the subjects of progressive practice, undergraduate seminars, territorial links, and professional research lines.

In turn, it is projective-applied in nature, as its purpose is to construct a conceptual and operational solution—the MADIV model—based on the analysis of documentary, regulatory, and pedagogical sources (Table 2). In this sense, the projective research was aimed at generating a specific educational device (the model), based on an interpretative diagnosis of the tensions and opportunities presented by the articulation between teaching, research, and links with the environment in initial teacher training (Figure 1). It is a new way of systematizing processes that were identified as separate, and therefore involves an active and collaborative relationship, to optimize the quality and relevance of this training. In other words, teaching is nourished by research and experiences in outreach. Likewise, research is carried out based on real problems detected in teaching processes and social practice. At the same time, outreach allows academic knowledge to be applied and validated in real contexts (educational organizations). Similarly, an emerging design is developed, as the model is built in dialogue with the corporate and disciplinary context, in accordance with public policies (Ley 20.129, Ley 21.091), the Pedagogical and Disciplinary Standards for Initial Teacher

TABLE 1 Evidence of the link between teaching and scientific research.

Students training to become PE professionals apply the guidelines provided by academics *in situ*, and these guidelines are, in turn, the result of shared and in-depth reflection.
Academics have incorporated new knowledge into the course curricular in line with their scientific research.
Faced with the need to seek out and apply new knowledge, students have been trained by academics in the use of the scientific method.
The use of products resulting from scientific research has made the subject of learning more comprehensible.
You learn procedures and techniques for collecting, processing, and interpreting information.
Students are involved in the research process carried out by the academic.

TABLE 2 Instrumentalization of research through MADIV.

Evidence	Interpretation
Students apply guidelines from academic staff based on shared reflection.	Meaningful learning is promoted through guided practices that arise from teacher research.
The subject programs incorporate scientific research findings.	Curriculum planning draws directly on the academic output of the teaching staff.
Students are trained in the use of the scientific method.	The development of research skills is encouraged from an early age.
Research products make the learning object more comprehensible.	Learning is facilitated by using examples or tools derived from real research.
Techniques for collecting, processing, and interpreting information are taught.	Essential methodological skills for research are developed.
The student is involved in research conducted by the academic.	Participation in research projects, promoting situated learning.

In summary, this table shows how the link between teaching and research is established through specific practices that can be observed and evaluated within the educational process.

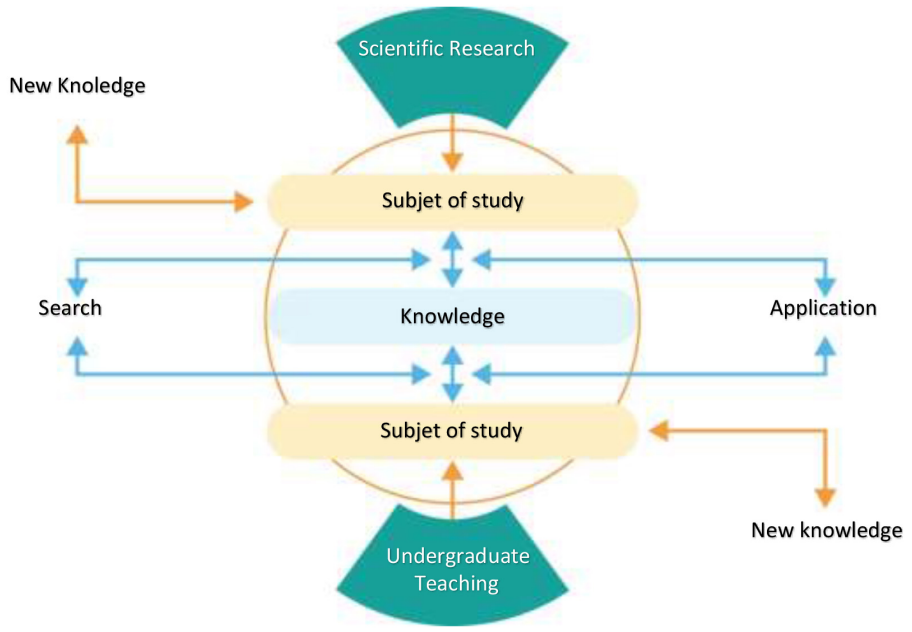

FIGURE 1
Representation of the link between teaching scientific research in physical education pedagogy.

Training (In Spanish-Estándares para la formación inicial docente, Ministerio de Educación, MINEDUC, República de Chile, 2022), and the requirements of the Accreditation Criteria for Pedagogy Degrees (National Accreditation Commission (CNA Chile), 2021; National Accreditation Commission, 2023).

From this point of view, the development of situated research allows for objective and subjective interaction between the environment, teaching, management, research, and situated learning itself (Figure 2). Planning for the development of teaching allows for the articulation of activities, the application of assessment tools, and the recognition of the identities of the environment, students, and teachers from an authentic perspective, considering social participation and its contribution to the development of areas of knowledge (O'Brien and Battista, 2020).

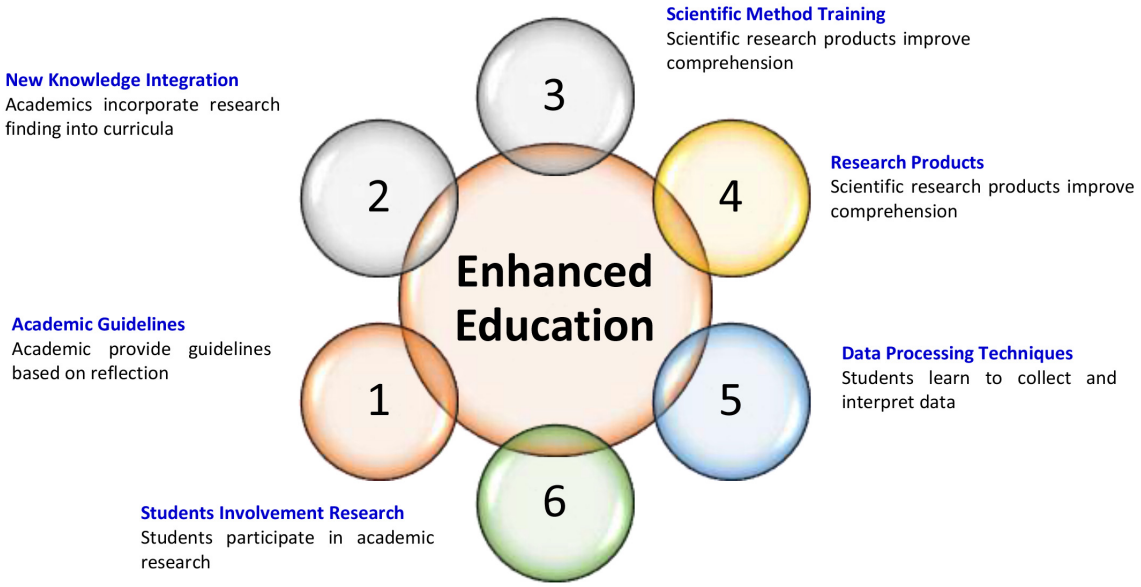

FIGURE 2
Evidence of the link between teaching and scientific research.

2.3 Information analysis

This was carried out using qualitative content analysis techniques, with inductive thematic coding, which allowed us to identify emerging categories related to curriculum integration, situated experience, links with the environment, and the re-signification of the teaching role. This analysis enabled the progressive construction of the MADIV model as a result of situated interpretation (Figure 3). This process was carried out taking into account the guidelines of Taylor and Bogdan, 1994 and Worku et al. (2023) regarding qualitative analysis. For this reason, the process was organized into three phases, which are detailed below:

- First phase, ongoing discovery: this allowed for the identification of thematic topics and the development of concepts and propositions.
- Second phase, which included the coding of data by determining dimensions and a comprehensive structure of the phenomenon in analysis matrices, to gain a deeper understanding.
- Third phase, revitalization of meanings and significances in accordance with the design of the model.

Information gathering techniques and tools

Various qualitative techniques were used to gather data, allowing for a deeper understanding of the MADIV design process:

- Document review
- Design of analysis matrices

3 Results

3.1 Context

The Universidad de Las Américas (UDLA), like all higher education institutions in Chile, has three core functions: teaching, scientific research, and Public Engagement From this perspective, to fulfill its commitment to quality, student-centered, and contextualized education, UDLA has developed its Educational Model (EM), which has four dimensions: the Philosophical Dimension, the Pedagogical Dimension, the Organizational Dimension, and the Quality Assurance Dimension (University of the Americas, 2021). Thus, in order to strengthen the initial teacher training of students in the Physical Education Pedagogy program at the UDLA Faculty of Education, the Teaching, Scientific Research, and Public Engagement Model has been developed (Figure 4).

This model responds to the institution's mission, as well as to the regulations and legislation for admission to teaching degrees (BCN, 2022), such as Law 20129 on Quality Assurance in Higher Education (BCN, 2006) and Law 21091 on Higher Education (BCN, 2018). It also addresses key requirements for the accreditation processes of institutions for undergraduate and graduate programs, as established by the National Accreditation Commission (in Spanish, CNA) (National Accreditation Commission, 2023).

Similarly, it has been deemed essential to consider the main precepts of the Framework for Good Teaching (In Spanish, MBE-Marco para la Buena Enseñanza, 2022), the standards of the teaching profession in Physical Education (2021), and the following laws: Law 20129 establishes a national system for quality assurance in higher education; Law 21091, on higher education; Law 21490 modifies the requirements for admission to teaching degrees; Law 21625 establishes a single teacher evaluation system, and Law 20903 creates the teacher professional development system and modifies other regulations. All from MINEDUC.

3.2 Teaching

Teaching at universities involves teaching and facilitating learning for students who are training to become future

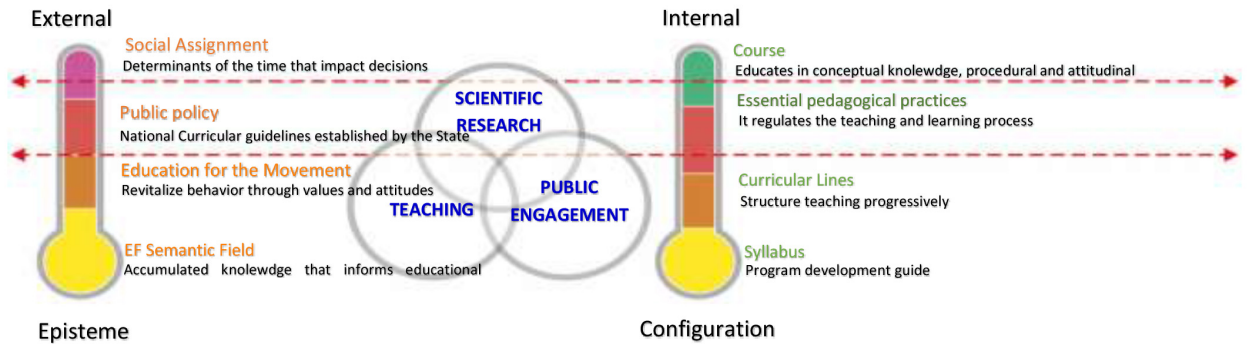

FIGURE 3
Model for articulating teaching, scientific research, and public engagement.

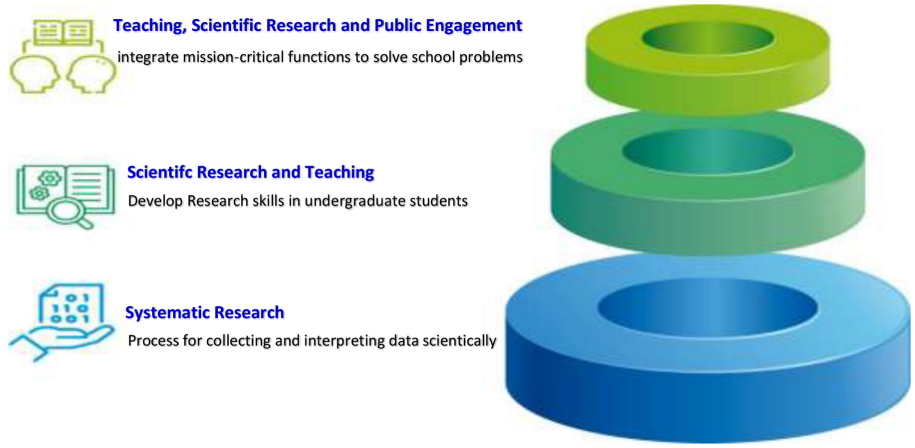

FIGURE 4
Hierarchy of scientific research in the MADIV.

professionals in a particular field or specialty. This teaching focuses on contributing to critical, autonomous, and contextualized thinking among students, which is possible thanks to the activities of the teacher related to planning, activity design, knowledge transfer, guidance and tutoring, assessment, and learning feedback, among others, which enable them to facilitate their students' learning (Mastrokoukou et al., 2022).

In the Latin American context, teaching and training future professionals present different challenges for their development, given a constantly changing social context. This is because they come from diverse cultural, social, geographical, ethical, political, economic, and legal contexts (Bennasar-García et al., 2021), among others, such as the composition of their family nucleus (Martínez et al., 2020), which sometimes hinders their learning from the outset (Pérez et al., 2013) and sometimes leads to university dropout (Arancibia and Trigueros, 2018; Gallegos et al., 2018; Garrido and Pajuelo, 2023).

From this point of view, teaching in higher education allows students to transform their lives, as it provides them with new experiences in which they have the power to transform their learning through teaching (Jarni and Gurr, 2024).

3.3 Scientific research

The development of research in universities is key because it advances knowledge, promotes professional development, and drives innovation, allowing students and faculty to examine new ideas for problems that arise from their context and thus provide viable solutions for a better quality of life, identifying gaps in their field of study and future professional development (Alcántara-Rubio et al., 2022; Dissanayake et al., 2022).

In Latin America, the development of research activities is subject to public and economic policies, which makes it difficult to generate opportunities for collaborative development between researchers and citizens (Ciocca and Delgado, 2017). However, this difficulty can be reduced if universities develop internal policies geared toward research in key areas where their students are trained (Sarthou et al., 2022). In this way, economic resources are planned for the generation of knowledge, the strengthening of teaching, and cultural, social, economic, and human development.

In this regard, research in higher education is key to developing new opportunities for knowledge production. Based on this logic, faculty and students explore areas of knowledge related to

the curriculum, teaching and learning, student trajectories and experiences, among others (Muñoz-García et al., 2019).

3.4 Public engagement

Public Engagement in universities is key because, from its strategic role, it strengthens their educational, social, academic, formative, innovative, and transformative functions (CNA, 2023; Manríquez and Goñi, 2023). From a bidirectional and transformative position with the environment, Public Engagement allows for the comprehensive strengthening of student development, from an ethical and professional standpoint and a commitment to society, as well as in their participation as agents of social change (de Ferari et al., 2022; Mardones and Guzmán, 2024).

Currently, Public Engagement has brought about crucial, mandatory, critical, and transformative changes in public and university policy. Thus, it is necessary to unify this requirement through the necessary connection with society, establishing the co-construction of knowledge and mutual recognition (Castañeda et al., 2021; Verdejo-Cariaga, 2024).

In this sense, universities participate collaboratively, bidirectionally, and locally with the communities in which they are located. Likewise, this partnership makes it easier for communities to reveal their needs and for universities to generate opportunities for local intervention, incorporating real situations into their planning that allow for the systematization of actions by faculty and students, providing real and contextualized solutions (Culum, 2020).

3.5 Development of the MADIV model

The creation of this model focuses on contributing to and committing to Initial Teacher Training in Chile. The creation of this model focuses on key principles of Quality Assurance in Higher Education (BCN, 2006), Support and Professional Development (BCN, 2023), and the Teacher Professional Development System (BCN, 2016). In this way, the model is projective for the professional work of future physical education teachers in the country.

Finally, it is worth noting the importance of developing proposals or models contextualized from UDLA's internal regulations, which recognize the particular characteristics of the student body (Fuentes-Rubio and Castillo-Paredes, 2022) as well as those of its community (Fuentes-Rubio et al., 2023), providing an assertive and consistent response to its commitment to quality education, which underlies ministerial regulations and national legislation.

3.6 Teaching-scientific research link

In line with its mission, UDLA's educational model assigns scientific research carried out by its academics the important role of nurturing and updating the pedagogical and disciplinary content of the courses it teaches. In this vein, teaching is described as an activity that promotes knowledge and is significant in the process of constructing and accumulating knowledge. For its part, research represents a systematic process of organizing and understanding knowledge, which allows for scientific responses to problems in pedagogical contexts. When the two parts interrelate and strengthen initial training, the link between teaching and research has undoubtedly been established.

Given the above, Physical Education Pedagogy students have opportunities to practice and develop their research skills and participate in groups that deploy systematic processes for seeking and applying knowledge. Assuming that the essence of the link is related to the increase in critical mass, this is reflected in the opportunities for academics and students to share their research experiences and the impact on their ability to reflect together. This foundation is essential when evaluating the capabilities of teaching professionals. Accordingly, the educational act is conceived not only as a mere transmission of knowledge, but also as an instance during training that can strengthen critical and deep thinking. It is therefore necessary to engage students in experiences that bring them closer to research and action in their respective pedagogical and disciplinary areas, which is productive for a better understanding of real-world phenomena.

The latter is linked to pedagogical-disciplinary issues or knowledge, which is developed during scientific research as an object of study and during teaching as an object of learning. In turn, both the actions to be developed and the interrelationships allow for the construction and deconstruction of new knowledge. This situation is highly valued by the scientific community. The link between teaching and research during the transition from initial training is made concrete when the following is observed:

As long as Physical Education Pedagogy continues to consider the teaching-research link as a strategic axis, the evidence confirming this articulation will be consolidated. This is currently happening, thanks to the incorporation of the Practice-Centered Model (PCM) by the Faculty Education (in Spanish FEDU) and the implementation of Essential pedagogical practices (in Spanish PPE-Prácticas Pedagógicas Esenciales) starting in 2023, a thread that is linked to the signatures of the Training Program 2018 adjusted training plan, the redesign in Training Program 2025, and the incorporation of learning situations that stimulate and develop thinking among students. This issue represents the status of scientific production by the PPE faculty of education. The PCM is a practical training model that allows students to respond to what and how in a synchronized manner, enabling them to learn how to implement pedagogical strategies in each educational context (Rendich et al., 2024; Rendich, 2024). PPE refers to a set of collaborative actions carried out with different educational agents, aimed at promoting the comprehensive training of future teachers and, in doing so, contributing to sustainable social development (Rico-Gómez and Ponce, 2022; Tobón et al., 2018).

The above is further implemented in Table 2.

3.6.1 Teaching-scientific research-public engagement

In recent years, senior government bodies have recognized the mission of community engagement as essential to professional training processes. It allows us to engage with different territories,

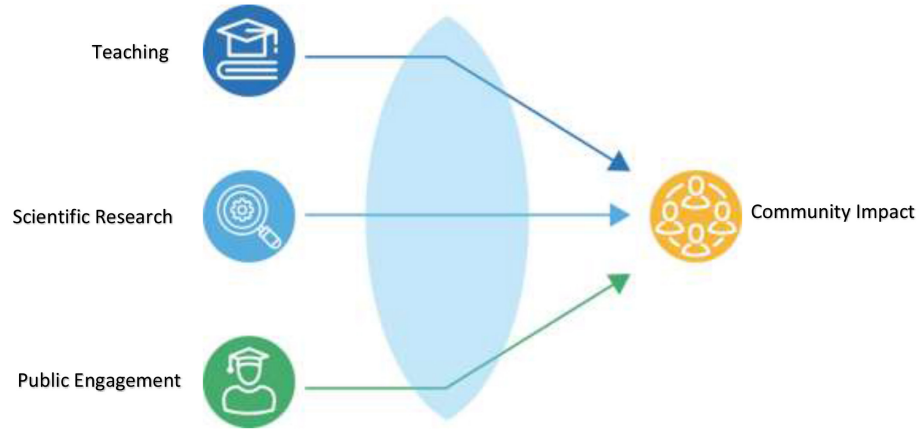

FIGURE 5
Convergence of missionary functions.

identify problems and critical issues, seek consensual solutions, and have a positive impact on sociocultural environments (González L. et al., 2017) (Figure 5). In this sense, public engagement, in addition to bringing common goals between organizations closer together in a bidirectional manner, is a way of bringing teaching and research closer together in the school context, using the university's internal philosophy as a frame of reference (Irarrázaval, 2020). In this context, PEP develops initiatives that strengthen these mission-critical goals.

Among these, we can highlight the presence of two PEP academics on the editorial team of Education in the Americas Magazine, one of whom is the director and the other an academic editor (https://revistas.udla.cl/index.php/rea). Starting in 2025, the Teaching, Research, and Public Engagement Model (MADIV) will be implemented, through which we aim to consolidate the required bi-directionality, taking into account the guiding principles of the Practice-Centered Curriculum, the evolution of the discipline of Physical Education in the educational context, the pedagogical and disciplinary standards for initial teacher training (in Spanish FID), and the paradigm of Human Motricity. The model and its specifications are detailed in Figure 3.

Their characteristics mainly coexist, taking into account the following connections:

- Object of study ↔ Object of teaching: Scientific research identifies problems or phenomena from a disciplinary approach, and those same objects are then addressed in teaching as content to be taught.
- Cognitive actions (application and search): These represent skills that students develop when searching for and applying knowledge in both dimensions (teaching and research).
- New knowledge: This is constructed bidirectionally in both areas, strengthening students' critical thinking.

This figure conceptualizes how the three mission functions of the university are articulated simultaneously and coherently.

- Model structure: It starts from the abstract (concepts, regulatory frameworks, institutional philosophy) and is operationalized in concrete actions through regulatory mechanisms.
- Convergence of functions: Each mission function (teaching, scientific research, public engagement) does not act in isolation but rather complements the others in educational practice.
- Regulatory and pedagogical support: The model is aligned with public policies, FID standards, the practice-centered curriculum, and the human motor skills paradigm.

This model allows for the projection of an integrative, reflective, and situated approach to the training of teachers in physical education, facilitating real impact in the territories.

In summary, this figure aims to represent how knowledge flows and is co-constructed between the fields of teaching and scientific research, generating a consistent basis for the pedagogical and disciplinary understanding of the teaching profession in physical education.

3.7 Presentation

The model arises from the need to coordinate actions associated with mission functions, that is, to link the abstract and the concrete simultaneously and coherently: teaching, scientific research, and public engagement. Hereinafter, we will use the acronym MADIV to refer to this model. A priori, we assume that any model designed must correspond to the problems and needs that arise in everyday professional teaching. While it is true that it is abstract in nature, it is graphically represented and conceptualized in a context in which the current state of humanity in general, and Chilean society in particular, requires coherent and consistent responses to pressing needs. Subsequently, it is operationalized in actions and strategies in an articulated manner between the aforementioned mission functions. Along with this specification, it is pertinent to mention that the didactic treatment during the development of teaching has an inherent impact on the progressive development of the proposed

research skills; this will be implemented from 2025 and is fully in line with MADIV.

3.7.1 Self-regulation mechanisms

We understand regulation as the establishment of mechanisms that allow for systematic control of the stages involved in the design and implementation of the model. Therefore, we will have a system of indicators to evaluate the manifest state of pedagogical practices (In Spanish SEPPE-Sistema de Prácticas Pedagógicas Esenciales). The project consists of the design and implementation of a system of qualitative indicators for monitoring and analyzing the apparent state of understanding and application of essential pedagogical practices. This will be done in the context of progressive practices and during the exercise of the profession. These strategies are consistent with the practice-based curriculum, a core component of FID. It also includes process and impact indicators, in order to provide methodical monitoring and evidence to verify the articulation between the congregated mission functions. This process is organized as follows: (a) External coherence; (b) Internal coherence; and (c) Instrumentalization, which are detailed below:

(a) External consistency: The model provides a representation of reality in which various dimensions converge that originate from outside the institution but influence decisions to implement it. As noted, the external frame of reference is divided into four dimensions, which are described as follows:

- Public policy: We recognize that it is the State of our independent Republic that establishes national curriculum guidelines through the foundations, transition, and continuous updating. It also establishes the mechanisms that regulate the actions of the institutions responsible for training teachers in Chile. In this regard, we adhere to the Framework for Good Teaching (In Spanish MBE-Marco para la Buena Enseñanza) and the Disciplinary and Pedagogical Standards, and as a result, we understand the importance of this jurisprudence that regulates the teaching profession in Chile and work for our students to act in accordance with this state requirement.
- Social mandate of the period: In this component of the MADIV reference framework, the following are considered to be the main determinants of the period, as they have influenced government decisions that impact all citizens. Among the most representative, we highlight the following: (1) The social unrest in 2018; (2) The collateral effects of the coronavirus pandemic; (3) In February 2024, there were 56 active wars in the world, the highest number since World War II; (4) The number of vehicles in Chile has increased since before the pandemic. Specifically, in the Metropolitan Region, more than four million vehicles are traveling through the city; (5) According to the audited registry for 2024, 786,466 foreign nationals live in Chile; (6) Chile already has a population of nearly 20 million inhabitants; (7) rising vulnerability indices; (8) unusual crime rates; (9) According to the UN, Chile will have a deficit of 30,000 teachers by 2030; (10) It is imperative to move toward knowledge built in accordance with the rapid advancement of science from a transdisciplinary approach; (11) It is necessary to institutionalize processes and procedures connected with the practice-based curriculum and consistent systems and mechanisms.
- Semantic field of Physical Education and Human Motricity: We conceive of the semantic field as all the accumulated knowledge that is articulated with the discipline and that allows actions and interrelationships to be deployed in the educational context, both in the teaching of subjects in PEP and in IE. Therefore, pedagogical and didactic decisions must provide a coherent response to the paradigmatic trend linked to the discipline and the practice-based curriculum.
- Education for Movement: Education focused on dispositions, attitudes, and values can revitalize the behavioral and procedural guidelines associated with the formal education of children and youth. Undoubtedly, the above must be organized in accordance with the previous characterization of the educational context. Therefore, it is necessary to strengthen these components from the FID. Education in values needs to be systematized.

(b) Internal Consistency: This model is linked to the curricular, pedagogical, and didactic decisions developed by PEP. This is based on a practice-centered model and the elements of the macro curriculum (curricular guidelines and syllabus), which must be aligned with the PPE that must be implemented during physical education classes.

(c) Instrumentalization: Phase of the model in which decisions are made on the spot, during actions and interactions between the various agents. We will identify these in two groups: (1) To identify students and teachers in the degree program, we will use the acronym PEP; and (2) in the case of students, teachers, inspectors, teaching assistants, minor service personnel, and authorities of the educational institution, we will use the acronym IE.

3.7.2 Roles in the MADIV context and inherent mission functions

Teaching: A set of experiences in the educational field that allows students during their undergraduate training to progressively, coherently, and contextually apply the teaching-learning process, taking into account the characteristics of teaching physical education and the unique qualities of the students in their charge. For this mission, and taking into account the components of MADIV, the meanings of its main subcomponents have been established, as indicated below:

- Subjects: Institutionalized spaces that bring together a set of strategies and constructs organized for the purpose of educating people in conceptual, procedural, and attitudinal knowledge consistent with a graduate profile, curriculum, and the discipline being developed.
- Essential pedagogical practices (In Spanish PPE): These represent strategies that serve to guide and regulate the teaching and learning process. In a nutshell, their implementation involves three essential propositions, which are as follows: (a) asking questions; (b) listening to and interpreting students' answers; (c) asking additional questions

to verify and understand what students are saying. This involves conceiving the formal education process as an opportunity to individualize learning, involve all students, and provide constant feedback on the procedures involved in the deployment of pedagogical and didactic tools in the context of Physical Education classes.

- Curriculum Guidelines: a set of descriptors, learning outcomes, content, methodology, teaching and learning activities, and assessment milestones that are interrelated within a curriculum. These guidelines are organized according to areas of knowledge, skills, and behavior, and their main purpose is to structure teaching progressively and coherently throughout the educational program.
- Syllabus: This is a guide that allows for the planning of a course program. It consists of five steps that place students at the center of the process, progressively giving them a leading role and mechanisms to make decisions independently. Therefore, the strategies suggested must be connected to PPE, self-learning, participation, and collaborative work.

3.7.3 Scientific research in the context of MADIV

We consider scientific research to be a core element of this model, as it is conceived as a systematic process that allows data to be compiled, processed, and interpreted using scientific criteria. In turn, this is done through validated procedures related to the context of FID and the discipline of Physical Education.

- Scientific Research and Teaching: A conglomerate of conceptual and procedural objects that enable students to begin developing skills in searching for, processing, analyzing, and interpreting results during their undergraduate training, as well as to experience the application and experimentation of knowledge during the development and systematization of research processes in the school environment.
- Scientific Research, Teaching, and Public Engagement: The triad that brings together these three mission functions must be realized through actions and interrelationships *in situ*, in and for the educational institution. Contribute to providing academic and scientific responses to the pressing problems of the school organization. For this reason, it is very important to determine two fundamental elements: the first is that during regular teaching, the search for and analysis of documents should be encouraged, monitored, evaluated, and graded. The second should be implemented during the development of progressive practices, complementing the two actions outlined above with observation and recording in the field of action (school).
- Public Engagement: Missionary function that allows the interrelation of PEP with IE, through teaching, scientific research, and university outreach. While it is true that its purpose, within the context of MADIV, will allow for the establishment of contacts and convergent actions between both organizations. The above, with the purpose of installing the model, its socialization, and impact on the communities and territories adjacent to PEP.
- Bi-directionality: We conceive of bidirectionality as the process in which two or more organizations are linked through a common action or purpose, which unwaveringly implies that the actions and interrelationships must be agreed upon by the various actors in the bidirectional link. This also includes the elements required for the smooth management of the bidirectional initiative. In turn, the regulation of the behavior of the result, process, and product indicators must be systematically implemented. This will facilitate the pursuit of a heuristic itinerary that responds to the link with juxtaposition.

It highlights the role of bidirectionality in the university-community relationship, allowing for the co-construction of knowledge and strengthening teacher training from a participatory approach.

4 Discussion

The findings of this study confirm the need to move toward teacher training models that overcome the traditional fragmentation between university functions. The experience gained in developing the MADIV model shows that it is possible to design integrated training pathways, where teaching, scientific research, and public engagement (Taliento, 2022) are coordinated in line with the pedagogical challenges of university training in Physical Education Pedagogy.

This process is aligned with the guidelines of practice-based curricula (Shulman, 1986, 1987, 1999; Niman and Chagnon, 2023; Star, 2023), which propose training that is situated, reflective, and committed to the environment. The integration of university functions allows future teachers to develop scientific research and pedagogical innovation skills from a collaborative and transformative perspective.

In this sense, the MADIV model provides a concrete methodological proposal to operationalize the articulation of functions within the framework of initial teacher training. At the same time, it poses an institutional challenge: to consolidate interdisciplinary spaces and pedagogical strategies that promote teacher collaboration, co-teaching, and interdisciplinary work.

Although the results are consistent with the aims of the institutional educational model, its validation in other degree programs or contexts will require specific adaptations. Nevertheless, it constitutes a replicable benchmark for other academic units seeking to strengthen the educational coherence and social impact of their teacher training programs.

4.1 Practical implications

This analysis allows us to identify that the MADIV Model:

- Emerges as an organic and localized response to regulatory requirements (CNA, MINEDUC, current legislation).

- Is outlined from the critical unification of purposes inherent to initial teacher training in Physical Education, avoiding the logic of silos.
- It brings together epistemological and pedagogical references from a transformative perspective (Freire, 1970; Ocampo, 2008; Schön, 1983; Gadamer, 1999; Mashhadi et al., 2020; Cappiali, 2023; Boylan et al., 2023).
- It is operationalized through specific mechanisms, such as SEPPE, PPE, curriculum redesign, and active territorial links.

4.2 Future lines of research

- Process, progress, and product indicators to verify the quality of teaching performance, through evidence, in students in training.
- MADIV Management Model, which allows for monitoring its implementation and development.
- MADIV, Bidirectionality, and impact of scientific research in the school context

5 Additional requirements

This study enabled the systematization of a model for coordinating university functions related to teaching, scientific research, and public engagement, focusing on initial teacher training in physical education. The MADIV model is based on the provisions of institutional documents, public policies related to initial teacher training and institutional accreditation processes, and, in particular, guidelines for education degrees. In turn, the experience of the practice-based curriculum and its implementation during the initial teacher training process. It is concluded that the articulation of functions strengthens the professional identity of teachers, improves the quality of the training process, and enhances the social impact of universities in the territories. In addition, it allows for a meaningful integration of disciplinary, pedagogical, and contextual knowledge, which is key to addressing the current challenges of Chilean education. Finally, it is proposed to advance the institutionalization of the model, promoting curricular policies and practices that foster comprehensive, transformative teacher training committed to educational justice.

Data availability statement

The datasets presented in this study can be found in online repositories. The names of the repository/repositories and accession number(s) can be found in the article/supplementary material.

Author contributions

JV-D: Validation, Conceptualization, Writing – review & editing, Supervision, Resources, Methodology, Writing – original draft, Investigation, Visualization. AC-P: Investigation, Writing – review & editing, Supervision, Validation, Methodology, Conceptualization, Visualization. JO-A: Methodology, Supervision, Investigation, Conceptualization, Writing – review & editing, Visualization, Validation.

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