Innovation, Entrepreneurship, Higher Education: Integrated and Transversal Basic Sciences

Ana Lucia Ferró-Gonzáles[1], Medina, Wenceslao T.[2], Juan Walter Tudela Mamani[3], Hubert A. A. Alvarez[4*]

[1]School of Economics, National University of Juliaca

[2]School of Agroindustry Engineering, Faculty of Agrarian Sciences, National University of the Altiplano of Puno

[3]National University of the Altiplano, Faculty of Economic Engineering

[4]Former Senior Manager PMESUT-BID / VRI-Vice-Rectorate of Research - National University of the Altiplano of Puno / UNA-Peru

***Corresponding Author**

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ABSTRACT

Peru possesses vast natural wealth in forestry, energy, water, maritime, agricultural, and mineral resources, yet its consumption of derived goods and services is low compared to Mexico and Brazil, where collaboration between universities, industry, and government has driven innovation and sustainable technological development.

In this work, we address the transversal interrelation of scientific disciplines such as chemistry, physics, biology, and mathematics. Thus, through an interdisciplinary didactic model, we propose a conceptual framework that fosters understanding and synergy among these disciplines, allowing students to integrate and apply knowledge holistically. This model is structured into five stages: identification of key concepts, classification of transversal interactions, design of didactic activities, assessment of comprehension, and feedback for continuous improvement.

This approach aims to develop critical skills and facilitate the practical application of knowledge in complex problems and real-life situations. By integrating these basic natural science disciplines, the quality of learning would be improved, promoting a deeper understanding of natural phenomena. This proposal would be validated through indicators measuring its effectiveness in promoting interdisciplinary integration, critical skills, practical application, and creative, collaborative problem-solving.

The objective is to prepare students for the 21st century by fostering creative problem-solving, interdisciplinary collaboration, and critical thinking, with the involvement of teachers and administrators in curricular adaptation and basic science integration. Implementing this educational model could represent a significant evolution in higher education in Peru, enhancing academic and professional training and contributing to economic and social development.

INTRODUCTION

Since 2010, investment in Research and Development (R&D) in Peru has decreased to 0.20% of GDP, falling below countries such as Mexico and Brazil. This insufficiency limits Peru's participation in critical areas such as health, education, security, and the rural sector [1, 2, 62].

In developing countries, the responsible consumption of goods and services produced by key sectors strengthens the national and/or regional economy. This strengthening is the result of a transversal education system [3, 4]. Educational, scientific, and technical policies oriented toward an innovative and entrepreneurial model contribute to the economic strengthening of these countries [5, 6]. These outcomes are made possible by the involvement of academic and scientific managers who drive a higher education system aligned with economic, academic, and technological demands, identifying threats and weaknesses and transforming them into opportunities [7].

The indicators of internal and external production and trade in Peru are weak relative to its GDP. Therefore, it is suggested to transform the conventional higher education system into a transversal system, where innovation serves as the driving force to offer solutions with social and economic impact, aligned with the country's interests and opportunities [8-11].

Successful Experiences Of Open Innovation In Universities

Globally prestigious universities have demonstrated that open innovation plays a crucial role in research, technological development, and innovation (R&D&i). These institutions not only facilitate knowledge transfer but also meet the needs of society and the productive sector [12-15].

Below are some of the most outstanding and innovative universities in this field:

Brazil [16-18]: Brazil has recorded significant interaction between universities and companies through models such as spin-offs and technology transfer platforms. Key examples include:

- **Polytechnic School of USP:** Implements programs that facilitate the creation of innovative companies based on research conducted at the school.
- **COPPE at UFRJ:** The Coordination of Postgraduate Programs at the Federal University of Rio de Janeiro develops spin-off programs to support researchers in creating technology-based companies.
- **Federal University of Santa Maria (UFSM):** Develops an innovation platform that facilitates connections between researchers and companies, promoting technology transfer and collaboration.
- **Mexico [19-22]:** The academic sector has launched various initiatives that integrate technical and soft skills to prepare students for a dynamic work environment. Representative examples include:
- **Dual Education Model:** Implemented by Tecnológico de Monterrey, combining academic education with practical experience in companies.
- **Entrepreneurship Programs in Universities:** UNAM supports students and entrepreneurs in creating and developing new businesses.
- **STEM Education and Transversal Skills:** The National Baccalaureate System in Science and Technology (SNBCT) promotes training in STEM areas and transversal skills.
- **Innovation Projects in Technical Education:** Conalep offers innovative programs in technical education.
- **Collaboration between Universities and Companies:** The University of Guadalajara collaborates with local companies to provide practical experiences for students.
- **Teacher Training Initiatives:** The National Teacher Training Program (PNFD) aims to update teaching skills.
- **Project-Based Learning (PBL) Projects:** The Technical Secondary School in Ciudad Juárez applies project-based learning to develop critical skills.

Netherlands (Holland) [23-26]: Collaboration between universities and industry in the Netherlands is fundamental for innovation, facilitated by government policies that promote knowledge and technology transfer. The open innovation policy and established platforms connect universities, companies, and other actors in the innovation ecosystem. A successful case is Delft University, which promotes applied research and technology transfer through collaborative projects with companies.

United Kingdom [27-30]: In the United Kingdom, the interaction between universities and companies has focused on strengthening ties and analyzing environmental factors. Government policies encourage research collaboration and the development of new technologies, with notable success cases:

- **Innovate UK:** A government agency that supports technology transfer and the creation of spin-offs.
- **Cambridge University:** Has developed a robust ecosystem for industry collaboration.
- **Catapult Centres:** Government-funded centers of excellence that promote collaboration in specific areas such as advanced technology, energy, and biomedicine.

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These cases highlight the effectiveness of collaboration between academia and industry in maximizing economic impact and meeting social and productive needs, promoting a future of innovation and sustainable development.

ANALYSIS AND DISCUSSION

Economic and Technological Development in Latin America [R&D]

The Gross Domestic Product (GDP) of Latin American and Caribbean countries shows significant differences in terms of economic and technological development (Figure 1). Despite these disparities, the region's natural wealth offers considerable potential for creating opportunities and sustainable growth. To transform this wealth into development opportunities, it is essential to combine several key factors, including:

- **Effective Resource Management:** The efficient administration of natural resources is essential to maximize their value and ensure long-term sustainability. This involves implementing policies for rational use, conservation, and strategic utilization.
- **Investment in Infrastructure and Technology:** The development of modern infrastructure and the adoption of advanced technology are crucial to improving the region's competitiveness. Investments in transportation, energy, communications, and technology enhance productive efficiency and foster innovation.
- **Political and Economic Stability:** Creating a stable political and economic environment is a decisive factor for attracting investments, promoting economic growth, and generating confidence in international markets.
- **Education:** Investment in education is fundamental to developing skills and capabilities that drive innovation and entrepreneurship. The formation of a qualified human capital contributes to technological progress and regional competitiveness.

Strategic investment in these aspects will enable economic diversification and access to international markets, strengthening the sustainable development and economic contribution of Latin American countries [31-33]. Additionally, focusing on education and technology will foster the generation of quality jobs and the development of high value-added productive sectors, enhancing the regional economy.

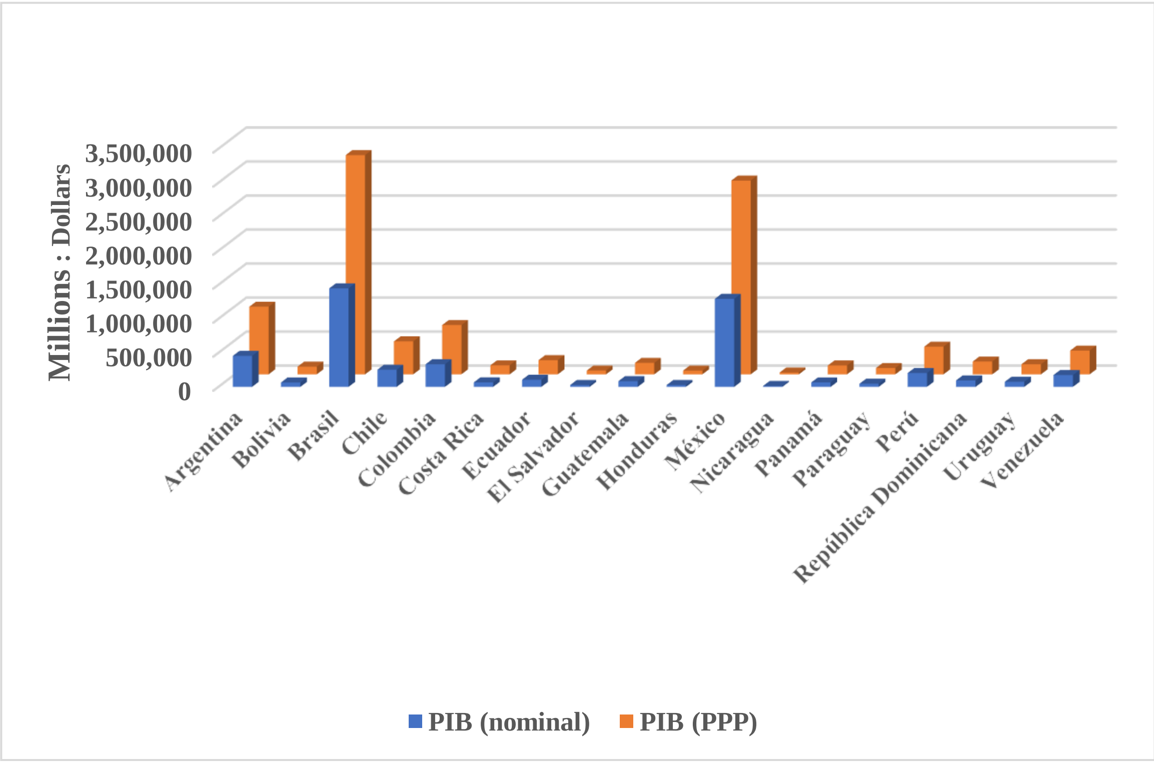

Figure 1: Gross Domestic Product in Latin America and the Caribbean 2023 [34-36].

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Exploring and Harnessing Natural Resources for Economic Growth

Innovation and entrepreneurship in the exploitation of natural resources are essential for economic growth. It is crucial to formulate policies that steer higher education towards a transversal approach to transform these resources into high value-added and sustainable products and services. Latin American countries face the challenge of converting their natural wealth into consumer goods and services, and academic and technological indicators (R&D) highlight the need to invest in productive activities and economic opportunities (Figures [2-5]) [37-39].

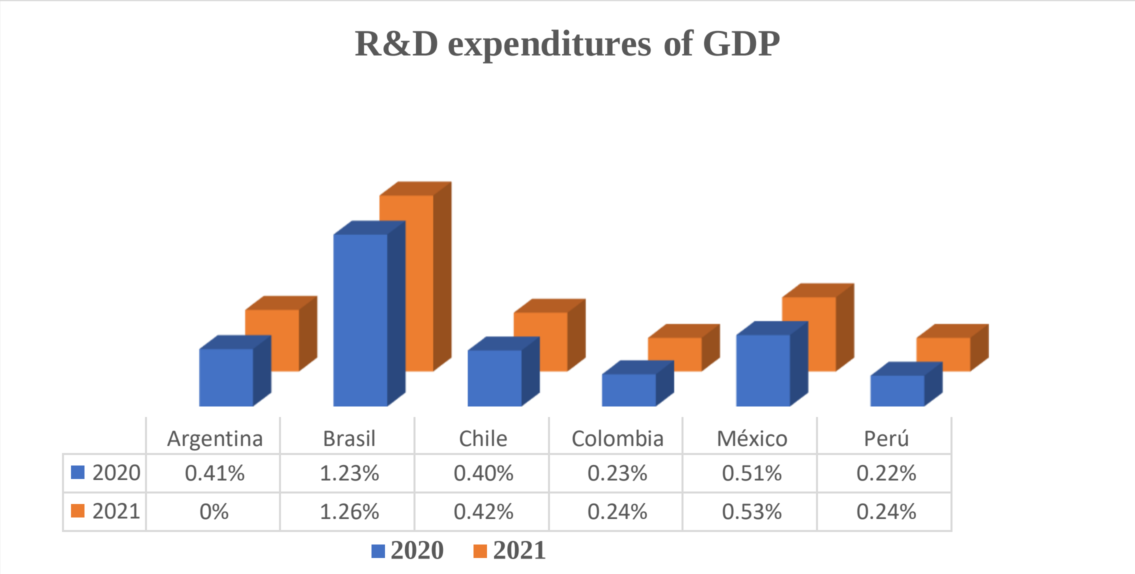

Figure 2: Investment in R&D by Latin American Countries [40-42]

Investment in Innovation and Entrepreneurship for Sustainable Development

Investment in innovation and entrepreneurship is key to harnessing the potential of natural resources and fostering sustainable development. Adequate investment in R&D allows countries to face challenges related to economic growth, innovation, and social well-being. The effective use of resources would improve the quality of life and contribute to sustainability. The positive impact depends on R&D investment relative to GDP, and an integrated model of Research, Development, Innovation, and Entrepreneurship (R&D+i+e) is ess

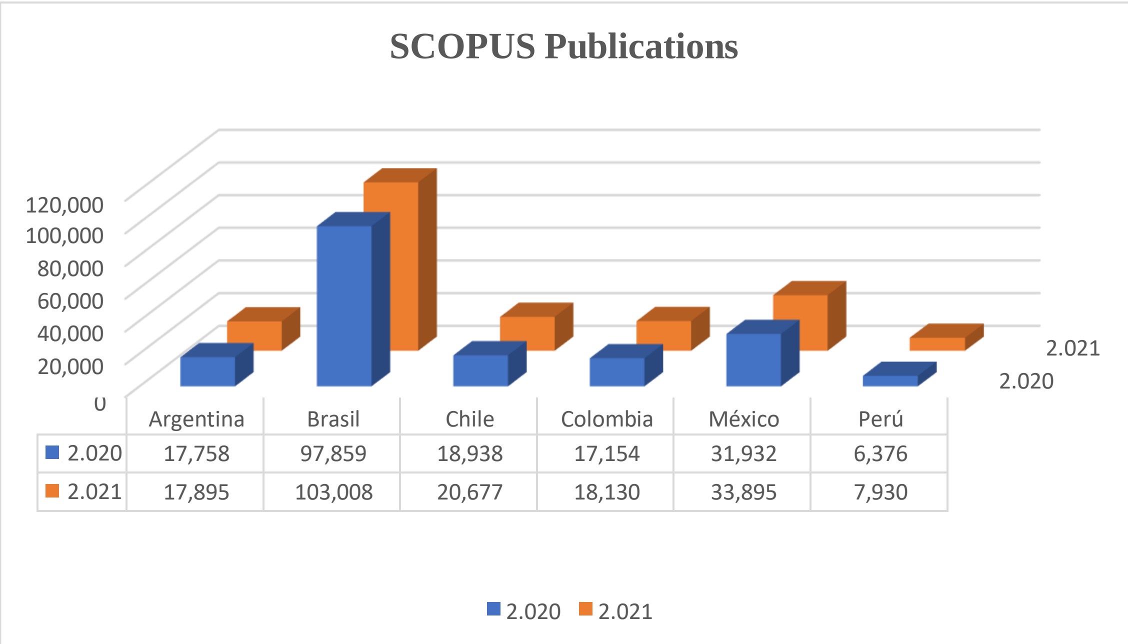

Figure 3. Scientific and Technological Publications in [R&D&I] [43,44]

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Investing in innovation and entrepreneurship is essential for boosting competitiveness and economic growth. This investment will contribute to strengthening the GDP and reducing the technological gap. By focusing on these areas, countries will promote the development and adoption of new technologies, which will improve the quality of life, as reflected in the results of Figures [4, 5].

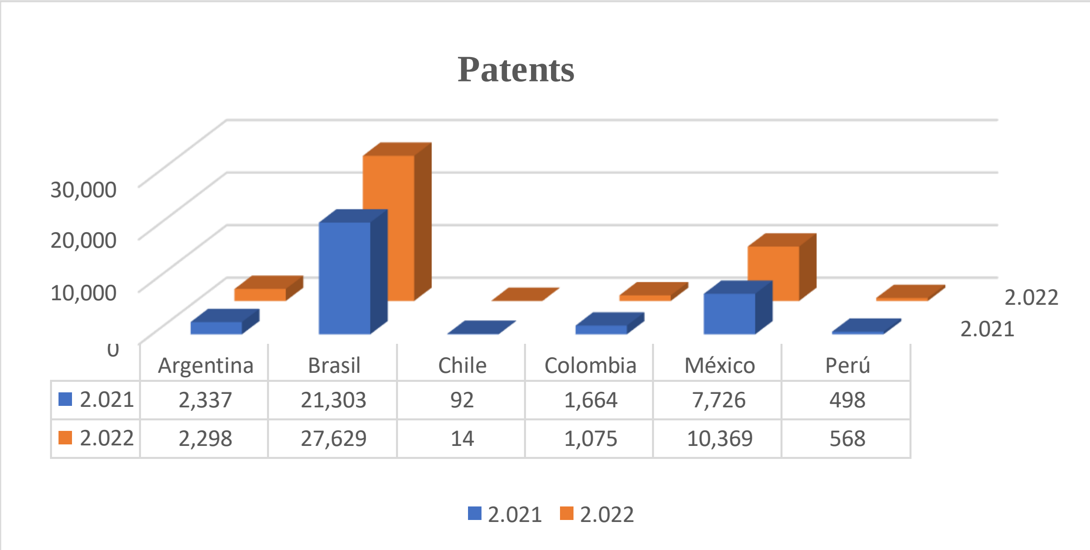

Figure 4: Patents Developed by Each Country [45-49]

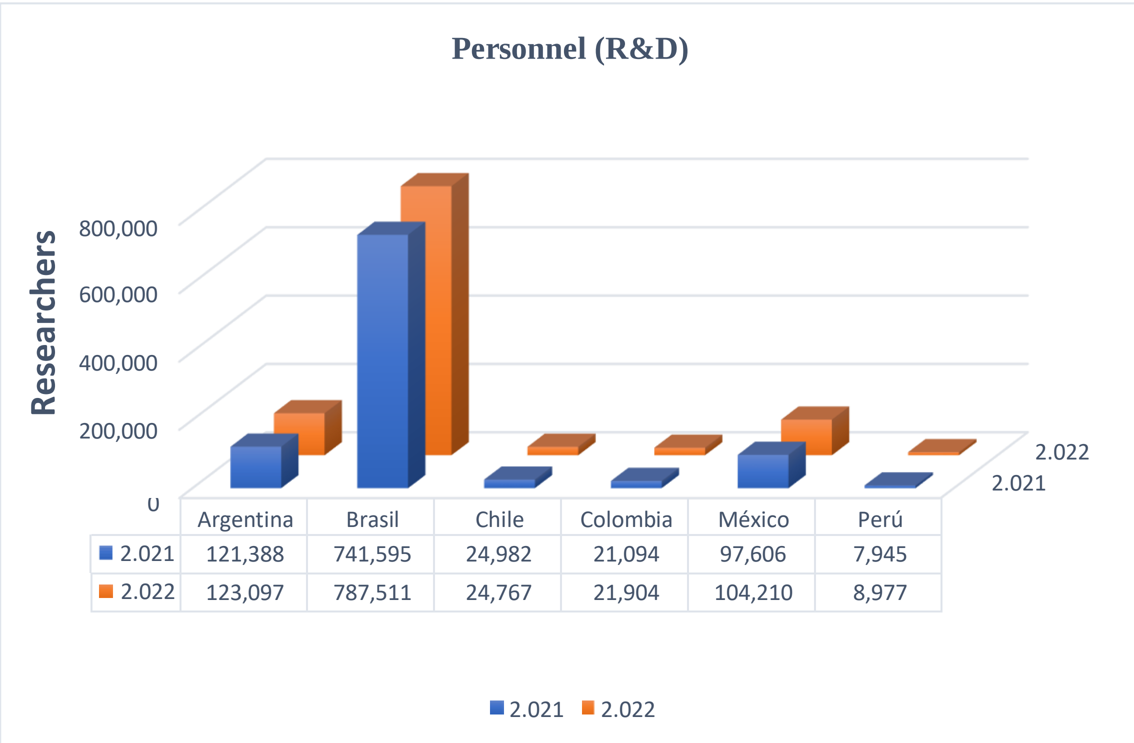

Figure 5: Academic and Scientific Personnel in Each Country [41, 42, 50, 51]

Figures [4, 5] reveal a technological gap in science and technology, reflected in the academic and technological outcomes of the region. Despite variations in academic and scientific personnel, all countries share natural, agricultural, and energy wealth that awaits sustainable transformation [52-55].

To promote technological development and equitable growth, it is recommended to increase investment in innovation and entrepreneurship through a transversal education system, which would strengthen economic and social progress [56, 57]. In Peru's case, challenges exist in exploiting its natural resources due to low research activity, making educational system reform crucial [58-60].

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Peru has made progress in R&D, such as the creation of technological parks like CIT-Peru. However, these institutions need to have a real and effective impact. Universities should play a key role in transforming natural resources sustainably and responding to social needs, contributing to closing the gap in higher education.

Table 1: Industrial Parks in Peru - CIT-Peru [61-66]

Region	**Scientific and Technological Park (PCyT)**
Arequipa	PCyT: National University of San Agustin (UNSA)
Callao	PCyT of Innovation in Callao
Cusco	PCyT of Cusco Region
Huánuco	PCyT of Central Peru
Ica	PCyT of Ica
Lima	PCyT of Lima South
Lima	PCyT of Lima North

It is necessary to implement regulations that establish a transversal policy to position the higher academic sector as a leader in sustainable development and the utilization of the country's natural resources [62, 63]. This would promote technological and economic progress, fostering equitable and sustainable growth. Strengthening the role of academic institutions in R&D will facilitate innovation and the adoption of sustainable practices, improving quality of life and social equity [64, 65].

Transversal Education in the World and Peru

High-level universities that promote innovation and entrepreneurship through incubators, start-ups, and spin-offs are essential for social, educational, and technological development, preparing students to transform natural resources sustainably and generate employment [67, 68]. Therefore, investing in education, research, and innovation, together with the participation of managers in technology transfer, would boost a sustainable long-term ecosystem [69, 70].

The World Economic Forum highlights that skills such as critical thinking and creativity will be vital for the future labor market and will enable students to create job and energy opportunities [71, 73].

The Peruvian education system must evolve toward developing extracurricular skills, promoting equitable and sustainable development [74-76]. The lack of professionals in innovation and the limited coordination between universities, companies, and governments demonstrate the need to reform the educational system so that students acquire transferable skills [77, 78].

Strengthening cooperation between sectors would optimize the use of natural resources, boost economic productivity, and create an innovative and resilient environment, ensuring long-term benefits for society and the economy [79, 80]. Effective collaboration between academic institutions and employers would facilitate the transition to the job market and turn research into useful products for society [81, 82].

DIDACTIC PROPOSAL FOR INTERDISCIPLINARY INTEGRATION IN SCIENCE TEACHING [83-85]

This methodology is based on an approach that interrelates the content of various scientific areas of basic science, which would facilitate students' understanding and identification of the connection between concepts and their application to real-world problems. Therefore, this pedagogical framework would promote creativity,

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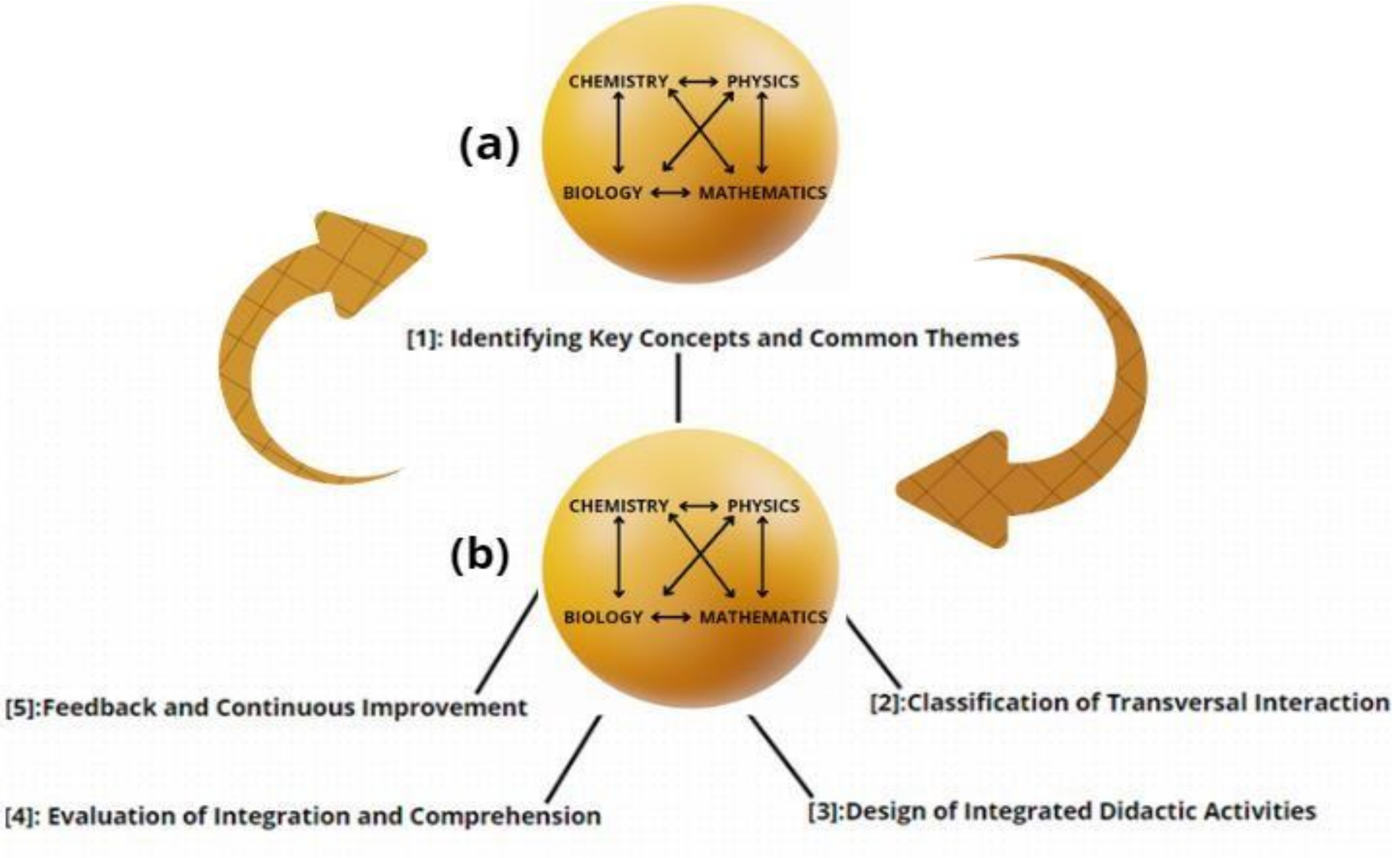
independence, and freedom for students to innovate and solve real problems, identifying opportunities through academic, scientific, technological, and business entrepreneurship.



Scheme 1: Interdisciplinary Integration Cycle: Didactic Approach for Innovation and Continuous Improvement (a+,b) Models: (a) Natural Sciences Multidisciplinary Integration (b) Transversal and Multidisciplinary Science in Higher Education

Interdisciplinary Integration Cycle Strategy [86-90]

The scheme presents two main models:

- **Multidisciplinary Integration in Natural Sciences:** This model shows how the disciplines of chemistry, physics, biology, and mathematics are integrated within a collaborative framework. This integration facilitates the understanding and application of scientific concepts, promoting a holistic and contextualized view of scientific knowledge. Students develop a deeper understanding of the interconnections between these disciplines, enabling them to approach complex problems more effectively and creatively.
- **Transversal and Multidisciplinary Science in Higher Education:** This model illustrates the application of interactions between disciplines in an educational, academic, scientific, and technological context. The process is cyclical and includes the identification of key concepts, the classification of transversal interactions, the design of integrated didactic activities, the assessment of understanding, and feedback for continuous improvement. In this way, deeper and more meaningful learning is promoted, aligned with the demands of today's society.

This interdisciplinary integration cycle provides a didactic approach that drives innovation, entrepreneurship, and adaptability in the learning of natural sciences in higher education. By fostering interdisciplinary collaboration and critical thinking, essential skills for problem-solving and creativity are developed from multiple perspectives.

The proposed educational model prepares students to face the challenges of the 21st century, both professionally and in their daily lives, equipping them to address complex problems creatively and effectively.

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The integration of knowledge from different disciplines allows students to develop a broader and multidimensional understanding of phenomena, enhancing their ability to innovate and adapt to an ever-changing environment.

The adoption of an integrative, multidisciplinary, and transversal education in basic sciences provides a solid foundation for students to understand the complexity of the real world. This comprehensive training is essential for their personal and professional development in a globalized and multidimensional environment, encouraging their ability to innovate and solve problems from diverse perspectives.

The success of this approach largely depends on the participation of teachers, who must continually adapt the curriculum to ensure the effective integration of disciplines. Moreover, collaboration with experts in academic and scientific transmission, identified as R&D&i (Research, Development, and Innovation) managers, is essential to propose the integration of basic science following a sequence of transversality.

As shown in Table 2, these managers play a crucial role in enriching the educational process, ensuring that higher education evolves in line with the needs and challenges of today's society.

Table 2: Design of Integrated Didactic Activities for Interdisciplinary Learning

Item	Description	Didactic	Academic	Innovative	Entrepreneurial
1.Identification of Key Concepts and Common Themes	Focuses on identifying and selecting fundamental concepts that appear in multiple disciplines. It facilitates students' deep and connected understanding, providing a conceptual framework that enables them to connect knowledge from different areas. It also helps teachers structure teaching cohesively, promoting less fragmented learning.	Facilitates a comprehensive understanding of fundamental concepts, promoting deeper and more connected learning.	Promotes a solid academic foundation by focusing on central concepts applicable across multiple disciplines.	Encourages the creation of innovative solutions by integrating concepts from different areas of study.	Stimulates entrepreneurial thinking by identifying opportunities at the intersection of various disciplines.
2.Classification of Transversal Interaction	Focuses on classifying and analyzing interactions between disciplines such as physics, mathematics,	Enhances students' ability to apply knowledge from various disciplines in an integrated	Strengthens academic understanding of how disciplines interact and support each	Promotes novel approaches to solving complex problems by combining knowledge from different fields.	Facilitates the development of entrepreneurial initiatives that require multidisciplinary knowledge.

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	biology, chemistry, etc. It explores interdisciplinary and transdisciplinary approaches, showing how one discipline can enrich another. It fosters an integrated vision and the ability of students to apply combined knowledge to solve complex problems.	manner.	other.		
3. Design of Integrated Didactic Activities	Involves the creation of projects, case studies, and activities that require the application of knowledge from various disciplines. These activities strengthen theoretical learning and allow students to experience interdisciplinary connections in real contexts, promoting critical thinking and creative problem-solving.	Provides meaningful learning experiences by engaging students in practical and integrative projects.	Enriches academic training through the application of theories in real contexts.	Encourages educational innovation through the design of activities that cross disciplinary boundaries.	Prepares students to identify and develop projects with entrepreneurial potential based on knowledge integration.
4. Evaluation of Integration and Understanding	Refers to the development of evaluation tools that measure both disciplinary knowledge and the ability to integrate and apply that knowledge. It promotes	Ensures that students not only memorize but also understand and apply knowledge holistically.	Raises the academic level by demanding a deep understanding and practical application of knowledge.	Introduces innovative evaluation methods that value integration and the real applicability of knowledge.	Allows students to demonstrate entrepreneurial skills through integrative projects that solve real-world problems.

	meaningful learning, ensuring that students can connect ideas from different disciplines coherently and practically.				
5. Feedback and Continuous Improvement	Highlights the importance of collaboration between teachers from diverse disciplines to provide effective feedback and make curriculum adjustments. It focuses on a cycle of evaluation and continuous improvement that reinforces the academic foundation and ensures teaching remains relevant and aligned with real needs. It fosters educational innovation and the ability to respond to emerging challenges and opportunities.	Encourages a culture of continuous improvement in teaching, adapting to students' needs.	Strengthens the academic foundation through adjustments based on specialized feedback and content updates.	Drives educational innovation by incorporating continuous improvements and multidisciplinary feedback.	Promotes the development of entrepreneurial skills by adapting programs to align with current trends and market needs.

Teaching and Learning Strategies [91-94]

- **Identification of Common Concepts:** The first step is to identify the key concepts and transversal themes that connect the disciplines of chemistry, physics, biology, and mathematics. These concepts can include principles such as energy conservation, the structure of matter, biogeochemical cycles, and the use of mathematical models to analyze natural phenomena.

This identification is fundamental for developing a holistic approach to science education, as it allows students to see the interconnection between disciplines and facilitates learning complex concepts by relating them to different contexts. *Example:* The principle of energy conservation can be addressed from different disciplines. In biology, it explores how energy transforms in biological processes, while in mathematics, calculations and modeling of these transformations are conducted. In chemistry and physics, the conservation and transfer of energy in chemical reactions and physical processes are studied.

- **Projects Based on Real-World Problems:** The use of projects based on real-world problems is proposed for students to apply interdisciplinary knowledge and develop skills to solve complex real-world problems.

This methodology fosters creativity, innovation, and the practical application of learned scientific concepts. Real-world problem-based projects prepare students to face current challenges, developing their ability to think critically and work collaboratively, essential skills in the contemporary academic and professional environment.

Example: Students could participate in a sustainability project focused on reducing carbon emissions, integrating knowledge from chemistry (CO_2 reactions), physics (heat and energy transfer), biology (carbon cycle), and mathematics (emission modeling and energy efficiency calculations).

- **Collaborative Classes and Co-Teaching:** Collaboration among teachers from different disciplines is encouraged to teach in an integrated manner. Chemistry, physics, biology, and mathematics teachers can design and teach joint lessons, showing students how scientific concepts interrelate and apply in different contexts.

Co-teaching not only enriches the student experience but also promotes learning among teachers, allowing an exchange of knowledge and methodologies that strengthen the quality of teaching.

Example: A collaborative class could involve a chemistry teacher and a biology teacher teaching the photosynthesis process. The biology teacher would explain the biological process, while the chemistry teacher would address the underlying chemical reactions.

- **Use of Interactive Models and Simulations:** Digital simulations and models allow visualization of complex concepts that connect various disciplines, facilitating the understanding of how scientific theories apply in reality and how changes in one variable affect other disciplines. Using models and simulations is an effective tool for promoting the understanding of abstract concepts, allowing students to experiment and observe natural phenomena interactively.

Example: Use simulations to model the water cycle, showing how physical principles (evaporation and condensation) interact with biological processes (photosynthesis), and how mathematical modeling can predict changes in natural systems.

- **Design of Integrated Activities:** Integrated activities promote the interconnection of disciplines through experiments, data analysis, and projects requiring the application of concepts from all areas. This enhances students' ability to approach problems from multiple perspectives. Integrated activities develop critical thinking and the ability to apply knowledge practically, contributing to the formation of professionals capable of facing interdisciplinary challenges.

Example: An experiment on the decomposition of a chemical substance in a natural environment could involve biology principles to understand the ecosystem, chemistry to measure reactions, and mathematics to analyze and represent the obtained data, providing a complete and integrated learning experience.

Structure of the Didactic Proposal [95-98]

The didactic proposal is developed through a five-stage structure that ensures interdisciplinary learning and the development of deep understanding and practical skills in students. Each stage is detailed below:

- **Identification of Concepts and Transversal Themes:** In this stage, teachers identify the key themes that connect the disciplines, establishing clear learning objectives aligned with the interdisciplinary approach. Identifying transversal concepts is crucial to providing a solid foundation and allowing students to see how knowledge is related and applied in different contexts. This facilitates building more cohesive and meaningful knowledge.
- **Classification of Transversal Interaction:** This stage classifies how the disciplines interact in the selected themes, identifying natural connections between them and determining how to present these interactions

didactically. The classification of transversal interaction allows teachers to plan strategies that make connections between disciplines visible, promoting smoother and less fragmented learning for students.

- **Design of Integrated Didactic Activities:** Activities integrating the disciplines are designed in this stage, such as experiments, research projects, and simulations requiring the application of knowledge from chemistry, physics, biology, and mathematics.. Designing integrated activities is fundamental for students to develop practical skills and verify the application of concepts in real situations. This fosters creativity and critical thinking, preparing students to solve complex problems from a multidisciplinary approach.
- **Evaluation of Interdisciplinary Understanding:** Evaluation tools are implemented to measure students' ability to integrate and apply interdisciplinary concepts. Evaluations may include exams, reports, projects, and complex problem-solving, focusing on practical application and critical thinking. Interdisciplinary evaluation provides a more complete view of student progress, allowing the assessment of not only acquired knowledge but also the ability to apply concepts in an integrated and creative manner.
- **Feedback and Continuous Improvement:** Finally, teachers review student progress and adjust teaching strategies as necessary. In turn, students provide feedback on their learning experience, contributing to a process of continuous improvement.Feedback and continuous improvement are essential elements to ensure the effectiveness of the educational process. They allow the adaptation of teaching strategies and ensure that the interdisciplinary approach evolves and adjusts to students' needs and educational objectives. This structured approach promotes more dynamic and effective learning, where students not only acquire knowledge but also develop essential skills for their professional and personal lives in an increasingly interconnected and multidisciplinary world.

Tools and Resources [99-101]

To effectively implement the interdisciplinary proposal, the following tools and resources are identified:

- **Digital Technology:.**Technology plays a fundamental role in this proposal. Using simulations, virtual laboratories, and educational applications facilitates interdisciplinary learning, allowing students to model problems, visualize data in real-time, and collaborate online. Using digital tools in the classroom enhances the understanding of complex concepts and prepares students for the modern work environment, where technology is ubiquitous and necessary for problem-solving.
- **Teamwork and Collaboration:.**Collaborative work is an essential part of the proposal, allowing students to solve problems, design experiments, and develop projects in groups. This would foster communication, cooperation, and critical thinking, essential skills in academic and professional settings..Encouraging teamwork helps students develop leadership skills and understand the importance of collaboration in solving complex problems, reflecting real-world interdisciplinary work.
- **Didactic Resources and Materials:** Resources that promote the integration of disciplines should be used, such as experiment manuals, interdisciplinary study guides, and digital simulations that address scientific phenomena from various perspectives. Using appropriate didactic resources allows students to apply and reinforce learned concepts, facilitating the connection between different disciplines and promoting more meaningful learning.

Evaluation of Progress [102-105]

Evaluating interdisciplinary learning requires a more complex approach than traditional evaluation, ensuring students can effectively integrate and apply acquired knowledge. The following evaluation tools are considered essential:

- **Formative Evaluations:** Continuous evaluations are conducted during project development, allowing teachers and students to adjust their approach and improve the understanding of interdisciplinary concepts..Formative evaluations enable early detection of difficulties and the adaptation of teaching strategies, ensuring a more efficient and personalized learning process.

Final projects, whether individual or group, serve as a demonstration of students' ability to integrate knowledge from multiple disciplines and their deep understanding of interdisciplinary topics. Final projects allow students

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to apply acquired knowledge in a real context, demonstrating their ability to tackle complex problems in an interdisciplinary and creative manner.

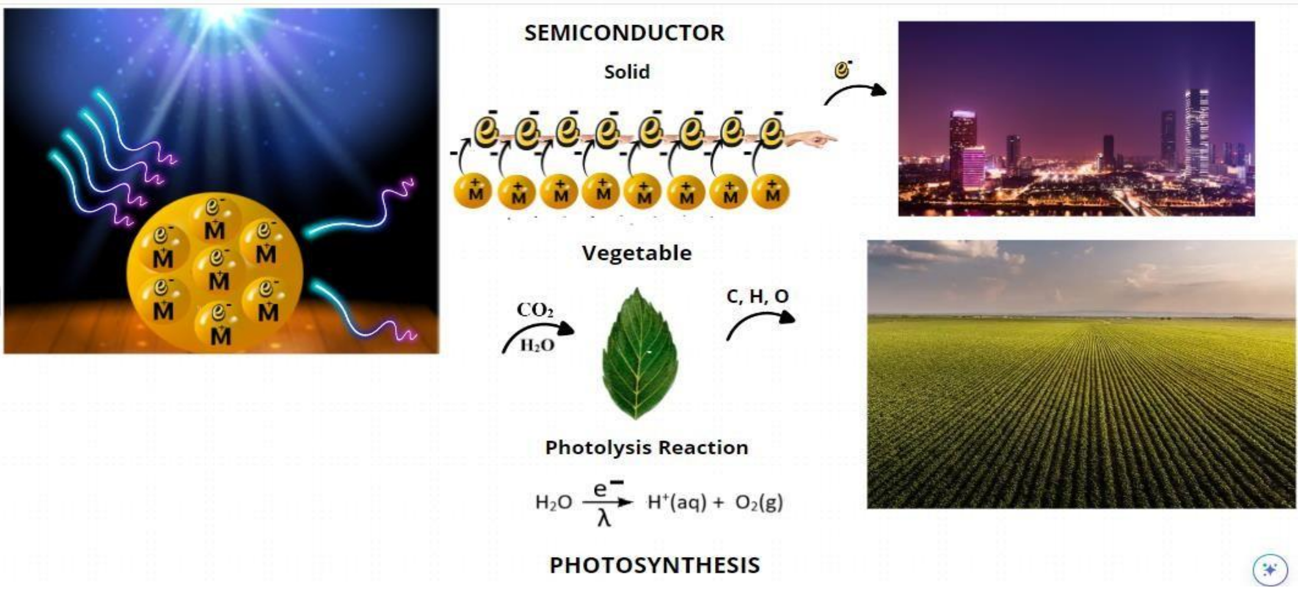
- **Self-Assessment and Peer Assessment:** Students participate in evaluating their work and that of their peers, developing critical skills for self-assessment and reflection on their learning process. Self-assessment and peer assessment foster self-awareness and responsibility in learning, allowing students to identify their strengths and areas for improvement, as well as learn to give and receive constructive feedback.

This comprehensive approach to tools, resources, and evaluation methods ensures that students not only acquire interdisciplinary knowledge but also develop practical and critical skills essential for their academic and professional training.

This approach prepares students to become critical and creative thinkers in an interdisciplinary and technological world, contributing to academic, scientific, and professional development. Therefore, higher education becomes a training tool that, by combining knowledge and methodologies from basic sciences, enriches the understanding of complex processes and promotes the development of innovation mechanisms, with an entrepreneurship-oriented approach [106, 107].

For example: "Is the Sun's energy responsible for the habitat of Humanity and Nature: How, When, and Where does it occur?"

The image illustrates how sunlight is used in two systems: semiconductors (for electricity generation) and photosynthesis in plants (for producing organic compounds from CO_2 and H_2O). Both processes involve light absorption and electron transfer in solids (semiconductors) and plants (photolysis pathways) and are characterized as opto-semiconductor systems.



Scheme 2: Light Energy: Driver of Conversion to Electrical Energy and Its Role in Human and Natural Development through Photosynthesis

Theoretical Foundation of Each Mechanism:

- **Chlorophyll and Photosynthesis:** Chlorophyll absorbs sunlight, facilitating the photolysis of water to generate electrons, protons (H^+), and oxygen (O_2). This reaction produces ATP and NADPH, which, along with CO_2, are used in the Calvin cycle to synthesize glucose, releasing O_2 as a by-product.
- **Optical Solar Solid:** A photovoltaic semiconductor absorbs sunlight, exciting electrons from the valence band to the conduction band. This generates electron-hole pairs, and an internal electric field drives the electrons through an external circuit, producing electricity.

Detailed Analysis of the Image on Solar Energy (Scheme 2): The image offers a synthetic and clear view of the central role of solar energy in natural systems and humanity, showing the interdependence between life on Earth and the energy from the Sun. Understanding these concepts is fundamental for developing more efficient and sustainable technologies in the production and use of solar energy. In this context, the teacher, following Scheme 1 and Table 3, will describe the related items through an integrative, multidisciplinary, and transversal approach in education

Table 3: Electron Transfer Analysis: Semiconductors and Photosynthesis from the Perspective of: Chemist, Physicist, Biologist, and Mathematician [108-113]

Discipline	Metal	Plant
Chemistry	- Redox reactions in solid media: Studies how electrons are transferred between atoms in the metallic semiconductor, affecting its reactivity. - Conductivity: Analyzes how material properties and impurities affect the efficiency of electron transfer - Applications: Use in electrochemical cells and catalysts	- Redox reactions in aqueous media: Investigates how electrons are transferred within the aqueous medium inside chloroplasts. - Compound formation: Impact on the synthesis of organic compounds during photosynthesis - Energy conversion: Effects on ATP and NADPH production
Physics	- Band theory: Studies the electronic structure of the semiconductor and how electrons move in the conduction and valence bands. - Electronic properties: Analyzes how the material structure and interactions affect conductivity	- Electron dynamics: Investigates how electrons move through biological membranes and aqueous solutions - Photosynthesis: Studies how electron transfer in chloroplasts converts light into chemical energy.
Biology	- Biocompatibility: Evaluates how metallic semiconductors interact with biological systems in biomedical devices - Impact on biotechnology: Applications in sensors and other devices using semiconductor properties.	- Photosynthesis: Analyzes the detailed electron transfer during photosynthesis in chloroplasts. - Energy production: How electron transfer contributes to ATP and NADPH generation in plant cells
Mathematics	- Mathematical models: Uses differential equations and network theory to describe electron behavior in metallic semiconductors - Simulations: Application of models to predict conductivity and other material properties.	- Kinetic models: Applies equations to describe electron transfer in photosynthesis - Simulation: Mathematical models to represent transfer rates and energy efficiency in the photosynthetic process.

This multidisciplinary model would integrate the knowledge from each discipline regarding the effect of solar radiation, demonstrating how electron transfer induced by solar radiation is fundamental for societal progress, agricultural production, and the development of nature.

CONCLUSIONS

The proposed integrative, multidisciplinary, and transversal educational model represents a significant evolution in higher education, adapting to the needs of the contemporary world and providing students with the necessary tools to succeed in a complex and increasingly competitive environment.

This approach fosters the ability to face challenges through creativity and innovation, strengthening the development of critical skills for innovation, research, and the development of sustainable and global technologies. It not only enhances the academic and professional training of students but also contributes significantly to their personal and professional development to face future challenges.

The study argues the imperative need to implement transversal and entrepreneurial education with the objective of reforming and harnessing natural resources, transforming them into energy and/or work sustainably through the Research [R], Technology Development [D], and Innovation [i] model: [R&D&I]. To achieve this, the following items must be activated and/or strengthened:

- Explore and convert natural resources into high-value-added products and services.
- Create connections between the various actors: society, industry, and universities.
- Develop transversal skills in students, such as critical thinking, creativity, and independence, which become fundamental pillars for contributing to society.
- Prepare students to face an increasingly competitive and globalized labor market, where differentiation and adaptability are key to professional success.

A SWOT analysis of the traditional educational system is proposed, along with the development of viable solutions to implement this proposed model effectively. The proposals include:

- Modifying the conventional educational model by incorporating academic and research managers in R&D&I, who will guide and/or design a curriculum that cultivates essential skills and knowledge adaptable to diverse areas.
- Promoting the capacity for creative thinking and effective problem-solving to identify and transform potential, opportunities, deficiencies, and threats into opportunities required by society.

In summary, the study concludes that integrative and transversal education is established as a strategic tool of vital importance for the economic and social development of Latin America, particularly for the case of Peru.

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