BREAKING DISCIPLINARY BOUNDARIES: INTERDISCIPLINARITY FROM SCIENCE TO THE CLASSROOM

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ABSTRACT

The concept of interdisciplinarity has become essential in contemporary education, particularly in a world where social, economic, and environmental issues are increasingly complex and interconnected. There is a clear need for a strategy that integrates diverse fields of knowledge, as many challenges cannot be understood or solved from a single discipline alone. Conventional education, often compartmentalized, may restrict students' ability to think critically and solve problems effectively. Therefore, encouraging interdisciplinary practices in the classroom is crucial to equip students for a dynamic and multifaceted future. This study employed a qualitative methodology and utilized a literature review as a research method, which was vital for fostering dialogue with researchers specialized in the same topic discussed herein. The general objective of this research was to explore and examine the relevance of interdisciplinarity in contemporary education, highlighting how the integration of various fields of knowledge can enhance the teaching-learning process and prepare students to address the challenges of an ever-changing world. The study underscored the importance of uniting multiple areas of knowledge to

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cultivate critical, creative citizens ready to collaborate in an increasingly complex global context. Therefore, it is imperative that educators and educational institutions adopt interdisciplinary practices, promoting a more cohesive and relevant education for all students.

Keywords: Interdisciplinarity. Education. Integration. Knowledge.

INTRODUCTION

Interdisciplinarity has become a central concept in contemporary education, especially in a world characterized by rapid social, technological, and scientific transformations. The need to break disciplinary boundaries is evident, as many complex problems faced today cannot be understood or solved from a single perspective. In this context, the integration of different fields of knowledge emerges as an effective strategy to enrich the teaching-learning process, promoting a more holistic education that is adapted to the demands of the 21st century.

The methodology employed in this study followed a qualitative approach and utilized a literature review as a research procedure, which was essential for fostering dialogue with researchers specializing in the addressed theme. This review allowed for the identification of practices and theories that support the importance of interdisciplinarity in education, while also providing a solid foundation for analyzing the reported experiences.

The general objective of this study is to investigate and analyze the significance of interdisciplinarity in contemporary education, emphasizing how the integration of different fields of knowledge can enhance the teaching-learning process and prepare students to face the challenges of an ever-changing world.

The specific objectives planned are: to examine examples of pedagogical practices that implement interdisciplinarity in classrooms, identifying effective strategies that promote collaboration between disciplines and student engagement; to analyze how professional training can be improved through the integration of knowledge, highlighting the need for a curriculum that prepares students to act articulately in diverse contexts; and to investigate the relationship between scientific interdisciplinarity and educational practices, emphasizing how the inclusion of scientific knowledge in pedagogical approaches can foster a critical and investigative mindset among students.

Finally, the article is organized into four sections: introduction, methodology, theoretical framework, and final considerations.

METHODOLOGY

The methodology employed in this study followed a qualitative approach and utilized a literature review as a research procedure, which was essential for fostering dialogue with researchers specializing in the same theme addressed herein.

Regarding the qualitative approach, González (2020, p. 02) states that:

> The qualitative approach refers to a wide range of perspectives, modalities, approaches, methodologies, designs, and techniques used in the planning, execution, and evaluation of studies, inquiries, or investigations interested in

> describing, interpreting, understanding, or overcoming social or educational situations considered problematic by the social actors who are their protagonists or who, for some reason, have an interest in addressing such situations in an investigative sense.

In the opinion of Lunetta and Guerra (2023, p. 03):

> Bibliographic research is an approach based on existing materials such as books and scientific articles. It is common in various studies to find research that focuses exclusively on bibliographic sources. Often, exploratory studies fall into this category. Additionally, research aimed at analyzing ideologies and different perspectives on a problem is frequently developed solely based on bibliographic sources.

The main authors who contributed to the foundation of this research were as follows: Fazenda (2011); Martins et al. (2017); Mendes (2020); and Sousa (2024).

THEORETICAL FRAMEWORK

Interdisciplinarity emerges as a fundamental pedagogical approach in contemporary education, reflecting the need for learning that transcends traditional disciplinary boundaries. In an increasingly complex and interconnected world, the ability to integrate diverse knowledge becomes essential for the development of critical and creative individuals. This foundation aims to explore interdisciplinarity from various perspectives, beginning with its practical application in classrooms, where collaboration between disciplines can enrich the educational process and promote more meaningful learning.

Subsequently, the importance of professionalization and knowledge integration in contemporary education will be discussed. In this context, education must prepare students not only for mastery of specific content but also for articulating across different fields of knowledge, equipping them to face the challenges of the job market and societal life. This integration is vital for developing competencies that enable students to operate effectively in multifaceted scenarios.

Finally, we will address scientific and educational interdisciplinarity, emphasizing how this approach can transform educational practices and contribute to a more dynamic and collaborative learning environment. The intersection of science and education is crucial for fostering an investigative mindset among students, allowing them to become active agents in the construction of knowledge. Thus, this theoretical foundation seeks to establish the basis for a deeper understanding of interdisciplinarity and its implications for current educational formation.

PRACTICAL INTERDISCIPLINARITY

Practical interdisciplinarity is related to practical, technical, or procedural knowledge applied in daily life, as well as to the expertise of those who engage in professions involving interpersonal relationships, such as nurses, doctors, teachers, and social workers. This form of interdisciplinarity clearly differs from other fields of interdisciplinary application, as it is primarily grounded in the experience accumulated or acquired by individuals (empirical knowledge) in various areas or everyday situations. It is also characterized by its instrumental nature aimed at solving problems and addressing emerging situations in daily life. Interdisciplinarity is a central feature of everyday life, manifesting in various activities that require the combination of knowledge from multiple fields.

The following are five examples that illustrate this interaction in common situations:

1. Gardener and Botany: A gardener caring for a garden needs to understand not only how to plant and water the plants but also the basic principles of botany. Knowledge about the specific needs of each species, such as light, water, and nutrients, is essential for successful cultivation. Although the gardener does not need to be a botanist, their practical experience leads them to apply scientific concepts to ensure that the plants grow healthy and thrive.

Neves, Bündchen, and Lisboa (2019, p. 06) argue:

> Whether through the use of various technologies, different didactic resources, interdisciplinary approaches, or informal environments, contextualized practical experiences grounded in the conceptions and realities of individuals are recurrent in many of the strategies described and published. The role of the teacher is highlighted as essential in this process, also related to the need for initial and ongoing training that recognizes the relevance of plants in daily life.

2. Teacher and Psychology: A teacher managing a diverse classroom should have a basic understanding of psychology to handle different learning styles and student behaviors. By applying psychological techniques such as motivation and conflict management, the educator can create a more effective learning environment. Thus, pedagogical practice is enriched with knowledge from psychology, promoting a more inclusive education tailored to students' needs.

Novikoff, Brito, and Oliveira (2023, p. 03) state:

> Dialogical scientific thinking develops at the intersection between Psychology and Teacher Education. It introduces contemporary research concepts and methods that expand these areas while encouraging educational reflections focused on human growth while addressing challenges and proposing effective approaches.

3. Nurse and Public Health: The work of a nurse extends beyond direct patient care; it also involves understanding principles of public health. When conducting vaccination campaigns or promoting healthy habits within the community, the nurse utilizes knowledge about epidemiology and health policies. This integration allows the professional to operate not only in individual treatment but also in promoting collective health.

Ferraz et al. (2022, p. 07) comprehend that:

> The process of Continuing Education in Health, from an interdisciplinary perspective, enables responses to demands in health management and public health. This is because interdisciplinarity presents itself as an alternative to mitigating the complexity involved in managing a health system. It is emphasized that the term interdisciplinarity refers to the integration of knowledge while interprofessionalism refers to the integration of practices through intentional and collaborative articulation among different professions.

4. Architect and Sustainability: An architect designing sustainable buildings must consider aspects of engineering, environmental design, and even urban legislation. By integrating sustainability principles into their projects—such as efficient use of natural resources and implementation of green technologies—the architect applies multidisciplinary knowledge to create spaces that respect the environment while meeting societal needs.

Nunes, Carreira, and Rodrigues (2009, p. 06) opine that:

> Sustainable architecture, also known as green architecture or ecological architecture or eco-architecture, consists of an interdisciplinary stance within the professional practice of civil construction that values human perceptions regarding the environment while also considering the new social trend towards sustainability. This way of producing space consists of having the community execute and consume its technologies while sustainably utilizing available renewable resources.

5. Chef and Nutrition: A chef who creates healthy menus must have basic knowledge of nutrition to offer balanced dishes to customers. Understanding the nutritional benefits of ingredients and how to combine them appropriately is essential for creating flavorful and healthy meals. Thus, culinary arts intertwine with nutrition, resulting in food that promotes well-being.

Lima et al. (2017, p. 02) state: "Interdisciplinarity enables the ongoing construction of effective processes for acquiring knowledge among nutritionists in training that can be transposed into professional practice across various future settings."

These examples demonstrate how interdisciplinarity permeates various professions and daily activities. The ability to integrate knowledge from different fields not only enriches professional practices but also contributes to more effective and innovative solutions in our everyday lives.

Interdisciplinary Integration in the Professions

In various service-oriented professions, such as doctors, engineers, lawyers, and educators, as well as social workers and human resources managers, professional training and its application are embedded (or should be) in a complex and interconnected relationship with both scientific and empirical knowledge. Professional interdisciplinarity refers to the merging of approaches and knowledge (both scientific and practical) and the development of the necessary competencies for each profession. This interdisciplinary approach requires an evolution from the classical conception of interdisciplinarity, which, in its narrowest sense, refers to effective interactions between two or more disciplines, encompassing their concepts, methodologies, and techniques (Teixeira et al., 2021).

Thus, interdisciplinarity is not compatible with a cumulative perspective—one that merely adds knowledge—but rather with the need for real interactions between disciplines. Furthermore, this integration is based on a set of principles that include disciplinary complexity, equality among knowledge areas, complementarity of approaches, the need for mutual collaboration, and relationality among the professionals involved.

For example, in the field of agriculture, engineers, animal scientists, and agricultural technicians must work together, utilizing their different expertise to provide more comprehensive service to the client. Therefore, professional interdisciplinarity not only enriches professional practice but also contributes to more effective and innovative solutions in various contexts.

PROFESSIONALIZATION AND KNOWLEDGE INTEGRATION IN CONTEMPORARY EDUCATION

The process of professionalization, both in initial and ongoing training, differs from the traditional interdisciplinary approach by the goals it seeks to achieve. This distinction manifests in several aspects: the focus is on a logic of action rather than a purely disciplinary and cognitive logic; the aim is to promote an integrative perspective that involves the implementation of competencies through the practical mobilization of different approaches and knowledge; furthermore, this approach differs from strict interdisciplinarity by including intervention practices based on practical application as an essential component of the formative process (Rufino, 2018).

Rufino and Sousa Neto (2022, p. 06) emphasize that:

> The relationship between knowledge and teachers' experiences is central to understanding the action of interdisciplinarity, whose prominence has been significantly highlighted in recent years, particularly from the idea of profession and

> professionalization of the teaching craft, which resonates intensely in both training contexts and everyday educational practices in higher education institutions.

The primary purpose of training is, therefore, mastery in professional practice. It is not sufficient merely to establish connections between scientific disciplines. For example, a chemical engineer must not only understand engineering principles but also integrate knowledge from chemistry, biochemistry, and public policies when developing projects that respect nature as a whole. It is important to note that the process of professional training cannot be restricted to an interdisciplinary level characterized by the interrelation of knowledge.

It requires the incorporation of knowledge that can be considered "adisciplinary," meaning social reference practices that are detached from specific professional acts (which may derive from a professional framework), interacting dynamically, non-linearly, and non-hierarchically with theoretical knowledge to effectively realize professional action. For instance, a psychiatrist does not merely apply medical techniques; they must also understand the social and psychological aspects of patients to provide comprehensive care. This adisciplinary approach enables professionals to develop a holistic and integrated view of their field of action, empowering them to confront complex challenges in the workplace (Almeida et al., 2023).

Thus, contemporary professional training should be viewed as a continuous and adaptable process where the integration of different knowledge and practices is fundamental for developing the competencies necessary for effective performance in the market. The mobilization of this diverse knowledge not only enriches professional practice but also contributes to innovation and continuous improvement across various fields (Almeida et al., 2023).

SCIENTIFIC AND EDUCATIONAL INTERDISCIPLINARITY

Now, we will consider both scientific and educational interdisciplinarities in parallel to clearly highlight their distinctive elements, taking into account their purposes, reference systems, objects of study, and modalities of application. We will conclude by addressing the epistemological consequences that arise from this analysis.

Martins et al. (2017, p. 91) present the following understanding of scientific and educational interdisciplinarities:

> The former aims at the production of new knowledge in response to social demands; its object consists of scientific disciplines, its application is related to research, and its reference system comprises the disciplines as sciences (knowledge as wisdom), the consequence of which is the production of new disciplines (biophysics,

biochemistry, etc.). On the other hand, educational interdisciplinarity aims at the dissemination of knowledge through the integration of learning and knowledge; its object consists of school subjects, its application occurs through teaching, that is, the relationship established between the learner and knowledge; its reference system comprises disciplines as school subjects (school knowledge), and the consequence is the establishment of complementary relationships between school subjects, such as Physics complementing Chemistry, which is complemented by Mathematics.

Therefore, resorting to interdisciplinarity in the educational context requires significant adjustments compared to scientific interdisciplinarity. Many previous attempts were mere direct transplants from the scientific domain to the educational one.

As is often the case with many mobile concepts, migration to other domains of application provokes reinterpretations of meaning and modifications in content and scope that must be considered when addressing interdisciplinarity. Thus, just as it is necessary to distinguish between school discipline and scientific discipline, it is equally important to differentiate scientific interdisciplinarity from educational interdisciplinarity (Mozena & Ostermann, 2014).

Purposes

Two major currents prevail when discussing the purposes of the interdisciplinary approach, both in scientific and educational contexts: one promotes the establishment of a super-science that would replace a universalizing paradigm with the specific scientific paradigms of each disciplinary field (the operational disciplinary matrices); the other proposes the implementation of multidisciplinary negotiations in response to problematic situations related to social issues.

Researchers such as Fazenda (2011, p. 90) express the following view regarding interdisciplinarity and super-science: "Interdisciplinarity fundamentally presupposes intersubjectivity; it does not aim to construct a super-science but rather to change attitudes toward the problem of knowledge, replacing the fragmented conception with a unified one of the human being."

For instance, in environmental sciences, specifically in environmental education, the integration of knowledge from natural, social, and human sciences is essential for addressing complex issues such as sustainability.

Similarly, in projects involving public health, collaboration among professionals from medicine, sociology, and psychology can result in more effective solutions for social problems. These examples illustrate how interdisciplinarity can enrich both scientific knowledge and educational practices, promoting a more holistic and contextualized understanding of the phenomena studied (Rufino, 2018).

Thus, when considering the purposes of interdisciplinarity, it is crucial to recognize its capacity to foster dialogues among different areas of knowledge and contribute to the formation of professionals better prepared to face contemporary challenges. However, these two currents manifest distinctly within sciences and education. Furthermore, regardless of the conception adopted, interdisciplinarity should be understood as a means rather than an end in itself, as discussed below.

In this dialogical journey, on one side we have a reflective and critical interdisciplinarity that seeks epistemic meaning—where the relationship with knowledge is omnipresent—provoked by a more or less unifying interdisciplinary structuring that may ultimately lead to the pursuit of a metatheory or a metadiscipline (Martins et al., 2017).

On the other hand, an instrumental interdisciplinarity has developed, particularly in the United States, oriented towards projects and focused on functional searches for operational responses (how to do) to issues raised within society.

These different approaches to interdisciplinarity reflect not only the particularities of the academic and social contexts in which they are embedded but also the specific needs and challenges faced by each area. Understanding these distinctions is fundamental for promoting effective interdisciplinary practices that meet contemporary demands in both sciences and education (Martins et al., 2017).

Thus, interdisciplinarity has been called upon in scientific realms both by an epistemic demand—the production of new knowledge—and by a social demand—the response to societal needs. On one hand, its rationale lies in addressing the cognitive gap observed between two or more scientific disciplines, resulting in the emergence of new scientific disciplines.

Sousa (2024, p. 06) confirms:

> Interdisciplinarity tends toward internal and reciprocal action among the contents of two or more disciplines, approaching the unity of science and knowledge—a philosophy that underlies the interdisciplinary approach. The theme of interdisciplinarity arose from recognizing that approaching the world through a specific discipline was biased and generally too limited. Thus, it has increasingly been acknowledged that multiple approaches are necessary to study a particular issue in everyday life.

Furthermore, Jantsch and Bianchetti (2010, p. 35) align with Fazenda (2011) by considering that interdisciplinarity presents two attitudes:

> The first is to construct a new representation of the problem that is much more adequate regardless of any particular criterion. It is expected that biology will be associated with sociology, psychology, among others. A more convenient, objective, and universal interdisciplinary health science could emerge because it would examine many other aspects of the problem. It is assumed that this super-science

> will not carry the biases of each particular approach. However, such an interdisciplinary approach does not create a more objective super-science than others; it merely produces a new particular approach. The second attitude does not aim to create a new discourse that transcends singular disciplines but rather seeks to be considered a specific practice for addressing everyday existence problems.

Thus, in many recently established disciplines, two or more parent disciplines are called upon to establish the domain of these new forms of knowledge. Conversely, these new disciplines arose from the need to respond to practical societal problems (Fazenda, 2011).

Traditional disciplines lack—or no longer possess—the means necessary to confront such challenges in isolation or simply do not address socially relevant new issues as their objects of study; this has resulted in the establishment of new disciplines aimed at filling observed "gaps."

For illustrative purposes, ecology, social psychology, environmental sciences, environmental engineering, cultural anthropology, social psychology, geophysics, nuclear physics, endocrinology, and sociolinguistics are examples of disciplines with a clearly interdisciplinary character.

However, all scientific disciplines are interdisciplinary at their inception. This initial characteristic highlights the interconnection between knowledge areas and emphasizes the importance of collaboration among different fields to address complex contemporary issues (Mines Júnior, 2014; Santhi et al., 2022; Silva et al., 2023).

In the table below, Sousa (2024) outlines the challenges of applying interdisciplinarity in educational institutions.

Table 1: Barriers to the Application of Interdisciplinarity

Barriers	Description
Rigid academic systems	Structures that hinder the flexibility necessary for the integration of different disciplines.
Asymmetry between areas of knowledge	Inequality in the valuation and recognition of various fields of knowledge within institutions.
Lengthy approval processes for new study plans	Significant delays in the implementation of curricula that incorporate new concepts of integration.

Source: Sousa (2024)

Interdisciplinarity in the context of school education also faces the tension between two major social challenges: on one hand, the quest for meaning, epistemic reflection, and understanding; on the other, empirical social issues, functionality, and instrumental activity. However, a fundamental difference compared to the scientific perspective lies in the

pursued purpose, which is not to produce new knowledge or respond to social needs but to disseminate knowledge and train social agents by establishing the most appropriate conditions to foster and support the development of integrative processes and the appropriation of knowledge as cognitive products by students (Perin & Malavasi, 2020).

Regarding the scientific perspective, Perin and Malavasi (2020, p. 07) consider that:

> Interdisciplinary work in education, at this historical moment marked by significant changes primarily related to the global political and economic landscape, reveals that in order to avoid an 'alienation' or estrangement that deprives us of reality and understanding of the 'whole,' our intellectual foundation must be grounded in theories supported by scientific perspectives that enable us to think about the relationships present in contemporary social contexts.

It is evident that a restructuring of school knowledge is necessary within curricular, didactic, and pedagogical realms. Consequently, educational interdisciplinarity aims to enhance students' cognitive understanding through the interaction of knowledge from different disciplines and/or promote a better grasp of the functional utility of the knowledge to be acquired (Jesus et al., 2024).

Jesus et al. (2024, p. 07) explain that:

> Interdisciplinarity aims to broaden students' perspectives by promoting the development of essential skills such as creativity, observation, integration, and critical thinking. This approach contributes to the formation of informed and empathetic citizens, encouraging students' autonomy in seeking innovative solutions to presented challenges. By breaking away from traditional fragmentation of knowledge, interdisciplinarity fosters deeper critical analyses and integration across different fields of knowledge, reinforcing the importance of active methodologies at various educational levels.

The rationale for educational interdisciplinarity lies, therefore, in integrating learning processes (the learning approaches) and in integrating the resulting knowledge. Its objective is to promote the mobilization of cognitive processes and knowledge to ensure action and its success; that is, to facilitate students' integration of learning processes (the integrating processes) and knowledge (the integrated knowledge), as well as their mobilization and application in real-life situations (Lunetta, Guerra, & Rozendo, 2023).

This distinction between meaning and functionality is fundamental as it crystallizes two trends that constitute the poles of a continuum connected to two orientations: one focused on seeking a conceptual synthesis and the other on an instrumental approach. These two views, which may initially seem antithetical, should be preserved and maintained; it is essential to utilize them complementarily since "they are not mutually exclusive."

According to Santos, Rosa, & Engler (2020, p. 269), "The significant meaning of interdisciplinarity lies in the fact that it should be considered beyond a method or didactic technique. Interdisciplinarity involves a necessity as well as a problem situated within a historical-cultural and epistemological context."

The replacement of pluridisciplinarity with interdisciplinarity is a topic that merits careful analysis considering the nuances and implications of each approach within the educational context. Pluridisciplinarity involves multiple disciplines addressing the same topic while each maintains its own methodology and objectives without necessarily interacting deeply. In contrast, interdisciplinarity seeks to integrate knowledge from different areas, promoting more meaningful dialogue among them. This integration allows students to better understand the complexity of studied phenomena since many contemporary problems cannot be resolved within the rigid boundaries of a single discipline. Authors such as Thiesen (2008) and Mendes (2020) advocate for the importance of interdisciplinarity as a means to overcome the limitations of pluridisciplinarity.

Mendes (2020) argues that interdisciplinarity should not be viewed as a mere overlay of disciplines but rather as an approach that promotes a more organic and integrated construction of knowledge. He emphasizes that this integration is fundamental for forming individuals capable of confronting complex challenges in today's society.

Thiesen (2008), for his part, highlights that interdisciplinarity allows students to develop critical and creative skills essential for problem-solving in real contexts. However, it is important to consider that transitioning from pluridisciplinarity to interdisciplinarity is not straightforward and may present significant challenges.

The effective implementation of interdisciplinarity requires adequate teacher training, careful planning, and a school environment that fosters collaboration among different fields of knowledge. Additionally, it is crucial to respect each discipline's particularities while ensuring that students not only integrate knowledge but also achieve a deep understanding of each area.

In summary, while pluridisciplinarity has its value in offering multiple perspectives on a topic, interdisciplinarity proves more advisable for promoting a more integrated and meaningful education. The adoption of interdisciplinarity can enrich the teaching-learning process, better preparing students for contemporary challenges (Thiesen, 2008; Mendes, 2020).

FINAL CONSIDERATIONS

The study conducted fully achieved all established objectives, confirming the importance of interdisciplinarity in contemporary education. The evaluation of pedagogical practices that apply interdisciplinarity in the classroom revealed effective strategies that encourage cooperation among disciplines and active student participation. Furthermore, the investigation into professional training highlighted the significance of knowledge integration to empower students to act cohesively in various scenarios.

The connection between interdisciplinarity in science and pedagogical practices also emphasized that incorporating scientific knowledge into teaching methodologies can stimulate a critical and investigative attitude, which is crucial for enhancing competencies in the 21st century.

Future studies are recommended to delve deeper into the necessary conditions for the effective application of interdisciplinarity across various educational levels and cultural contexts. Additionally, it would be relevant to explore the impact of interdisciplinarity on enhancing students' socio-emotional skills, as well as its effects on motivation and academic performance across different subjects. The evaluation of digital platforms and technological tools that can simplify interdisciplinary practice also emerges as a promising area for new research.

In summary, this text emphasizes that transcending disciplinary boundaries through interdisciplinarity not only enhances the teaching-learning process but also equips students to address the challenges of an ever-changing world. It is essential to integrate diverse fields of knowledge to cultivate critical, creative citizens capable of collaborating in an increasingly intricate global landscape. Therefore, it is imperative that educators and educational institutions implement interdisciplinary practices, fostering a more unified and relevant education for all students.

REFERENCES

1. Almeida, L. A., Bianco, M. F., Moraes, T. D., & Alves, R. B. (2023). The contribution of interdisciplinarity to the development of competencies for action in mental health related to work in primary health care. *Organizations & Society*, 30(107), 656-685. ISSN 1984-9230. https://doi.org/10.1590/1984-92302023v30n0023PT

2. Martins, E. A., Zilli, B., Guarnieri, P. V., & Diniz, T. H. (2024). A review of interdisciplinary approaches in science teaching: Approximations to scientific and school interdisciplinarity. *International Contemporary Management Review - ICMR*, 5(2), 1-12. ISSN: 2595-0428. https://doi.org/10.54033/icmrv5n2-003

3. Bianchetti, L., & Jantsch, A. P. (Eds.). (2010). *Interdisciplinarity: Beyond the philosophy of the subject*. Petrópolis: Vozes.

4. Fazenda, I. C. A. (2011). *Integration and interdisciplinarity in Brazilian education: Effectiveness or ideology* (6th ed.). São Paulo: Loyola.

5. Ferraz, E. A. M., Mendonça, F. F., Carvalho, B. G., Santini, S. M. L., Almeida, E. F. P., Silva, J. F. M., & Andrade, S. K. A. V. (2022). Interdisciplinarity in the construction of permanent education in health with management teams. *Saúde em Debate*, 46(spec.6). https://doi.org/10.1590/0103-11042022E619

6. González, F. E. (2020). Reflections on some concepts of qualitative research. *Qualitative Research Journal*, 8(17), 155–183. http://dx.doi.org/10.33361/RPQ.2020.v8.n17

7. Jantsch, A. P., & Bianchetti, L. (Eds.). (2010). *Interdisciplinarity: Beyond the philosophy of the subject*. Petrópolis: Vozes.

8. Lima, C. R. de, Silva, E. E. da, Orange, L. G. de, & Silva, V. de L. (2017). The challenge of interdisciplinarity in the professional training of nutritionists: An experiential report. *Revista Docência Ensino Superior*, Belo Horizonte, 7(2), 166-181. ISSN: 2237-5864.

9. Lunetta, A., Guerra, R., & Rozendo, J. F. (2023). Interdisciplinarity as a tool for success in teaching mathematics and physical education in PROEJA. *Academic Journal of Technologies in Education*, 3(3).

10. Lunetta, A. de, & Guerra, R. (2023). Scientific and academic research methodology. *Owl Journal*, 1(2), Campina Grande. http://dx.doi.org/10.5281/zenodo8240361

11. Mendes, S. R. (2020). The concept of knowledge areas in the new high school. *Retratos Da Escola*, 14(29), 479–490. http://doi.org/10.22420/rde.v14i29

12. Mines Júnior, R. O. (2014). *Environmental engineering: Principles and practice*. Wiley-Blackwell.

13. Mozena, E. R., & Ostermann, F. (2014). A bibliographic review on interdisciplinarity in the teaching of natural sciences. *Ensaio Journal*, Belo Horizonte, 12(02), 185-206.

14. Neves, A., Bündchen, M., & Lisboa, C. P. (2019). Plant blindness: Is it possible to overcome it through education? *Ciência e Educação* (Bauru), 25(3), Jul-Sep. e-ISSN 1980-850X. http://doi.org/10.1590/1516-731320190030009

15. Nunes, I. H. O., Carreira, L. R. M., & Waldecy, R. (2009). The building on sustainable architecture: An economic and environmental analysis. *Arquiteturarevista*, 5(1), 25-37. http://doi.org/10.4013/arq2009

16. Perin, C. S. B., & Malavasi, S. (2020). Interdisciplinarity in the current educational scenario. *Images of Education*, 10(2), 139-151. http://doi.org/10.4025/imagenseduc.v10i2

17. Rufino, L. G. B. (2018). Between school and university: Analysis of the process of grounding and systematization of the epistemology of the professional practice of physical education teachers (Doctoral thesis). São Paulo State University Júlio de Mesquita Filho, Institute of Biosciences.

18. Rufino, L. G. B., & Souza Neto, S. (2022). Teacher knowledge, educational practices and teacher training: Challenges, possibilities and future directions. *Colloquium Humanarum*, 19(1), 158-175.

19. Santhi Devi, R., Rajasugunasekar, D., & Sivakumar, A. (2022). *Ecological environment: A new perspective*. Papua New Guinea: Edta. Lulu Publication.

20. Santos, T. F. D., Rosa, B. O., & Engler, H. B. R. (2020). The senses of interdisciplinarity: Reflections on different concepts. *Interfaces Científicas*, Aracaju, 8(3), 265-274. http://dx.doi.org/10.17564/2316-3801

21. Thiesen, J. S. D. (2008). Interdisciplinarity as an articulating movement in the teaching-learning process. *Brazilian Journal of Education, ANPEd*, 13(39), 545-554.