INTERDISCIPLINARITY IN HIGHER EDUCATION: FROM UNDERGRADUATE TO GRADUATE

INTERDISCIPLINARIDADE NO ÂMBITO DO ENSINO SUPERIOR: DA GRADUAÇÃO À PÓS-GRADUAÇÃO

LA INTERDISCIPLINARIEDAD EN LA ENSEÑANZA SUPERIOR: DEL GRADO AL POSTGRADO

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ABSTRACT: Interdisciplinarity tends to present academic contexts of research and scientific production more accurately. The objective of this work was to analyze its application in higher education, from undergraduate to postgraduate. To answer the guiding question of this work, we first searched for the genesis and the concept of the word in question. Then, the historical context of its evolution in employability was verified in higher education institutions abroad and Brazil. After analyzing it was verified that there are still barriers that hinder the application of interdisciplinarity in the context of the higher education course because the concepts described lack more excellent discussions within the faculty and students.

KEYWORDS: Higher education. Interdisciplinarity. Integration of knowledge.

***RESUMO**: A interdisciplinaridade tende a apresentar contextos acadêmicos de pesquisa e produção científica com mais acurácia. O objetivo desse trabalho foi analisar a aplicação dela no ensino superior, desde a graduação até a pós-graduação. Para obter resposta ao questionamento norteador do trabalho, fez-se, em primeiro plano, uma busca sobre a gênese e o conceito da palavra em tela. Em seguida, verificou-se o contexto histórico da evolução em empregabilidade dela, nas instituições de ensino superior, no exterior e no Brasil. Após análise desses aspectos, verificou-se que ainda há barreiras que impedem a aplicação da interdisciplinaridade no contexto do curso superior, pois os conceitos descritos carecem de maiores discussões no âmbito docente e discente.*

***PALAVRAS-CHAVE**: Ensino superior. Interdisciplinaridade. Integração de saberes.*

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***RESUMEN**: La interdisciplinariedad tiende a presentar los contextos académicos de la investigación y la producción científica con mayor precisión. El objetivo de este trabajo fue analizar su aplicación en la educación superior, desde el pregrado hasta el postgrado. Para obtener una respuesta a la pregunta guía de este trabajo, el primer paso fue buscar la génesis y el concepto de la palabra en cuestión. Luego, se verificó el contexto histórico de la evolución en las instituciones de educación superior, en el extranjero y en Brasil. Tras el análisis de estos aspectos, se constató que aún existen barreras que impiden la aplicación de la interdisciplinariedad en el contexto del curso de educación superior, ya que los conceptos descritos carecen de mayor discusión en el seno del profesorado y del alumnado.*

***PALABRAS-CLAVE**: Educación superior. Interdisciplinariedad. Integración de conocimientos.*

Introduction

The genesis of the term interdisciplinarity, according to Oliveira and Moreira (2017) and Melo (2015), has its roots in the Middle Ages, when scholars of the time realized that different disciplines or branches of knowledge had something in common with two or more distinct disciplines, or were able to establish relationships with each other such as, for example, the *Trivium*, which encompassed Grammar, rhetoric, and dialectics, or even Quadrivium, which encompassed geometry, arithmetic, music, and astronomy. For Olga Pombo (2008), the term interdisciplinarity is a complement to another: discipline. This, if looks converge towards cooperation among disciplines. This convergence and cooperation should be adopted both in undergraduate and graduate courses, both in the *Lato sensu* and *Strictu sensu*.

As for the concept, Ivani Fazenda (1999), states that there is no specific definition because interdisciplinarity associates knowledge, understanding and learning. Therefore, it is necessary that each learner has self-knowledge and that this can be shared with others. For other pioneering researchers such as Hilton Ferreira Japiassu (1934-2015), in the work entitled "Interdisciplinarity and the Pathology of Knowledge" published in 1976, he wrote that there is no adequate conceptualization for interdisciplinarity. For Ivani Fazenda (2008), when conceptualizing interdisciplinarity, one must first observe the use of this action, and cites an example: in teacher training. In this case, she defines that there is an interaction between certain disciplines, which may be two or more.

About the historical context of the application of interdisciplinarity in the educational process, Dántino and Seabra (2020), Karppinen, Kallumki and Komulainen (2019) and Andrade (2016), reported that the use of this term, occurred, for the first time, in 1930, by Louis Wirtz (1918-2009), German sociologist, to express what can be done from the cooperation

between several disciplines. In the same decade, Nery (2021) and Suzano Junior (2019), identified the occurrence of the historiographical and conceptual movement of the dichotomy "problem-history" associated with the foundation of the "*Escuela de los Annales*" in France, by Lucien Febvre (1878-1956) and Marc Bloch (1886-1944), this fact allowed the production of various forms and intentions of scientific writings, in addition to numerous academic productions and the exchanges of knowledge were effective.

In the 1960s, George Gusdorf (1912-2000) presented to the United Nations Educational, Scientific, and Cultural Organization (UNESCO), a project with an interdisciplinary approach in the Human Sciences, because in his view, this would allow greater depth in the teaching-learning relationship. According to França, André *et al*. (2021) and Baptista (2016), this caused an expansion of this approach, and reached North America, in the United States, and there, according to Sá (2008), the first application of the interdisciplinary approach occurred from the university reform proposed in 1996, adopted by Rockefeller University; in Central America, according to what is stated by Garcia and Oca (2017), in 2006, the Higher Pedagogical Institute of Cuba, creates the educational guidelines relating to interdisciplinarity.

In 1973, according to what Pereira and Nascimento (2016) write, Jean Piaget (1896-1980) argued, in the work entitled "General problems of interdisciplinary research and common mechanisms", about the need to arrange the disciplines so that fragmentation of knowledge was avoided, and reciprocity between heterogeneous sectors was implemented. Thus, this line of thought would be in line with what René Descartes (1596-1650) stated about the non-separation of sciences, that is, scientific knowledge, in this sense Okamura (2019) and Vilela (2019), who complement about the need to apply this to the reality of the learner both in undergraduate and graduate education.

In Colombia, according to what was found by Castro (2017) and by Mousinho (2018), this interdisciplinary action is already in use and in discussion the expansion of this type of scientific research, in the *Vicerrectoría Académica de la Universidad Autónoma de Occidente*. Finally, since 2009 in Uruguay, the *Universidad de la República*, had already generated new cores of study that presented the interdisciplinary approach that identified the university triad: teaching, research and extension. In Brazil, Vasen and Vienni (2017), identified that in 2007, in Brazil, interdisciplinarity in the undergraduate curriculum occurred through the proposal of the Southern Bahia Federal University (UFSB) and, currently, it has already been adopted by the ABC Federal University.

In this country, Dántino and Seabra (2020) and Santos *et al*. (2017), reported that, since 1999, there has been an exacerbated growth in the numbers of undergraduate and postgraduate

courses. They stated this after analyzing data on course creation at these two levels of education, and identified a total of 46 undergraduate, master's, and doctoral courses in that year. To accompany the process of increasing interdisciplinarity in Brazil, Pereira and Nascimento (2016) wrote that the Coordination for the Improvement of Higher Education Personnel (CAPES), in 2008, changed the multidisciplinary axis to interdisciplinary. This fact, further increased the expansion of higher education institutions, since, from the realization of the census of higher education conducted in 2019, it was found that there were 2,608 institutions of higher education divided into: 2,076 colleges; 249 university centers; 198 universities; 40 federal institutes of education and federal centers of technological education (MEC, 2020).

That same year, CAPES (2019) recognized the importance of interdisciplinarity for the *Stricto sensu* level. Since the interdisciplinary area was already home to 484 graduate courses (255, master's degrees; 133, doctorates; 94, professional master's degrees; 06, professional doctorates). Satolo *et al*. (2019) explain this volume of courses led to the creation of Thematic Chamber I, Environment & Agrarian in which the documents follow the curricular guidelines of international regulatory agencies, such as UNESCO, for example.

Despite all these facts, interdisciplinarity has not yet expanded to all undergraduate and graduate courses in Brazil. To confirm this fact, it is enough to access the Final Papers (TCC), dissertations and thesis to verify that there is still no unanimity. In order for this unanimity to exist, it is necessary to break down existing barriers in undergraduate and graduate courses, especially those where the "isolation of disciplinary content" is still visible, in addition to the individuality of each faculty member with respect to not changing the content from monodisciplinary to interdisciplinary.

About these barriers, Bammer *et al*. (2017), Keynejad, Yapa and Ganguli (2021) ask the following question: is it possible, in higher education to overcome barriers such as, for example, the aptitude and adherence of faculty to the practice of interdisciplinarity in this degree of education? If this is not yet occurring in an expansive manner in the HEIs in Brazil, then it is necessary to improve the interdisciplinary training of educators, exposing them how to confront the position of the human being and the surrounding world in the ethical, political and social sense.

Besides this, other barriers to interdisciplinarity were identified by Herberlein (1988), especially between the social sciences and the natural sciences, which, according to him, are five in number: 1) The former has developed less than the latter; 2) This is noticeable and discussed by social scientists and those of the natural sciences; 3) the weaknesses of the social

sciences are real and hinder interdisciplinary research; 4) lack of a disciplinary structure; and lastly, 5) Questions of control and power because science does not do itself by its own will.

One way to break through these barriers is with the application of Problem Based Learning (PBL). According to Duch *et a*l. (2001), PBL is a teaching method that employs the complexity of academics' everyday lives to enhance learning about a given subject, to develop critical thinking skills, to find plausible solutions to the problem, and to communicate effectively to stakeholders.

On the use of PBL, Medeiros, Dias and Therrien (2021) and Saúl and Munenchen (2020), summarized that from the conduct of classes in which the PBL method is frequent as in rural education, the interdisciplinary context will be made encompassing agriculture with ecology (agroecology) and the conservation of natural resources, such as the correct use of soil (sustainability), or even, sustainability and territories. In such a way that its range of applicability is not limited, however, one cannot allow other disciplines to lose their scientific context, but rather to "add" knowledge for a good education of the apprentice and for him to become a professional with a broad vision in the future. Especially in studies of the environment and anthropic impacts, such as, for example, deforestation and road construction, soil permeability and low infiltration rate of rainwater, because all these studies are based on "the problem" (anthropic impacts), and the learning generated should be from it and the situation that it causes (e.g. global warming). This is the foundation of PBL.

Another barrier that generates a new question: what would be the best way to encourage an interdisciplinary experience for those who are beginning their academic careers? The answer lies in the suggestion made by MacLeod (2018), Tripp and Shortlidge (2019), to think about a reworking of pedagogical policy plans (PPP's), whose goal is to obtain an investigative process in the limits: cognitive, methodological and the conceptual ones and the integration of various disciplines and insert the learners for a continuous adherence and practice of this process. This statement corroborates the proposal of Chillón *et al*. (2019), when they state that due to the complex nature of reality, a multidimensional approach should be adopted from the curricular interdisciplinarity, especially in undergraduate courses.

The suggestion discussed by these authors is due to the fact that the PPP identifies and defines which directions the higher education institution wants to follow and how it can have the participation of several areas (For instance.: mathematics, biology, climatology, geography, among others). The insertion of interdisciplinarity should be accepted by all, and this way all HEIs will have a direction: the academic education of the students with greater amplitude about what surrounds them, independent of undergraduate and graduate courses.

One of the courses whose PPP requires interdisciplinarity is that of Environmental Sciences, either at the undergraduate or graduate level. One of the justifications for this statement is in the formation of the learner, in one of these levels of education, because he/she should be able to respond to the needs of the labor market, increasingly integrated in all senses because in this science the problems occur in integrated areas: water, air and soil, as concatenated with Article 43, of the Law of Directives and Bases of Brazilian Education (BRAZIL, 1996).

The application of interdisciplinarity to Environmental Sciences and Science of Technology should provide environmentally sustainable solutions. In this respect Philippi Júnior *et al.* (2000), cite part of chapters 34 and 35 of Agenda 21, which states that science is the basis for sustainable development, associated with an academic training that allows a global view of a particular "environmental problem" as, for example, the leakage of crude oil in ocean waters that requires solutions proposed by hydrologists, oceanographers, geologists, meteorologists, among others, and this shows that it is of paramount importance to build groups in Brazilian university education.

Finally, the objective of this work was to carry out an analysis of the application of interdisciplinarity in higher education institutions for graduation, specialization, master's and doctorate degrees, especially in Brazil. The results indicated that there is a slow expansion of the application of this teaching-learning modality and also identified the main barriers that prevent a more active expansion of interdisciplinarity, for the non-division of inter-teacher knowledge and the scarce inclusion of students in learning processes with PBL.

Methodology

This research is aligned with the so-called bibliographical and the methodological procedure of the exploratory type was applied. According to Gil (2017), the most common exploratory research is precisely the bibliographic survey. Since in this line there is production of scientific character based on interpretations of the researched objects, which in this case was interdisciplinarity. In this aspect, Pereira *et al*. (2018), summarized that when such methodological procedures are employed, the data described will be able to support future research.

Regarding the approach, the qualitative approach was used, as Sant Ana and Lemos (2018) described it. They stated that this type of research allows confronting information as well as data on the topic at hand. Another justification for this type of approach was the

statement by Gutierrez *et al*. (2020), regarding the application of interdisciplinarity in undergraduate and graduate courses: the maintenance of a critical-reflective posture, with an expansion of thinking about the social and political meaning and the performance of teachers at these levels of academic education.

The secondary data were obtained from open access electronic links such as the Periodical Portal of the Coordination for the Improvement of Higher Education Personnel (CAPES), Scientific Electronic Library Online (SciELO), Science Direct, WebScience, and others. In addition, the time frame was between 2007 and 2021, i.e., the last 15 years. There are two justifications for this cut-off: 1) the promulgation of Decree 6.906 (BRAZIL, 2007); 2) the movements of greatest impact on interdisciplinarity that began in 1970: a) philosophical explanation for interdisciplinarity; b) sociological search to develop a method for interdisciplinarity; c) construction of the epistemology of interdisciplinarity and the search for the anthropological project (FAZENDA, 1995). For the time period, exceptions were made to the published legislation (Law of Directives and Bases, 1996), in addition to pioneering literature on the subject under analysis (HERBERLEIN, 1988; FAZENDA, 1995; 1999, PHILIPPI JÚNIOR *et al*., 2000; DUCH *et al.*, 2001).

Results and Discussion

In the international context

The literature review indicated that for the European context, the interdisciplinary form of teaching and learning is the factor that will contribute to a more effective dimension in learning, especially at undergraduate and postgraduate level, whether *Lato sensu* or *Stricto sensu*. They also indicated that it is a methodological approach that promotes the integration of disciplines in both the international and national contexts.

In this regard, Carr *et al*. (2017) and Keynejad, Yapa, and Ganguli (2021), point out that in London, United Kingdom, the application of this methodology is present in Lato sensu or Stricto sensu graduate courses with research on water resources in health research from interdisciplinary programs signed between Arizona State University, King's College London and the University of New Wales for new approaches to the study of COVID-19, due to the probable genesis of the microorganism and the movement of waters via ocean currents that can cause displacement of this virus.

In this context, it is noticeable that the implementation of interdisciplinary spaces in which the exchange of knowledge there is a greater understanding, especially in the area of

health (immunologists, virologists), because any imbalance in the quality of air (meteorologists), soil (agronomists, environmental and forestry engineers) or water (sanitation engineers) induces the proliferation of pathogenic vectors. Therefore, understanding and studying in the light of interdicisplinarity is extremely important for the learner and for society. In this sense, Bammer (2017) and Gantogtokh and Quilan (2017), explain that both society and the environment need to be evaluated by teams composed of environmental and health sciences, so that there is effectiveness of interdisciplinarity and unification of the contents of each of those sciences.

In the United States, interdisciplinary practice is more frequent and involves everyday problems, linked to the environment in which the cycling of nutrients, chemical elements, and the formation of various substances, under a certain degree of temperature (physics) and the context of their use by living beings (biology). In this associative line You, Delgado and Deatley (2021) and Zowada, *et al*. (2019), reported that experiments with two chemical elements such as carbon and phosphorus, under interdisciplinary practice elevates learning about biogeochemical cycles which may induce better conservationist actions of these chemical elements.

Another applicability of interdisciplinarity was described by Awad, Salman, and Barak (2019) and White and Delaney (2021), with approaches about the study of physics (sound, sound waves, and sound systems) and the Science, Technology, Engineering and Mathematics (STEM) system, with the goal of verifying the success that may be obtained by teachers of these areas in interdisciplinary environments. The researchers concluded that the results are still sparse, but the advance exists, however, it lacks more interdisciplinary applications.

Another application of interdisciplinarity in undergraduate or graduate education can occur between libraries, academic information systems/information technology, and scientific research. On this, Shu (2018), from McGill University in Canada, reports that this interdisciplinarity improves the publishing behavior of doctoral students, as there is a prospect of speeding up their research and thereby publishing the data obtained in the form of results in journals that are linked by IT, and this can raise the number of citations of such research.

At this same academic level, that is, the doctorate, Gallemi-Perez and Chavéz-Medina (2021) and Pammer-Schindler *et al*. (2020), summarized that the field of interdisciplinarity, involving Psychology, Social Sciences, Physics, Biology, and among others, is still a factor that requires a lot of work. In light of this, Wallace and Clarck (2017) and Zhinin *et al*. (2019), stated that this is still a challenge, both for higher education institutions and for faculty, who

must possess a highly competent methodological vision regarding the solution of everyday problems at any level of higher studies.

In Latin America

For Latin America the information on the application of interdisciplinarity in higher education courses, identified that in two higher education institutions (HEI), the University of Buenos Aires (UBA) and the University of the Republic of Uruguay (UdelaR) this is already a reality. In this context, Vasen and Vienni (2017) and Zinhin *et al*. (2019) stated that this is due to the autonomy to propose that academic investigations in them, have an interdisciplinary character. Thus, according to what Nicolleti (2019) and Rodriguez (2017) summarized that this autonomy is important because it allows a better understanding of the social and political concepts that involve environmental problems, making interdisciplinarity an effective tool in academic research.

Brazil in the context of Interdisciplinarity

As for the data analyzed for the national territory, it was identified that the officialization of these modifications occurred from the publication of Decree No. 6,096 and what was described by Castro and Pereira (2019), the implementation of the Support Program for Restructuring and Expansion Plans of Universities (REUNI), whose stages of university learning occurs in three cycles: interdisciplinary baccalaureate, professional training, and the third, the post-graduation. In this vein, Medina, Pereira and Paiva (2019) and Carvalho and Santos (2021) identified that the insertion of interdisciplinarity in higher education can occur both in the field, in Petrolina - PE, and in several other cities, as was evidenced in the courses of Education, Nursing, Development and Environment, Teaching in Biosciences Health and Information Science.

About this expansion of interdisciplinarity in undergraduate courses, Cezarino and Correa (2019) and Coneglian, Valentim and Santarém Segundo (2021) reported that the results are still insignificant, because this has not yet been clearly identified in the teaching plans. However, there are exceptions such as in the Communication and Information Science courses with the Semantic Web, in which this is evident, i.e., when building model airplanes, where computational drawings and physics laboratory are used to elaborate tests of this model airplane. In the view of Pavanelo, Germano, and Freitas-Lemes (2017) and Santos *et al*. (2017),

the nuclear focus of the integration of disciplines and teachers that induce student learning are currently reasons for discussions in higher education institutions, whether in engineering or nutrition courses.

As for the *Lato sensu* post-graduation area, there was identification of the presence of the term interdisciplinarity. For Lima (2017) and Lança, Amaral and Gracioso (2018), there is always a tendency to state that it is a ubiquity and that although there has been a positive perception regarding interdisciplinarity notably in Information Science. For Jorge and Pontes (2017) and Rios, Sousa, and Caputo (2019), both in Social Work and in Health, there should always be dialogues between Social Workers, Pedagogues, Psychologists, and Doctors, so that there is an interdisciplinary vision that can help the individual in social insertion and in the search for a cure to the illness.

For the *Stricto sensu*, whether master's and/or doctorate, the analysis of the literatures indicated that there is still a resistance of the faculty, with very rare exceptions as to the functionality of this disciplinary junction, which becomes a barrier to interdisciplinarity in post-graduation. In the conception of Oliveira and Moreira (2017) and of DÁntino and Seabra (2020), this occurred due to the Cartesian type training, although there are characteristics between disciplines that are convergent and this makes it possible to break the fine lines of the scientific and technological frontier. Thus, Macêdo *et a*l. (2017) and Satolo (2019) reported that interdisciplinarity in graduate programs has evolved and contributed to the critical construction within this perspective and that there are 335 courses at this level of education and there are difficulties to be overcome such as the low frequency in communication between researchers.

Final considerations

The application of interdisciplinarity is already active in undergraduate and graduate courses both internationally and nationally, and this occurred because there was a change from the multidisciplinary approach to the interdisciplinary one, followed by the insertion of this practice in undergraduate and graduate courses, but in few institutions of higher education, whether private or public. However, obstacles still remain as to the application in federal and state universities, one of them is linked to the definition of the individuality of each discipline, as well as to the different views of the professors regarding this new university and the information society that requires a more holistic view of the man-nature relationship.

In Europe and North America, the resulting studies and publications already present a more intense interdisciplinary character, which is explained by the changes in the context of the

teaching projects, the extension and the research adopted by higher education institutions in these regions. In Latin America, interdisciplinarity is already being used in Colombia and Uruguay. Meanwhile, in Brazil, there is still no effective application of interdisciplinarity both in undergraduate and postgraduate courses, since the number of distance learning and classroom courses at both levels has grown considerably over the last 12 years.

Furthermore, two barriers were identified: the sectorization of knowledge and the political-pedagogical projects that are not being updated with the reality of the holistic vision in the teaching-learning relationship. Thus, when its application is more effective, it can occur regardless of the academic background of the teacher-teacher of any area, making possible a better analysis for the problems that need it, and enabling a solution in which the living being and the environment are contemplated with better quality of life.

Therefore, a greater effort is needed, especially in Brazil, so that there is the possibility of maintaining a more open dialogue in which a higher level of inter-university, inter-sector university and inter-teacher information exchange, and a greater integration of students can become a reality. Thus, both research and extension projects can present a greater interdisciplinarity of the areas of scientific and/or empirical knowledge that cause local, regional and global changes so that society realizes that in higher education, academic training with the application of interdisciplinarity can contribute to a harmonious and healthy way of living.

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