ISSUES IN INTERDISCIPLINARY STUDIES
No. 34, pp. 122-142 (2016)

INTERDISCIPLINARY GRADUATE STUDIES IN BRAZIL: LESSONS FROM SUSTAINABILITY AND ENVIRONMENTAL SCIENCES

by

Marcel Bursztyn
Professor, Center for Sustainable Development
Universidade de Brasília

and

María Beatriz Maury
Professor, State Department of Education

and

Gabriela Litre
Postdoctoral Researcher, Center for Sustainable Development
Universidade de Brasília

Abstract: This article analyzes the process of institutionalizing interdisciplinary graduate programs in Brazil, which has over more than four decades of experience implementing masters and doctoral problem-oriented programs designed to operate outside the disciplinary structure of universities. Brazil has a high degree of centrality and government regulation, requiring systematic performance reports. The main focus of this case study is the bottlenecks and lessons emerging from programs focused on sustainability, environmental management, and environment and society, all of which are strictly supervised by a national system of accreditation and evaluation. The article includes detailed presentation of one particular graduate program that has existed for twenty years, the Sustainable Development Center at the Universidade de Brasília. Several overall topics are also considered, including the idea that interdisciplinarity is an opportunity to integrate knowledge needed

for confronting complex problems and does not compete with disciplinary efforts towards progress in science.

Keywords: interdisciplinarity, university graduate studies, sustainability, environment, Brazil.

Introduction

Since the 1960s, interdisciplinarity has become an important topic in academic and political discourse worldwide, both in knowledge production and education. Expansion of interest in topics, questions, and problems that require interdisciplinary (ID) approaches has been accompanied by increased focus on defining and operationalizing ID research in national and international academic funding agencies (Huutoniemi, et al., 2010). However, theoretical, practical, and evaluational difficulties arise, because the complexity of such research challenges defies the *status quo* (Klein, 2006). The search for paths and strategies to integrating disciplines has become a research issue in itself (Bammer, 2013).

In Brazil, rapid growth of ID initiatives has occurred especially in graduate programs, demonstrating a creative quest to approach complex problems as well as a response to the difficulties of institutions in adapting themselves to new forms of science (Maury, 2014). Since at least the Manhattan Project created to build the first atomic bomb in 1945, a growing number of scientific and technological problems have required mobilization of multiple disciplinary skills to work on an integrated basis. Involving more than just joining parts, the biggest challenge is *integration*. The history of such projects reveals obstacles of various kinds in the behavior of research teams dealing with complex problems, including differing rationales and methods, problems of communication and coexistence with others, and the hierarchy of evaluation criteria. These concerns are compounded by institutional obstacles and inevitable stigmas associated with practices that move beyond the logic and order of established disciplines (Ledford, 2015). Complex contemporary problems require complex interdisciplinary tactics and approaches. Pressing problems include urban planning, sexually transmitted diseases, an aging population, environmental management, sustainability, and anthropogenic climate changes.

The Brazilian experience with ID practices reflects a global trend in which complex challenges require redesigns in institutional structures of the academy. At the same time, it has singularities reflecting the heavily regulated nature of graduate studies in the country. In Brazil, multi- and

inter-disciplinary graduate programs have grown dramatically in recent decades. This article presents an overview of interdisciplinarity in graduate programs, especially those in environmental and sustainability science. It is organized into five main sections plus an Introduction and Conclusion. The first section explains why rigid rules remaining from the colonial period meant Brazilian universities were created late compared to other countries in North America and in Hispanic America. The second section shows how interdisciplinarity is institutionalized in graduate programs evaluated by the National System of Accredition and Evaluation (NSAE), and analyzes their evaluation models. The third section, focused on the University of Brasilia (UnB), traces the history of an innovative and pioneering interdisciplinary project in the early 1960s that was interrupted by military dictatorship. Later, in the 1990s, the UnB broke new ground by creating several multi- and inter-disciplinary centers. The Sustainable Development Center at UnB (CDS), presented in section four, documents the origin of the graduate course and analyzes how interdisciplinarity has fared therein. Section five discusses topics and challenges for practice, including the role of the state and the emergence of new public universities along with the disciplining of interdisciplinarity.

1. Brazil: Belated Emergence of the University

Since the beginning of Brazilian colonization by Portugal in the 16th century, attempts to create higher education in Brazil were accompanied by resistance. Laws and rules established by the colonial authority did not allow higher education in the country. In contrast, in the 17th century Hispanic America already had several universities and the U.S. had Harvard University. As a result, Brazil sent youth of the elite to study in Coimbra, Portugal. The first colleges within the country–a law school in Pernambuco and a medical school in Bahia–came quite late, in the 19th century. Not until the 1920s did Brazil have its first institution with a university structure, the University of Brazil, later named the Federal University of Rio de Janeiro (Favero, 2006). Subsequently, in 1934, the University of São Paulo (USP) was created. Notable French intellectuals had a prominent role in implementing USP. Some remained for several years, including anthropologist Claude Levi-Strauss, historian Fernand Braudel, sociologist Roger Bastide, and geographer Pierre Monbeig.

By the late 1950s, Brazil's economy was experiencing an economic boom, accompanied by expansion of higher education. Brazil was seeking

a modern identity, reflected in a flourishing industrial sector as well as in various art fields including music (with *bossa nova*) and movies (with *cinema novo*, the "new movie"). The universities, on the other hand, still followed a conservative model, typical of the first half of the century even when expanding. Creation of the University of Brasilia in 1961 was a notable exception. Its innovative educational initiative, examined in the next section, invoked an idea of interdisciplinarity, although that concept was not mentioned at that time, as will be presented further in this article. Gathering only a small contingent of the children of the elite, the Brazilian universities were marked by political demonstrations in a period of great national turmoil. With few exceptions, such as Catholic universities, Brazilian universities were also public and free. After a military *coup d´état* in 1964 which ushered in a new regime lasting until 1985, higher education became the target of rigorous control and political repression. Student demonstrations in 1968–parallel to ones taking place in France, Argentina, Mexico, and many other countries–led the government to promote university reform. Decentralization of educational units and credit systems were key mechanisms aimed at minimizing students' interaction space.

Yet another change occurred in the 1980s. Driven by a re-democratization process and the return of many politicians and researchers from exile, universities in Brazil soon acquired a leading position in Latin America. The actions of two governmental agencies contributed greatly to this development: the National Council of Scientific and Technological Research (CNPq) and the Coordination for the Improvement of Higher Education Personnel (Capes), the national agency that coordinates the graduate system in Brazil. Both were created in the early 1950s and survived the military regime. However, Brazilian higher education has continued to face limitations. During the 1980s and 1990s, general shrinking of the state was reflected in reduction of the government´s investment in public universities. One consequence was the growth of private higher education. With few exceptions, private higher education has a more commercial character than a commitment to academic excellence. In early 2010, this sector accounted for about 80% of students enrolled in undergraduate courses in Brazil. Since the end of the 2000s, however, the government has restored priority to public higher education and increased the number of federal public universities, while also creating new campuses of older universities. By 2013 the total number of students reached more than seven million.[1]

[1] According to data from Censo da Educação Superior 2013, retrieved from http://portal.inep.gov.br/web/censo-da-educacao-superior (March 30, 2016).

Given this expansion, higher education in Brazil is now facing a new configuration. A new geographical distribution of high level professionals in the country is expected to occur in the coming years. Although it is still early to analyze the latest education data, some characteristics may already be defined based on empirical observations. The academic structures of new federal higher education institutions tend to be more flexible and open to new types of arrangements and courses, unlike traditional structures that are rigid and resist change. New courses are being directed to serve geographical particularities, as well as cultural and economic identities. There is also a clear correspondence between the centrality of some regional centers (medium cities) and establishment of new universities in those areas. And, within a university system that is young and vulnerable to government priorities and performance of the economy, graduate studies have emerged as a strongly dynamic segment of higher education in Brazil with a discernable interdisciplinary character.

2. ID Graduate Studies in Brazil

Until the early 1970s, graduate schools were not significant in Brazilian higher education. Masters and Ph.D. students were mostly educated abroad. In 1976, the total number of courses (masters and doctorates) was 699. By 2010, however, the total was 4,757, documenting remarkable growth. The total number of students enrolled in masters and doctoral programs in 2016 was roughly 160,000, which corresponds to a volume of 12,000 Ph.D.s and 40,000 masters students annually. In addition, more than 57,000 teachers, all with doctorates, are affiliated with graduate programs (Brazil, 2010a). The state plays a crucial role in the evolution of graduate courses and research performance. About 90% of the courses are in public universities, and more than 60,000 students receive government scholarships. According to the Ministry of Science, Technology and Innovation (MCTI), 57.7% of the national investment in R&D is made by government agencies.[2] Of the remainder, much is linked to public companies.

The National System of Accreditation and Evaluation (NSAE) is a key player in the organization of graduate education in Brazil. It manages multiple functions, including regulation, accreditation, evaluation, financing, and scholarships. According to 1976 federal regulations, a masters or doctoral program must first obtain approval by the NSAE, a

[2] Retrieved from http://www.mcti.gov.br/noticia/-/asset_publisher/epbV0pr6eIS0/content/aumenta-o-investimento-em-c-t-no-brasil;jsessionid=46A91E0819550F86C58D857018EC9EA3 (March 30, 2016).

requirement accompanied by performance evaluations every four years. Programs accredited by NSAE are classified by "fields of knowledge" that are hierarchically subdivided into different levels, including respective disciplinary areas and sub-areas. In 1999, NSAE created a new field of knowledge, "Multidisciplinary," an umbrella classification for programs that do not fit the usual categories, located as they are in border areas between disciplines. Since then, the fields of knowledge have been Exact and Earth Sciences, Biological Sciences, Engineering, Health Sciences, Agricultural Sciences, Applied Social Sciences, Humanities, Linguistics, Literature and Arts, and Multidisciplinary.

The new Multidisciplinary field of knowledge was born and developed with caution because of concerns among established epistemic communities. Its creation was not a consequence of a theoretical or conceptual debate within the NSAE, but rather a response to two sets of circumstances: a bottom-up pressure for the accreditation of courses that did not fit into the traditional disciplinary slots; and a pragmatic accommodation of the bureaucratic procedures involving such a situation. To prevent mere rejection of the cases that were not clearly absorbable by the existing structure, a "catchall" solution was set up. The choice of the name "Multidisciplinary" for this new "field of knowledge" testifies to the lack of a theoretical basis: Under its umbrella, several emerging disciplines (such as Biotechnology) were placed along with ID courses (such as Gerontology or Sustainable Development).

In spite of its blurry origin (or maybe because of it) the Multidisciplinary field of knowledge is the fastest growing sector of academic programs in the country. While the system as a whole recorded increases at a rate of around 12% per year over the last two decades, Multidisciplinary graduate studies has shown an annual rate of increase of about 25% since the late 1990s (Bursztyn & Maury, 2012a, 2012b). In 2008, the Multidisciplinary area comprised 293 accredited courses, amounting to 11% of total programs, thus exceeding in quantity other consolidated groups such as Biological Sciences (Brazil, 2009, 2010b). The NSAE divides the Multidisciplinary field of knowledge into areas, one of which is Interdisciplinary. By listing 199 courses in 2008, the Interdisciplinary area documents the growing relevance of interdisciplinarity in graduate courses. And since then, the Interdisciplinary area has had the highest growth rate within NSAE. In light of this trend, in 2011, the NSAE subdivided the Multidisciplinary field of knowledge into four new categories: Biodiversity, Environmental Science, Education, and Nutrition. Programs that did not fit in any of these new groups remained in the Interdisciplinary group. In 2013, the Multidisciplinary field of knowledge included 522 graduate courses while the Interdisciplinary area had 269.

Because of their innovative nature and placement outside parameters consolidated under disciplinary committees of evaluation, programs in the Multidisciplinary field of knowledge are subject to strict scrutiny. While the rate of approval of the institutional demands for accreditation of new masters and doctoral courses fitting in the traditional disciplines was about 30%, new Multidisciplinary programs had an approval rate of only 15%. This low approval rate of new Multidisciplinary masters and doctoral courses has a double reason:

- regarding the strict requirements for accreditation of Multidisciplinary courses and programs: NSAE acts as a goalkeeper against the frequent opportunism and/or fragility shown by universities, sometimes understaffed or with unprepared faculty;
- regarding evaluation criteria: greater austerity is apparent in a cautionary attitude towards developments outside evaluators' comfort zones.

Furthermore, processes of institutionalization of ID activities need an appropriate trajectory and model of implementation. ID courses were born in adversity in two respects: institutional legitimacy and means of realizing their goals. For that reason, though, they are examples of innovative metabolism. In addition to being innovative in their *modus operandi* to deal with current challenging and complex problems and questions, they are also creative structures in bureaucratic organization (Bursztyn, 2004). Even so, despite the great fertility of ID programs in Brazil, many challenges to implementation, consolidation, and evaluation remain. The reasons stem in part from a gap between what is practiced in these courses, empirically, and the understanding of the meaning of interdisciplinarity, challenging both faculty and students to build new models of research and teaching. In spite of the increase in the number of existing ID programs, the debate about the conceptual and methodological bases of such practices is still confined within a very small group of researchers. Both faculty and students tend to just join the trend, without much theoretical ground. The observation applies to evaluators as well, who are often tied to disciplinary programs and are not sensitive to and informed about practices that differ from their own. Seventeen years after the creation of Multidisciplinarity as a field of knowledge, all the presidents of the Multidisciplinarity evaluation committee still came from disciplinary programs, and none of them was a member of any ID initiative. When evaluators have conflicting attitudes and predispositions, peer review is reductive. As a consequence, ID remains stigmatized and is still associated with shallow science. The ghost of opposition between shallow and deep

sciences inspires a more rigorous approach by evaluators, but at the same time haunts ID programs subjected to standards of the NSAE.

3. Creation of the University of Brasilia

The University of Brasilia (UnB) is located in Brazil's capital city and was established simultaneously with the construction of the new city in the early 1960s. Brasilia was an answer to the the country's much-needed internalization, which involved moving political headquarters from the coast (Rio de Janeiro) to the most central region of the country. The primary motivation of this geopolitical move was to shift the socio-economic and cultural axis away from the southeast region, bringing development to more central and less favored regions. In the late 1950s, Brazil was emerging from a defining historical moment when the nation's intellectual and artistic values were being lauded. Influential intellectual and political figures emerged and with them a desire to make the country a "nation" with its own identity and political, economic, and cultural autonomy. Brasilia was born, then, under the sign of modernity and in a spirit of profound changes. The debate about interdisciplinarity in the education field arrived in Brazil in the 1970s, with the work of Hilton Japiassu (Fazenda, 1979). Japiassu was a disciple of Georges Gusdorf, a French thinker who was a pioneer in the analysis of ID and himself a disciple of Gaston Bachelard. According to Japiassu, interdisciplinarity could be characterized by the intensity of exchanges among specialists and by the degree of real integration of disciplines within the same research project. Interdisciplinary work demanded, as a consequence, the complementarity of methods, concepts, structures, and axioms, which are the basis of the diverse pedagogical practices of academic disciplines. Japiassu also pointed at the need to guarantee a balance between breadth (assuring a large base of knowledge and information), depth (assuring the knowledge needed for the task that needs to be performed), and synthesis (which guarantees the integrative process) (Japiassu, 1976, pp. 65-66)

In the words of Japiassu, an interdisciplinary project could be identified as such when it was able to incorporate the results of various disciplines, borrowing from other disciplines certain instruments and methodological techniques, making use of the conceptual schemes and analysis which exist in various branches of knowledge, with the purpose of integrating them. The specific role of the interdisciplinary activity was to build a bridge to allow connection across the boundaries that had previously been established between disciplines, with the precise objective of ensuring to each of them their proper positive character (Japiassu, 1976, p. 75).

With the exception of Japiassu and a few others, the rhetoric of Brazil's intellectual elite showed, in general terms, no further indication of interdisciplinary intentions. But there existed at the time a clear will to integrate theory and practice, science and humanities, and technical knowledge with creativity. This will was especially reflected in the sphere of Brazilian higher education. Since its implementation, UnB's project innovations represented answers to the main challenges Brazilian universities were facing. They are still reference points when people are thinking about the future of academic institutions. Unlike the rest of Brazilian higher education at the time, UnB had a structure of functions spanning teaching, research, and extension already in place (Salmeiron, 2007, p. 87). The anthropologist Darcy Ribeiro, a UnB founder, was keenly aware of the need for restructuring and modernizing the university of the 1960s. Remarkably, more than 50 years ago Ribeiro already envisioned the need for integrating knowledge within a university, considering the highly complex aspects of civilization. In his view, planning for development, science, and technology could not be contained in the narrowness of knowledge subdivisions (Ribeiro, 2011). The proposal for UnB in particular was a response to the problem of lack of integration in typical university structure and therefore of the knowledge it generated, a gap already noted by some intellectuals of that period.

Although there was little explicit discussion about interdisciplinarity in Brazil (and in the world) at that time, the interdisciplinarity of the ideal of integrating knowledge Ribeiro proposed for UnB was evident. One of the most important proposals was structural: in the form of organization into institutes and colleges and the creation of stem courses in which students would experience a 2-year basic formation before beginning specialization. In this model, young students had an early opportunity to explore several subjects, absorbing as they did concepts and experiences from various fields of knowledge. The structure of UnB was based on integrating these two types of bodies: the central institutes and colleges. The first type—institutes—were responsible for offering introductory classes for all students of the university, in order to provide them with an academic and intellectual basis for later enrollment in a specialization course within selected colleges. Accordingly, and while there was no explicit reference to the terms "interdisciplinarity" or "multidisciplinarity" at the founding of the UnB, ideas about curricular flexibility, a Customized Learning System (or individualized education, also known as the Keller method), interactions of students from various fields of study, broad humanistic and scientific-cultural training, and general culture courses at the start of the career all set the basis of ID. The individualized education designation, in particular, referred to a set of teaching strategies

that was intended to suit the differences among students. In the '60s, one of these teaching strategies became known as the Personalized System of Instruction. Fred Keller presented and applied it first at Columbia University in 1963, and from 1964 on it was applied, with some alterations, at UnB (Keller, 1968).

Close inspection of the often neglected historical record reveals the role of Anísio Teixeira, a renowned Brazilian educator who was responsible for creating the UnB project. Although he did not mention the terms "multi-," "inter-," or "trans- disciplinarity," Teixeira was already using concepts and terms related to what we understand today as science integration. In his view, both in institutes and in colleges, the core unit was the department, not the chair. Thus, he sought to give teaching a team spirit of collaboration. The courses could conceivably be as long and intense as interdisciplinary, interdepartmental, interinstitutional, and intercollegiate activities (Ribeiro, 2011, pp. 105-106). With his proposal of this *New University* model, Teixeira also set the basis for interdisciplinarity in Brazil by idealizing stem courses (cursos-tronco), which aimed at establishing a rich background in general culture at the beginning of any university career. In his own words, Teixeira intended those courses to be tools to broaden the minds of the students, to provide them with new and/or alternative views of reality, to help them appreciate diversity, and to cultivate a rich imagination (Teixeira, 1998, pp. 154-5).

With this structure and particularly with this spirit in mind, the University of Brasilia laid the foundation for interdisciplinary training at the young Brazilian institution that had been born as a discipline-based and in that sense a "disciplined" structure. As part of the initial cycle of learning, students were free to build their own curricula. They could navigate between various departments and courses, and had the opportunity to diversify their training, creating interdisciplinary foundations for their professional future. It is important to acknowledge that in the global context UnB was not a pioneer in adopting this structure, which already existed in some American and European universities (Salmeiron, 2007, p. 88; UnB, 1962; Keller, 1968). Nevertheless, UnB innovated this modality in Brazil, putting it on the agenda of discussions of university models in the country. As evidence of its influence, this structure of institutes and departments was later adopted by other Brazilian universities, mainly after the university reform of 1968 (Sousa, 2008) and is well known today in the national university system.

At UnB itself, however, the initial cycle of the project was discontinued for political reasons. Its implementation was interrupted by a change of regime in April 1964, when a military coup terminated the modernizing

project, culminating in persecutions, layoffs, arrests, and even deaths. This era of the country's history had a great impact on UnB, which for various reasons including proximity to power became a focus of resistance to the new government. The government deemed the use of force necessary, and the police and army invaded the campus several times, spreading an atmosphere of uncertainty and unrest. Gathering all students in general classes was considered as a threat by the military regime. As a consequence, the new structure set by the reform of 1968 aimed at separating students into disciplinary courses from their first moments in the university. It was only after a political amnesty in 1979 that the country's democratization process began and allowed the return of politicians, educators, artists, and scholars exiled abroad. Restablishment of civil rights then arrived in universities.

During the period of "re-democratization" it became clear Brazilian public universities had been transformed by years of dictatorial government and growth of private enterprises. The neoliberal tide, a mark of the 1980s and 1990s, had been preceded by lack of priority for education. Resources were cut, hindering hiring of teachers, constructing and renovating buildings, purchasing equipment, and addressing other structural needs. During the process of consolidating democracy in the 1990s, when there was much discussion of curriculum for quality public education, UnB sponsored a series of debates about the country's current challenges, in addition to modes of knowledge production in the university. Some of Anísio Teixeira and Darcy Ribeiro's ideas were revived. Other proposals also emerged such as a Tri-dimensional University proposed by Cristovam Buarque, dean of UnB at the time (Buarque, 1989, 1993). His proposal encompassed the three basic university missions (teaching, research, and extension) in a new structure grounded in basic academic tools (departments, debate forums, and cultural groups) and complementary instruments and auxiliary tools (a library, institutes and colleges, a multidisciplinary advanced studies center, permanent extension support groups, a cultural activities support center, observatories, and inter-university centers). The proposal included aspects and dimensions forgotten and discarded by discipline-based approaches.

4. The Center for Sustainable Development

The Sustainable Development Center (CDS) at the University of Brasilia originated in the context of heated debates at UnB in the 1990s and in actions following the United Nations Conference on Environment and Development (UNCED)—Rio 92, when environmental and sustainability issues were on

the agenda of national and international discussions. At that time it was crucial, both at the university level and in society in general, to create spaces for discussing the existing model of civilization while seeking new patterns of development. At the same time, universities also needed a space for self-criticism, seeking to define new methods and strategies, including the search for more integrated knowledge. The CDS was created in 1995, starting by a group of teachers and external participants who were reflecting on debates set out in the Tridimensional University project (Buarque, 2010).

Discussions evolved around the concept of a new humanism that recognized limits of humankind´s power. The project aimed to foster interdisciplinarity, with appreciation for feelings and ethical values (Buarque, 2010). Several of the ideas had influenced the proposal for a Tridimensional University: those already present in the original project of UnB, but also Manfred Max-Neef's (2005) concept of *transdisciplinarity*, Ignacy Sachs's (1980) proposition of an *ecodevelopment* connecting economics to ecology, and Edgar Morin's (1990) *complex thought*. A double criticism voiced then is still heard today:

- criticism of the paradigm of industrial civilization that could lead to new views of development; and
- criticism of the paradigm of Western knowledge that could inspire new forms of organization in the academic world.

Informed by this double criticism, the CDS aimed to be a new space less confined to strict academic patterns than in earlier times and endowed with greater freedom to discuss and understand reality from a more integrated perspective. Thus, the Center resulted from reflections of many people from different origins and backgrounds, most imbued with the ideal of an unusual space for debates and practices that could bring together people representing diverse knowledge and assorted disciplines. Even though the CDS arose from a collective movement that aggregated ideas and people, some individuals had major roles as catalysts in the creation process. They included Cristovam Buarque (in Brazil), Manfred Max-Neef (in Chile), Ignacy Sachs (in France), and Enrique Leff (in Mexico), whose thoughts connected ethics, economics, and ecology. Against this intellectual backdroup, a space for related reflections emerged. The chosen formula was a center independent from the traditional and departmental academic structure, gathering teachers from various disciplinary backgrounds (Drummond & Nascimento, 2010).

The CDS became a permanent unit of UnB dedicated to teaching, research, and extension while charged with managing the Graduate Program in Sustainable Development (PPG-DS) that began operating in 1996. Apart from integrating several research, education, and scientific and technical advice networks, the Graduate Program develops studies and interdisciplinary

research on the environment and society, with three major research focuses: (i) public policies, culture and, sustainability; (ii) technology, consumption, and sustainability; and (iii) land, environment, and society. The PPG-DS was designed despite strong corporatist pressure from departmental forces of UnB. Three circumstances made the proposal feasible: (i) support from the Dean's office in spite of the opposition from departmental representatives), (ii) previous recognition by the NSAE, and (iii) financial support within a national development program for strategic research areas (Bursztyn, 2004, p. 71). The creating process was the result of reverse engineering: The doctoral course was first created in 1995, but its physical structure was only provided afterwards. In 1998, the masters course was created, then in 2009, the CDS started operating at the undergraduate level in an interdepartmental course of Environmental Sciences (Bursztyn, 2012).

Despite initial challenges regarding faculty allocation with creation of the CDS on an interdisciplinary basis, the method that worked was the practice of "institutional phagocytosis" (Maury, 2014), which consisted in recruiting/enticing teachers from various UnB departments using a joint appointment system. Aware of the need for a comprehensive and integrative approach to construct a new field of science that addressed environmental and social issues from diverse perspectives in accordance with the principles of sustainability, faculty were often willing to be recruited/enticed, despite the obstacles imposed by their departments. This strategy resulted in teachers from different areas being brought together, bringing their share of knowledge and expertise. All pioneer members of the CDS maintained activities in their respective departments and institutions, though, and participating in the new ID "adventure" entailed an increased workload. Thus, in practice the appointment was more "exended" than "joint." It did not allow full-time dedication to the Center, though individuals brought ideas, research, studies, and practices to the unit and departments, a cross-fertilization vital to construction of ID experience at UnB.

By 2005, enjoying good visibility and reputation in the NSAE, UnB allocated full-time teaching positions for the CDS. Interestingly enough, this institutional empowerment somehow led to a decline in the fertile interface with different departments. Senior faculty who have actively participated in and witnessed the evolution of the CDS since its foundation feel that, paradoxically, when the Center did not have enough institutional influence to convince the UnB administration to open positions for full-time professors, the integration and ID interaction with the departments was much more intense. Now empowered with its own staff and institutional framework, the CDS` internal dynamic has become similar to that of disciplinary

departments, thus posing a serious risk to its interdisciplinary practice, a phenomenon that unfortunately seems to echo experiences elswhere in the broad history of interdisciplinary units.

5. Discussion

The preceding analysis of Brazilian universities, their graduate studies systems, and in particular the experience of their interdisciplinary programs, brings a number of lessons to the forefront. Some are common with those of other countries, such as prejudice suffered by ID initiatives in the face of entrenched disciplinary structures in the academy (Bursztyn & Drummond, 2013). Others are specific to Brazil, where two features stand out: (i) the role of the state linked with the public nature of university funding, and (ii) the emergence of new universities along with pressure to discipline ID programs subjected to strict regulation and rules for graduate studies.

The Role of The State

The state has been a major factor in the history of interdisciplinarity in Brazilian graduate studies. The first masters program in Urban and Regional Planning (URP) in the early 1970s was promoted by demand and supported by government funding. Brazil was undergoing accelerated migration from rural areas to cities, resulting in an increased urbanization rate from 30% in 1940 to 60% in the 1970s. Imbalances between regions demanded policies to reduce rural migration. Typical problems of big cities in underdeveloped countries were also emerging, such as infrastructure deficit, marginality, and irregular occupation of land. And other complex challenges were evident, including the environment and climate, sexually transmitted diseases (especially HIV-AIDS), an aging population, and diseases transmitted by the mosquito Aedes aegypti. Combined with lack of highly qualified human resources, these problems were catalysts for interdisciplinarity.

National government agencies, local governments, NGOs, communities and international organizations demanded the academy confront these complex challenges. Similar demands have promoted ID academic programs worldwide. In Brazil, however, ID graduate studies have had a strong top-down aspect. In the 1990s, influenced by debates in UNCED (Rio 92), the Brazilian government's Ministry of Science and Technology launched a call for applications to support graduate courses in Environmental Sciences. Funding with World Bank resources was a lever for the birth and consolidation of the first interdisciplinary graduate courses in Sustainable

Development, Environment and Development, and Environment and Society. Subsequently, in the second half of the 2000s, in consonance with the growing international agenda centered on climate change, the Brazilian government created Climate Network as a national research structure similar to the Intergovernmental Panel on Climate Change (IPCC). This initiative, with an ID basis, generated a broad study program involving 15 subjects related to generating knowledge for a national positioning on international protocols. It also supported the process of defining public policies for coping with climate disasters and defining risk mitigation. The Climate Network has great linkage with graduate courses and the emergence of ID courses on issues related to climate change.

The role of the state is complex. On the one hand, the state is the major supporter of ID initiatives. On the other hand, the rigidity of NSAE, which is linked to the state apparatus, inhibits them. Being a regulatory system based on the disciplinary organization of knowledge, NSAE follows an operational dynamic in which the academic and/or scientific community sets the rules and parameters of evaluation. Anything not fitting into the universe of a discipline tends to be denied consideration or sent to another disciplinary evaluation committee. Under the NSAE, for instance, graduate courses in URP (Urban and Regional Planning) were treated bureaucratically the same way as courses in disciplines. ID suffers a kind of "bastard´s syndrome" (Bursztyn, 2004), marked by difficulties in even entering the system that accredits, evaluates, and ranks. Thus, the state has an ambiguous role because ID initiatives arise largely due to its support, but face barriers given the mechanisms of the government agency in charge of validation.

The Emergence of New Universities and The Question of Disciplining Interdisciplinarity

In recent years, the emergence of new universities has been a striking event in the overall history of ID graduate programs in Brazil. These institutions are usually small and lack enough teachers to create graduate programs in specific disciplines. The trend toward creating ID masters courses is both opportunistic and pragmatic. It fosters a spirit of collaboration among teachers in different disciplines while meeting demands of local communities. In several new universities, even undergraduate courses have been structured differently from traditional organization into disciplinary departments, a practice that bonds teachers to a single unit. In 2011, growth in the number of graduate courses on topics related to Sustainability Science prompted formation of a new assessment committee in the agency responsible for managing NSAE. Roughly a hundred masters and

doctoral courses were moved from the large ID group to a new category—Environmental Sciences. Preliminary analysis of such developments reveals a tendency to form an interdisciplinary "discipline," since (as noted above) criteria and evaluation mechanisms are still established in accordance with traditional practices of institutionalized disciplines. The idea that complex issues–such as sustainability–require flexible and interactive arrangements tends to be limited by the usual segmenting of knowledge into independent disciplines. Thus, the same framing the URP was subject to 30 years earlier characterizes these new arrangements.

In a complementary move towards disciplining of ID programs, consolidation of the oldest courses related to environmental issues has limited interfacing with other fields of knowledge. Because of the institutional culture of universities, faculty members are increasingly linked to their full-time programs and less connected part time to other departments. The practice of joint appointment (discussed above) is losing ground as a result and with it productive exchange of knowledge and feedback with cutting-edge disciplines is reduced, curbing the fertility of ID practices. Moreover, ID courses tend to be confined to spaces of *aggregation* (as in Multidisciplinary practices) but not of *integration* (as is necessary for ID processes). This reduction makes the possibility of an overarching transdisciplinary paradigm of sustainability less likely.

In this sense, the predominant expansion of disciplines observed over the 20th century, which Nicolescu (2002) called "the discipline Big Bang" is being replicated: New disciplines arise by *fragmentation* and/or *aggregation* of the originating disciplines. The qualitative distinction representing interdisciplinarity, which leads to flexible integration of subjects, becomes limited by the process of institutionalization.

More than two decades of Brazilian ID graduate courses in the environmental field raise an additional question being debated in other countries, as well. What is the ideal time for ID education? During undergraduate or graduate studies? Following an international trend, Brazil has extended ID studies from graduate to undergraduate levels. Two movements stand out: (i) creation of seminars dealing with ID issues open to students from any field of study, such as *Introduction to Sustainable Development*; and (ii) creation of ID undergraduate courses, such as *Environmental Sciences*, which are proliferating in several universities. In the first case, broadening horizons of knowledge in disciplinary training has yielded positive results. In the second case experiences are still recent, so consistent evaluation of effectiveness in training students at the undergraduate level in courses with an ID perspective is not yet possible. Furthermore, such initiatives are accompanied by risk of

producing professionals lacking a consistent knowledge base in any discipline, reviving earlier suspicion that interdisciplinarity is shallow and generic.

In the early years of the CDS, students were encouraged to let go of their disciplinary training areas when they worked in an ID manner. The results sometimes were questionable in terms of quality, including theses and dissertations lacking in depth. The lesson learned was that a disciplinary anchor is not only desirable but also necessary for developing a reputable ID approach. It also became clear that people are not individually ID, at least in their early academic lives. Even though ID issues are addressed, the personal contribution of students should be based on their educational backgrounds, which function as their academic anchors. ID is, in this sense, the result of collective practices, interaction, and integration of knowledge. The main lesson learned in the practice of ID in graduate courses on Sustainable Development is that more important than seeking to train ID individuals is to train them to interact with those in other disciplines in institutional spaces which are friendly towards such practices.

Lingering Challenges and Final Considerations

Many advances have occurred in four decades of experience at the graduate level in Brazil, especially since 1999 when the Multidisciplinary major area in the NSAE was created. Some barriers, however, remain. One is lack of appropriate evaluation metrics. Although ID courses and practices are generally inspired by concern for complex problems of society, their results are still expected to be similar to those of "hard science" disciplines. Pitched between a problem-solving vocation and imperatives of *publish or perish*, ID courses in Brazil are paying a high price. They are confronted by the challenges of a double commitment: publishing in high impact-factor journals and, at the same time, providing answers to society's demands. Fulfillment of the first part of this double commitment is constrained by the fact higher impact journals are traditionally discipline-oriented or field of knowledge-oriented. The openness of some of them to ID is recent. Most of the periodicals oriented to ID research are still young and do not have a high impact factor. A recent study conducted by Van Noorden (2015) in the Web of Sciences, considering papers using references from various disciplines, shows that the "citability" of ID articles tends to be lower than that of disciplinary ones: "Over three years, papers with diverse references tend to pick up fewer citations than the norm, but over 13 years they gain more" (Van Noorden, 2015, p. 306).

Methodological challenges also arise. The plasticity of ID practices implies a wide range of methods borrowed or adapted from disciplines.

Choice of methodological procedures to adopt in ID studies has proven to be challenging and sometimes renders projects and products vulnerable when subjected to the scrutiny of evaluators. Since evaluators in peer-reviewing processes tend to be disciplinary, misunderstanding persists between what ID researchers present as projects and the ability (or willingness) of those who have the power to decide on their value.

Even with lingering challenges, the rich experience of ID graduate courses in Brazil is yielding lessons through both accomplishments and mistakes. The large size of the graduate system and its extreme regulation make the Brazilian case a laboratory for analyzing the process of program design and practice in real time. Abundant data on historical series and modes of implementation of ID strategies are available. So is evidence of a tendency in the prevailing institutional culture to transform interdisciplinarity into a discipline. That tendency, however, carries an imminent risk of sacrificing the richness of interaction among those in different fields of knowledge. The inevitable result is a rigid and clearly defined structure. Interdisciplinarity is a process. It can constitute specific fields and even form epistemic communities with their own identities. But the integration that characterizes interdisciplinarity and makes its application to complex real-world problems so valuable will not occur if institutionalization continues to follow the usual practices of training and research within university departments.

Unlike a jigsaw puzzle in which the pieces fit together to form a definite structure, as in the case of disciplines, the image that most closely matches interdisciplinarity is a kaleidoscope. The pieces take on new shapes every time a movement occurs, such as a new issue or complex problem. In each case researchers must reorganize, looking at different concepts and methods from a varied hierarchy of disciplinary inputs in an integrated manner. Progress in modernity confirms that specialized disciplines play a valuable role in this interdisciplinary process. The crux of the matter is not about opposing ID and disciplinary practices in the formal structure of the academy. It is, rather, to open spaces in that structure for complex problems to be addressed through integration of teams composed of individuals from various disciplinary backgrounds and for the training of academics in programs that produce relevant knowledge. Interdisciplinarity is therefore not anti-disciplinary. It is a means to the end of integrating disciplinary skills.

Biographical Notes: Marcel Bursztyn holds a B.A. in Economics (1973) and a M.Sc. in Urban and Regional Planning (1976) from the Federal University of Rio de Janeiro. He also holds a Diploma in Planning Studies from the University of Edinburgh (1977), a doctorate in Social and Economic Development from Université

de Paris I (1982), and a doctorate in Economics from Université de Picardie, France (1988). He is a full professor in the Center for Sustainable Development at the University of Brasília.

Maria Beatriz Maury holds a B.A. in Languages, a M.Sc. and a Ph.D. in Sustainable Development, all from the University of Brasilia. She also holds a diploma in Political Science. She is a professor in the State Department of Education, a researcher at the Laboratory of Built Environment and Sustainability—University of Brasilia, and Executive Editor of the journal *Sustainability in Debate*. Professor Maury previously was Director of Environmental Education at the State Department of the Environment.

Gabriela Litre holds a B.A. in Social Communication and Journalism (1996) from the Universidad del Salvador, Buenos Aires, Argentina, and a M.Sc. in Globalisation and Latin American Studies from the University of London - Institute of Latin American Studies (2004). She studied Sociology at the University of Buenos Aires (2001, final dissertation pending). She also holds a specialization in Journalism, Freedom of Expression, Racism in the Media (1998) from the University of Florida, U.S.A., a degree in international relations and regional economic integration from the Ministry of Foreign Affairs of Spain, a Ph.D. in Environmental Management and Public Policy for Sustainable Development (Center for Sustainable Development, University of Brasilia, 2010), and a Ph.D. in Geography and Territorial Urban Planning (IHEAL, Université Paris 3, Sorbonne-Nouvelle, 2010). She is a postdoctoral researcher at the Center for Sustainable Development at the University of Brasília.

References:

Bammer, G. (2013). *Integration and implementation sciences for researching complex real-world problems*. Camberra: ANU E-Press. Retrieved from http://epress.anu.edu.au/titles/disciplining-interdisciplinarity

Brasil, MEC-Capes. (2010a). *Plano nacional de Pós-Graduação (PNPG) 2011-2020.* Brasília. Retrieved from http://www.capes.gov.br/images/stories/download/Livros-PNPG-Volume-I-Mont.pdf

Brasil, MEC-Capes. (2010b). *Relatório de avaliação 2007-2009 - Trienal 2010.* Brasília. Retrieved from http://trienal.capes.gov.br/wp-content/uploads/2011/08/relatorio_geral_dos_resultados_-finais_da-avaliacao_2010.pdf.

Brasil, MEC-Capes. (2009). *Documento de Área. Triênio 2007-2009.* Brasília. Retrieved from http://www.capes.gov.br/images/stories/download/avaliacao/INTER03ago10.pdf

Buarque, C. (1989). *Na fronteira do futuro. (O projeto da UnB)*. Brasilia: Editora da UnB. Retrieved from http://books.google.com.br/books/about/Na_fronteira_do_futuro.html?id=xrxQAAAAMAAJ&redir_esc=y

Buarque, C. (1993). *A aventura da universidade.* São Paolo: Editoras Unesp e Paz e Terra.

Bursztyn, M. (2004). The environment and interdisciplinarity: Challenges to the academic world. *Desenvolvimento e Meio Ambiente (UFPR-Curitiba)*, *10* (1), 67–76.

Bursztyn, M. (2007). L'institutionnalisation de l'interdisciplinarité au sein de l'Université brésilienne: Le cas des sciences de l'environnement. *Natures Sciences Sociétés* 15, 57-64. DOI: 10.1051/nss:2007025 Retrieved from http://www.nss-journal.org/articles/nss/pdf/2007/01/nss7109.pdf

Bursztyn, M., & Maury, M.B. (2012a). The Brazilian experience with institutional arrangements for interdisciplinary graduate programs – I2S may provide a way forward. In G. Bammer. *Disciplining interdisciplinarity: Integration and implementation sciences for researching complex real-world problems* (pp. 343-347). Canberra: ANU Press. Retrieved from http://epress.anu.edu.au/apps/bookworm/view/Disciplining+Interdisciplinarity/10241/ch43.html

Bursztyn, M., & Maury, M.B. (2012b). A interdisciplinaridade necessária. Desafios à universidade brasileira. In R. Bartholo & C. Cipolla (Eds.). *Inovação social e sustentabilidade: Desenvolvimento local, empreendedorismo e design* (pp. 95-116). 1st ed. Rio de Janeiro: E-papers.

Bursztyn, M., & Drummond, J. (2013). Sustainability science and the university: Pitfalls and bridges to interdisciplinarity, *Environmental Education Research*, DOI:10.1080/13504622.2013.780587 http://dx.doi.org/10.1080/13504622.2013.780587

Drummond, J.A., & Nascimento, E.P. (2010). *O desafio da interdisciplinaridade. O Centro de Desenvolvimento Sustentável da Universidade de Brasília (1995-2010)*. Brasilia: Abaré Editorial.

Fávero, M.L.A. (2006*)*. University in Brazil: From its origins to university reform – 1968. Educar, 28, 17-36. Retrieved from http://www.scielo.br/pdf/er/n28/a03n28.pdf

Fazenda, I. C. (1979) *Integração e interdisciplinaridade no ensino brasileiro*: Efetividade ou ideologia. São Paulo: Loyola.

Huutoniemi, K., Klein, J. T., Bruun, H., & Hukkinen, J. (2010). Analyzing interdisciplinarity: Typology and indicators. *Research Policy 39,* 79–88. Retrieved from http://ideas.repec.org/a/eee/respol/v39y2010i1p79-88.html

Japiassu, H. (1976) *Interdisciplinaridade e patologia do saber*. Rio de Janeiro: Imago.

Keller, F.S. (1968) Good-bye, teacher... *Journal of Applied Behavior Analysis, 1,* 79.

Klein, J. T. (1996). Crossing boundaries: Knowledge, disciplinarities, and interdisciplinarities. Charlottesville: University Press of Virginia.

Ledford, H. (2015). Team Science. *Nature, 525,* 308-311.

Maury, M. B. (2014). O mosaico e o caleidoscópio. Da Multi à interdisciplinaridade na universidade. Ph.D. dissertation. Brasilia: Centro de Desenvolvimento Sustentável. Universidade de Brasília. Retrieved from http://repositorio.unb.br/bitstream/10482/17126/1/2014_MariaBeatrizMaurydeCarvalho.pdf

Max-Neef, M. (2005). Foundations of transdisciplinarity. *Ecological Economics, 53,* 5-16.

Morin, E. (1990/2008). *On complexity*. Cresskill, NJ**:** Hampton Press.

Nicolescu, B. (2002). *The manifest of transdisciplinarity***.** NY, NY: State University of New York Press.

Ribeiro, D. (Ed.). (2011). *Universidade de Brasília. Projeto de organização, pronunciamento de educadores e cientistas e Lei no. 3.998-61*. Brasília: Editora Universidade de Brasília.

Sachs, I. (1980). *Stratégies de l'éco-développement*. Paris: Ed. Ouvrières.

Salmeron, R. (2007). *A universidade interrompida: Brasília 1964-1965*. 2nd ed. Brasília: Editora Universidade de Brasília.

Sousa, P.R.C. (2008). A reforma universitária de 1968 e a expansão do ensino superior fede Brasileiro: Algumas Ressonâncias [The 1968 university reformation and the expansion of the Brazilian superior federal teaching: Some resonances.] *Cadernos de História da Educação, 7*(1), 117-134. Retrieved from http://www.seer.ufu.br/index.php/che/article/view/1886/1571

Teixeira, A. S. (1998). Educação e universidade. Rio de Janeiro: Editora da UFRJ.

UnB. (1962) Plano orientador da Universidade de Brasília. Brasilia: Ed. UnB. Available at http://docplayer.com.br/4491686-O-plano-orientador-de-anisio-teixeira-e-darcy-ribeiro-e-o-inicio-da-universidade-de-brasilia-1962.html. Last Retrieved on 1st August, 2016.

Van Noorden, R. (2015). Interdisciplinary reseach by the numbers. *Nature, 525*, 306-307.