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Advancing the evaluation of graduate education: towards a multidimensional model in Brazil

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Part III

Strenghts and weaknesses in Brazilian evaluation

6

Rethinking a national classification of research and graduate education

> *After many centuries of constructive but yet inconclusive search for a perfect classification scheme, the only sensible approach to the question appears to be the pragmatic one: what is the optimal scheme for a given practical purpose?*
>
> **— Wolfgang Glänzel & András Schubert**

The Brazilian science system exists primarily within graduate programs (PPG), composed of master's and doctoral levels. This design was not an accident, but a consequence of a science system that did not develop spontaneously; it was the object of public policy that prioritised the link between research and education. Most of that effort took place from the 1950s, initially by shaping the system and then towards its expansion (Balbachevsky and Schwartzman, 2010; Brasil, 2020). One of the key strategies adopted was to implement a scholarship system to allow Brazilians to pursue degrees abroad, with the aim of building critical mass to materialise the country's graduate education(CNPG, 1974; Gouvêa, 2012).

In the early 1970s, the number of scholarship holders from the leading agency in charge of funding the research and graduate system in the country, CAPES,

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was significantly small. The agency's grant report from 1971 revealed that only 1831 scholarships were awarded for graduate students in the country, and an additional 134 were granted to study abroad. Because of the manageable numbers, scholarships were handled mainly by a deliberative council that would analyse candidates in the face of the available funding. According to Darcy Closs, CAPES' executive director from 1974 to 1979, this process was particularly challenging, as many national figures would pressure the council to award grants to proteges (Castro and Soares, 1983; Córdova, 2001; Ferreira and Moreira, 2002).

To avoid lobbying, CAPES sought inspiration from the peer review experience of accreditation agencies in the United States. The first effort in Brazil, still in 1974, consisted of the installation of a single peer review committee with a small group of experts from broad areas such as engineering and social sciences. Academic merit would guide decisions on scholarship distribution, and the list of awardees would be submitted to the minister of education for endorsement. The task at hand was beyond the certification of the results, as the real challenge was neutralising the complaints of influential people who had their requests denied. Reports on the initiative of the advisory committee acknowledge that positive results were only possible due to the performance of the minister in protecting the newly established merit system (Ferreira and Moreira, 2002).

However, the single committee would not be able to keep up with the number of scholarships granted every year, which grew more than 400% in less than a decade (Castro and Soares, 1983). Therefore, two significant changes were implemented: (i) The evaluation evolved to an institutional model, where CAPES would assess graduate programs instead of individual candidates, granting a quota of scholarships to the programs based on performance. Then, the PPG would distribute the scholarships based on internal criteria; (ii) The original advisory committee was transformed into a series of disciplinary committees, which multiplied according to the growth of graduate programs and consequent increase in demand (Córdova, 2001; Ferreira and Moreira, 2002).

According to the most recent official reports, in early 2021, there were 4691 graduate programs active in Brazil, and CAPES granted around 95.000 scholarships for master's and doctoral courses in the country and 4500 for study and research abroad. The distribution of these scholarships is still heavily based on the evaluation performance of graduate programs, with a system organised around 49 evaluation areas, developed from the original disciplinary peer review committees (CAPES, 2020e; CAPES, 2021e).

This study looks at the current evaluation areas and analyses whether a reorganisation may be necessary. For that, we consider three different perspectives: (i) the dynamics of the expansion of evaluation areas and the observed inconsistencies in how they are organised; (ii) an international comparison of classification systems of research and education; (iii) a recommendation from a special committee in charge of monitoring the Brazilian National Plan for Research and Graduate Education (PNPG)[1]. Finally, after identifying weaknesses in the structure of the Brazilian evaluation areas, the study advances to propose a scientometric approach to rethink such areas and the distribution of graduate programs within them.

6.1 Evaluation areas and their roles

Evaluation areas are a core component of the established evaluation system in Brazil. Each area counts with its peer review committee, coordinated by representatives appointed by graduate programs in each discipline and nominated by CAPES for a four-year term. The coordinator's work is supported by two deputies, one for academic and the other for professional programs. Although broader regulations guide national evaluation, each area has some freedom to determine specific criteria and indicators in its analyses (CAPES, 2016a). For instance, as described in a previous study, areas can choose which types of technical and technological products should be recognised as appropriate research outputs valued by the committees in the evaluation process (Brasil, 2021a).

The configuration in 49 areas also plays a pivotal role in the organisation of the science system. Accreditation of new graduate programs is mandatory in the country. Once a proposal is approved, the new PPG becomes part of the corresponding area, subject to their specific evaluation criteria. Additionally, every four years, accreditation must be renewed in a national evaluation that is comparative within each area. PPGs are graded on a scale of 1 through 7 based on how well they perform compared to the overall performance of the other programs in the same areas (Brasil et al., 2022; CAPES, 2021d).

[1] See Brasil (2020) for further discussion on the National Plans for Graduate Education.

The evident relevance of the evaluation areas is established even in related legislation, where they are given the responsibility to guide CAPES' programs and courses of action (CAPES, 2016a).

Table 6.1 shows CAPES evaluation areas, with unique identifiers in parentheses, aggregated into the nine broad areas and three upper groups adopted by the agency (CAPES, 2020e).

Table 6.1.: CAPES evaluation areas with respective broad areas and upper groups

Upper Group	Broad area	Evaluation area
Exact Sciences	Engineering	Engineering I (10), Engineering II (12), Engineering III (13), Engineering IV (14)
	Exact and Earth Sciences	Astronomy and Physics (03), Chemistry (04), Computer Science (02), Earth Sciences (05), Mathematics and Statistics (01)
	Multidisciplinary	Biotechnology (48), Environmental sciences (49), Interdisciplinary (45), Materials Science (47), Teaching and Learning (46)
Humanities	Applied Social Sciences	Architecture, Interior and Industrial Design (29), Business and Administration, Accounting and Tourism (27), Economics (28), Journalism and Information (31), Law (26), Social Work (32), Town Planning and Demography (30)
	Humanities	Anthropology and Archaeology (35), Education (38), Geography (36), History (40), Philosophy and Ethics (33), Political Science and International Relations (39), Psychology (37), Religion and Theology (44), Sociology (34)
	Linguistics, Literature and Arts	Arts (11), Literature and Linguistics (41)
Life Sciences	Agricultural Sciences	Agricultural Sciences (42), Food Science and Technology (25), Veterinary Medicine (24), Zootechnics and Fisheries (23)
	Biological Sciences	Biodiversity (07), Biological Sciences I (06), Biological Sciences II (08), Biological Sciences III (09)

Continue. . .

Table 6.1 Continued

Upper Group	Broad area	Evaluation area
	Health Sciences	Dental studies (18), Medicine I (15), Medicine II (16), Medicine III (17), Nursing (20), Nutritional Science (50), Pharmacy (19), Physical Education, Therapy and Rehabilitation (21), Public Health (22)

Source: CAPES (2020e)

Although the names of some evaluation areas shown in Table 6.1 are very descriptive, such as “Environmental Sciences” or “Computer Science”, others are more difficult to understand unless subareas or specialities are considered. For example, CAPES (2020e) shows that electrical and biomedical engineering are subareas included in “Engineering IV”, and that “Medicine I” aggregates specialities such as oncology and cardiology.

In addition to cryptical names, some areas combine broader sets of disciplines with different levels of affinity for their objects, cognitive methods, and instrumental resources. A significant example is in “Anthropology and Archaeology”, combining disciplines in a single evaluation area under the broad area of “Humanities”. The American Academy of Arts and Sciences, for instance, considers archaeology to be part of the humanities, and anthropology to be a social science, despite recognising its humanistic perspective (AAAS, 2022). In other occasions, some proximity appears to exist, like in the case of “Architecture, Interior and Industrial Design”. However, a comparative evaluation here becomes harder to perform due to quite distinct citation practises in those disciplines.

The evaluation area system designed by CAPES evolved over time, in part following the “cognitive” approach described by Glänzel and Schubert (2003), where areas can be iteratively defined according to the experience of those involved, in this case the agency’s experts and committee members. However, CAPES (2020e) states that the area classification also has an eminently practical purpose, aiming to provide research units with a functional way to report their activities to the science and technology agencies in the country. As a consequence of the administrative component involved in the delimitation process, an unnatural delimitation of areas becomes evident in the literature, for instance:

i) Dias et al. (2017) reviews the process in which the area "Teaching of Science and Mathematics" was created from the existing "Education" area. According to the authors, the new area was the consequence of a long political movement within the original area, where a group of researchers could not find autonomy and recognition. Their work focused on applied research toward improving the training of human resources, for all levels, through the improvement of teaching methods. Aiming to strengthen the connections between science and society, CAPES supported the creation of the new area, leading to a clear division of applied research in "Teaching of Science and Mathematics" and the more conceptual and theoretical research in "Education". Two decades later, the areas have evolved towards better integration of academic and professional research, and the borders between the areas are no longer clear. As a consequence, their leaders have been calling for either a redesign of the areas or their unification.

ii) CAPES' ordinance n.º 83 (2011) renamed the "Teaching of Science and Mathematics" area to "Teaching".[2] The ordinance also created other areas such as "Environmental Sciences", with research programs migrating from existing areas. However, an analysis of CAPES' database of existing programs in the "Interdisciplinary" area (CAPES, 2021c), for example, reveals that there are several PPG in that area that did not migrate to the new area, despite obvious connection. Some PPG in the "Interdisciplinary" area are even named "Environmental Science".

iii) Stern (2019) describes how the areas of "Philosophy and Ethics" and "Religion and Theology" were created in 2016 from the division of a single area. The author reports that, despite the epistemological differences between the areas, it took more than a decade of negotiations to achieve the desired separation. Ultimately, the new areas were only created after a political crisis: during the election of the coordinator of the original combined area, all research programs in "Religion and Theology" unified to support a single candidate, while no consensus was found within the "Philosophy and Ethics" ones. The philosophers called for CAPES to annul the election, which was denied, but that gave traction for the separation to finally happen.

[2] This research translates the original Portuguese term "Ensino" as "Teaching & Learning" according to commonly used international terminology.

Different types of stories can be told about how new evaluation areas have been created, and others have been combined or restructured over time. Those stories show how the Brazilian classification of evaluation areas was created with a purpose, and that its development aimed to address issues such as the expansion of the country's research and graduate education system, and the evolution of science. However, the main challenge regarding the CAPES' classification can be described by Glänzel and Schubert (2003, p. 1), who said that "after many centuries of constructive but yet inconclusive search for a perfect classification scheme, the only sensible approach to the question appears to be the pragmatic one: what is the optimal scheme for a given practical purpose?"

From this perspective, the main purpose of the classification system adopted by CAPES has been the evaluation of graduate programs in the country. Linked to this primary goal is the allocation of funding in a comparative perspective within each area, relying on metrics which often fail to capture the variation of disciplinary practises. Furthermore, the classification is also relevant to analyse the evaluation of the Brazilian science system in the international scenario, which also determines funding distribution.

6.2 The Brazilian classification compared

Assessing Brazilian science from the CAPES classification is particularly challenging, as adjustments made in the model to address local peculiarities have led to a significant mismatch with other classification systems, such as the OECD Fields of Research and Development (FORD) and the UNESCO International Standard Classification of Education (ISCED). Some of these inconsistencies are visible in Figure 6.1 and Figure 6.2, where broad areas adopted by CAPES were matched with the broad classifications of FORD and ISCED. For that, a multilevel analysis was performed based on areas, subareas, and specialities for the three systems (CAPES, 2020e; OECD, 2015; UNESCO, 2015).

Figure 6.1 shows the nine broad areas in the CAPES classification system on the left, with numbers representing the evaluation areas. Fractional numbers can be seen in the FORD part of the Sankey chart, as the areas or sub-areas of the Brazilian system may be divided into different groups as defined by OECD (2015). For the broad group of Biological Sciences, for example, some

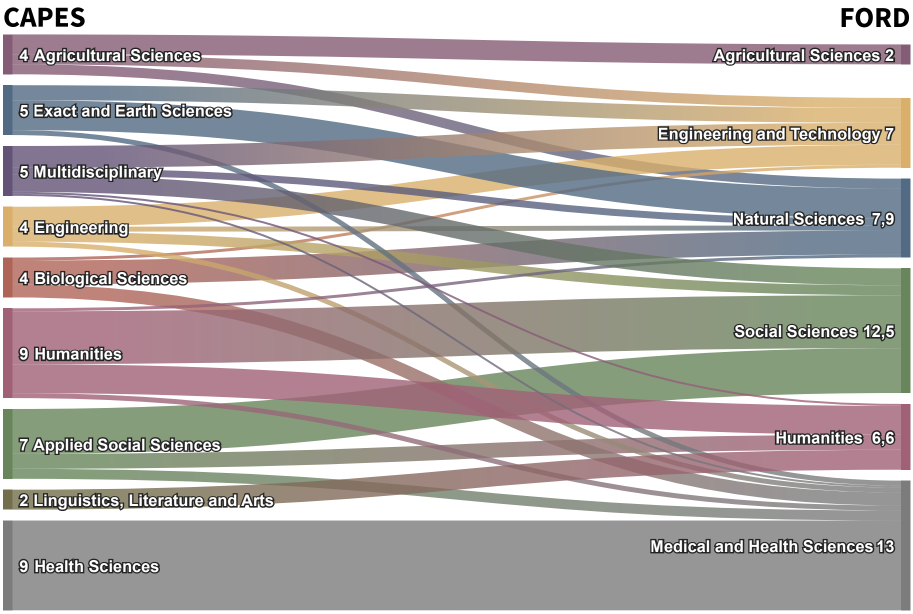


Figure 6.1.: CAPES broad area relations with FORD's broad classification.

subareas of "Biological Sciences III" fit into "Medical and Health Sciences" (for example, immunology and parasitology) and others belong to 'Engineering and Technology' in the FORD schema (e.g., cell & tissue engineering).

Another distinction between the two systems connected in Figure 6.1 is related to the social sciences and humanities, as inconsistencies can be seen in the distribution of groups among classifications. For instance, more than half of what CAPES considers part of the humanities is classified as social sciences by FORD (e.g., political science and psychology). One could argue that the observed conflicts may come from the design of the Brazilian system with graduate education in mind. However, such mismatches in SSH are also visible in Figure 6.2, where the broad areas of CAPES relate to the ISCED classification.

The ISCED groups are significantly different from the FORD ones, especially due to broad classifications such as "Services", "Education", and "ICTs". Once again, the connections between the SSH disciplines are very inconsistent. Additionally, the CAPES multidisciplinary broad area has a small connection to nearly all ISCED groups, as the system counts with a specific code in each group to include

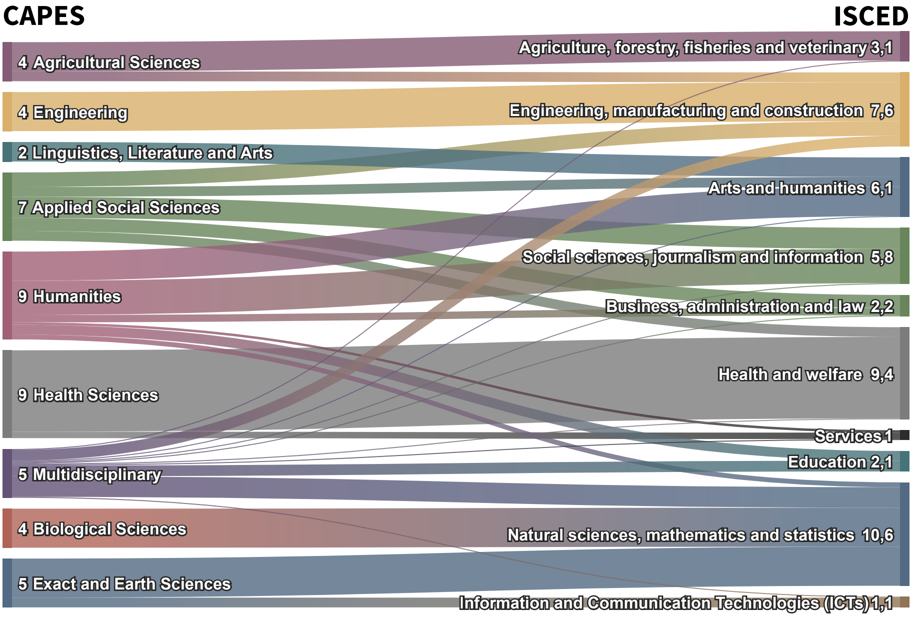


Figure 6.2.: CAPES broad area relations with ISCED's broad classification.

interdisciplinary programs and qualifications. Therefore, many of the different graduate programs within the CAPES "Interdisciplinary" evaluation area find a specific home within the ISCED classification.

6.3 Rethinking the Brazilian classification

The differences between the main classification system adopted in Brazil and alternatives such as FORD and ISCED are a problem for the country to conduct comparative studies on funding allocation, research dynamics in countries and disciplines, scientometrics. Although matching classification systems at their most granular levels – like what has been done for this chapter – can help conduct some of the types of study mentioned, it is unlikely that the time-consuming activity will be replicated widely and consistently. A solution would be to review the Brazilian classification to improve international equivalence, something also suggested by the special committee in charge of monitoring the Brazilian National Plan for Research and Graduate Education (PNPG).

Since the 1970s, Brazil has issued periodic PNPGs to help guide evaluation and science funding policies in the country (Brasil, 2020). The most recent plan covered the period 2011-2020 and the execution and results were monitored by a special committee. At the end of their term, the group prepared a report with many recommendations, including the need to rethink the current classification system, as the 49 areas do not reflect the modern panorama of science (PNPG Committee, 2020). Although the committee's recommendation for change is aligned with the findings of this study, there is a significant disagreement on the methods.

The PNPG Committee (2020) report suggests a substantial reduction in the number of evaluation areas, using the nine broad areas as a reference. However, we have seen significant discrepancies between the broad areas of CAPES and those of international classifications. Additionally, merging areas can represent a setback to a crucial achievement for research evaluation. After decades of area expansion, peer review committees achieved a level of freedom to customise evaluation criteria to suit their practises and value their principles. Moreover, the comparative perspective of the evaluation system has value when similar PPG exist within each area, but can be damaging in heterogeneous environments. Perhaps, the most adequate approach is not aiming for numbers, but for an adequate distribution of research that can be suitable for national evaluation and funding purposes, as well as international comparisons.

A possible method for reviewing the classification system may be supported by scientometrics. To demonstrate one possibility, microdata from the 2017-2018 papers in the three "Biological Sciences" areas (BioSci) have been collected from the CAPES Open Data System (CAPES, 2021a). Information such as DOI, ISSN, authorship, volume, page numbers, etc. was used to match the publications to the Web of Science.

Departing from the 15.375 documents matched to WoS, a term map of BioSci papers was produced using the VOSviewer software (van Eck and Waltman, 2009). For that, the title and abstracts of the articles were collected from WoS (Clarivate Analytics, 2022). Binary counting was used to extract more than 280 thousand noun phrases from the corpus, of which 8161 appeared in at least ten documents. A relevance score was calculated for each of these terms, with a threshold of 60%, and the resulting 4897 terms were used to produce the map seen in Figure 6.3.

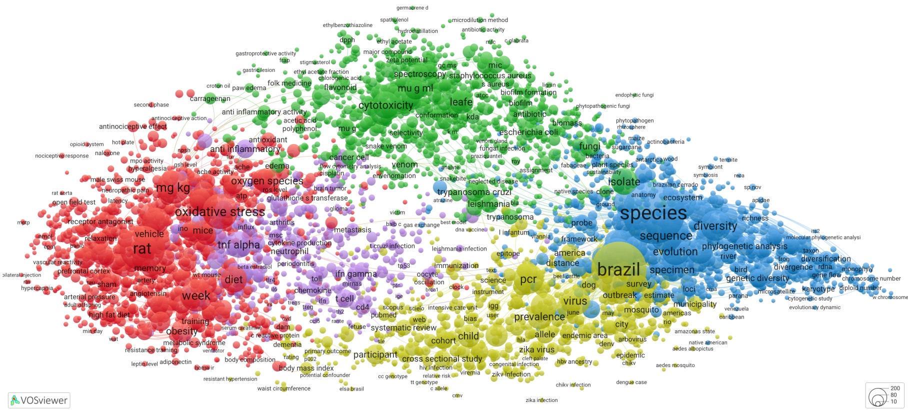


Figure 6.3.: Term map of papers from the Biological Sciences areas (2017-2018).

In Figure 6.3, the size of each circle represents the number of documents in which a term occurs. Proximity or distance between terms reflects co-occurrence, which also influences the creation of the five observed colour clusters.

With the term map representing the thematic publication profile of the three BioSci evaluation areas, Figure 6.4 adds a colour overlay to highlight publications of researchers affiliated with graduate programs in each of the areas. To improve comparability across the three areas, the scale is normalised by subtracting the mean from each variable and dividing the result by the standard deviation.

The bibliometric profiles in Figure 6.4 are revealing. First, we notice that BioSci I (a) and II (b) operate on opposite sides of the term map, showing that the areas focus the majority of their attention on specific research interests. Regarding BioSci III (c), the area operates towards the middle of the map, slightly overlapping BioSci I, but with greater attention to issues such as parasitology and immunology and with greater focus on issues of regional interest (observed in the 'Brazil' cluster). Although an expert committee could reach more robust conclusions from the maps provided, deciding whether the three areas need adjustment, the bibliometric perspective indicates that the research outputs of each area align with their associated subareas and specialities listed in the CAPES classification document (2020e).

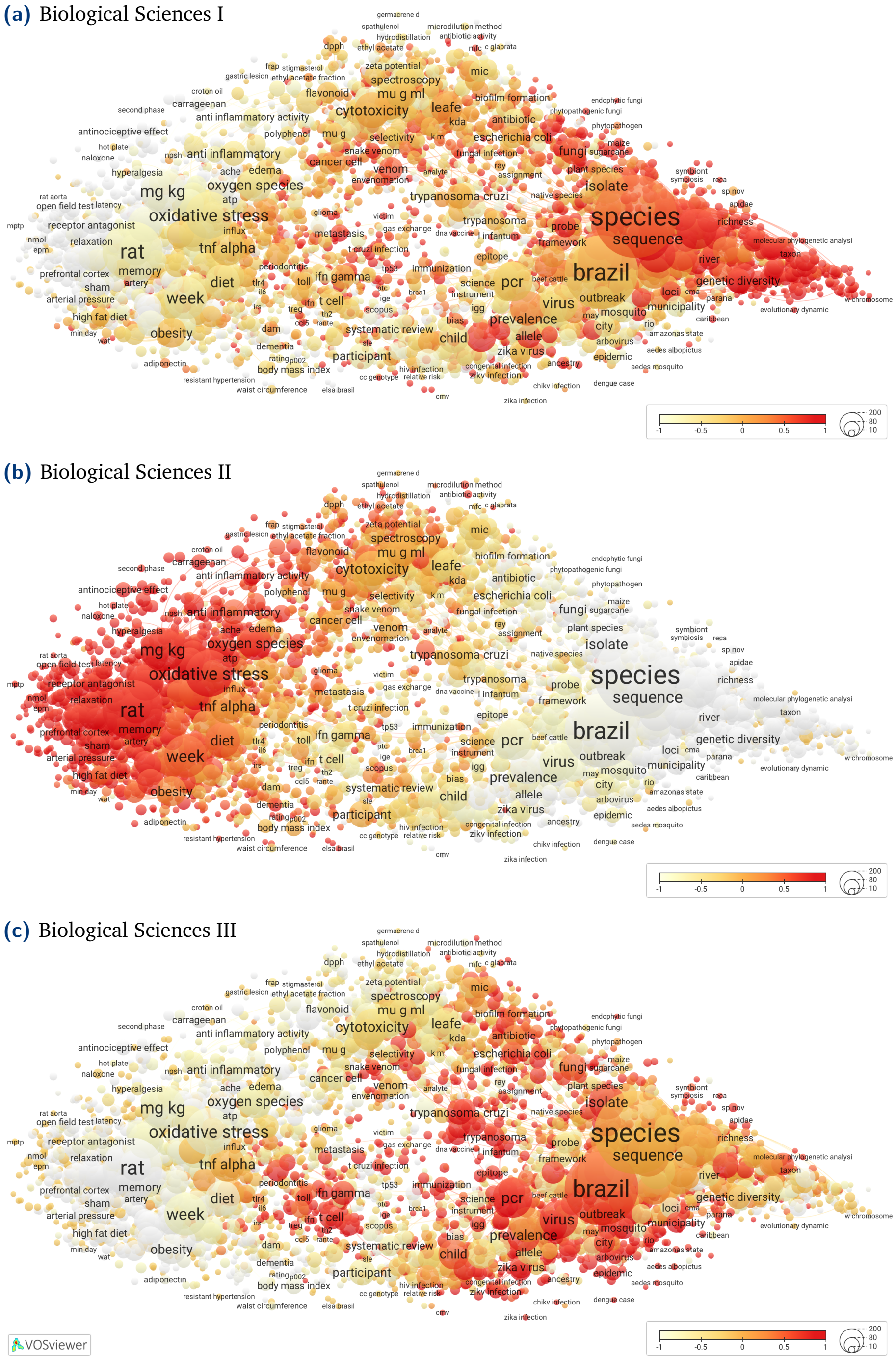
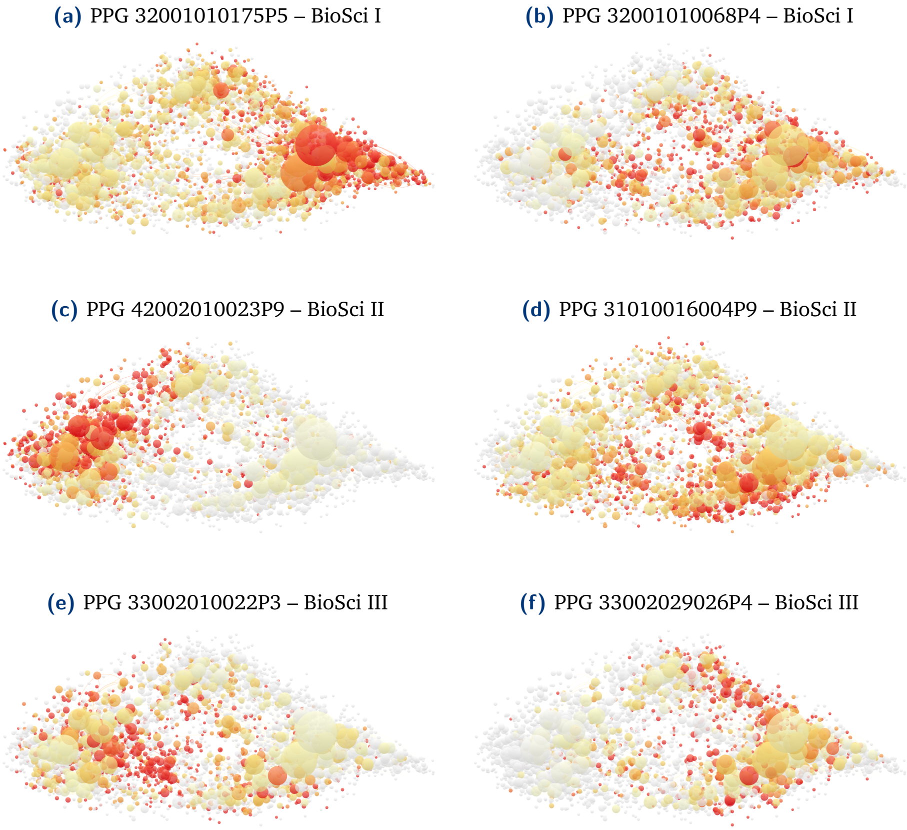


Figure 6.4.: BioSci term maps with publications highlighted per area (2017-2018).

Another application of term maps, as seen in Figure 6.5, is to focus on the profiles of individual graduate programs and how their research compares with the broader map of BioSci research.



(a) PPG 32001010175P5 – BioSci I

(b) PPG 32001010068P4 – BioSci I

(c) PPG 42002010023P9 – BioSci II

(d) PPG 31010016004P9 – BioSci II

(e) PPG 33002010022P3 – BioSci III

(f) PPG 33002029026P4 – BioSci III

Figure 6.5.: Term maps of papers from the BioSci evaluation areas, highlighting the publication profiles of individual PPG (2017-2018).

Figure 6.5 displays publication profiles of two graduate programs in each of the Biological Sciences areas. The term maps shown on the left (a, c, and e) are from graduate programs whose profiles fit within the publication topics shown in Figure 6.4 for their respective areas. However, the maps shown on the right (b, d, and f) are examples of PPG profiles that may be more well suited for a different BioSci area.

It would be feasible to consider the profiles seen in Figure 6.5 as evidence to support the migration of some of these programs to different areas that would be more suited to their research profiles. However, the proposed approach should only be considered if it supports the work of disciplinary experts who have the required background to analyse the evidence and decide whether or not a migration would be recommended.

A complementary approach to help disciplinary committees in the further assessment of these publication profiles is the observation of how papers from selected areas are inserted into a broader map of science. To proceed with the analysis of the three areas of "Biological Sciences", the 2022 version of such a map was used as a starting point. The resulting visualisation seen in Figure 6.6 is built using the Leiden Algorithm, a method that performs cross-citation and semantic analyses of titles and abstracts between WoS-indexed publications since 2000 (Traag et al., 2019). The map in question displays a total of 4159 clusters, each of them composed of papers that have thematic relationships. Clusters are sized according to the total number of publications from 2017-2018, and the distances between them reflect the proximity of research subjects and citation-relations.

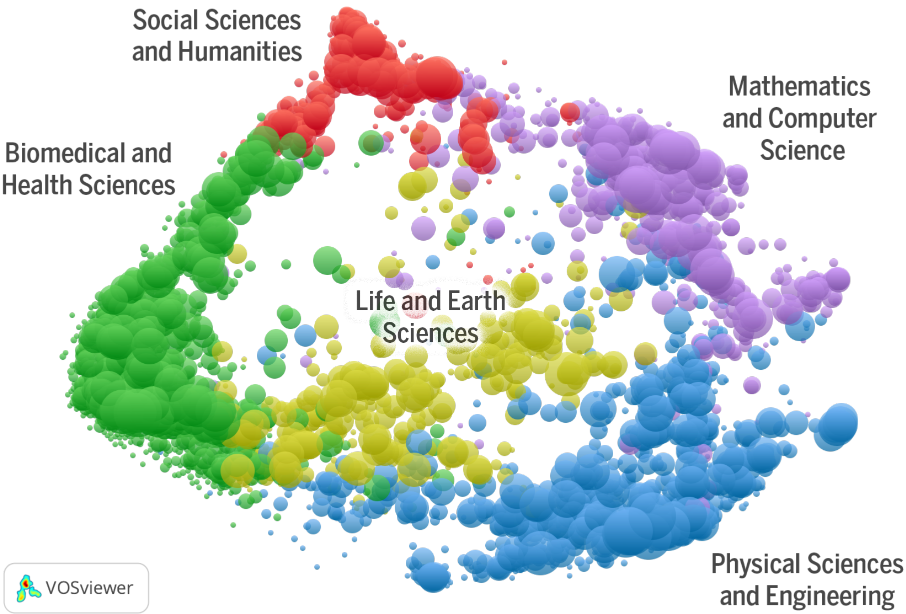


Figure 6.6.: Map of scientific publications indexed by the Web of Science (2017-2018)

Using Figure 6.6 as a canvas, it is possible to visualise publications from the three BioSci areas under analysis, recalculating the sizes of the respective clusters. The result, seen in Figure 6.7, shows the expected distribution of the papers mainly around clusters connected to the major fields of "Life and Earth Sciences" and "Biomedical and Health Sciences", which were highlighted in green and yellow on the previous map.

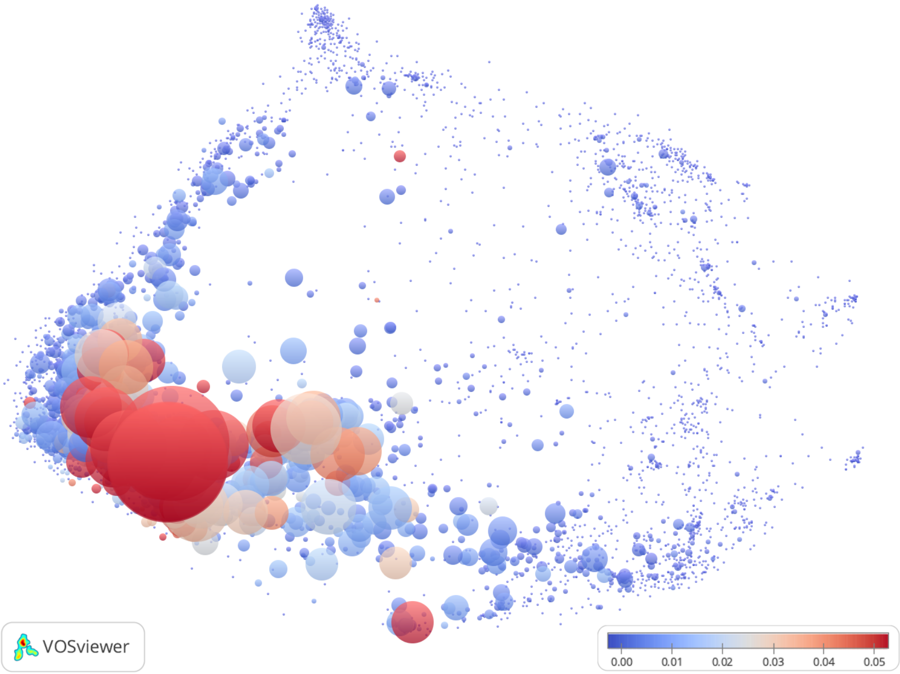


Figure 6.7.: Map of WoS-indexed scientific publications from Brazilian graduate programs in the BioSci evaluation areas (2017-2018)

Of the 4159 clusters on the displayed map of science, the BioSci graduate programs contribute to a total of 1580, 420 of those with more than 10 papers in the period. The colour overlay added to Figure 6.7 shows the percentage of those publications in relation to global production. Clusters displayed in vivid red are those in which the percentage of Brazilian papers is higher in relation to the total output. For instance, an analysis of the interactive version of the visualisation, available at https://bit.ly/xxxxxxxx, reveals that almost 20% of the world's publications in clusters related to tropical diseases such as Chagas and Leishmaniasis or in topics such as antivenom come from Brazil.

However, more than its contribution to global science, for the purpose of this study, the most relevant is understanding how Brazilian BioSci research is distributed in the three existing evaluation areas. For that, Figure 6.8 shows the previous map filtered for each of the BioSci areas. The visualisations are cropped to display the lower right of the original map, where most of the publications of those areas can be found.

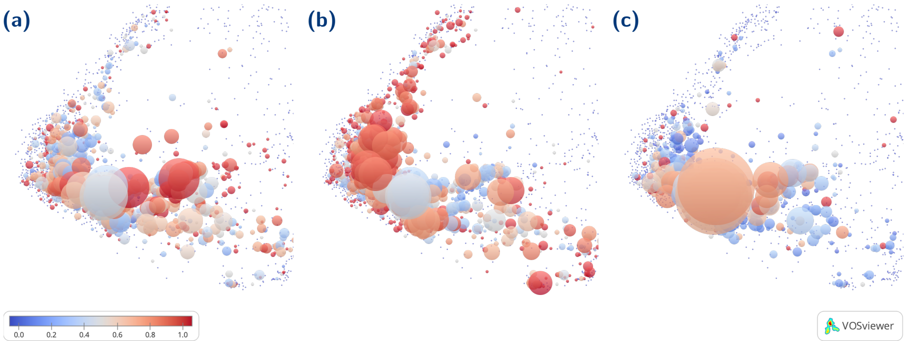


Figure 6.8.: Map of scientific publications indexed in WoS from Brazilian graduate programs in: (a) BioSci I; (b) BioSci II; and (c) BioSci III (2017-2018).

Figure 6.8 seems to confirm the conclusions derived from Figure 6.4, for instance, with respect to BioSci II (b) operating in its own research topics, while some overlap can be observed between BioSci I (a) and III (c). Such an overlap can be seen with the help of a new colour overlay, which applies the scale to the percentage of publications in each BioSci area in relation to the total of the three areas. Therefore, the predominance of reddish tones in many of the BioSci II clusters (b) indicates that 80 to 100% of the papers included there come from the area. However, while there are clusters highlighted in (a) where a majority of the papers belong to BioSci I, that is not the case for (c) where even clusters particularly large record only around 60% of the papers.

To better understand what the map reveals, Table 6.2 looks at the top 10 clusters for each of the three areas (as there is some overlap, the three top 10 are seen in 20 clusters). The table identifies the clusters with their unique id at the database and includes associated keywords to give some perspective of the topics included. For each of the three BioSci areas, the total number of papers (P) and their percentage in relation to the entire area are shown. The same is done for the combination of the three areas.

Table 6.2.: Top 10 clusters for each BioSci area, combined and sorted by total number of publications (2017-2018)

Id	Keywords	SciBio I		SciBio II		SciBio III		SciBio (all)	
		P	%	P	%	P	%	P	%
503	visceral leishmaniasis, psychodidae	127	10.0	141	11.1	238	18.7	364	13.0
521	chagas disease, reduviidae, hemiptera	175	13.8	172	13.6	197	15.5	353	12.6
53	zika virus, dengue, west nile virus, aedes	137	10.8	123	9.7	241	19.0	332	11.9
1190	phospholipase, snakebite, lipoprotein	88	6.9	72	5.7	67	5.3	150	5.4
1117	histoplasmosis, cryptococcal meningitis	62	4.9	42	3.3	112	8.8	144	5.1
7	microsatellite marker, genetic structure	127	10.0	2	0.2	5	0.4	132	4.7
1804	characiformes, teleostei, siluriformes	128	10.1	28	2.2	1	0.1	129	4.6
66	cerebral malaria, chloroquine, antibody	30	2.4	30	2.4	104	8.2	119	4.2
50	carvacrol, thymol, ocimum basilicum l	34	2.7	85	6.7	18	1.4	118	4.2
520	schistosomiasis, strongyloides stercorali	66	5.2	35	2.8	62	4.9	114	4.1
145	ixodidae, lyme disease, babesia	54	4.3	24	1.9	57	4.5	109	3.9
675	p2x, p2x7 receptor, extracellular atp	24	1.9	94	7.4	10	0.8	108	3.9
473	renin receptor, ace2, angiotensin ii	23	1.8	92	7.3	2	0.2	100	3.6
294	candida albican, candidemia	27	2.1	34	2.7	58	4.6	88	3.1
1707	galectin, tim, t cell immunoglobulin	56	4.4	59	4.7	26	2.0	84	3.0
272	urocortin, fever, cytokine, interleukin	17	1.3	69	5.4	9	0.7	80	2.9
82	morphine, ketamine, gabapentin, opioid	16	1.3	69	5.4	6	0.5	77	2.7
615	monogenea, acanthocephala, perciformes	14	1.1	14	1.1	54	4.2	73	2.6
45	tetrahydrobiopterin, arginase, nitroxyl	9	0.7	66	5.2	4	0.3	69	2.5
769	fabry disease, pompe disease	56	4.4	16	1.3	0	0.0	58	2.1

The first interesting observation from Table 6.2 is that the top 3 clusters represent more than 37% of the total number of publications in the combined areas. These are particularly relevant for BioSci III, as they concentrate more than half of the papers in the area, which are shown as the largest adjacent circles seen in Figure 6.8 (c). However, despite the high proportion of papers from the area in those clusters, the contributions from BioSci I and II are also significant. In fact, they reveal another interesting perspective: collaboration.

When the total number of papers of the BioSci combined is compared to those of the individual areas, they do not seem to add up. However, that happens because the same paper can be counted for more than one area, when a coauthorship led the publication to be reported in PPG from distinct areas. In the case of cluster 503, a total of 364 papers from all BioSci are mapped, 238 without crossarea collaborations (54, 57, 127 per area). Out of the 111 remaining papers from BioSci III, for instance, 42 were coauthored with BioSci I and 53 with BioSci II researchers, while 16 came from collaborations involving the three areas.

Evidently, the calculations used to build the maps of science and underlying clusters could consider fractional counting of publications to the proportion of the contribution of each area into account. However, the goal here is to map the research with which graduate programs are involved, making the full count approach appropriate, even because it helps identifying the crossarea collaborations.

Regarding the graduate programs, it is also possible to visualise and list their individual publications to the map of science and respective clusters, identifying those which are more or less aligned with the respective area profiles. The method, similar to what was shown in Figure 6.5, would be even more powerful, as the visual alignment would be complemented by a detailed list of publications in each cluster, complete with journals, collaborations and other resources that would be valuable for expert committees rethinking the classification system of evaluation areas in Brazil.

6.4 Conclusions

This study investigated the Brazilian classification system for research and graduate education. An analysis of the system's history has shown that the motivation behind its creation was a noble one: to guarantee that merit was a core element to the distribution of grants awarded by the chief funding agency in the country. Through the implementation of peer review committees, an evaluation model anchored by expert analysis was established. This is a model that is still current in Brazil.

Over time, the original committees multiplied towards the current 49 evaluation areas, organised into nine broad areas and three upper groups. This evolution was guided by the evaluation dynamics at CAPES, in part to follow the advancement of science, but also as a strategy to better manage the immense growth of the Brazilian National System of Graduate Education (SNPG). Furthermore, since the resulting classification played a central role in a high stakes national evaluation, its use beyond CAPES by other agencies and also by every higher education institution engaged in research in Brazil was inevitable.

Considering its evolution process, the Brazilian classification system under analysis became somewhat peculiar, especially when compared to international classification systems such as the OECD Fields of Research and Development (FORD) and the International Standard Classification of Education (ISCED). In particular, the misalignment among the evaluation and broad areas of the Brazilian system and their corresponding levels in the alternatives analysed is significant, especially in the SSH profiles.

One of the conclusions of this study is that the Brazilian classification system needs to be re-examined. Not only because of the misalignments identified, but because of other issues such as cryptical names of some evaluation areas, inadequacies in the allocation of graduate programs, the combination of sub-areas with significant epistemical differences, and the existence of areas which evolved to become apparent duplicates of each other.

Furthermore, the proposal for revision is aligned with recommendations from the special committee that was in charge of monitoring the Brazilian National Plan for Research and Graduate Education (2011-2020), which also highlighted the need for change. However, the PNPG Committee (2020) suggested the change to be one of significant reduction in the number of evaluation areas, reversing decades of efforts to build a system where the growing number of areas allowed for the comparative evaluation to be performed among graduate programs that were closer to each other.

This study proposes a different path. Instead of aiming for a reduction in the number of areas, the suggestion is to value and go beyond the "cognitive" approach described by Glänzel and Schubert (2003), which considers the input of different types of experts. For that, it is recommended to adopt the complementary "scientometric" approach to provide expert committees with evidence to suport their analysis.

The scientometric methods explored in this chapter demonstrate the potential of the approach, as the different analyses performed could be considered as starting points to help CAPES and the Brazilian academic community in the challenging task of promoting a sound and evolutionary review of the adopted classification system. With that, it is less important that the resulting classification decreases or increases the number of evaluation areas existing today. The important is that those new areas properly reflect the reality of the Brazilian science system and its international connections.

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