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Multilingualism in Scientific Literature Communicated by Journals from the SciELO Brazil Collection

ABEL L. PACKER

Fundação de Apoio à Universidade Federal de São Paulo (FapUNIFESP), R. Dr. Diogo de Faria, 1087, Vila Mariana, São Paulo, SP, 04037-003, Brazil
Email: abel.packer@scielo.org

This article describes the internationalization of the Scientific Electronic Library Online (SciELO), an open-science programme aimed at the development of capacities and infrastructure in research communication. It manages open-access collections of preprints, articles, research data, books, and book chapters, with a focus on national collections of non-profit peer-reviewed journals published by research communities of academic institutions, scientific societies, and associations. Celebrating 25 years of regular operation, SciELO improves research communication through professionalization, internationalization and sustainability of the indexed journals, maximizing their visibility and impact. In Brazil, the internationalization efforts by SciELO are aligned with national research policies, especially the internationalization of graduate programmes. The SciELO Brazil collection of journals evolves by adopting English solely or with Portuguese to improve the contribution of multilingualism to performing research by subject field. This article covers two decades of scientific literature in SciELO Brazil from 2003 to 2022. During this time, articles written in English or simultaneously in Portuguese and English increased significantly, resulting in a corresponding rise in access and citations received. The progress of the internationalization of the journals in the SciELO Brazil collection through multilingualism has been challenging both operationally and programmatically.

Introduction

Scientific literature consists of collections of texts such as articles, books, and other documents that record and convey knowledge resulting from research, essays, and

other intellectual exercises by researchers from yesterday, today, and tomorrow. It may span all geographies and thematic areas (Zilsel 1945). A project to achieve this is the SciELO Brazil collection, which, after 25 years of development and regular operation, brings together, as of 2024, more than 300 open-access journals from different disciplines and thematic areas, with a cumulative repository of 500,000 documents. This repository is updated annually with around 22,000 new documents. Over 180 academic institutions own the non-profit journals. The collection operates with a publication model adopted by Brazil and 16 other countries, forming the SciELO Network of national collections of journals with increasing quality. The conceptual framework governing the network and its collections is the SciELO Program (SciELO 2023a). As a public policy, SciELO Brazil is funded by the Coordination for the Improvement of Higher Education Personnel (CAPES) of the Ministry of Education, the National Council for Scientific and Technological Development (CNPq) of the Ministry of Science and Technology, and the São Paulo Research Foundation (FAPESP) of the State of São Paulo.

The collection is based on two documents adapted to the national specificities of each country. The first describes the policies, procedures, and indexing criteria applied in the evaluation of the entry and permanence of journals. It is periodically updated by a scientific committee formed by researchers representing the country's research community (SciELO Brazil 2022). The second document describes the priority actions for professionalization, internationalization, and operational and financial sustainability. It is updated every five years during the in-person meeting of the national coordinators of the SciELO Network (SciELO 2023b).

The content of the SciELO Brazil collection is scientific literature. The concept of scientific literature is used recursively and expresses the nature of science to continually update itself and accumulate new knowledge. In fact, the research of new knowledge, whose reports will feed the scientific literature, always presupposes the review and analysis of what is already known. Thus, the dynamism of information flows originated by new texts and references between texts that inform minds, new research, public policies, education systems, professionals, and society is inherent in the concept of scientific literature.

The temporal, geographical, thematic, and medium universality that characterizes scientific literature is also expressed in the different languages of the texts used throughout the scientific history of humanity. There have been periods of predominance of a language, such as Latin and French, the coexistence of two or more, as with German, French, and English in the early twentieth century, soon surpassed by the progressive dominance of English that emerged as the lingua franca of contemporary scientific communication (Ortiz 2004).

This article analyses the evolution of the adoption of English and Spanish by the journals in the SciELO Brazil collection because of the implementation of its internationalization policy aimed at maximizing the visibility and impact of the communicated research. The data used and produced in the articles are available for public access. The scientific literature referenced in this article is, whenever possible, self-referenced from the SciELO collection itself as an expression of its relevance.

Multilingualism vs. Lingua Franca

Despite the hegemonic force that the lingua franca globally exerts on research communication and exchange between researchers, multilingualism has always been present in scientific literature. This has been the fact notwithstanding the difficulty or impossibility of measuring its precise occurrence due to the limitations that libraries and bibliographic control systems have in identifying and encompassing a universal and comprehensive scientific literature. These limitations have been progressively overcome with the predominance of the digital format of new texts and the digitization of texts originally on paper. The web, through the network of digital collections, has made the dream of humanity to create a universal library of all texts a reality. In fact, one of the significant contributions of this networked universal library was to overcome the phenomenon of 'lost science in the third world' (Gibbs 1995). This concept found pioneering implementation in the Scientific Electronic Library Online (SciELO) with an open-access online publishing model for nationally published journal collections. It was launched in São Paulo four years before this publishing modality was proposed and formalized in the Budapest Declaration (Packer and Meneghini 2015).

However, a significant portion of contemporary bibliographic services for scientific literature has its policies, methodologies, criteria, procedures, and coverage technologies conditioned by the hegemony of the English language, dominant in their geographic origin (Salatino 2023). In fact, the commercial bibliographic indexes of international reference – such as Scopus and Web of Science – used for the past 20 and 50 years, respectively, to measure the scientific production in countries, institutions, thematic areas, and researchers, have exacerbated the dominance of English in global production with about 95% of journal article records in recent years. Meanwhile, the more exhaustive OpenAlex index presents a proportion of 72% of articles in English. National bibliographic indexes, such as those of the SciELO Network in 17 Ibero-American countries and South Africa, have more records in Portuguese and Spanish than in English. Several comprehensive indexes cover all journals in the SciELO Brazil database, such as Google Scholar (which covers the web), OpenAlex and others that have the Crossref DOI registration platform as their main source of articles. SciELO Network collections are indexed in the WoS platform within the All Databases collection under the name of SciELO Citation Index, which is a source to follow up the citation performance of the collections, journals and articles.

The SciELO publication model, as a means of overcoming the 'lost science of the third world' phenomenon, emerges as a determinant force striving to secure a place in the sun for non-commercial journals published nationally, previously excluded from bibliographic indexes. These journals were traditionally printed on paper with limited distribution, communicating predominantly in Portuguese in Brazil and Spanish in Hispanic-American countries. Moving the publication to the web in an appropriate model brought extraordinary visibility to the journals and the research they communicated, giving strength and feedback to SciELO's geographic, thematic,

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and language diversity and inclusion. Thus, SciELO, deployed as an integral part of the global flow of research communication, organized a network of national collections of scientific literature. While produced progressively according to state-of-the-art editorial practices, it possessed national historical and cultural characteristics and was driven by national conditions and priorities (Packer 2001). Over the last four decades, the SciELO model was developed within a Latin American and Caribbean environment of open-access related capacities and infrastructures, involving policies, methodologies, technologies, systems, products, and services of scholarly communication. It highlights systems such as the Latin American Population Documentation System (DOCPAL/CELADE), Latin American and Caribbean Health Sciences Literature (LILACS), the Scientific Information System Redalyc, the Regional Cooperative Online Information System for Scholarly Journals from Latin America, the Caribbean, Spain, and Portugal (Latindex) and the Federated Network of Institutional Repositories of Scientific Publications (LA Referencia) (Beigel *et al*. 2024). After 25 years of continuous development, SciELO is asserting itself as an open-science communication programme as part of the global flow with unique characteristics expressed by the motto 'SciELO Open Science with IDEIA – Impact, Diversity, Equity, Inclusion and Accessibility' – that serves as an experience and model for national research systems (SciELO 2023c).

The SciELO Brazil collection quickly became the reference index for quality journals of Brazil, serving the function of communicating nationally scoped and relevant research largely in the Portuguese language. The same happened with the other collections of the SciELO Network, contextualized by national conditions and priorities with a predominance of the Spanish language in Hispanic-American countries, Portuguese in Portugal, and English in South Africa and the West Indies. One noteworthy feature of SciELO as a bibliographic index and meta-publishing web space is its native ability to index articles made available in two or more languages simultaneously. Among international indexes, only Google Scholar has this capability. Full text articles are structured in XML according to a JATS compatible schema, which helps web dissemination, exchange and interoperability. Documents in Portuguese or Spanish have their title, abstract and keywords also available in English.

In the Brazil context, the goal of maximizing the visibility and impact of journals and the research they communicate required overcoming their endemism determined by two concurrent factors. First, the origin of the journals aimed at facilitating national scientific production and communication, mainly generated by graduate programmes since the 1950s. In fact, half of the journals in the SciELO Brazil collection were created after 1995. Second, the national Portuguese language limits international collaboration and the submission of articles from abroad, a condition that is less restrictive to SciELO journals in Hispanic-American countries, which communicate a high proportion of research from other countries (Beigel *et al*. 2024; Salatino 2023). Thus, in the year 2006, a total of 200 journals of SciELO Brazil published 71% of their articles in Portuguese.

Internationalization emerged as a solution to provide more access and obtain more citations. Therefore, the collection's leadership established, in the indexing criteria from 2014 onwards, an expected proportion of articles in English, the international affiliation of authors, and foreign researchers in the editorial management bodies according to thematic areas (SciELO Brazil 2014; SciELO Brazil 2022). The adoption of English was in the short term the most viable policy and operationally feasible line of action for internationalization implemented by the journals. An inherent solution in the methodological and technological platform of SciELO is to publish simultaneously in two or more languages, an option that we suggested in response to the question 'Is there science beyond English?' (Meneghini and Packer 2007). Furthermore, the indexing criteria of SciELO Brazil were reinforced by the internationalization policy of Brazil's graduate education promoted by the Ministry of Education through the Coordination for the Improvement of Higher Education Personnel (CAPES), responsible for approving and evaluating graduate programmes (Ramos 2017; Feijó and Andrade 2021).

Characteristics of the SciELO Brazil Collection

Geographic Origin and Institutional Affiliation of Journals

At the end of 2022, the SciELO Brazil collection indexed and published 314 active journals primarily focused on national research communities. These journals are published by 182 different institutions, of which 153 have only one indexed journal. Approximately 62% of the journals are published by educational and research institutions – universities through their faculties, departments, and graduate programmes, research institutes, museums, and institutions linked to ministries – while 37% are published by scientific and professional societies and associations. Commercial publishers only put out five of the journals.

All five regions of Brazil, comprising the 27 federative units, are represented in the collection, with a high concentration in the Southeast region (73%) and the South region (15%), followed by the Central-West (7%), Northeast (4%), and North (1%) regions. Among the 27 federative units, 17 (63%) have indexed journals. The distribution of journals in the collection broadly mirrors the distribution of Brazil's infrastructure and scientific production across federative units.

Thematic Areas of Journals and Author Affiliation

The SciELO collection classifies journals into thematic areas defined by CAPES in three hierarchical levels. The first level comprises (1) Life Sciences, (2) Exact, Technical, and Multidisciplinary Sciences (hereafter referred to as Physical Sciences), and (3) Social Sciences and Humanities. At the second level, the Life Sciences journals include those in (1a) Health Sciences, (1b) Agricultural Sciences, and (1c) Biological Sciences, while the Physical Sciences, include (2a) Engineering, (2b) Exact and Earth Sciences, and (2c) Multidisciplinary journals. The Social Sciences and

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Table 1. Distribution of journals and articles in the SciELO Brazil collection by thematic areas, years 2020–2022.

Field	Journals (%)	Articles (%)	Scopus (%)
Life Sciences	*45*	*60*	*58*
Health Sciences	63	69	–
Agricultural Sciences	24	19	–
Biological Sciences	13	12	–
Physical Sciences	*9*	*11*	*42*
Engineering	57	49	–
Exact and Earth Sciences	27	23	–
Multidisciplinary	17	28	–
Social Sciences and Humanities	*46*	*29*	*18*
Humanities	61	67	–
Applied Social Sciences	28	25	–
Linguistics, Letters and Arts	11	9	–

Note: A few journals in the Life Sciences and the Social Sciences and the Humanities are attributed to two or more thematic areas. When in three or more areas they are named multidisciplinary. Thus, the table shows weighted percentages of journals and articles in SciELO Brazil collection.

Humanities for their part include journals in (3a) Humanities, (3b) Applied Social Sciences, and (3c) Linguistics, Letters, and Arts. Table 1 presents the distribution of journals by thematic areas and the articles they published in the years 2020–2022. It shows that the journals in the Life Sciences and the Social Sciences and Humanities each comprise 45% and 46%, respectively, of the journals, while those in the Physical Sciences constitute a minority with 9%. However, in terms of the number of articles, those published by the Life Sciences journals constitute 60% of the collection, while the Social Sciences, and the Humanities contribute less than a third at 29%, and the Physical Sciences only 11%. In contrast, the production of articles from Brazil for the years 2020–2022 indexed in Scopus is distributed with 58% in the Life Sciences, 42% in the Physical Sciences and 18% in the Social Sciences and the Humanities.

Among the Life Sciences journals, the Health Sciences predominate, constituting 63% of the journals and contributing to 69% of the articles, while Engineering dominates within the Physical Sciences with 57% of the journals and 49% of the articles. Among the Social Sciences and Humanities journals, those in the Humanities predominate with 61% of the journals and 67% of the articles.

With respect to author affiliation, it is clear that the journals in the SciELO Brazil collection were predominantly created to disseminate research conducted by communities involving mainly Brazilian researchers. With the promotion of internationalization led by SciELO, research agencies and evaluation programs, there has been an average annual growth of 4% over the last ten years, increasing from 17% of foreign affiliation in 2013 to 30% in 2022. Of the three major fields, the journals in the Life Sciences and the Physical Sciences had 32% of their articles by foreign authors and 9% of articles in collaboration between Brazilians and foreigners. As expected, the Social Sciences and the Humanities journals published a

Table 2. Minimum limits for articles in English in the SciELO Brazil collection by thematic area and criteria years.

Field	2014	2022
Life Sciences		
Health Sciences	80%	90%
Agricultural Sciences	50%	95%
Biological Sciences	85%	95%
Physical Sciences		
Engineering	70%	75%
Exact and Earth Sciences	70%	75%
Multidisciplinary	85%	100%
Social Sciences and Humanities		
Humanities	25%	35%
Applied Social Sciences	25%	50%
Linguistics, Letters and Arts	20%	32%
Total	*60%*	*76%*

smaller proportion of articles with foreign authors (23%), and collaborations between Brazilians and foreigners (6%). The majority of foreign authors came from Asia (22%), Latin America and Caribbean countries (18%), Spain or Portugal (16%), North America (14%) the Middle East (14%), Western Europe except Iberia (5%) and Africa (4%).

Evolution of Multilingualism in Portuguese, English and Spanish Publication

In the last 20 years (2003 to 2022), the journals in the SciELO Brazil collection have shown a notable and systematic evolution towards multilingualism, with the progressive adoption of English as the sole language or simultaneously with Portuguese as a strategy for the internationalization of research communication. On a smaller scale, Spanish is relevant in specific groups of journals. As shown in Table 2, the minimum indexing criteria of the SciELO Brazil collection for the proportion of articles in English – the total number of articles in English divided by the total number of articles in the area – were raised between 2014 and 2022 for the journals in different thematic areas. In the Life Sciences to 90% and above, in the Physical Sciences to 75% for Engineering, Exact Sciences and Earth Sciences, and to 100% for Multidisciplinary research. For the Social Sciences and the Humanities, the proportions were between one third and one half. The criterion applied by thematic area thus allows for flexibility in the proportions of articles in English and Spanish for individual journals, providing some leeway for compliance, including allowing journals that publish only in Portuguese. While translation from Portuguese to English became common, very few journals have chosen to translate articles submitted in Portuguese into Spanish.

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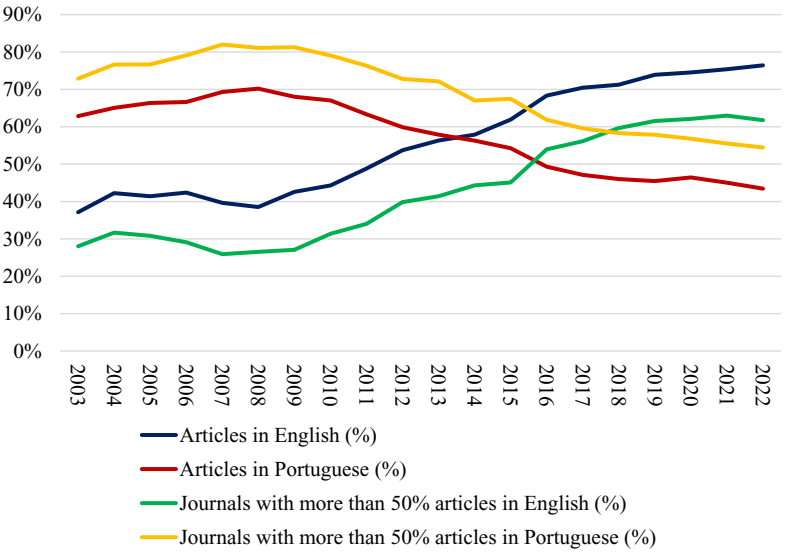

Figure 1. Evolution of the proportion of articles and journals in English and Portuguese.

Although limits for the Life Sciences and the Physical Sciences were already relatively high in 2014, they were raised in 2022. At that time, only a small portion of articles authored in Portuguese and rarely in other languages than English were permitted in the Life Sciences, about a quarter in the Physical Sciences, whereas the limits were considerably less restrictive in the Humanities and the Social Sciences.

An unequivocal expression of the multilingualism of the SciELO Brazil collection is the fact that, as stated in the instructions to authors, 52% of all journals, 83% of those in the Social Sciences and the Humanities, 29% in the Life Sciences, and 21% in the Physical Sciences accept manuscripts in any of the languages English, Spanish, or Portuguese. The greatest restriction comes from 31% of the journals that accept only manuscripts in English, predominantly among those in the Life Sciences (42%) and the Physical Sciences (72%). Journals in the Social Sciences and the Humanities are the most inclusive, with 97% accepting manuscripts in English, 96% in Portuguese, and 84% in Spanish.

The evolution of the proportion of articles in English varies with the adoption of English by journals that previously published in Portuguese and with the entry of new journals where the proportion of English is a key indexing criterion, especially from 2014, when minimum requirements were defined by thematic area. Spanish was also adopted in the wake of internationalization, especially among the journals in Social Sciences and Humanities. The evolution of international author affiliations also contributes, with articles in Spanish from Hispanic-Americans and in English from those outside Ibero-America.

As demonstrated in Figure 1, there has been a steady increase between 2003 and 2022 in the share of articles published in English (from 37% to 76%) and the share of

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journals publishing more than 50% of their articles in English (from 28% to 62%). At the same time, there has been a decline in the share of articles published in Portuguese (from 63% to 43%) and the share of journals publishing more than 50% of their articles in Portuguese (from 73% to 54%). In 2018, the number of journals publishing more than 50% of articles in English surpassed those publishing 50% or more in Portuguese.

A closer look at the development clearly reveals three periods in the evolution of plurilingualism and multilingualism between 2003 and 2022: 2003–2009, 2010–2015 and 2016–2022 (Table 3).

2003–2009

The number of journals increased at an annual average rate (AAGR) of 11% from 107 to 203 and articles at 13% from 8,080 to 17,028, with a steady distribution of the annual percentage of articles in English and in Portuguese of around 40% and 67%, respectively. The share of journals with more than 50% of articles in English and Portuguese averaged 28% and 77%, respectively. The share of articles in Spanish increased from less than 2% to 4%, and the share of journals with more than 15% of articles in Spanish increased from 2% to 5%.

2010–2015

The number of journals increased at an annual average of 6% from 220 to 286 and articles at 2% from 18,078 to 19,599, with the percentage of English articles increasing at an annual average rate of 6% from 44% to 62%, while the Portuguese articles decreased at an annual average rate of 4% from 67% to 54%. The number of journals in 2015 with more than 50% articles in English and in Portuguese reached 45% and 67%, respectively. Articles in Spanish remained around 4%. The share of journals with more than 15% articles in Spanish increased from 4% to 7%.

2016–2022

The number of journals and of articles increased steadily in the SciELO Brazil core collection at an annual average of 1% from 291 to 314 and from 19,939 to 21,250, respectively. The share of English articles increased at an annual average of 4% from 68% to 76%, while Portuguese articles decreased at an annual average rate of 3% from 49% to 43%. The share of journals with more than 50% articles in English increased from 54% to stabilize around 62% in the last four years, while the publishing in Portuguese went in the opposite direction: from 62% to 54%. In 2018, the number of journals publishing more than 50% of articles in English surpassed those publishing 50% or more in Portuguese. Articles in Spanish stabilized just above 4%, and journals publishing more than 15% of articles in Spanish increased at annual average of 11% from 7% to 12%.

Further evidence of the development is the fact that those journals publishing only in Portuguese decreased from 14% to 1%, after a peak of 17% in 2006. At the same time, journals with more than 50% of articles in English increased from 28% in 2003

Table 3. Number of journals, number of articles and publishing languages 2003–2009, 2010–2015 and 2016–2022 with annual average growth rates (AAGR) in the SciELO Brazil collection

Period	2003–2009			2010–2015			2016–2022		
Years	2003	2009	AAGR	2010	2015	AAGR	2016	2022	AAGR
Number of journals	107	203	11%	220	286	6%	291	314	1%
Number of articles	8,080	17,028	13%	18,078	19,599	2%	19,939	21,250	1%
Articles in English	37%	43%	3%	44%	62%	6%	68%	76%	4%
Articles in Portuguese	63%	68%	1%	67%	54%	–4%	49%	43%	–3%
Journals with more than 50% articles in English	28%	27%	0%	31%	45%	9%	54%	62%	5%
Journals with more than 50% articles in Portuguese	73%	81%	2%	79%	67%	–3%	62%	54%	–3%
Articles in Spanish	2%	4%	19%	4%	4%	1%	4%	4%	2%
Journals with more than 15% in Spanish	2%	5%	21%	4%	7%	12%	7%	12%	11%

Note: As percentages of languages are calculated independently, they sum above 100% due to the simultaneous publication in two or more languages.

to 62% in 2022, those with more than 90% from 22% to 56% and those with English only from 17% to 41%. A particular aspect of this evolution was the maintaining of communication in Portuguese for a significant set of journals. In fact, simultaneous publication in Portuguese and English advanced: the share of the journals publishing 25% or more of the articles in English and Portuguese increased from 5% to 24%. Those publishing more than 90% in English and Portuguese now constituted 11%. The number of journals publishing more than 15% of articles in Spanish increased systematically, moving from less than 2% in 2003 to 12% in 2022.

The practice of multilingualism varies among thematic areas. In the Life Sciences in 2003, 10% of the journals published only in Portuguese, but this had ceased in 2020. In the Physical Sciences, the two journals that only published in Portuguese stopped doing so in 2017. Even in the Social Sciences and Humanities, journals that published only in Portuguese declined, from 30% to 1%. At the same time, the proportion of journals with more than 90% of articles in English increased: from 22% to 56% for the fields in total, from 27% to 84% in the Life Sciences journals, from 39% to 76% in the Physical Sciences and from 0% to 23% in Social Sciences and Humanities. In the same period, the proportion of journals with more than 15% of articles in Spanish contributed to multilingualism in the Health Sciences and the Social Sciences and the Humanities, reaching 6% and 24%, respectively, in 2022.

The adoption of English through simultaneous publication in Portuguese and English was more significant among journals in the Life Sciences, and the Social Sciences and the Humanities, something which has stabilized in recent years at around 25% and 17% of journals with 50% or more multilingual articles, and 14% and 9% with 90% or more articles in English and Portuguese, respectively. The Physical Sciences journals, in contrast, did not commonly engage in multilingual publication, and only one journal published in Portuguese and English in the last two years. Articles in Spanish with simultaneous publication in Portuguese or English or both in more than 15% of the articles has limited occurrence, with only 5% and 3%, respectively, in the Health Sciences and the Social Sciences and the Humanities journals.

The progressive adoption of English, and to a minor degree Spanish, as a means to contribute to the internationalization of the research communicated by SciELO Brazil journals, whether alongside or abandoning Portuguese, has simultaneously altered the composition of the collection of articles. Table 4 illustrates the evolution of the proportion of articles in English, Portuguese and Spanish in the three periods selected.

In the Life Sciences, the share of 38% in 2003 had risen to 92% in 2022, in the Physical Sciences from 60% to 82% and in the Social Sciences and the Humanities from 6% to 40%. Overall, the share of English articles increased from 37% to 76%. At the same time, publishing in both English and Portuguese increased from 2% to 27% in the Life Sciences, from 1% to 23% the Social Sciences and the Humanities, and from 2% to 22% as a whole. In the Social Sciences and Humanities, the share of articles in Portuguese in the same period dropped from 89% to 75% and from 63% to 43% in total. The proportion of articles in Spanish stabilized in 2015 at 4%.

Table 4. Evolution of article multilingualism in English, Portuguese and Spanish by major subject areas 2003–2009, 2010–2015 and 2016–2022 in the SciELO Brazil collection.

Language	Scientific field	Period					
		2003	2009	2010	2015	2016	2022
English	Life Sciences	38%	49%	51%	74%	82%	92%
	Physical Sciences	60%	54%	56%	71%	75%	82%
	Social Sciences and Humanities	6%	6%	11%	20%	28%	40%
	Total	37%	43%	44%	62%	68%	76%
English and Portuguese	Life Sciences	2%	12%	19%	2%	26%	27%
	Social Sciences and Humanities	1%	3%	4%	2%	12%	23%
	Total	2%	9%	14%	2%	20%	22%
Portuguese	Social Sciences and Humanities	89%	92%	89%	82%	77%	75%
	Total	63%	68%	67%	54%	49%	43%
Spanish	Total	2%	2%	4%	4%	4%	4%

Note: Owing to simultaneous publication, the percentages may sum to a total above 100%.

Language and Performance of Journals in Communicating Research

The promotion of multilingualism with the adoption of Portuguese and English as the main languages in the SciELO Brazil collection, and Spanish to a minor degree, specifically aims to enhance the visibility and impact of journals and the research they communicate. This can be verified by bibliometric indicators of visibility and impact based on the evolution of the number of accesses and citations received, filtered by document languages.

Table 5 presents the total number of unique accesses per document from 2019 to 2022 for documents published from 2016 to 2018, categorized by document language and major subject areas. The measurements use the COUNTER release 5 methodology, which eliminates robots and counts only one possible access to the same document during a session. The numbers of all versions of documents – articles, reviews, editorials, etc. – accessed in 2016, 2017 and 2018 were 22,235, 22,753 and 23,377, respectively. From 2019 to 2022, they received a total of 60.9, 66.7 and 71.6 million accesses, respectively. The tabulated data show that documents accessed most are those simultaneously published in Portuguese and English (row 4 in Table 5) followed by those in Spanish (row 5), Portuguese (row 3), and English (row 2). Documents of the Social Sciences and the Humanities journals (column 5) are more accessed followed by the Life Sciences (column 3) and lastly the Physical Sciences (column 4). The total access to 2016 documents is lower than to 2018 documents, signalling that recent documents tend to be more looked for, especially in the Life and Physical Sciences.

In terms of citations, the H5 indicator from Google Scholar (h-index in five years) and the CiteScore indicator applied to SciELO Citation Index of the Web of Science All Databases, both covering all SciELO Brazil journals, provide a comprehensive citation metric to follow up the evolution of the performance of the collection. The

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Table 5. Accesses/document from 2019 to 2022 to documents from 2016 to 2018 by language and subject area in the SciELO Brazil collection.

Language (1)	Year (2)	Life Sciences (3)	Physical Sciences (4)	Social Sciences and Humanities (5)	Total (6)
English (2)	2016	1,538	1,503	1,821	1,547
	2017	1,700	1,550	1,859	1,698
	2018	1,712	1,649	1,673	1,704
Portuguese (3)	2016	2,924	2,379	3,508	3,051
	2017	3,142	2,487	3,691	3,321
	2018	3,514	2,505	3,630	3,568
English and Portuguese > 50% (4)	2016	4,834	4,313	5,161	4,666
	2017	5,266	5563	4,209	5,126
	2018	5,374	3,591	4,520	5,146
Spanish (5)	2016	2,630	1,721	4,254	3,461
	2017	1,908	1,808	3,901	3,173
	2018	2,082	1,707	5,085	3,813
Total (6)	2016	2,657	1,868	3,608	2,740
	2017	2,815	1,903	3,778	2,933
	2018	2,929	1,928	3,851	3,066

upper part of Table 6 presents the evolution of the median value of the H5 indicator between 2013 and 2022 for all journals and by major subject areas, alongside the evolution of the proportion of documents published in English. The H5 indicator has a broad coverage of journals, surpassing the limitations of indexing in traditional indices commonly used to measure the impact of journals, especially those in the Social Sciences and Humanities and published in languages other than English. It is therefore a key indicator for measuring the impact of journals in the SciELO Brazil collection. In the series from 2013 to 2022, the H5 operates as a five-year moving indicator of year-to-year evolution. For all disciplinary areas, there is an annual average growth rate (AAGR) ranging from 6% for the Life Sciences to 9% for the Social Sciences and the Humanities. This growth is highly correlated in all areas to the growth of the proportion of English (middle part of Table 6), with a particular emphasis on journals in the Social Sciences and Humanities (0.96).

Similarly, the bottom part of Table 6 presents the evolution of the median value of the Scopus CiteScore indicator between 2013 and 2022 for all journals and by major subject areas, parallel to the evolution of the proportion of documents published in English. The indicator was applied to journals in the SciELO Citation Index operating on the Web Science platform as part of the ALL Databases collection. The CiteScore indicator is similar to that applied to journals in the Scopus index, calculating the average number of citations received by journal documents over four-year periods. In the years between 2013 and 2022, it operates as a four-year moving average. As with the H5, there is a high correlation between the growth of the proportion of English and the CiteScore indicator in all areas, with a particular emphasis on journals in the Social Sciences and Humanities (0.93).

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Table 6. Evolution of the median values of the H5 indicator from Google Scholar, the average of the journal's percentage of articles in English from 2013 to 2022, by subject area, and the CiteScore indicator in the Web of Science with respective average annual growth rates and correlations.

Indicator	Field	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	AAGR	*r*	*p*
H5	Life Sciences	13	14	14	14	15	16	17	19	21	21	6%	0.83	0.003
	Physical Sciences	9	10	11	11	13	12	14.5	16	17	17	8%	0.86	0.001
	Social Sciences and Humanities	7	9	9	10	11	12	14	15	15	15	9%	0.96	<0.001
	All	10	12	12	12	13	13	15	17	18	17	6%	0.85	0.002
English (%)	Life Sciences	70%	73%	76%	82%	85%	88%	90%	90%	91%	91%	3%		
	Physical Sciences	61%	70%	68%	73%	81%	82%	83%	81%	84%	85%	4%		
	Social Sciences and Humanities	26%	29%	28%	35%	36%	39%	42%	41%	43%	41%	5%		
	All	57%	60%	59%	64%	66%	69%	70%	69%	71%	69%	2%		
CiteScore	Life Sciences	0.75	0.87	0.90	0.96	0.95	1.06	1.18	1.37	1.47	1.51	8%	0.86	0.001
	Physical Sciences	0.41	0.43	0.44	0.50	0.54	0.87	0.97	0.98	1.19	1.19	14%	0.85	0.002
	Social Sciences and Humanities	0.20	0.25	0.29	0.31	0.31	0.38	0.44	0.49	0.53	0.45	10%	0.93	<0.001
	All	0.39	0.43	0.48	0.53	0.56	0.66	0.77	0.87	0.88	0.86	9%	0.91	<0.001

Discussion

The internationalization of scientific literature processed and communicated by journals across different subject areas in the SciELO Brazil collection over the past two decades has been successful, primarily due to the systematic adoption of the English language in most of the journals and of the Spanish language among the Humanities journals. Since 2016, more than 50% of all journals in the collection have been publishing over 50% of their articles in English, primarily the Life Sciences and the Physical Sciences journals. In fact, since 2018, the percentage of journals publishing more than 50% in English surpassed those publishing more than 50% in Portuguese. Between 2015 and 2022, there was an average annual growth of 4% in the share of English-language articles, with a notable 14% growth for journals in the Social Sciences and Humanities. Hence, in the same period, the proportion of Portuguese-language articles declined at an annual average rate of 3% from 54% to 43%, while the Social Sciences and Humanities declined only 1%. A key aspect of SciELO Brazil internationalization by language is the bilingual publication in Portuguese and English, accounting for a remarkable 22% of total articles in 2022. This practice is predominantly adopted by journals in the Life Sciences, and the Social Sciences and the Humanities, with shares in 2022 of 27% and 23%, respectively. The affiliation of foreign authors, as a second measure of internationalization, has also been steadily increasing at an average annual rate of 4% over the last decade, reaching 30% of articles in 2022, further contributing to the rise in the proportion of articles in English and Spanish.

The internationalization that has enhanced the visibility and impact of journals and communicated research, as measured by accesses and citations received, was practically induced by the indexing criteria of the SciELO Brazil collection. These criteria are aligned with Brazilian research internationalization policies, emphasizing graduate programmes whose scientific production is assessed by CAPES through journal rankings primarily based on bibliometric citation indicators. The performance of all journals grew at an annual average of 6% in the Google Scholar H5 indicator and 9% in the CiteScore indicator in the SciELO Citation Index of All Databases collection of the Web of Science platform. There is a correlation above 0.84 between these indicators and the proportion of articles in English. However, access per article to Portuguese-language articles is significantly higher than to English-language articles, justifying the practice of bilingual publication to cater to both national and international audiences. Thus, the adoption of English as the sole language for articles – while contributing to increased citations and international access – may reduce national access.

The challenge in managing the future development of the SciELO Brazil collection lies in striking an ideal balance between the proportions of publications in Portuguese and English for all journals as well as Spanish for the Humanities and the performance growth of access and received citations. This balance has been adjusted by subject areas, meeting indexing criteria, with the limits of English-language articles being reached in all subject areas. However, the adoption of English as the

only language in many cases and particularly with Portuguese, strains the pursuit of balance in the multilingual composition of the SciELO Brazil collection in two critical competing operational aspects: first, the high cost involved, leading many journals to adopt publication fees to cover translations and editing, and second the limitation of global bibliographic indexes, except for Google Scholar, to cover all versions.

The evolution of multilingualism in the SciELO Brazil collection as a national policy occurs in a global context where indexed scientific literature is dominated by English by over 90% in Scopus and Web of Science. However, there are significant global, regional, and national stances on the relevance of multilingualism that conceptually support the policy of the SciELO Brazil collection. However, these stances often tend to unilaterally defend or promote national and regional languages other than English, contrasting with the promotion of English by the SciELO Brazil collection as a critical dimension of multilingualism to balance the endemism of scientific literature that emerged from Portuguese predominance. This discrepancy usually arises from the perspective with which the visibility and impact of research are assessed, often due to the simplistic use of bibliometric indicators produced by platforms such as Scopus and Web of Science, which favour English and limit the indexing of nationally edited journals. Most analyses ignore that, besides the inclusiveness of national regional indexes, indexers such as Google Scholar index articles regardless of language. Recently, the popularization of search systems based on language models with high natural language processing capabilities contributes to the exhaustive indexing of scientific literature available on the web regardless of language.

Globally, SciELO Brazil's adoption of publication in English, Portuguese and Spanish in proportions adjusted by thematic areas aligns with the promotion of multilingualism as an international policy, which has historically been led by UNESCO and reaffirmed in its recent Recommendation on Open Science by '[e]ncouraging multilingualism in the practice of science, in scientific publications and in academic communications' (UNESCO 2022). In the international research and scientific communication community, the Helsinki Initiative on Multilingualism in Scholarly Communication (2019), whose recommendations gained global adherence, plays a significant role in supporting the protection of 'national infrastructures for publishing locally relevant research' and the promotion of 'language diversity in research assessment, evaluation, and funding systems'. This underpins the essence of the SciELO publication model, which also includes the publishing of internationally relevant research. In the Ibero-American context, three stances systematically promote multilingualism in favour of Spanish and Portuguese. The Ibero-American General Secretariat (SEGIB), which supports the development of the Ibero-American community reaffirms in its 2023–2026 strategic plan the bilingualism of Portuguese and Spanish as 'a distinctive characteristic of the identity and common heritage of the Ibero-American Community' and as languages of scientific communication (SEGIB, 2023). The Ibero-American Program on

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Multilingualism and the Promotion of the Portuguese and Spanish Languages of the Organization of Ibero-American States for Education, Science, and Culture (OEI) stands out. In 2022, it organized the CILPE International Conference on the Portuguese and Spanish Languages, Languages, Culture, Science, and Innovation with a section dedicated to 'Plurilingual Science: Portuguese and Spanish in Science' whose analysis is permeated by the recognition of the strength of the regional research communication multilingual infrastructure (OEI 2023). Since 2019, the Latin American Forum on Research Assessment of the Latin American Council of Social Sciences (FOLEC/CLACSO) advances a common agenda on research assessment policies in the region and has stated that multilingualism 'favours the development of socially relevant research and contributes to sustaining cultural diversity' as one of its principles (FOLEC/CLACSO 2022). Its intention is 'to show the potential of Latin America and the Caribbean to promote a more diverse dissemination of knowledge in terms of format and language, with a quality seal that strikes a better balance between global standards and local or national needs' (FOLEC/CLACSO 2021).

Certainly, SciELO Brazil faces, in many senses, unique challenges, both operationally and programmatically, in seeking properly balanced multilingualism as a well-established indexing and publishing policy that ensures, primarily, the communication of nationally relevant research, but also international research, maximizing their presence in the global flow of scientific information. This is achieved, first, with the adoption of English, and, second, by contributing to the process of internationalization of Portuguese as a scientific language (Oliveira 2013). It is in many senses a unique configuration globally, but particularly in comparison with the Ibero-American collections of the SciELO Network, which published a steady yearly average of 75% or more of all articles in Spanish in the last ten years.

Operationally, the main challenges lie in maximizing the cost-effectiveness of internationalization in general but specifically related to English translation and editing costs and the benefits in terms of visibility and impact. Strategically, the main gain is the successful development of capacities and infrastructures in Brazil, through journals, private service providers and the SciELO platform, to regularly operate multilingualism with high complexity involved in structuring full texts in XML, HTML, and PDF formats, and metadata following FAIR principles. Collateral negative effects include the sharing of translation costs with authors, which has forced many journals to abandon the traditional pure diamond open-access model. Another operational challenge is to overcome the inability of classic bibliographic indexes, except for Google Scholar and SciELO itself, to adequately manage articles published simultaneously in two or more languages. They either manage only one version at the expense of others or all versions as separate records, artificially inflating scientific production and the denominator in bibliometric calculations.

Programmatically, considering that multilingualism is a critical foundation of SciELO, the main common questionings of the SciELO Brazil policies rely on the required adoption of English by native Portuguese authors communicating research

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on problems that are of local, national or regional interest. Considering that these questionings apply mainly to the Social Sciences and Humanities articles, it is worth noting that 40% and 75% of articles in English and Portuguese in 2022 in the Social Sciences and Humanities journals are compatible with the research output of 37.5% English and 57.2% in local languages of seven Northern and Western European countries between 2013–2015 (Kulczycki *et al.* 2020).

The questioning in the SciELO Brazil literature of why native Portuguese-speaking Brazilians choose or are called to publish in English is grounded, on the one hand, in the premise of a loss of their full communication capacity or the limitations of translations that could ultimately impact the performance of texts, as well as the negative impact on the training of students, the continuous education of professionals, and the dissemination of reliable information to society. There is also concern about the negative impact on the development of the ability of the Portuguese language to express the state of the art in scientific knowledge and the advancement of national culture. On the other hand, there is a questioning about the type of internationalization based simply on the adoption of English, which would indicate submission to the dominance of the mainstream scholarly communication by central capitalist countries expressed in prestigious journals published by commercial publishers or large scientific societies that profit from scientific communication. It also has the side effect of Brazilians reading articles in English on national research topics authored by Brazilian colleagues (Beigel and Digiampietri 2023, Carvalho and Sasseron 2014, Diniz 2017).

Nevertheless, these questionings also suggest paths for improving existing policies and establishing new ones for the enrichment of multilingualism as an essential condition for the development with diversity, equity, and inclusion of the SciELO Brazil collection as a whole, but especially for each of the journals it indexes and publishes. The central focus is on recognizing the relevance of the communicated research and maximizing its visibility and impact. Therefore, the most immediate and promising path lies in refining the management of publication in Portuguese or English or both simultaneously with the help of indicators measuring the gains in the cost–benefit relationship. A similar practice should be promoted for simultaneous publication in Portuguese and Spanish in specific areas covering converging research communities from different Ibero-American countries.

Regarding the broader internationalization of journals beyond simple English publication, the challenge is to enhance mechanisms that contribute to increasing the active presence of foreign researchers in journal management roles as editors, reviewers, and authors. This is aimed at improving the quality and international positioning of the journals (Ferreira *et al.*, 2019). In terms of disseminating research to society at large, SciELO should improve current practices of research press releases and its partnership with the Bori Agency dedicated to public science dissemination through a network of journalists (Righetti *et al.* 2022).

Looking to tomorrow's scientific literature, the new direction that should guide SciELO's multilingualism is the use of language models across different disciplines

and journals to minimize losses in the transition between languages, with the perspective that both Portuguese and Spanish also acquire the status of scientific lingua franca.

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About the Author

Abel L. Packer is co-founder and Director of the Scientific Electronic Library Online (SciELO) Program of the São Paulo Research Foundation (FAPESP) and Project Coordinator at the Foundation of the Federal University of São Paulo (UNIFESP),

Brazil, since June 2010. Previously, he was Director of the Latin American and Caribbean Centre on Health Sciences (BIREME) of the Pan-American Health Organization/World Health Organization for 11 years. Packer participated proactively in the conception, management, operation and dissemination of major Latin American and Caribbean multilingual scientific information networks, such as the Latin American Population Documentation System (DOCPAL), the Virtual Health Library (VHL) and the Scientific Electronic Library Online network that currently publishes over 1,300 journals through national collections from 17 countries, most from Latin America in addition to Portugal, Spain and South Africa.