

CORRELATION OF THE ENGLISH LANGUAGE PROFICIENCY OF BRAZILIAN CHEMISTRY RESEARCHERS WITH THEIR SCIENTIFIC PUBLICATIONS

CORRELAÇÃO DA PROFICIÊNCIA DE LÍNGUA INGLESA DE PESQUISADORES DE QUÍMICA BRASILEIRA COM SUAS PUBLICAÇÕES CIENTÍFICAS

CORRELACIÓN DEL DOMINIO DEL IDIOMA INGLÉS DE INVESTIGADORES QUÍMICOS BRASILEÑOS CON SUS PUBLICACIONES CIENTÍFICAS

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ABSTRACT: English is the most used language for publishing scientific studies, which can be an obstacle for non-fluent researchers. This paper analyzed the self-assessments (speaking, reading, listening and writing in English) in curricula of researchers working in Postgraduate Programs in Chemistry *stricto sensu* in Brazil. Information on the researchers' scientific production was obtained from the Lattes Platform. A total of 24 programs were evaluated with grade 4 from Coordination for the Improvement of Higher Education Personnel (CAPES), 10 with grade 7 and 337 researchers. Most consider themselves to have a good command of English, with the best assessment for reading. Researchers were characterized as fluent/non-fluent based on their evaluations for reading and writing. Articles in English were published, mostly, by those who read/write fluently. These researchers have the highest averages in relation to citations and h-index.

KEYWORDS: Scientific production. English language. Chemistry. Post-graduation.

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RESUMO: O inglês é o idioma mais utilizado para publicação de estudos científicos, o que pode ser um obstáculo para pesquisadores não fluentes. Este artigo analisou as autoavaliações (fala, leitura, escuta e escrita em inglês) em currículos de pesquisadores atuantes em Programas de Pós-Graduação em Química stricto sensu no Brasil. As informações sobre a produção científica dos pesquisadores foram obtidas da Plataforma Lattes. Ao todo foram avaliados 24 programas com nota 4 da Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES), 10 com nota 7 e 337 pesquisadores. A maioria considera ter bom domínio da língua inglesa, com a melhor avaliação para leitura. Os pesquisadores foram caracterizados como fluentes/não fluentes com base em suas avaliações para leitura e escrita. Os artigos em inglês foram publicados, em sua maioria, por quem lê/escreve fluentemente. Esses pesquisadores apresentam as maiores médias em relação às citações e ao índice-h.

PALAVRAS-CHAVE: Produção científica. Língua inglesa. Química. Pós-graduação.

RESUMEN: El inglés es el idioma más utilizado para publicar estudios científicos, lo que puede ser un obstáculo para los investigadores que no lo dominan. Este artículo analizó las autoevaluaciones (hablar, leer, escuchar y escribir en inglés) en los currículos de investigadores que trabajan en Programas de Posgrado en Química stricto sensu en Brasil. La información sobre la producción científica de los investigadores se obtuvo de la Plataforma Lattes. Se evaluaron un total de 24 programas con grado 4 de la Coordinación de Perfeccionamiento del Personal de Nivel de grado y posgrado (CAPES), 10 con grado 7 y 337 investigadores. La mayoría considera tener un buen dominio del idioma inglés, con la mejor calificación de lectura. Los investigadores se caracterizaron como fluidos / no fluidos en función de sus evaluaciones de lectura y escritura. Los artículos en inglés fueron publicados en su mayoría por personas que leen / escriben con fluidez. Estos investigadores tienen los promedios más altos en relación con las citas y el índice-h.

PALABRAS CLAVE: Producción científica. Lengua inglesa. Química. Posgraduación.

Introduction

Scientific production advances positively both on the national and international scene. The Clarivate Analytics 2019 (WEB OF SCIENCE GROUP, 2019) report from the Coordination for the Improvement of Higher Education Personnel – (CAPES - Brazilian Federal Agency for Support and Evaluation of Graduates and Postgraduates Programs) analyzed Brazilian scientific publications from 2013 to 2018, having found that Brazil is in the 13th place in the world ranking, with an about 280 thousand publications in the period.

Although this is low when compared to countries such as the United States (2.6 million publications) and China (1.8 million), it is relatively better than some more developed countries, such as, Netherlands (260,000), Russia (217,000), Switzerland (197,000) and Sweden (176,000) when *per capita* production is not considered. Although Brazil occupies

only 13th place in the world ranking and in the present moment there is great uncertainty in relation to investments in research and technology, the country is still viewed favorably by the authors of the report on international collaboration. This favorable view can be attributed to the higher average performance in the impact factor, when compared to the countries belonging to the BRICS (Brazil, Russia, India, China and South Africa).

The internationalization of scientific publication shows a predilection for the use of the English language, on the part of the most renowned magazines and periodicals for the publication of papers and the like. According to Santin, Vaz and Stumpf (2016), English is considered the language of world science and technology and, according to several authors (MEADOWS, 1999; MENEGHINI; PACKER, 2007; ROYAL SOCIETY, 2011). The use of this language influences directly in the internationalization of publications, proving to be important not only for papers in international journals, but also for national journals that aim for international insertion.

In view of this scenario, it is natural to question whether researchers/professors and other members of Brazilian scientific research have adequate proficiency in English. Both these factors are which are both necessary and even sufficient to publish their papers in this language.

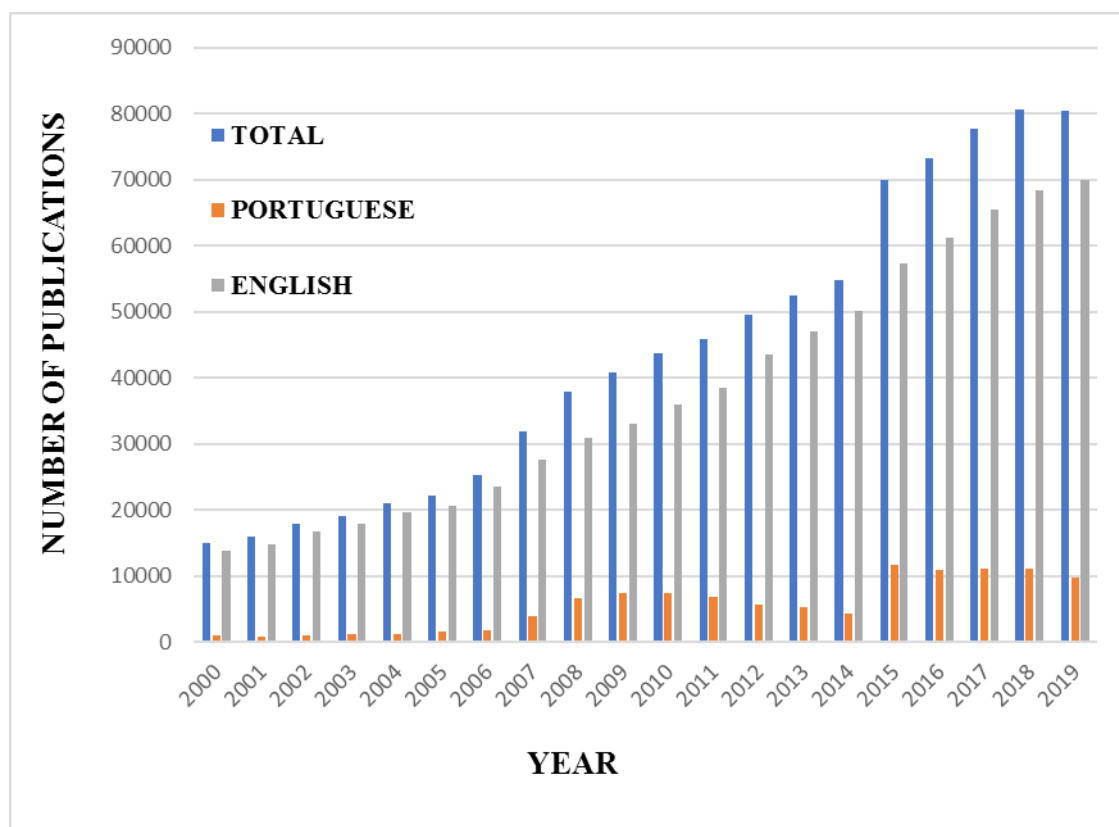
The results of a survey of the last 20 years using the Web of Science (WoS) database, with the filters: Country of origin: Brazil and Language of publication: English or Portuguese, are shown in figure 1. In this figure, the number of scientific publications per year is presented with Brazil as a country of affiliation for at least 1 (one) of the authors, a continuous increase in the last 20 (twenty) years can be observed and the majority of publications are written in English.

Figure 2 shows the division between publications written in English and Portuguese, and it can be seen that in the years 1998 to 2005 and from 2013, the percentage of publications in English remains constant at approximately 85 to 90% of the total. The growth of publications in Portuguese between 2005 and 2010 is possibly linked to an increase in the number of national publications, while its decrease from 2010 may be related to the requirements of publishing in English imposed by several national publishers.

Currently, several researchers, who do not have English as their native language, publish the results of their research in English to disseminate their results to the global scientific community. The idea of having a *lingua franca* allows researchers to communicate through a single language, facilitating interaction, accessing to information and data relevant to research published anywhere in the world. However, writing in another language may not

be so simple and, consequently, make it difficult to reach the established objectives, especially if we compare such writing with those performed by researchers from countries where English is the native language (DI BITETTI; FERRERAS, 2017).

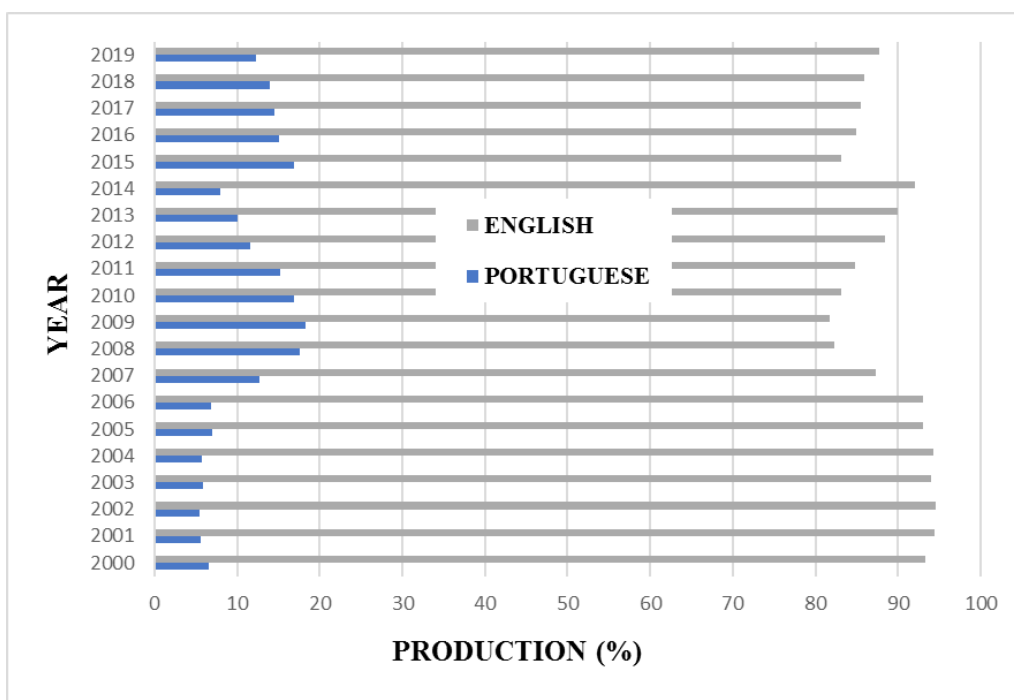
Figure 1 – Number of publications in English and Portuguese with at least one author with a Brazilian address, as indexed in the years 1998–2019 in the Web of Science database



Source: Elaborated by the authors

In a historical search, several causes or situations found were decisive for the English to take such a proportion. Crystal (2003) deals with the advance of English, as a consequence of the impositions of the British Empire, in the middle of the 19th century, and regarding the economic explosion reached by the United States in the 20th century. In other words, during periods of remarkable and extremely important events for humanity, the protagonists of these events were English speakers. Everything that subsequently emerged in technology culminated in the English language becoming “a first language in industries” and, consequently, covering all branches of society, including, since the first decades of the 20th century, the academic and already adopted English for international meetings (CRYSTAL, 2003).

Figure 2 – Number of Brazilian scientific publication in English and Portuguese using the research term Brazil address, as indexed in the years 1998–2019 in the Web of Science database



Source: Elaborated by the authors

Despite the controversial discussions about language teaching in public schools in Brazil, English is the *lingua franca* used to communicate scientific findings around the world. According to Almeida and Pinto (2011) the important role of the Education Development Plan (PDE) and the Support Program for Scientific and Technological Development (PADCT) that encouraged the teaching and progress of Brazilian chemistry. Chemistry has had an extraordinary development and today it is, within the broad area of exact sciences, the fastest growing in the country. Therefore, this study aimed to conduct a data survey with 337 Brazilian researchers working in Graduate Programs in Chemistry in Brazil (Masters and Doctorate levels) with levels of 4 and 7. The information of the selected researchers was obtained through their resume registered on the Lattes Platform and related to self-declared competencies in English, with indicators of the number of publications, the h-index and citations in their research, including those published in journals with an impact factor from the Journal Citation Reports (JCR). This work investigated whether researchers face obstacles or not to publish their papers in the English language.

Methodology

This survey used quantitative research with data collection from Brazilian researchers in a postgraduate program in Chemistry, with level 4 and 7. The thematic focus of this research was defined as follows:

- Total of 66 programs in Brazil, with 2,132 researchers/professors.
- Exclusion criteria: Programs with levels 2, 3, 5 and 6 in the CAPES/2017 Quadrennial Evaluation, which corresponds to 32 programs and 825 researchers/professors.
- Inclusion criteria: Programs with levels 4 and 7 in the Quadrennial Evaluation of CAPES/2017, which corresponds to 34 programs and 1,307 professors, of which 1,042 are permanent professors. After calculating the sample, the inclusion criteria result in:
 - 165 researchers/professors from 24 level 4 programs.
 - 172 researchers/professors from 10 level 7 programs.

Totalizing 337 researchers/professors participating in this research.

According to data collected (FERREIRA, 2018), there are about 1,850 researchers/professors linked to the best chemistry programs evaluated by CAPES with a score equal to or higher than 4. For the sample calculation, the population of 1,042 researchers in the area was considered as a reference of Chemistry members of the Graduate Courses in Chemistry in Brazil, at the Masters and Doctorate levels, evaluated with levels 4 and 7, and the parameters: sample error of 0.05, 95% confidence interval and population proportion of 50%. Thus, the calculation of the minimum sample resulted in 281, being the process of random sampling simple. To compensate for possible losses, the estimated sample size was increased by 20%, making a necessary sample of 337 individuals. The sample distribution was according to the level of the Graduate Programs, with 49.0% for level 4 and 51.0% for level 7 (ARANGO, 2009).

Initially, a random sampling of 337 professors from postgraduate chemistry programs was carried out, whose curricula contained the most recent update date were available on the Lattes Platform, and evaluated as follows:

1. What are the levels of proficiency in self-declared English, based on the 4 (four) categories of reading, writing, speaking and listening, conceptualizing them as little, reasonably or well, remembering that the above options are required when registering the curriculum on the Lattes Platform, in the Language item.

2. What are the levels of publications based on the total number of papers published in English, papers indexed by the Web of Science, publications in journals with JCR, number of citations and the h index of the researchers.
3. After collecting all the necessary information, the statistical analysis of the data of this research began. Subsequently, the results were presented and discussed to elucidate the competencies in the English language self-assessed by Brazilian researchers in Chemistry and their publications in that language. Emphasizing that the English language categories evaluated are classified as reading, speaking, writing, and listening, and skill levels are measured in little, reasonable or good.

Results and Discussion

Geographic and population distribution of the selected programs

A total of 24 graduate programs with score 4 were evaluated from all the five regions of the county. The courses are distributed in all 5 regions of the country, with the South and Southeast regions (5 and 8 programs, respectively) being the most represented. Additionally, 10 programs were evaluated with the highest score (7), and these are located only in the Southeast and South regions at the states of São Paulo (5), Minas Gerais (1), Paraná (1), Santa Catarina (1) and Rio Grande do Sul (2). It should be noted that all graduate programs in chemistry with a score of 7 are in the Southeast and South regions of Brazil and, therefore, this does not constitute a bias in the selection.

According to data from the Brazilian Institute of Geography and Statistics (IBGE), the Brazilian regions with the highest *Gross Domestic Product* (GDP) are the Southeast (52.9%) and the South (17%) (IBGE, 2017). In addition, the largest state research funding agencies are found in the states of São Paulo (FAPESP), Santa Catarina (FAPESC), Rio Grande do Sul (FAPERGS) and Paraná (Fundação Araucária). Considering that the two regions have the highest GDPs and important financing organizations, it is possible to believe that this will enable universities to raise more financial resources, which allow for a better level of research, more qualified professors, and a greater level of students, which ends up creating a virtuous cycle. Funding for science in other regions of Brazil is predominantly of federal origin, and it should be noted that funds have become scarcer in recent years.

As for the gender of the 337 researchers studied, 60% of the overall total are male, and the results for each region are given in table 1. In all the programs studied, male researchers are the majority, from 53% to 66% of the total. In programs that score 4, the largest female

presence is in the South with almost 50% and the lowest in the Southeast with 35%. In the score 7 programs, women represent 41% in the Southeast and are in a smaller proportion in the South with 34%. Thus, comparing the graduate programs, it is clear that women in the Chemistry area are underrepresented. It is worth mentioning that the gender category was not considered as a determinant in the data collection step.

Table 1 – Gender of researchers by region

Regions	GRADE 4		GRADE 7		
	F	M	F	M	
Midwest	44%	56%	No Grade 7 programs in these regions		
Northeast	40%	60%			
North	44%	56%			
Southeast	35%	65%		41%	59%
South	47%	53%		34%	66%

Source: Elaborated by the authors

The academic profile of the researchers

To teach at a Brazilian higher education institution in the field of chemistry, most selection processes require a doctorate degree, postdoctoral experience and a research project on a well-defined and innovative theme. Thus, the academic career begins with a degree in chemistry (4 years), followed by a master's degree (2 years) and a doctorate (4 years), and in addition to the time spent on postdoctoral studies. In some cases, the master's degree does not need to be done, and the doctorate starts right after the end of the undergraduate course. Thus, a potential researchers/professors spends between 4 and 6 years after completing the undergraduate course before being able to apply for a faculty position at universities. The time spent on this path can be considered, to a certain extent, an indication of a professional's dedication to the academic career because between obtaining a graduate degree and a doctorate several career options may occur.

Figure 3 shows the number of years spent in obtaining undergraduate and doctoral degrees by professors working in level 4 and 7 graduate programs. It can be seen that until the early 1990s, several professors were hired shortly after completion of the undergraduate course. Studies at the doctoral level started to become more common from the mid-90s.

Considering the average time of 6 years between the end of the undergraduate course and the completion of the doctorate, the analyzed data show an average time of formation 8.8 years for researchers/professors in level 4 programs and 8.16 for level 7 programs. It should

be mentioned that cases of extreme intervals were observed in the different stages, such as the time between the end of graduation and obtaining a doctorate. up to 34 years old in programs with level 4 and up to 12 years old in programs with level 7. However, more recently, several graduate programs in Chemistry have instituted the so-called *direct doctoral degree*, i.e., excluding the stage corresponding to the master's degree. This practice, applied to students with solid scientific initiation experience, reduces the average time to obtain a doctoral degree by up to 2 years.

In order to understand the current dynamics of graduate education in Brazil, a brief retrospective, starting at the end of the military regime, is necessary. At this time there was a considerable incentive for science and technology by the government (HOSTINS, 2006), which resulted in the establishment of researchers/professors training programs, with scholarships, and in the offer of attractive salaries for university professors, acting in existing graduate programs.

At the same time, the National Postgraduate Plans were approved, which initially proposed improvements for universities, both financially and operationally, in the use of resources. In addition, proposals were made to create several federal universities, in order to serve all regions of the country and increase the number of courses offered.

Other contributions to improve university education were made by federal and state governments after the military regime, also with a strong effect on the history of Brazilian graduate studies. According to an analysis based on the latest reports from the Higher Education Census, carried out by INEP, it is possible to observe (Table 2) a significant increase in the number of faculty members with MSc and PhD degrees, between the period 1998 to 2018 (INEP, 2019).

Figure 3 – Years of training in undergraduate and doctoral courses for grade 4 **(a)** and grade 7 **(b)** courses

A

B

Source: Elaborated by the authors

According to the 2018 Higher Education Census, the qualification of higher education professors has been increasing each year, with more than 80% of the 384,000 university professors qualifying with a master's and/or doctorate (INEP, 2019). However, it should be noted that these data include several private institutions that can hire professors who have just graduated.

Table 2 – Number professors, in practice, in Higher Education, by degree of education

YEAR	Master	Increase from previous year (%)	Doctorate	Increase from previous year (%)
1998	45.2	-	31.073	-
2002	77.4	70.2	49.287	58.6
2008	114.537	48.0	77.164	56.5
2018	149.775	30.8	166.363	115.6

Source: Elaborated by the authors

Proficiency in English and other foreign languages

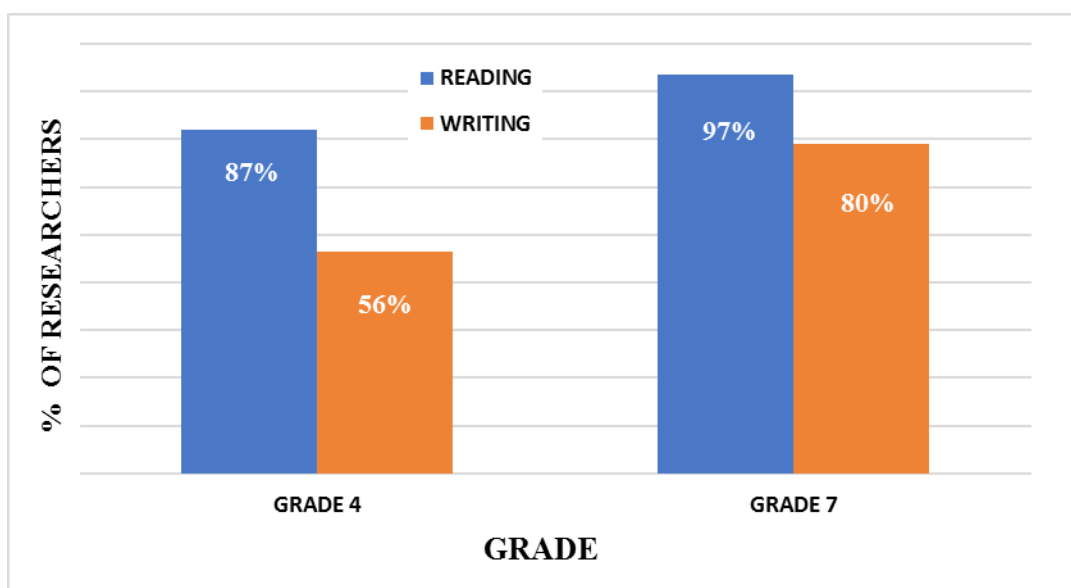
The Lattes Platform system allows self-assessment in English (and other languages) by the researcher, based on the four basic skills of reading, speaking, writing and listening. The analysis of these self-assessments, illustrated in figure 4, showed that reading is the best self-assessed category, with 87% of program researchers in the 4th level group and 97% in the 7th level group declaring that they have a good command of English for reading.

Iglesias and Batista (2010) point out that the high level of understanding of the English language in reading between students and teachers is related to national education issues, compatible with the National Curriculum Parameters for Foreign Language (PCN-LE), in which "... it is recognized that the use of language in our country is more related to this skill than to others."

In general, self-assessments of English language proficiency by researchers in chemistry showed positive results. In figure 5, it can be seen that level 7 programs have a higher incidence in the "good" category, with writing and comprehension being linked. On the other hand, in the group of 165 researchers referring to level 4 programs, 56% and 62% of the total rated their writing and comprehension skills as good, respectively.

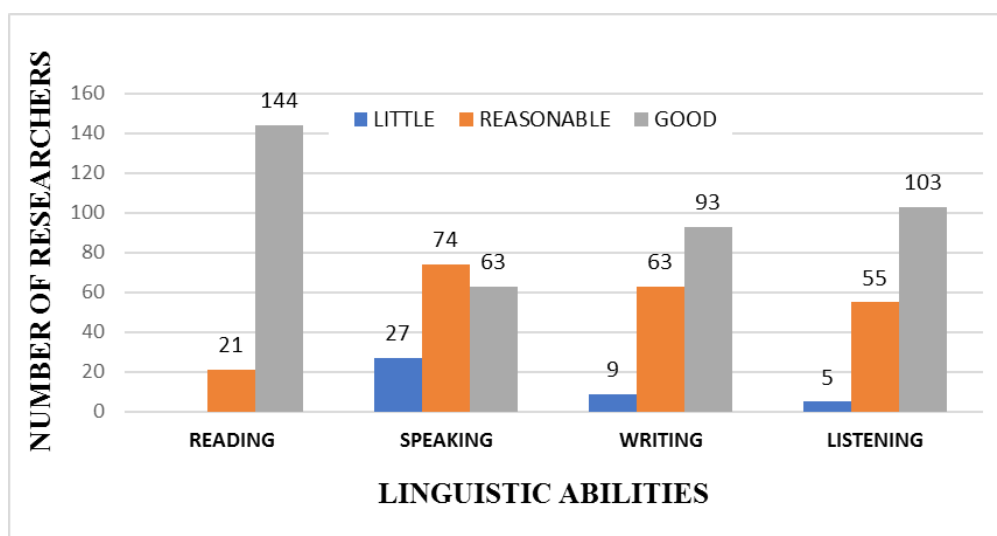
As for speaking, only 38% of researchers/professors linked to level 4 programs indicated that they speak English well, while level 7 programs, out of 172 researchers, this percentage was 69.7%. In addition, in level 7 programs, 80% of researchers claim to write and understand well.

Figure 4 – Percentage of lecturers who self-assess with good writing and reading in English - Groups 4 and 7

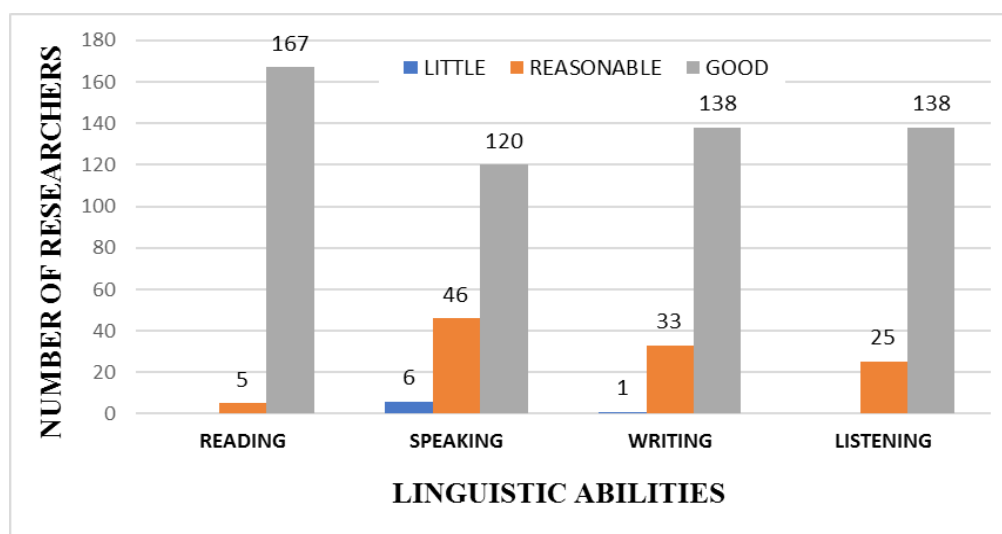


Source: Elaborated by the authors

Figure 5 – English-language skills self-assessed by graduate in Chemistry. **(a)** Grade 4 group; **(b)** Grade 7 group



(a)



(b)

Source: Elaborated by the authors

This may be associated with the fact that level 7 programs have more access to international exchange programs promoted by federal and state development agencies or simple lack of experience. In addition, universities with a tradition of scientific research tend to attract a greater number of international collaborations, in which English is the predominant language of communication. In view of this, it is possible to assume that

researchers linked to programs with level 7 have a greater opportunity for exposure to the English language than those belonging to level 4 programs.

The English language is dominant in science, according to Forratini (1997), who justifies that it is the language that allows communication between all peoples and nations, both in written and verbal form. On the other hand, Ortiz (2004) does not see an advantage for scientists who embrace the English language exclusively, characterizing them as “more limited than many Brazilian scientists”, because they read only in English, and Brazilian scientists, for the most part, endeavor to read in another language, more specifically English, French and Spanish.

Most researchers at the two levels studied, claim to have knowledge of two or three languages, of which English, Spanish, French, Italian and German are the ones that present the best self-assessments. From the results of table 3, it can be seen that self-assessments, referring to the French and Spanish languages, are better at reading and understanding than at speaking and writing.

Table 3 – Total publication and publication in English by group and by English speakers

Groups	Publications			Publications in English		
	Total Group	Fluent	%	Total Group	Fluent	%
GRADE 4	8.115	4.919	60.6%	6.879	4.312	62.7%
GRADE 7	14.320	11.841	82.7%	13.273	11.037	83.2%

Source: Elaborated by the authors

English language proficiency versus total publications

The need for fluency must be recognized to establish effective communication in any language, based on the four basic skills: reading, speaking, writing, and listening. In the Brazilian educational scenario, this situation seems to be quite different, more specifically in elementary education, in which reading, and writing receive more attention in the teaching of a foreign language.

According to Celani (2009), the 1998 National Curriculum Parameters (PCNs) for Foreign Language emphasize reading and writing the foreign language instead of the four skills, because the large number of students per classroom and the low weekly workload for students. Thus, considering the situations pointed out by Celani (2009), the present analysis was restricted to the best qualifications self-assessed by the researchers (reading and writing), considering that both are of primary importance in the making of a scientific publication.

Thus, in this analysis, researchers will be designated as fluent and non-fluent in English for the treatment of the results obtained.

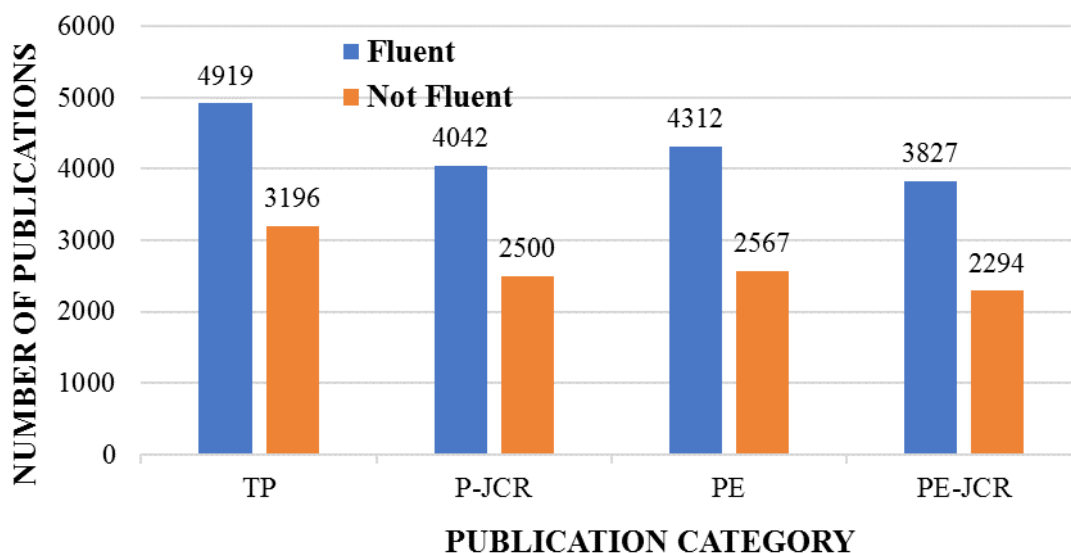
It can be seen in Figure 6 that reading is the most developed skill among researchers, with 87% in the level 4 group and 97% in the level 7 group. On the other hand, writing skills, despite their extreme relevance to communication, is considerably less developed compared to reading, corresponding to 56% of the total of 144 researchers in level 4 programs and 80% of the total of 172 researchers in level 7 programs. Reading and writing in English, according to the norm's language, specific terms in the field of science and others, is not a simple and easy task for individuals who are not born native speakers and are starting their scientific careers.

For Cunha *et al.* (2014), graduate students in psychiatry consider that the obstacles to the preparation of papers in English stem from a small ability to write, including meeting the requirements of the journals and ignorance of scientific terms. As a way to overcome this obstacle, this same study points out the need to offer courses in writing papers in Portuguese and English for graduate students.

Considering the reading and writing skills presented by the evaluated researchers, the results of their publications were categorized as total publications (TP), which were divided into publication with JCR (PA-JCR), publications in English (PA) and publications in English with JCR (PE-JCR). Figure 6A shows the publications of researchers referring to level 4 programs, and it can be seen that the number of publications is considerably higher for those classified as fluent in the English language. In relation to the TPA category, the number of publications is 54% higher for fluent researchers, as reflected in the other aspects analyzed, 62% for PA-JCR, 68% for EA-JCR, 67% for AE and 67% for the AE-JCR.

Among level 7 researchers, the data in figure 6B indicates a similar scenario to level 4, with the divergence between researchers being much more extensive. The total publication is 378% higher for researchers fluent in English, in addition P- JCR with 10,323 publications for fluent researchers against 2,113 for non-fluent and also the PE and PE-JCR of whom reading and writing well show a high difference of 394% and 388%, respectively, more than those who do not have the same performance in English.

Figure 6 – Number of publications: **(a)** Group 4 and **(b)** Group 7. TPA = Total Publications; PA-JCR = Publications with JCR classification; PE = Publication in English; PE-JCR = Publication in English with JCR classification



(a)



(b)

Source: Elaborated by the authors

Relating the results of the groups, in the same aspects of the publication, the percentage of TPA in the group of programs with level 7 is 141% higher than in the group of programs with level 4 and, on average, 156% higher publication with P-JCR, in English (PE) and in English with JCR (PE-JCR). Thus, it is observed that researchers fluent in English, with good reading and good writing skills, are more productive and have better evaluated articles than those who are not fluent. In the two groups analyzed, it is possible to verify

(Table 4) that the production of knowledge in Chemistry is quite expressive, more in English than in Portuguese. In the level 4 programs, it can be seen that 84.7% of all the group's publications (8,115 publications) are in English and, for Group 7, the percentage is 92.7% (14,320 publications) of publications in English related to total production (fluent and non-fluent).

Again, researchers considered fluent in English appear in a relevant majority, in the list of publications in English and in the total number of publications. The analysis of the group of programs with a level of 4 indicates that 60.6% of all publications and about 63% of publications in the English language come from researchers who read and write well. In the same characteristics is the group of programs with level 7, with 82.7% of the total publications and 83.2% of the publications in English made by researchers with good competence in reading and writing in English. Thus, it can be concluded that Brazilian scientists are committed to producing in another language, with the purpose of increasing their visibility and scientific qualification, in addition to increasing the notoriety of Brazilian science in the world scientific scenario. Schütz (2006, p. 6) justifies that “knowledge and proficiency in the global language is today a basic qualification of the individual, both for his academic and professional career”.

Table 4 – Articles published in Web of Science - Groups 4 and 7

English	Professors		Publications WoS				≅ Publications		≅ Citations		≅ h-index	
	4	7	4	%	7	%	4	7	4	7	4	7
Fluent	93	138	4198	63	11108	83	4514	8049	672.1	1497.6	12.91	19.22
Not Fluent	72	34	490	37	2213	17	3458	6509	447.0	1055.5	9.99	17.76
Total	165	172	6688		13321	-	-	-	-	-	-	-

Source: Elaborated by the authors

Correlation English fluency with publications in WoS, citations and h-index

In order to establish an analysis that presents results that ratify the data presented so far, new aspects were evaluated in both groups regarding the number publications in the Web of Science (WoS) database, citations and the researchers' h index.

Silva and Grácio (2017) agree that the h index is “an evaluative parameter considered robust, as it simultaneously evaluates aspects related to production (quantity of papers produced) and impact (number of citations)”. Thus, for the same reason, the h index was also considered as an extremely important factor for the analysis, as shown in table 4.

Considering the number of publications in the WoS database, researchers fluent in English are at an advantage in both groups, with 63% (out of 6,668 publications) in the level 4 program group and 83% (out of the total 13,321 publications) in the level 7 program group. By the analysis of the production of each group, it can be seen that, in the group of programs with level 4, the publication by researchers with good reading and writing in English was over 68% in relation to those who reported reading and writing reasonably.

When considering the total of 14,320 complete publication by the Level 7 group and that 13,321 (93%) are included in the WoS database. The same observation is valid for publications by the level 4 group, in which 82% of papers indexed in WoS are in English.

When observing the average number of publications, citations, and h-index of the two groups, it is evident that the researchers with better reading and writing skills produce more publications and, in English, that they obtain an average of citations per publication higher than those who are not fluent. In the level 7 group, the average is 1,497 citations (fluent), which represents 41.89% more than the 1,055 citations of the non-fluent group.

Following the same reasoning, it is a well-known fact that the number of publications and the number of citations of these papers affect the researcher's h index. In the results presented in Table 4 (for fluent), the highest averages of this indicator follow the highest averages of publications and citations, with the level 4 group with 12.91 and the level 7 group with 19.22. In other words, the two fluent groups obtain better results when compared to those who are not proficient in the English language, determining that researchers with the best reading and writing assessments have the highest h-index values.

Marques (2017, s/p) argues that:

one cannot use the h-index to compare researchers at different stages of their careers - a senior researcher with an h-100 index in the field of chemistry can be proud of being extremely productive, as well as a young researcher of the same area that has an h-index 30.

It is important to be aware that the participants of this research are at different times in their academic and scientific life, but the use of the h index is justified due to its relevance in the qualification of scientific production, as an aggregator of the proposed analysis. It was not used as a single criterion to measure the selected data of the research participants, but it was added to others, such as the number of publications, in total and on the Web of Science, the number of citations per paper, publications in English, among others.

Although all the analyzes and interpretations carried out in this research were based on the self-declarations extracted from the researchers' Curriculum Lattes, it must be recognized

that this does not characterize proficiency in English, in fact, it exists if properly evaluated. According to Zanella (2016), the assessment of proficiency in a foreign language must consider factors such as skills and objectives. The degree of proficiency appropriate to the individual is very specific and is related to their ability at the time that best suits them, whether for an international trip, for business or leisure, professional progression; entry into a postgraduate program and others, as it is a private assessment and measured by the researcher himself.

Final Considerations

The results of this study show that the self-assessment of the English language is quite diversified for researchers in the four skills of reading, speaking, writing and listening, with almost 60% of researchers in score 4 programs self-assessing with good writing and listening skills. As for score 7 programs, 80% of researchers say they write and understand well. This directly influences the amount of scientific publication in journals with JCR and the number of publications in English and in high-JCR journals. Chemistry researchers invest in the publication of their studies in English and in quality journals, in order to disseminate their research, to qualify the graduate programs in which they work and to develop the academic environment, obtaining resources that can contribute with scholarships and technology for educational institutions. The results indicate that 63% of the papers are indexed in the WoS for score 4 and 83% for the score 7, are from fluent researchers. The same situation on average is seen for publications, citations and h-index, that is, those who read and write better in English showed better results in terms of quantity and quality. It is logical that this is a reflection of a specific group and that, in the face of so many difficulties that Brazilian education faces for a foreign language to be applied in Brazilian public schools, it is up to the government to establish public policies for the teaching of the foreign language. However, this establishment, regardless of English, Spanish or French, must meet the specificities of each region and causing this teaching to start earlier and earlier, in the first levels of the school, with the aim of arousing in young people the interest and pleasure of learn another language.

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