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CHEMICAL EDUCATION IN BRAZIL

EDUCAÇÃO QUÍMICA NO BRASIL

EDUCACIÓN QUÍMICA EN BRASIL

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ABSTRACT
This work seeks to describe the main facts and events related to the evolution of Chemical Education in Brazil, beginning in 1808 with the arrival of King John VI in Brazil, which is recorded as his first favorable achievement for Science and Chemistry (ROSA and TOSTA, 2005). Before the creation of Chemistry Courses, chemistry-related disciplines existed in the curricula of other Courses, but this is the beginning of Chemical Education. Subsequently, research was carried out on Chemistry Courses. To understand the development of Chemical Education in Brazil, this work addressed the following topics: a) The Role of Chemistry Educators; b) Chemistry Textbooks; c) Institutions that promote Chemical Education in Brazil; d) Events in the field of Chemistry; e) Main Journals that publish articles related to Chemical Education; f) Directories of the CNPq Chemical Education Research Groups; g) Dissemination and/or competitiveness activities of Chemical Education. Therefore, it is expected that this work will collaborate with chemistry educators.

Keywords: Chemical Education. Chemistry Educators. Chemistry Teaching.

RESUMO
Procurou-se descrever neste trabalho os principais fatos e acontecimentos referentes a evolução da Educação Química no Brasil, iniciando-se em 1808, com a chegada de D. João VI ao Brasil, sendo registrado como sua primeira realização favorável à Ciência e à Química (ROSA e TOSTA, 2005). Antes da criação dos Cursos de Química, disciplinas relacionadas com a química existiam nos currículos de outros Cursos, mas é aí o começo da Educação Química. Em seguida pesquisou-se sobre os Cursos de Química. Para se entender o desenvolvimento da Educação Química no Brasil, foram abordados neste trabalho os seguintes temas: a) Atuação dos Educadores de Química; b) Livros Didáticos de Química; c) Instituições que impulsionam a Educação Química no Brasil; d) Eventos na área da Química; e) Principais Revistas que publicam artigos referentes a Educação Química. f) Diretórios dos Grupos de Pesquisa em Educação Química do CNPq; g) Atividades de Difusão e/ou competitividade da Educação Química. Desta forma, espera-se que este trabalho colabore com os educadores de química.

Palavras-chave: Educação Química. Educadores de Química. Ensino de Química.

RESUMEN
Este trabajo busca describir los principales hechos y eventos relacionados con la evolución de la Educación Química en Brasil, comenzando en 1808 con la llegada del Rey Juan VI a

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Brasil, que se registra como su primer logro favorable para la Ciencia y la Química (ROSA y TOSTA, 2005). Antes de la creación de los Cursos de Química, las disciplinas relacionadas con la química existían en los currículos de otros Cursos, pero este es el comienzo de la Educación Química. Posteriormente, se realizó una investigación sobre los Cursos de Química. Para comprender el desarrollo de la Educación Química en Brasil, este trabajo abordó los siguientes temas: a) El Rol de los Educadores de Química; b) Libros de Texto de Química; c) Instituciones que promueven la Educación Química en Brasil; d) Eventos en el campo de la Química; e) Principales Revistas que publican artículos relacionados con la Educación Química; f) Directorios de los Grupos de Investigación en Educación Química del CNPq; g) Actividades de difusión y/o competitividad de la Educación Química. Por lo tanto, se espera que este trabajo colabore con los educadores de química.

Palabras clave: Educación Química. Educadores de Química. Enseñanza de la Química.

1 INTRODUCTION

Education: The process of acting on the individual, in order to take him to a state of maturity, which enables him to encounter his reality in a conscious, balanced and efficient way, and to act in it as a participating and responsible citizen (NÉRICI, 1981). **Chemical Education**: it is the branch of Education applied to the area of Chemistry, and, therefore, when we are chemically making people aware to act correctly, mainly to protect their health, their well-being and that of others, as well as the preservation of the environment, we are applying Chemical Education. As examples, we can mention: expiration date of a product; air and water pollution; proper use of garbage; sustainability; vegetables, legumes and fruits treated with pesticides.

Chemical Education is not only dealt with in the classroom, but in the environment in which the community lives. Thus, any work, whether scientific, technological or industrial in the area of chemistry, that fulfills this role, will be treated as Chemical Education. **Teaching**: Instruction, indoctrination, transmission of knowledge or modification of human conduct, effort directed towards training (NÉRICI, 1981). **Chemistry teaching** is the transmission of knowledge of Chemistry contents. All research in this area has as its main objective the improvement of the Teaching of Chemistry.

2 HISTORY OF CHEMISTRY COURSES IN BRAZIL

2.1 CHEMISTRY DISCIPLINES

Before the creation of Chemistry courses, there were disciplines related to chemistry contents in several courses, such as: a) Medical-Surgical College of Bahia, in 1808; b) Medical College of Rio de Janeiro, in 1808 (ROSA and TOSTA, 2005); c) Royal Military Academy, 1810.

In Brazil, the first chemistry classes began to be taught at the Royal Military Academy, at the Medical Schools of Bahia and Rio de Janeiro (ALMEIDA and PINTO, 2011).

The first chemistry laboratories in the country were: the laboratory of the Count of Barca (1808) and the Chemical-Practical laboratory of Rio de Janeiro (1812-1819), which had as its basic premise the analysis of materials from the various Portuguese colonies, which could be used in trade, especially between the Portuguese and Chinese. In 1824, the Chemical Laboratory of the National Museum (1824-1931) was created to enable the analysis of national materials, both vegetable and mineral. In this laboratory, in addition to the analysis of brazilwood and national minerals, chemistry classes were taught at the Higher Schools

and the Collegio de Pedro II, and research was carried out in toxicology and forensic medicine (AFONSO & SANTOS, 2009).

A great boost to the teaching of chemistry in the country is due to the Royal Tableer of 28/01/1817, signed by D. João VI (CABRITA, 1921). Although the regulation of 31/01/1838 (LEIS, 1838) provided for the installation of a chemistry laboratory at Colégio Pedro II, its implementation took place later.

During the nineteenth century, the courses of medicine and pharmacy consolidated chemistry as a discipline for the training of their professionals. In decree 1.387 of 28/04/1854 (BRASIL, 1854), there was a subject (discipline) of "Chemistry and mineralogy", in the 1st year of the course, and another of "Organic Chemistry" in the 2nd year (O VELHO BRAZIL, 1854). In 1892, at the Faculty of Medicine of Rio de Janeiro, chemistry was divided into three disciplines: "medical inorganic chemistry" (1st year), "organic and biological chemistry" (2nd year) and "analytic and toxicological chemistry" (3rd year) (PROGRAMAS, 1892).

At that time, factories depended on the importation of technicians, along with equipment, processes and raw materials, due to the total lack of schools that prepared professionals for the chemical industries, to, for example, analyze the water and coal that fed the boilers of the locomotives of the D. Pedro II Railroad (CORREIO MERCANTIL, 1868).

2.2 CHEMISTRY COURSES

The first chemistry course that appeared in Brazil was in the early 10s of the twentieth century. The first course was industrial chemistry, technical level, at Makenzie College, which, four years later, in 1915, became a higher education course. In the same year, the Oswaldo Cruz School of Chemistry was created (SANTOS, PINTO and ALENCASTRO, 2006).

In the case of Mackenzie College, the architect behind the course was the British Alfred Cownley Slater (1873–1958), a graduate in chemistry, geology, and pedagogy, who arrived in Brazil in 1901. The chemistry course created by the school, lasting two years, arose from a practical experience. It is considered the first effective chemistry course to operate in the country, although it was better framed as technical rather than higher. It is estimated that, by 1933, 150 to 200 professionals had completed this course (EDITORIAL, 1933).

In 1910, Prof. Jacques Arié (1878-1936), from the Luiz de Queiroz School of Agriculture in Piracicaba, proposed to the Secretary of Agriculture of the State of São Paulo a course in agricultural industrial chemistry, lasting 3 years (CORREIO PAULISTANO, 1910). Industrialists who needed chemical services were forced to import from Europe chemists

who, if at times proved to be excellent experts, at other times, however, proved to be true castaways of their professions (BAHIANA, 1932). Chemistry disciplines were taught in the Higher Schools of Agriculture and Veterinary Medicine, founded in Pernambuco in 1912 by Benedictine monks. The curricula of these schools had a strong chemistry content, approaching the German pedagogical model, the agricultural chemistry of Justus Liebig. These schools, in 1967, became the Federal Rural University of Pernambuco. Perhaps this is one of the reasons why so many agronomists have had and have great prominence in Brazilian chemical science (MAGALHÃES & DE ALMEIDA, 2009).

The Álvares Penteado School of Commerce proposed a course in "industrial chemistry and dyeing" (CORREIO PAULISTANO, 1913a), to be held in two years. The establishment stated that it was the first industrial chemistry course in the country (CORREIO PAULISTANO, 1913b), and the incentive to industries would further accelerate the development of the State of São Paulo. At the beginning of 1914, the course changed its name: merceology and industrial chemistry (CORREIO PAULISTANO, 1914).

In 1915, the School of Chemistry of the Oswaldo Cruz School (O PAIZ, 1915) was created, directed by Prof. Henrique Potel, and with a qualified faculty.

In 1918, the Institute of Chemistry was created, idealized by physician Mario Saraiva and directed by him for twenty years. At the origin of this institute is the Laboratory for the Defense and Inspection of Butter, whose main purpose was the analysis of butter consumed in Brazil, all of it imported from France until the end of the 20s of the twentieth century.

In 1934, it received a new name: Institute of Agricultural Chemistry - IQA and a new regulation. The sections of Chemistry, Mineralogy and Genesis of Soils, Plant Food and Research, Corrective and Defensive Agents of Crops were created, as well as a special section that was responsible for research on medicinal plants (RHEINBOLDT, 1955, p. 66).

The explosion of regular chemistry courses would only occur after the article "Let's do chemists", by the pharmacist graduated from the Faculty of Medicine of Bahia, José de Freitas Machado (1881-1955), published in 1918 in the Revista de Chimica e Physica e de Sciencias Histórico-Naturaes. The presence of José de Freitas Machado (Figure 1) in the chemistry scene in the country extended until 1946, when he retired from the National School of Chemistry, currently the School of Chemistry of the Federal University of Rio de Janeiro, of which he was the first director (1934-1935) (AFONSO & SANTOS, 2009).

Figure 1

José de Freitas Machado

Source: Santos, Pinto and Alencastro (2006).

Efforts arose to create chemistry courses, so that the country could take advantage of its immense natural wealth and develop its industry, with emphasis on the actions of Deputy Cincinato Braga and Professor José de Freitas Machado. At that time, chemistry represented the main lever of the industrial sector in the developed world (SANTOS, PINTO and ALENCASTRO 2006). On 01/05/1920, Law 3.991 (BRASIL, 1920) was sanctioned, which provided for the creation of nine industrial chemistry courses in the main Brazilian cities.

In an ordinance of 17/06/1920, José de Freitas Machado was appointed Director of the industrial chemistry course at the School of Agriculture and Veterinary Medicine - ESAMV (BRASIL, 1920). The course began on June 10 of that year (CORREIO PAULISTANO, 1920a; JORNAL DO COMMERCIO, 1920), after adapting rooms for conversion into chemistry laboratories (RELATORIO, 1921). There was a reduced number of student enrollments, including one girl (MACHADO, 1953). This was the first of the courses to operate (CARVALHO, 1979). The one at the Polytechnic School of Rio de Janeiro (CORREIO PAULISTANO, 1920b) began its activities in August 1920.

The first class (nine students) to complete the industrial chemistry course was that of the School of Agriculture and Veterinary Medicine – ESAMV (ALMEIDA, 1923; O PAIZ, 1923). In 1926, the Industrial Chemistry Courses underwent the first reform, going from 3 to 4 years, the last dedicated to industrial specialization work (EDITORIAL, 1931).

Another important milestone was the creation, in 1959, of the Institute of Chemistry of the University of Brazil. The regulations of this institute were only approved in 1962. Professors João Christóvão Cardoso (National Faculty of Philosophy - FNFi), Athos da Silveira Ramos (Professor at the National School of Chemistry and FNFi) and João Cordeiro da Graça Filho (Professor at the National School of Engineering) participated in its elaboration. The first CEO of the Institute was Professor Athos da Silveira Ramos (AFONSO & SANTOS, 2009). The graduate program was born in 1963, at the Institute of Chemistry, when the organic chemistry and biochemistry courses were created.

Table 1 lists the Chemistry Degree courses in Brazil in the period from 1930 to 1965.

Table 1

Chemistry Degree Courses in Brazil from 1930 to 1965

Institution	Course Start Year
Catholic University of Pernambuco	1943
Federal University of Minas Gerais	1943
Federal University of Bahia	1943
Federal University of Rio Grande do Sul	1944
Federal University of Ceará	1958
São Paulo State University Júlio de Mesquita Filho	1961
University of Uberaba	1961
University of Brasilia Foundation	1962
Federal University of Amazonas	1963
Faculty of Philosophy, Sciences and Letters of Ribeirão Preto-USP	1964

Source: INEP ((MESQUITA and SOARES, 2011).

The Short Degrees consisted of teacher training courses on a "light" basis, which were implemented in the early 1970s and became known as Scheme I, for higher education professionals, and Scheme II, for secondary level professionals. These courses were standardized by the Opinions of the Federal Council Nos. 111 and 151, of 1970 (SILVA, 2004).

Despite all the manifestations against short degrees, these were only completely extinguished in 1999, with Resolution No. 2 of the Chamber of Higher Education, which provides for the plenification of short degrees (BRASIL, 1999).

Table 2 lists the Chemistry Teaching Degree courses in Brazil in the period from 1965 to 1990.

Table 2

Chemistry Degree Courses in Brazil from 1965 to 1990

INSTITUTION	BEGINNING OF COURSE (Year)	CATEGORY ADMINISTRATIVE
Federal University of Santa Maria	1965	Federal Public
State University of Campinas	1967	State Public Schools
University of Mogi das Cruzes	1967	Private Private
State University of Paraíba	1967	State Public Schools
Federal University of Pernambuco	1967	Federal Public
Faculty of Philosophy, Sciences and Letters Souza Marques	1968	Private Community/Confessional/Philanthropic
Regional University of Blumenau	1968	Municipal Public
North University of Paraná	1968	Private Private
Oswaldo Cruz College	1969	Private Private
University Center of the Barretos State Foundation	1969	Private Community/Confessional/Philanthropic
Pontifical Catholic University of Rio de Janeiro	1969	Private Private
Federal Rural University of Rio de Janeiro	1969	Federal Public
Federal University of Maranhão	1969	Federal Public
Federal University of Mato Grosso	1970	Federal Public
Federal University of Rio Grande do Norte	1970	Federal Public
Fluminense Federal University	1970	Federal Public
Federal University of Juiz de Fora	1970	Federal Public
University of Guarulhos	1971	Private Private
Federal University of Sergipe (in extinction)	1971	Federal Public
Federal University of São Carlos	1971	Federal Public
State University of Maringá	1971	State Public Schools
Federal University of Viçosa	1972	Federal Public
Federal University of Pará	1972	Federal Public
Federal University of Santa Catarina	1973	Federal Public
University of São Paulo (São Carlos)	1973	State Public Schools
State University of Londrina	1973	State Public Schools
Federal University of Uberlândia	1974	Federal Public
Federal University of Rio Grande do Norte Foundation	1974	Federal Public
Federal University of Pernambuco	1974	Federal Public
University of Western São Paulo	1975	Private Community/Confessional/Philanthropic
Mackenzie Presbyterian University	1976	Private Community/Confessional/Philanthropic
Salesian Catholic University Center Auxilium	1976	Private Community/Confessional/Philanthropic
Federal University of Paraíba	1977	Federal Public
Federal University of Alagoas	1979	Federal Public
University of Passo Fundo	1980	Private Community/Confessional/Philanthropic
Santa Cruz State University	1980	State Public Schools
State University of Rio de Janeiro	1980	State Public Schools
Federal University of Mato Grosso do Sul	1981	Federal Public
Catholic University of Pelotas	1983	Private Private
Federal University of Goiás	1985	Federal Public
Pontifical Catholic University of Rio Grande do Sul	1985	Private Community/Confessional/Philanthropic
University of France	1985	Private Private

University Center of Patos de Minas	1987	Private Community/Confessional/Philanthropic
University of Grande Rio Prof. José De Souza Heroly	1987	Private Community/Confessional/Philanthropic
Federal Rural University of Pernambuco	1988	Federal Public
University of Santa Cruz do Sul	1988	Private Community/Confessional/Philanthropic
Federal University of Espírito Santo	1988	Federal Public
University of the Sacred Heart (endangered)	1989	Private Community/Confessional/Philanthropic
University of Southern Santa Catarina	1990	Private Community/Confessional/Philanthropic
Camilo Castelo Branco University	1990	Private Community/Confessional/Philanthropic

Source: (MESQUITA and SOARES, 2011).

It is noteworthy that the increase in the number of Chemistry Degree courses continued in the 90s of the twentieth century, and from 2000 to 2010, mainly as a result of the enactment of Law 9394/96, which determined the training in full licensure as a minimum requirement for the exercise of teaching in Basic Education. In 2011, there were a total of approximately 318 Chemistry Degree courses created in the country since 1930 in Brazil. Of these, about 70 are paralyzed or extinct (MESQUITA and SOARES, 2011). According to the Higher Education Census carried out annually by the National Institute of Educational Studies and Research Anísio Teixeira (INEP), in the period from 2012 to 2013, enrollment grew 4.4% in bachelor's degree courses and only 0.6% in Teaching Degree courses (FADIGAS, 2019).

Bachelor's degree courses have a participation of 67.5% in the enrollment of new students in higher education, while Bachelor's degree courses participate with 18.9%, and technological courses only with 13.7%.

About the Degree in Chemistry; Jesus, Araújo and Vianna (2014) state that in the period from 2000 to 2012, "there was an increase of 759.0% in face-to-face vacancies, totaling 108 thousand vacancies". However, this increase in the number of vacancies does not reflect the proportional growth of enrollments in the Chemistry Degree course and, consequently, does not follow the growing demand for Chemistry teachers for High School.

The offer of Undergraduate Courses in Chemistry in Distance Learning is relatively new, having started in 2005, with the offer of the course by the Federal University of Rio Grande do Norte (UFRN). In 2018, there were 23 Distance Learning Chemistry Degree courses, for a total enrollment of 6,967, and of this total, almost half of the enrollments were made in private institutions and, of the total enrollments, 2,386 were carried out by federal public universities (AZEVEDO, 2020).

3 DEVELOPMENT OF CHEMICAL EDUCATION IN BRAZIL

According to Afonso et al. (2019, p. 4), since the 1st Brazilian Congress of Chemistry - CBQ, held in 1922, there was already a concern with the education and teaching of chemistry in the country, with two main purposes: a) for the purpose of training qualified professionals, to face the challenges caused by the backwardness of the national chemical industrial sector; b) to give the chemistry taught in technical and secondary education (now secondary) in tune with the evolution of technological advances.

The creation of the chemistry degree courses in the 30s of the twentieth century resulted from the training needs of professionals who would come to meet the educational project of urban-industrial Brazil.

The number of students who opted for a career as secondary school teachers was not significant. A survey carried out by Beisiegel cited by Schnetzler (2002), points out that in the period from 1937 to 1965, only 38 of the 316 students graduated from the Department of Chemistry at USP made a professional option for secondary teaching.

Around the 60s of the twentieth century, science books of American origin were introduced in Brazil through the University of Brasília – UnB, such as: Química CBA – Sistemas Químicos (Chemical Bond Approach Project), figure 1, and Química – uma ciência experimental (CHEMS - Chemical Education Material Study), figure 2, soon assimilated and adopted in Brazilian universities. These books highlighted: structures, chemical bonds and energy, subjects described precariously in Brazilian books.

They introduced the language of graphics and some laboratory procedures that aimed to make the student a true investigator, discovering information, planning experiments to solve a problem, and even extending their investigations beyond the frontier of current chemistry.

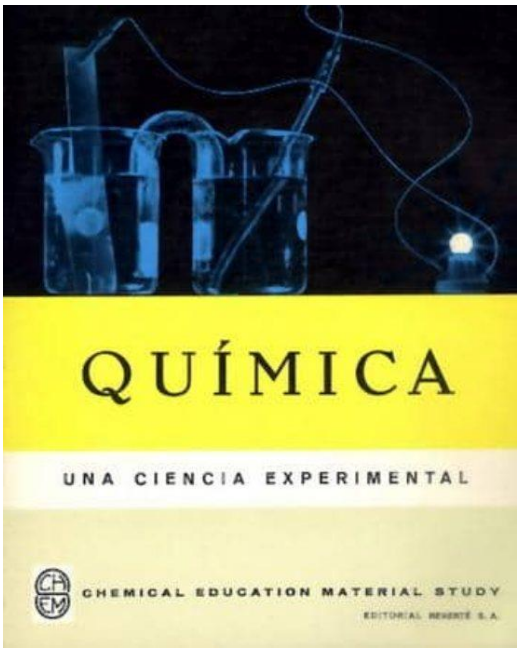
Figure 2

Cover of the CBA Chemistry Book

Source: Virtual Bookshelf (2022).

Figure 3

Chemistry Book Cover an Experimental Science



Source: Livraria Traça (2022).

Before the 70s, few professors were concerned with the Teaching of Chemistry, especially with research in this area. There were few chemistry books by Brazilian authors, which were practically prepared with theoretical content and exercises.

Chemistry teachers transmitted the contents of the books, with little association with everyday life. The Teaching of Chemistry has evolved in recent decades. The 60s and 70s saw many changes in chemistry courses, both in terms of content and methodology, which can be proven by the numerous innovative teaching projects that emerged in the United States and the United Kingdom, mainly bringing proposals for new methodological approaches and giving the great tribute of updating the contents transmitted in the 2nd Grade school (CHRISPINO, 1989, p. 17).

In the 70s of the last century, improvements in the teaching of chemistry in universities began, with groups of professors concerned with proposing changes in the methodology used by the professor in the transmission of content to students.

At the time, the groups formed at the Universities of Rio Grande do Sul, São Paulo, Minas Gerais, Rio de Janeiro and Unicamp stood out.

At the end of the twentieth century, new groups were consolidated in several HEIs in the country. Research in chemical education in Universities, Federal Institutes, Elementary and High Schools and Research Centers with the objective of making the teaching of chemistry more understandable and attractive to students stands out. The works related to Chemical Education are disseminated in magazines, congresses and science fairs. There are also other events related to chemistry, with emphasis on the Chemistry Olympics and Marathons. Other works are: Doctoral Theses, Master's Dissertations, Monographs and TCCs.

It is important to highlight the fact that the 80s of the twentieth century constituted a milestone for the area of chemical education, both for proving to be fruitful in relation to the organization of the constituted area and in relation to the "new" freedom of expression of ideas, considering the moment of political transition from dictatorship to democracy.

Such freedom enabled the area to influence public educational policies with more emphasis than during the period of the Military Regime (MESQUITA and SOARES, 2011). From the 80's on, a new field of research has been standing out in Brazil: the area of research in Chemistry Teaching, as initial milestones, the holding of the 1st Meeting of Debates on the Teaching of Chemistry – EDEQ, organized in 1980 by Áttico Chassot, in Rio Grande do Sul and, in 1982, the 1st National Meeting of Chemistry Teaching – ENEQ, carried out at the

Institute of Chemistry of the State University of Campinas - UNICAMP (FRANCISCO, 2006, p. 14).

Chrispino (1989, p. 17) classifies chemical education into 3 periods: a) the principle of teaching chemistry as an academic subject in the school curriculum; b) adaptation and reform of the existing curriculum in its various segments; c) it is still ongoing, which is the consequence of the analysis of successes and errors of the existing curricula, which observes the advance of Chemistry in its most diverse sectors, requiring a new change in the curriculum carried out from the achievements of the past (CHRISPINO, 1989, p. 17).

The Curricular Guidelines for High School were prepared based on extensive discussion with the technical teams of the State Education Systems, teachers and students from the public school system and representatives of the academic community. The objective of this material is to contribute to the dialogue between teacher and school about teaching practice (BRASIL, 2006).

During the 80s and 90s of the twentieth century, the main milestones related to the development of the area of Chemical Education in Brazil were, according to Schnetzler (2002): a) the insertion of the group of researchers in chemistry teaching; b) the organization of regional and national meetings to discuss issues of chemistry teaching at various levels of schooling in the country; c) the creation of the journal Química Nova na Escola; d) the increase in the number of masters and doctors with research directed to themes of chemical education and the consequent increase in the number of publications, including books and articles, to disseminate the results of research developed in the academic environment.

Among the researches developed, some were directed to the issues of the teaching-learning process of chemical concepts in High School and others focused on issues of the training of chemistry teachers. The teaching degrees in general and in chemistry, more specifically, which still operated in the 3+1 model, sought to adapt their proposals to the formative needs that presented themselves in the sense of overcoming the technicist view of education, which was a remnant of the educational conception from the perspective of militarism.

Freitas (2002), when discussing the clashes involved in teacher training policies in Brazil, tells us about the situation in the context of the 1980s:

The 80s represented the rupture with technicist thinking that predominated in the area until then. In the context of the training movement, educators produced and evidenced advanced conceptions about educator training, highlighting the socio-historical character of

this training, the need for a professional of broad character with full mastery and understanding of the reality of his time, with the development of critical awareness that allows him to interfere and transform the conditions of the school, education and society.

According to Silva (2011, p. 8), in 2011, the following situation was observed for the Teaching of Chemistry in Brazil:

I) Chemistry Teacher Training in HEIs is deficient due to the following aspects: a) with exceptions, most chemistry teachers in HEIs have a bachelor's degree and few have a degree; b) the predominant methodology is still the traditional class; c) didactic chemistry laboratories of the HEIs are becoming obsolete; d) lack of interest of graduates in the teaching profession. There are other aspects, but these are pointed out as the main ones. There is a need for Chemistry teachers in HEIs to discuss the training of chemistry teachers in more depth in the search for reducing the current deficiency.

II) The predominant methodology is not one of the best for teaching chemistry. Most teachers do not try to alternate traditional classes with other more attractive and efficient methodologies, which make the transmission of chemistry content more pleasant.

III) Laboratory is another complicated problem, both in high school and in higher education. Some high schools do not have adequate chemistry laboratories for experimental classes, there is a lack of teachers assigned for this purpose, and the number of weekly classes per class is few, already insufficient for classes considered theoretical. Many schools that have a laboratory face another problem, the scarcity of resources for their maintenance.

IV) The improvement of the Teaching of Chemistry passes through the teacher's salary. Generally, the starting salary of some professionals in other professions varies between 3 and 5 thousand reais. That of most teachers, especially in the North and Northeast of Brazil, even with a few years in high school teaching, is between 2 and 3 thousand reais. The discouragement of the class is great. Researchers in the field of education say that the lack of interest in being a teacher occurs mainly due to the low salaries paid in teaching and the low social valuation of the career.

V) Students' disinterest is a negative factor for the teacher, in which they often do not study the knowledge that is taught in a class. VI) Decrease in the Training of Graduates At the beginning of 2010, the Higher Education Census shows that Brazil trains fewer and fewer teachers. The biggest drops from 2006 to 2007 were in the areas of Languages (-10%), Geography (-9%), Chemistry (-7%) and Philosophy (-5%). In absolute numbers, there were 3.3 thousand fewer graduates in the period; The reduction occurred for the second

consecutive year. In 2007, 70,507 people graduated with a Bachelor's degree, 4.5% less than in 2006 and 9.3% less than in 2005. The data only aggravates a situation that is already worrying. A study by the Ministry of Education itself points out that there are 300 thousand people teaching classes in the country in areas other than those in which they graduated. Chemistry is a vital science for improving the quality of life of human beings (SILVA, 2011). Data from the 2019 Higher Education Census show that of the Chemistry teachers who teach in high school, 60.4% have a degree or bachelor's degree in Chemistry, with a completed pedagogical complementation course; 2.8% have a bachelor's degree in Chemistry, but without a degree or pedagogical complementation; 26.7% have a degree in an area other than Chemistry, or a bachelor's degree in the disciplines of the common curriculum and pedagogical complementation completed in an area other than Chemistry; 7.2% have another higher education degree and 2.9% do not have completed higher education. As can be seen from these data, around 40% of high school is committed to chemistry (CENSO, 2020).

4 PERFORMANCE OF CHEMISTRY EDUCATORS

Chemistry educators, who work in HEIs, are usually available to work in the following situations: a) In the Degree and/or Bachelor's Degree Courses in Chemistry; b) In teacher training disciplines, such as: Teaching Practice in Chemistry; Supervised Internship in Chemistry; Methodologies; c) Supervision of Monographs, TCCs, Dissertations and Theses, in which the focus is the teaching of chemistry; d) In Specialization Courses; e) In Research in Chemical Education.

Currently there is a large class of teachers in Brazil who are dedicated to Chemical Education, being very active in their respective educational institutions. It is impossible to mention in this work the vast majority, let alone all chemistry educators in our country.

5 CHEMISTRY TEXTBOOKS

The first chemistry book printed in Brazil was written by Daniel Gardner (1785-1831) entitled Syllabus, or Compendium of Chymica Lessons, by the Royal Printing Office, in 1810 (GARDNER, 1810), considered a descriptive program of his course at the Royal Military Academy (SANTOS and FILGUEIRAS, 2011).

In 1816, the work "Chemical Philosophy" by Antoine François de Fourcroy (1755-1809), translated into Portuguese by Manoel Joaquim Henriques de Paiva (1752-1829) in

1801, is considered the first compendium officially adopted in a regular chemistry course in Brazil (SANTOS AND FILGUEIRAS, 2011).

In 1875, the first Chemistry textbook for high school was published in Brazil. Mori and Curvelo (2014) state that Mortimer analyzed 10 Brazilian books ranging from the beginning of the nineteenth century to 1930 and observed that the books have a small part of general chemistry, well structured, presenting definitions accompanied by examples. They also state that Schnetzler (1980), in his master's thesis, analyzed 6 books (1875 to 1929) and his comments are similar to those observed by Mortimer (1988). Another fact pointed out by both Mortimer and Schnetzler is the absence of proposed activities, especially experimentation, although the books bring abundant examples of experimental facts.

At the time, secondary and higher education in Chemistry was initially based on French textbooks, but gradually began to recommend and be guided by books written by Brazilians and published in publishers such as the Imprensa Nacional and Francisco Alves, always in Portuguese. Over the decades, this production has increased, being preserved in numerous personal collections to the public, and available for the examination of historians, educators and chemists. Table 3 lists the Chemistry textbooks published in the period 1922-1929.

Table 3

Chemistry Textbooks Published in the Period 1922-1929

YEAR	AUTHOR(S)	WORK
1922	Ernesto Silva	Elements of General Chemistry
1922	Pedro Augusto Pinto	Rudimentary Notions of Descriptive Chemistry
1924	José Dutra de Oliveira	Notions of Physiology and Chemistry Biological Applied to the Laboratory
1924	C. A. Barbosa de Oliveira	Elemental Chemistry
1925	Raul Romano	Lessons in General, Analytical Chemistry Organic and Inorganic
1927	Álvaro Soares Brandão	Chemistry (high school)
1928	Antonio de Barros Terra	Theorica Organic Chemistry
1929	Agenor T. Queiroz	Metallurgy and Applied Chemistry
?	Manuel Rodrigues da Silva	Introductory Discourses to the Medical Chemistry Study
?	George Sumner/Ricardo R. Scallop	Practical Chemistry: Inorganic Chemistry, Analytical Chemistry for Fundamental Courses And complementary

Source: Adapted from the article by Mori and Curvelo (2014).

The education reforms of Francisco Campos, in 1932, and Gustavo Capanema, in 1943, stimulated the elaboration and dissemination of textbooks that were produced in

accordance with the teaching programs issued by the Ministry of Education and Public Health.

These works, a reflection of national reforms, would be adopted by a large number of secondary schools throughout the country (LORENZ, 1994).

From 1932 onwards, in the area of Sciences, new books appeared that could be adopted in schools, highlighting the Chemistry book, "Introduction to Chemistry" (1936), by Sebastião Lobo. Also the books on Chemistry by Decourt, in 1945 and that of M. Marciano, in 1946, and also the textbooks published by the publisher FTD (Frère Thóphane Durand).

From the 30s to the 1960s, several chemistry books appeared, maintaining great homogeneity among them, as a result of the existence of official programs followed to the letter.

The 60s of the last century presented the largest number of books with diverse approaches and contents, in accordance with the liberalizing and decentralizing spirit of the 1961 Law of Guidelines and Bases of National Education (MORTIMER, 1988).

According to a study on the evolution of Chemistry textbooks for secondary education, carried out by Mortimer (1988), for the period from 1930 to 1987, it is listed below, in chronological order of time of publication, and not in alphabetical order:

FRANCA, Leonel. **Notes on general chemistry**. 6.ed. Rio de Janeiro: Pimenta de Mello, 1933.
NOBRE, Francisco Ribeiro. **Treatise on Elementary Chemistry 1**. 4th ed. Porto: Lelo 1933.
PUIG, Father lgnácio. **Elements of chemistry**; fourth grade. Trad. Balduino Rambo Fr. Porto Alegre: Globo, 1935.
SILVA, A. B. Alves da. **Notions of general chemistry**. 2nd ed. Porto Alegre: Globo, 1936.
FACCINI, Mário. **Physics and Chemistry**; fourth grade. 3rd ed. Rio de Janeiro: F. Briguiet, 1939.
FROES, Arlindo. **Chemistry;** fourth grade. Rio de Janeiro: Francisco Alves, 1939.
LEÃO, Arnaldo Carneiro. **Chemistry**; Initiation to the study of chemical phenomena, third grade. 4th ed. São Paulo: Ed. Nacional, 1940.
PINTO, Pedro A. **Rudiments of chemistry**. 7.ed. Rio de Janeiro: Misericórdia, 1940.
AMARAL, João B. Pecegueiro do. **Compendium of chemistry**: general chemistry. v.1. 6.ed. Rio de Janeiro: F. Alves, 1944.
DECOURT, Paulo. **Chemistry**; 1st book; high school cycle. 3rd ed. São Paulo: Melhoramentos, 1949.
MACEDO, Luiz. **Chemistry.** v.1. 4.ed. São Paulo: Ed. Nacional, 1949.
SIMAS FILHO, Eduardo. **Chemistry**; 1st scientific year. 3rd ed. Rio de Janeiro: F. Briguiet, 1953.
AMARAL, Luciano F. Pacheco do. **Chemistry;** first grade; high school. 3rd ed. São Paulo: Ed. do Brasil, 1956.

CARVALHO, Geraldo & SAFFIOTI, Valdemar. **Chemistry**, 1st year of high school. 7th ed. São Paulo: Ed. Nacional, 1956.
COSTA., Carlos & PASQUALE, Carlos**. Chemistry**, 1st grade, high school 1. 4th ed. São Paulo: Ed. do Brasil, 1957.
CARVALHO, Geraldo & SAFFIOTI, Valdemar. **Chemistry**, 3rd year high school 1. 4th ed. São Paulo: Ed. Nacional, 1958.
BONATO, Firmino, Ir. **Chemistry**, third grade. São Paulo: Ed. do Brasil, 1959.
COSTA., Carlos & PASQUALE, Carlos**. Chemistry,** third grade, high school. 6th ed. São Paulo: Ed. do Brasil, 1959.
BORZANI, Walter et alii. **Fundamentals of chemistry**: theory. São Paulo: Ed. Clássico-científica, 1960.
AMADO, Gildásio. **Chemistry**, third year of high school. São Paulo: Ed. Nacional, 1961.
DECOURT, Paulo. – **Chemistry**, 3rd book, high school cycle. São Paulo: Melhoramentos, 1964.
MURAD, José Elias & RIOS, RAIMUNDO G. **Inorganic chemistry**. 5th ed. Belo Horizonte: B. Alvares, 1964.
PIMENTA, Aluísio & LENZA, Duílio de P. **Elements of chemistry,** high school cycle, v.1. São Paulo: Ed. Nacional, 1964.
PIMENTA, Aluísio & LENZA, Duílio de P. **Elements of chemistry**, collegiate cycle, v.2. São Paulo: Ed. do Brasil, 1966.
AMARAL, Luciano F. Pacheco do. **General and inorganic chemistry.** v.1**.** São Paulo: Ed. Brasil, 1969.
SILVA, Edson Braga da & SILVA, Ronaldo Henriques da. **Chemistry course 1**. São Paulo: Harbra, 1979.
CREPALDI FILHO, José & TARANTO, José Marcos. **Chemistry 1**, 2nd grade. Belo Horizonte: Lê, 1981.
FELTRE, Ricardo. **Chemistry**: general chemistry. v.1. São Paulo: Moderna, 1982.
SILVA, Edson Braga da & SILVA, Ronaldo Henriques da. **Basic principles of chemistry 1**. São Paulo: Harbra, 1982.
SARDELLA, Antônio & MATEUS. **Chemistry course**: general chemistry, v.1. São Paulo: Ática, 1984.
FELTRE, Ricardo. **Basic chemistry course**; general chemistry. São Paulo: Moderna, 1985.
LEMBO, Antônio & SARDELLA, Antônio. **Chemistry**, v.1. São Paulo: Ática, 1987.

From 1987 to the present day, a huge number of authors have prepared chemistry textbooks for elementary and high schools.

There are numerous, in such a way that it is impossible to elaborate a relationship in this work, but we can say that it is with satisfaction to observe that the authors no longer take into account only the theoretical content of chemistry subjects, but seek to associate the contents with everyday life, contextualizing and presenting the practical side of how chemistry really presents itself as a science, with the introduction of chemical experiments.

The part related to the environment and sustainability are addressed by several authors. There is also a concern with the focus on alternative methodologies, especially those related to play, through didactic games, referring to certain subjects of chemistry.

6 INSTITUTIONS THAT BOOST CHEMICAL EDUCATION IN BRAZIL

6.1 BRAZILIAN CHEMISTRY ASSOCIATION - ABQ

Founded in 1922, it has the Regional Offices installed in the states of the Brazilian territory that, depending on the region, develop important activities for Chemical Education, such as: courses; workshop; Chemistry Olympiad; chemistry marathon; Workshops; events, news about the current situation of chemistry in Brazil and in the world; information on current research in the field of chemistry.

It should be noted that the ABQ-Nacional, together with the Regional, annually promote two important events for Chemical Education: a) Brazilian Congress of Chemistry – CBQ and b) Brazilian Symposium of Chemical Education – SIMPEQUI.

In the last 103 years, the National/Regional ABQ system has acted strongly for the development of Chemical Education in the country.

6.2 BRAZILIAN SOCIETY FOR THE ADVANCEMENT OF SCIENCE – SBPC

The SBPC was created on July 8, 1948. The first years of the SBPC's existence coincided with the recognition and institutionalization of science in Brazil, with the creation by the federal government of organizations such as the National Council for Scientific and Technological Development (CNPq, 1951), and the Coordination for the Improvement of Higher Education Personnel (CAPES, 1951).

It is these organizations, combined with a network of higher education institutions that were being structured, and the strengthening of the scientific community, that gradually allowed the country to demonstrate the capacity to produce and use scientific and technological knowledge (SBPC, 2022a).

Annually, the SBPC promotes its Meeting, with discussions and presentations of scientific papers related to Chemical Education.

6.3 BRAZILIAN ASSOCIATION OF THE CHEMICAL INDUSTRY – ABIQUIM

Even though it is an Association focused on the Chemical industry, it has presented in some activities collaboration with Chemical Education.

It was founded on June 16, 1964. In 1992, it implemented the Responsible Care program. An evaluation system is also created in the areas of health, safety, environment and quality (HISTÓRIA, 2014).

6.4 BRAZILIAN SOCIETY OF CHEMISTRY – SBQ

The Brazilian Society of Chemistry (SBQ) was founded on 07/08/1977 and since its creation, SBQ has been acting significantly in the development and consolidation of the Brazilian chemical community, and in the dissemination of Chemistry. Some secretariats, alone or together with others, organize regional events, lecture cycles and other activities related to the area of Chemistry (SOCIEDADE, 2022).

In SBQ there is the Board of Directors of the Teaching Division, which has collaborated with the evolution of Chemical Education in Brazil. It should also be noted that in its Annual Meetings, lectures, courses and papers related to this area are presented.

6.5 BRAZILIAN ASSOCIATION OF DISTANCE EDUCATION – ABED

The Brazilian Association of Distance Education - ABED is a non-profit scientific society, focused on the development of open, flexible and distance education, created on June 21, 1995 by a group of educators interested in distance education and new learning technologies.

ABED organizes congresses, seminars, scientific meetings, and courses aimed at the systematization and dissemination of knowledge in distance education (ABED, 2022).

6.6 BRAZILIAN ASSOCIATION FOR RESEARCH IN SCIENCE EDUCATION – ABRAPEC

The Brazilian Association for Research in Science Education (ABRAPEC) was founded on November 29, 1997 as a civil society, of a scientific and educational nature.

ABRAPEC aims to promote, disseminate and socialize research in Science Education, through research meetings and training schools for researchers, the publication of bulletins, annals and scientific journals, as well as to act as a representative body of the community of researchers in Science Education with national and international education entities. research and development (ABRAPEC, 1997).

7 CHEMISTRY EVENTS RELATED TO CHEMICAL EDUCATION

7.1 NATIONAL EVENTS

7.1.1 Brazilian Congress of Chemistry – CBQ

The Brazilian Congress of Chemistry – CBQ, is a promotion and realization of the Brazilian Association of Chemistry – ABQ. The first event took place in November 1922 and in 2025 the 64th CBQ will be held in the city of Belo Horizonte-MG.

7.1.2 Annual Meeting of the Brazilian Society for the Advancement of Science – SBPC

The first Annual Meeting of the SBPC was held from October 11 to 15, 1949, in the city of Campinas-SP, at the Agronomic Institute (IA).

It takes place annually in a city in Brazil and, in this year 2025, the 77th Meeting was held in Recife, from July 13 to 19.

There are usually topics related to Chemical Education, especially in the presentations of scientific papers (SBPC, 2022b).

7.1.3 Annual Meeting of the Brazilian Society of Chemistry – SBQ

SBQ holds its Annual Meeting, in which the participants are professors, students and researchers in the field of Chemistry. The program presents activities with current themes, including works related to Chemistry Education and Teaching, responsibility of the Scientific Division of Chemistry Teaching. The first Annual Meeting took place in 1978, in São Paulo, from July 9 to 15 (SOCIEDADE, 2022). In 2025, the 48th Meeting was held in the city of Campinas-SP, from June 8 to 11

7.1.4 National Meeting of Chemistry Teaching - ENEQ

The National Meeting on the Teaching of Chemistry (ENEQ) had its first edition held in 1982, at the Faculty of Education of UNICAMP. This event currently has twenty-two editions. The last one was held in 2024, XXII, in the city of Belém-PA, from September 9th to 12th. It takes place biennially, organized by the community of chemical educators in Brazil, with constant support from the SBQ Teaching Division. In the ENEQ program there are lectures, mini-courses, debates, workshops and presentations of works, and thus, the event has collaborated intensely for the development of Chemical Education in this country (ENEQ, 2022).

7.1.5 National Meeting of Chemistry Students – ENEQUI

The National Meeting of Chemistry Students – ENEQUI, is a large academic event that has been growing with each edition. It began in the 80s of the twentieth century (ENCONTRO, 2020). From March 14 to 16, 2025, the XI Meeting was held, held in the city of Almada-SE. There is a vast program, which serves all the broad areas in which Chemistry operates, including the area of Chemistry Teaching.

7.1.6 National Meeting of Research in Sciences - ENPEC

The National Meeting of Research in Science Education (ENPEC) is a biannual event, promoted by the Brazilian Association for Research in Science Education (ABRAPEC). Its objective is to bring together and favor interaction between researchers in the areas of Physics, Biology, Chemistry, Geosciences, Environment, Health and related areas, with the purpose of discussing recent research works and dealing with topics of interest to ABRAPEC. (ENPEC, 2019).

ENPEC's audience is made up of those interested in research in Education in Natural, Health and Environmental Sciences, including teacher-researchers from Basic and Higher Education, graduate students, undergraduate students, teacher trainers and researchers. From 1997 to 2025 there are already 15 editions.

7.1.7 Chemistry Projects Fair – FEPROQUIM

The objectives of FEPROQUIM are: to encourage high school and/or technical students to develop experimental research projects in the area of Chemistry that contribute to the understanding of phenomena that involve scientific knowledge and that are present in various areas of society and the environment; to encourage these students to develop projects of didactic-pedagogical activities for the teaching of Chemistry, which enable a better understanding of the contents of the Natural Sciences and their relations with society, expanding languages and communications in the classroom; and also to enable integration with students from other regions, from other educational institutions, as well as with students from other levels of education and other professionals, in order to promote their improvement as a human person and as a future professional (FEPROQUIM, 2021).

FEPROQUIM is promoted and carried out by the Brazilian Chemistry Association, and the first was held in 2001 and XXIII will be held in 2025.

7.1.8 Brazilian Symposium on Chemical Education – SIMPEQUI

The Brazilian Symposium on Chemical Education – SIMPEQUI, is an event promoted and held by the Brazilian Association of Chemistry, with the purpose of bringing together educators in the area of chemical education in this country.

The 1st SIMPEQUI took place in 2003, held in the city of Rio de Janeiro, with the theme: Chemistry Teaching: analysis and trends. The opening lecture: "Chemistry Education in the world today and its trends" was given by Prof. Dr. Peter Atkins (Lincoln University-England), at the time president of the IUPAC Chemical Education Committee (CCE/IUPAC). In 2025, the 22nd SIMPEQUI was held.

8 MAIN JOURNALS THAT PUBLISH WORKS ON TOPICS OF CHEMICAL EDUCATION

8.1 BRAZILIAN JOURNALS

8.1.1 Publications of the Brazilian Society of Chemistry – SBQ

The SBQ publications are: **a) Química Nova** - launched in January 1978. It publishes original research articles, as well as reviews and papers on higher education and the history of chemistry. **b) Journal of the Brazilian Chemical Society (JBCS)** - is a publication entirely in English, dedicated to all aspects of chemistry. **c) New Chemistry at School** - specifically aimed at teachers who teach Chemistry in Brazilian schools. It is a space open to the educator, stimulating debates and reflections on the teaching and learning of chemistry**. d) Virtual Journal of Chemistry** is an electronic publication, with free dissemination on the Internet via the World Wide Web, which aims to be a source of consultation and dissemination in Portuguese or English for undergraduate and graduate students and professors of topics related to various domains of Chemistry. (SBQ, 2022).

8.1.2 – Journal of the Brazilian Society of Chemistry Teaching – ReSBEnQ

The Journal of the Brazilian Society of Chemistry Teaching - ReSBEnQ was conceived as a constitutive part of the process of creating the Brazilian Society of Chemistry Teaching - SBEnQ, approved in July 2016, at the XVIII National Meeting of Chemistry Teaching - XVIII ENEQ, held at UFSC and officially created at the General Assembly held on July 18, 2018, during the XIX ENEQ, at UFAC.

ReSBEnQ is a scientific journal of Chemistry Teaching, a statutory component of SBEnQ and, as such, its management and operation are articulated with the objectives of

this society and of the entire research community in Chemistry Education and Teaching (REVISTA, 2025a).

8.1.3 – Brazilian Journal of Research in Science Education - RBPEC

The Brazilian Journal of Research in Science Education (RBPEC) is a publication of the Brazilian Association for Research in Science Education (ABRAPEC) and aims to disseminate results and reflections arising from investigations conducted in the area of Science Education, with ethics and efficiency, in order to contribute to the consolidation of the area, to the training of researchers, and for the production of knowledge in Science Education, which supports the development of responsible educational actions committed to the improvement of scientific education and social well-being (REVISTA, 2025b).

8.2 FOREIGN JOURNALS

There are numerous foreign journals in which researchers in the field of Chemistry can make their publications and that many have been using for years.

To exemplify, we will mention only three that publish scientific articles in the area of Chemical Education.

8.2.1 Journal of Chemical Education

The Journal of Chemical Education is a peer-reviewed monthly journal available in print and electronic versions. It is published by the Division of Chemical Education of the American Chemical Society, and was created in 1924 by Neil Gordon (JOURNAL, 2022).

8.2.2 Revista Educación Química

Educación Química is a quarterly international journal published by the Faculty of Chemistry of the National Autonomous University of Mexico. It is an electronic, open-access academic journal of communication and expression that exists among students, teachers, and researchers of chemical education (EDUCACIÓN, 2022).

8.2.3 American Chemical Society Publications

The American Chemical Society (ACS) is an American organization of chemists that supports scientific research in the field of chemistry.

Founded in 1876 at New York University, ACS currently has more than 163 thousand members at all undergraduate levels and in all fields of chemistry, chemical engineering, and related fields (ACS, 2022).

9 DIRECTORIES OF RESEARCH GROUPS IN CHEMICAL EDUCATION – CNPq

The Directory of Research Groups in Brazil is the inventory of scientific and technological research groups in the country. The research groups are mainly located in universities, isolated institutions of higher education with stricto sensu graduate courses, scientific research institutes and technological institutes.

Currently, more than 400 research groups in the area of Chemical Education are registered, belonging to the most diversified HEIs in Brazil, in which the repercussions of the works, the lines of research, the researchers, students and technicians involved are described.

As can be seen, due to the large number of groups formed and with tendencies to increase the number in the coming years, it can be said that research in Chemical Education in Brazil tends to evolve in an increasing way, and thus, significant improvements in the Teaching of Chemistry are expected (DIRECTORY, 2022).

10 ACTIVITIES FOR THE DISSEMINATION AND/OR COMPETITIVENESS OF CHEMICAL EDUCATION

10.1 CHEMISTRY SHOW/CHEMISTRY IN ACTION

The idea of working on the image of chemistry and the chemist, and awakening in young people an appreciation for what is beautiful and interesting in Chemistry, was initially developed by Prof. José Atílio Vanin, from the Institute of Chemistry of USP. In 1965, Vanin was scouring the literature on chemistry education to discover the ways used to overcome the antipathy that many people have for chemistry, without even knowing what it really is (O "SHOW", 1989, p. 7-8).

Figure 4

Creator of the Chemistry Show

José Atílio Vanin
20/09/1944 - 08/05/2001

Source: (TOMA & SANTOS, 2001).

Prof. Atílio fulfilled his old childhood dream, as a witch and alchemist, letting all the magic then accumulated flow, through the magnificent shows of the group *Química em Ação*, under his coordination (TOMA & SANTOS, 2001).

The *theater group Chemistry in Action*, developed by students from the Institute of Chemistry (IQ) of USP, in São Paulo, has as its main objective to teach high school and elementary school students using plays that show the playful side of chemical reactions learned in everyday life in the classroom.

Formed by 17 people, the project was created in 1985, by the late professor José Atílio Vanin, at the time a graduate student at USP. "He was enchanted by chemistry and wanted to take it the way he saw it to other people.

The play *Chemistry of Sensations*, stimulated the audience's senses through chemical reactions, the flagship of the project. "There are two main characters: a presenter giving a class on the subject and his assistant doing everything wrong." The idea is to use comedy to convey information in a lighter way in order to draw the viewer's attention.

Another factor much explored in the group's productions is interactivity. In *Chemistry of Sensations*, for example, the experiments pass through the audience, so that the spectators can feel them, see them. At another time, people from the audience themselves are invited to the stage to participate in the staging. Among the members of the project are students from various courses at USP, most of them with little or no experience with theater (JORNAL, 2018).

The idea of Prof. José Atílio Vanin, which was put into practice in 1984, has proliferated in such a way that, today, 41 years later, in most Chemistry institutions in Brazil, there is a group formed for applications of "Chemistry in Action".

10.2 CHEMISTRY OLYMPIAD

10.2.1 Brazilian Chemistry Olympiad

Through the USP Institute of Chemistry, with the support of FAPESP, the São Paulo State Department of Science and Technology, and CNPq, the first Chemistry Olympiad in the country was held in 1986 (ABQ-SP, 2022).

On the initiative of professors from the Federal University of Ceará - UFC, in 1995, the North/Northeast Chemistry Olympiad was created, aimed at the 16 states of this region. The success achieved stimulated the creation, the following year, of the Brazilian Chemistry Olympiad, assumed by the Brazilian Chemistry Association, in 2000 (OLIMPÍADAS, 2010, p. 28-29).

The Brazilian Chemistry Olympiad evaluates the laboratory knowledge of enrolled students.

Students who achieve prominence in the Chemistry Olympiad seek to enter prestigious centers of excellence in teaching and research, both in Brazil and abroad. Institutions such as ITA, IME, UNICAMP and USP, which have a significant number of former Olympians.

Based on recent years, it is observed that, during this period, universities in Manchester, Tokyo and MIT received our former Olympians (OLIMPÍADAS, 2010, p. 28-29). The fifteen most outstanding students in this Olympiad are invited to participate in the Course of Deepening and Excellence in Chemistry taught by professors of the postgraduate course in Chemistry of one of the participating universities, from where the team that will represent Brazil in the International Chemistry Olympiad and the Ibero-American Chemistry Olympiad will be chosen (PROGRAM, 2022).

The Brazilian Chemistry Olympiad selects two teams to participate in international competitions. With the participation of approximately 70 delegations, the International Chemistry Olympiad - IChO takes place, organized by one of the member countries. In October, the Ibero-American Chemistry Olympiad will be held. At the end of each year, the coordinators meet to evaluate the actions carried out, the results achieved and to plan the activities for the following year.

The National Chemistry Olympiad Program is an educational event that, since 1995, seeks to stimulate the study of Chemistry and identify young people with talent and aptitude for this Science. The action includes students from elementary school to higher education, with five different Olympiads. According to Prof. Sérgio Melo, in 2021, 375 thousand students, from public and private schools, from all units of the federation participated in the Program. Annually, the National Chemistry Olympiad Program publishes the Annals, in which the results of the Chemistry Olympiads held in that year are presented. The Annals, from 1995 to 2021 (27 Annals) can be consulted at the link: https://obquimica.org/anais. After each Chemistry Olympiad, the award ceremony is held with the delivery of gold, silver and bronze medals to the winners, and those who are not awarded medals receive "Honorable Mention" certificates, for the classification (PROGRAMA, 2022).

10.2.2 North/Northeast Chemistry Olympiad

The North/Northeast Chemistry Olympiad, started in 1995, is an event promoted by the Federal University of Ceará and the Federal University of Piauí, and organized by the Brazilian Chemistry Association - ABQ.

Registration for this event must be made through the coordinators installed in the 16 states of the regions. Each state can participate with a maximum of 50 previously selected students in its regional Olympiads. The 5 best classified receive, at the closing ceremony, gold medals and their names are engraved on silver plates fixed to the base of the event trophy (PROGRAMA, 2022).

10.2.3 Chemistry Olympiad of the State of São Paulo – OQSP

In 1996, the IV Scientific Marathon in Chemistry was held in São Paulo during the 36th Brazilian Congress of Chemistry of ABQ. In 1997, ABQ-SP organized the Regional Chemistry Marathon. In 1998, the Marathon + Chemistry Olympiad of the State of São Paulo was accredited to register its 40 winners in the Brazilian Chemistry Olympiad. The name

Chemistry Olympiad of the State of São Paulo, OQSP, was adopted in mid-2000, with the launch of OQSP-2001 (OQSP, 2022). Its objectives are: to promote interest in Chemistry and its interrelations with other sciences and society; attract talented students for studies and careers in industry and academia dedicated to Chemistry; select and award medals to 50 students annually, allowing them to represent São Paulo in the Brazilian Chemistry Olympiad; improve society's perception of the contributions of Chemistry to quality of life and sustainability (CHEMISTRY, 2017). In 2025, OQSP completed 28 years of Chemistry Olympiad.

10.2.4 Chemistry Olympiad of Rio Grande do Sul – OQdoRS

The Chemistry Olympiad of Rio Grande do Sul – OQdoRS is held annually, aimed at talented students in Chemistry from Basic Education institutions. It is a promotion of ABQ-RS and the Institute of Chemistry of UFRGS. It is a program aimed at students with an interest in Chemistry through the creativity of solving problems. It promotes exchanges between professors, students, researchers, and curious people in the area who promote an exchange of experiences in a holistic way (ABQRS, 2021a).

It began in 2002 (ABQRS, 2021b). In 2025, the XXIV edition was held.

10.2.5 Rio de Janeiro Chemistry Olympiad – OQRJ

The Rio de Janeiro Chemistry Olympiad (OQRJ) is aimed at students from the state of Rio de Janeiro, who are regularly enrolled in regular or technical high schools. The main objectives are: to awaken and stimulate interest in Chemistry; Identify talented students in Chemistry, preparing them for the national (OBQ – Brazilian Chemistry Olympiad) and international Olympiads, encouraging them to pursue scientific-technological careers. In 2006, the 1st OQRJ was held (OQRJ, 2017). In 2025, the XXIV edition was held.

10.2.6 Brazilian Junior Chemistry Olympiad – OBQ Jr

The Brazilian Junior Chemistry Olympiad – OBQ Jr aims to stimulate Natural Sciences, especially Chemistry; contribute to the improvement of teaching; and to identify young talents with an aptitude for Natural Sciences. OBQ Jr is an Olympiad for 8th and 9th grade students. The exam works in two phases, the first phase consisting of 20 objective questions, with an eliminatory character. The second phase consists of 10 objective questions (which add up to 40 points) and 3 subjective questions (which add up to 60 points). The awards have defined

grades, which work as follows: grades from 95 to 100 = gold medals; grades from 85 to 94.9 = silver medals; grades of 70 and 84.9 = bronze medals; grades from 50 to 69.9 = honorable mention (OLYMPICS, 2022). The 1st OBQ Jr was held in 2008 and the 2025 edition was the XVIII edition.

10.2.7 Brazilian Chemistry Higher Education Olympiad - OBESQ

The Brazilian Chemistry Higher Education Olympiad (OBESQ) belongs to the National Chemistry Olympiad Program. After the success of the test edition held in 2017, in the State of Ceará, the Higher Level Olympiad became a reality and had its first national edition held in 2018, at UFC. The modality was divided into two phases: first state qualifying phase; second national phase. Like the Brazilian Chemistry Olympiad, the OBESQ aims to select students to represent Brazil in International Olympiads. This is another opportunity that the National Chemistry Olympiad Program promotes in the search for talented young people in the academic-scientific area (OQRJ, 2017). The 2nd edition was held in 2019 at IFRJ/RJ and the 3rd was held at UFC/CE, in 2021. In 2025, the VII edition was held.

10.2.8 Chemistry Olympiads of the Brazilian states promoted by ABQ

According to the ABQ website, available at:
http://www.obquimica.org/ news, the regional Olympics are:

a) Acre Chemistry Olympiad;
b) Alagoas Chemistry Olympiad;
c) Amapá Chemistry Olympiad;
d) Santa Catarina Chemistry Olympiad;
e) Ceará Chemistry Olympiad;
f) Chemistry Olympiad of the Federal District;
g) Chemistry Olympiad of Espírito Santo;
h) Goiás Chemistry Olympiad;
i) Maranhão Chemistry Olympiad;
j) Mato Grosso Chemistry Olympiad;
k) Pará Chemistry Olympiad;
l) Paraíba Chemistry Olympiad;
m) Pernambuco Chemistry Olympiad;

n) Piauí Chemistry Olympiad;

o) Chemistry Olympiad of Rio Grande do Norte;

p) Rondoniense Chemistry Olympiad;

q) Roraimense Chemistry Olympiad;

r) Sergipe Chemistry Olympiad;

s) Tocantins Chemistry Olympiad.

10.3 CHEMISTRY MARATHON

The Chemistry Marathon, instituted by the Brazilian Chemistry Association – ABQ, in 1993, aims to stimulate the participation of high school students in the context of scientific knowledge.

It is divided into 3 categories: Technical Schools (public and private); Regular Public High Schools; Private Regular High Schools.

The Chemistry Marathon is an activity aimed at encouraging high school students in the educational context of Chemistry Teaching, opening perspectives to these students, of better applicability of the observed chemical phenomena and arousing their interest in a career in Chemical Science and/or Chemical Engineering (MARATHON, 2021).

The I Chemistry Marathon was held at the 33rd Brazilian Congress of Chemistry, from October 25 to 29, 1993, in Fortaleza, and in 2025 the XXXI will be held, during the 64th Brazilian Congress of Chemistry, from November 4 to 7, 2025.

10.3.1 Regional Chemistry Marathons

10.3.1.1 Regional Chemistry Marathon of the State of São Paulo

The Brazilian Chemistry Association, through its Regional Section of São Paulo, ABQ-SP, with the support of the Regional Council of Chemistry - IV Region and the Institute of Chemistry of the University of São Paulo, promoted from June to September 1997, the I Regional Marathon in Chemistry. The Marathon was open to the participation of all students enrolled in high school courses and was carried out in three phases, with the following objectives: to involve high school students in a stimulating activity, which leads them to reflect on the importance of chemistry in the current and future context (phases 1 and 2); to reveal young talents with a vocation for chemistry (phase 3). In general terms, the three phases are similar to those of the Chemistry Marathon promoted by the Brazilian Chemistry Association,

held annually at the Brazilian Chemistry Congress, in a region of Brazil (ALLCHEMY, 1997). In 2025 the 28th edition was held.

10.3.1.2 Ceará Chemistry Marathon

The Brazilian Association of Chemistry – Ceará Regional, has been promoting, since 1998, the Ceará Chemistry Marathon, whose participants are the students of the 8th and 9th year of Elementary School and students in the 1st, 2nd and 3rd year of High School from Private and Public Schools in Fortaleza, and from the cities of Juazeiro do Norte and Sobral that are located in the interior of the state of Ceará.

The tests are applied in two stages. The first stage is eliminatory, in which a general knowledge test is applied to the candidates. The 20 candidates of each year are classified for the second stage, who obtain the highest scores. In the second stage, the finalists will be able to observe a demonstration of chemical experiment(s), carried out in the Chemistry Laboratory determined by the Commission. Then, they are submitted to a written evaluation of the observed experiment(s).

10 (ten) candidates are classified for each year. The final result is announced at the closing ceremony, in which the first, second and third places of each year receive certificates and, respectively, gold, silver and bronze medals. From 4th to 10th place, they receive honorable mention certificates.

The first Ceará Chemistry Marathon was held in 1998, and in 2019 the XXII was held, with no more achievements.

10.3.1.3 Chemistry Marathon of Mato Grosso do Sul

Since October 2017, promoted by the Coxim Campus of the Federal Institute of Mato Grosso do Sul – IFMS, the Chemistry Marathon has taken place, whose activities were: ecological trail, theater about chemistry in everyday life, quiz with questions on the theme and experimental test in the IFMS laboratories. (IFMS, 2017).

Participated in the 1st. edition about 150 high school students from the state schools Romilda Costa Carneiro, from Alcinópolis-MS, Pedro Mendes and Padre Nunes, from Coxim-MS, Professor Cleuza Teodoro, from Pedro Gomes-MS, Vergelino Mateus de Oliveira and Thomaz Barbosa Rangel, from Rio Verde-MS.

The objective was to stimulate students' interest in Chemistry, in addition to publicizing the performance of the IFMS. The Coxim Campus of the Federal Institute of Mato Grosso do

Sul (IFMS) promoted in 2020 the 5th edition of the Chemistry Marathon, with the participation of high school students from state schools in the city and other municipalities in the North Region of the state. In 2025 the X edition will be held.

10.3.1.4 Rio Grande do Norte Chemistry Marathon

The Brazilian Association of Chemistry – Regional RN implemented in 2019 the I Chemistry Marathon of Rio Grande do Norte. The objective, as in Ceará, is to promote the dissemination of Chemistry in the state. At this first moment, the marathon intends to reach high school students from the public and private network of RN. The objective tests were held in September and the subjective tests in October 2019. The marathon was held by ABQ-RN with the support of the Institute of Chemistry and the Center for Exact Sciences, both at UFRN (NOTÍCIAS, 2019).

11 CONCLUSION

As it is a long period, the main and most significant ones for Chemical Education in Brazil were recorded.

It is worth highlighting the article by pharmacist José de Freitas Machado, who in 1918 already warned: "Let's do Chemists", and thus collaborated for higher education institutions to create more chemistry courses, thus making up for the deficiency of professionals in the field of chemistry.

According to the results of the 2019 Higher Education Census, published by INEP, in Brazil there are 2,608 HEIs (Public and Private), in which Chemistry Courses are offered, in the face-to-face and/or distance learning modality, collaborating with the growth of this area. Also relevant are the actions of the institutions in the areas of Science and Chemistry, created over the years, and cited in this work, for the strong impulse provided to Chemical Education in the country.

This work also intended to praise the initiative of chemistry educators, who in the 80s of the twentieth century, formed the first groups with the objective of debating the Teaching of Chemistry, aiming at its improvement. There are currently more than 400 research groups in the area of Chemical Education, registered in the Directory of Research Groups of CNPq.

Chemistry teachers in elementary school have collaborated primarily to improve chemistry teaching, with applications of varied and attractive methodologies, and, even facing a series of obstacles, they manage to overcome some disadvantages and lead students to

be motivated to study chemistry, which can be observed in competitiveness activities, such as the chemistry Olympiads and marathons.

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