



Real Sociedad Española de Química (Spanish Royal Society of Chemistry, RSEQ) Annual Report to the EuCheMS Division of Chemical Education for 2019-2020¹

1. Abstract

From June 2019 to May 2020, the teaching of chemistry in Spain, as in other countries, has been marked by two events: the celebration during 2019 of the International Year of the Periodic Table of Chemical Elements (IYPT2019) and the confinement from mid-March 2020 until the end of the course, caused by the COVID19 pandemic. In the first case, it was a very celebrated occasion in Spain, with multitude of initiatives by teachers at all educative levels, and which has involved many students. In the second case, it has been an opportunity to promote online teaching: many teachers have been fully involved in modern educational methodologies.

2. National educational policy

For decades, there has been some instability in Spain at the legislative level regarding education. We are currently immersed in the elaboration of an eighth general legislation for secondary education since democracy began in 1977. At the University level, with the last change of government, in January 2020, the scope of the University depends on three different ministries.

In turn, the practical application of educational laws falls to the 17 autonomous governments (in which aspects such as education and health are transferred completely), so that in our field, the number of hours dedicated to chemistry is unequal. Specifically, there is a complaint from teachers in the Valencian Community for having fewer hours about Chemistry available in this regard than other regions in Spain. The heterogeneity of Spain is very large: there are co-official languages in 6 of the 17 autonomous communities, there are large areas with a low population very disseminated, cities with a large population and neighborhoods with very unequal economies and proportions of immigrants. Three educational types coexist for centers of secondary education: public, private and “concertada” (privately run but subsidized by the state).

Regarding the teaching of chemistry, at the university level the standards of the European Higher Education Area are met. At the secondary level, in general, there are few laboratory sessions, depending heavily on the school and the teachers involved.

¹June 2019- May 2020, all levels of chemistry education: primary, secondary schools, universities, LLL, general and vocational education.

A peculiarity of the Spanish educational system in secondary education is that the official body of teachers, with exceptions such as Mathematics, and for decades, has been grouped from two to two subjects: Geography and History, Biology and Geology, Physics and Chemistry. Traditionally, physicists choose more places in Mathematics, because in their Bachelor Degree they study less chemistry than chemistry graduates, so Physics and Chemistry teaching positions are more occupied by chemists. Often teachers who are physicists teach chemistry in a more limited way, and vice versa. There is only one subject in Chemistry, without Physics, and optionally, in the last year of high school. In previous courses the subject is "Physics and Chemistry". In any case, the teaching of chemistry, with the indicated nuances, is not very different from that of other European countries. We are currently immersed in the competency-based education model, leading to quite a few "headaches" for teachers, especially regarding the evaluation of these competencies.

There are about 20% of very enthusiastic and innovative teachers, who see little reward for their efforts by the administration. In any case, a small amount of the salary of secondary education teachers is assigned through six-year terms that are received throughout their working life, with a limited number, for tasks of educational innovation (courses received, participation in conferences, innovational projects...).

Among the most common problems at national level can be highlighted:

- Lack of job stability for teachers at different educational levels, who are sometimes in a different center each year.
- Concern about the amount of school failure and poor results in the successive PISA reports. When these reports are published, authorities and public opinion show the greatest interest in educational matters.

3. Events in chemical education

The RSEQ organized for the first time in 2019 the *National Chemistry Olympics* at the national level (we participate in two kinds of international Olympics: international and iberoamerican). Previously, this task was delegated to the *Asociación Nacional de Químicos e Ingenieros Químicos de España* (National Association of Chemists and Chemical Engineers of Spain, ANQUE). For the current year, 2020, it has been decided to carry it out virtually in next September.

The *Chemistry Quality Eurabel Seals* it is a certificate granted by an agency authorized by the European Chemistry Thematic Network Association (ECTN) to a University with respect to a Chemistry degree or master's degree evaluated according to a series of standards defined according to the principles of quality, relevance, transparency, recognition and mobility contemplated in the *European Higher Education Area*. For this reason, the RSEQ, as the country's most representative institution of the profession of chemist, and ANECA (*Agencia Nacional de Evaluación de la Calidad y Acreditación - National Agency for Quality Assessment and Accreditation* of Spain), as the main actor in the process of accreditation of degrees in Spain, carry out a joint collaboration that promotes quality and the international recognition of Spanish undergraduate and master degrees in the field of Chemistry.

In Spain, the IYPT2019 was lived very intensely. Here are included some actions for it by entities other than RSEQ, which we refer to in the next section. For example, a postal stamp,

a lottery ticket and a ONCE (popular game of chance) coupon were issued as a tribute to the periodic table.

The *Foro Química y Sociedad (Chemical and Society Forum)* developed on its website a section dedicated to the periodic table (<https://www.quimicaysocie.org/>) where downloadable periodic tables are included in various formats, the informative document "ABC of the periodic table", a section of curiosities and another one of news on actions related to the subject. Another entity known for its eagerness to inform and educate on aspects of Physics and Chemistry, *Foro Nuclear (Nuclear Forum)*, in its "educational corner" section, has developed an interactive periodic table (<https://bit.ly/2XyXz9H>) with the main characteristics of each element, as well as a "timeline" showing the year of its discovery. Through *Polimedia*, a system designed by the *Universitat Politècnica de València* for the creation of multimedia content to support teaching, two short videos have been produced with educational reflections. One (<https://bit.ly/2PTNgL2>) deals with the history of chemistry up to Mendeleev's periodic table proposal, and the other (<https://bit.ly/2VWY4NX>) focuses on the evolution of periodic table until it became the Periodic Law with Henry Moseley. There were a large number of conferences given on the subject, in which aspects such as periodic table and popular culture, the men and women who completed the periodic table, mythology and art in the periodic table, among others, were highlighted. The work carried out by the four Spaniards most directly involved in the discovery of chemical elements, between 1735 and 1801, was particularly highlighted on many occasions: wolfram by the brothers Fausto and Juan José Delhuyar; vanadium by Andrés Manuel del Río, and platinum by Antonio de Ulloa.

The *University of Jaén*, apart from other initiatives, such as a forum film series entitled "*Future achievements and challenges in chemistry*" with screenings of some films related to some aspect of chemistry, has developed so many activities that it has created a specific website (<https://bit.ly/2HtvA6h>) to report on them. The University of Córdoba programmed five conferences with titles such as *Madame Lavoisier, Illustration and Science at the time of the Revolution and Chemistry, Physics and the Periodic Table: from Mendeleev to Bohr*. At the University of Granada a cycle has been developed with conferences such as *Periodic table and art*.

Other courses on periodic table include "*Illustration and STEAM education: Bergara, La Bascongada and the IYPT*" (summer course at the University of the Basque Country), "*2019, IYPT*" (summer course of the Complutense University of Madrid) and "*Around the periodic table and the chemical elements*" (outreach course known as "*The advances of Chemistry and its impact on society*" organized by the CSIC in Madrid).

Regarding contests about IYPT2019 in Spain, the following stand out: "Sponsor an element", promoted by the Alicante territorial section of the RSEQ, for the realization of multimedia projects by students, on any of the chemical elements (<https://bit.ly/2QbhYSm>); "Periodic tables for members of the Autonomous University of Madrid," to design a periodic table in 3D format with originality (<https://bit.ly/2YC3ZFA>); several ones promoted by the University of Córdoba (<https://bit.ly/2Q7o5Vp>): Do you like science? (short videos on the periodic table), My favorite element (poster format), The periodic table is mine (monologues) and What you do not see (photography); From theatrical scenes "Elements to scene: the chemical elements and their discoverers", at the University of Jaén (website already mentioned); Scientific-literary competition Primo Levi (<https://bit.ly/2HAVk4c>) by the Complutense University of Madrid; and "What would Mendeleev do if he were YouTuber?", by the Castilla-La Mancha section of the RSEQ (<https://bit.ly/2WaXLPr>). Between February and May 2020, the School of

Chemistry and the López Piñero Inter-university Institute for Science of the University of Valencia organized the exhibition *Beyond Mendeleev. 200 years of classifications of chemical substances* (<https://links.uv.es/pT4M157>)

Obviously, what is collected here are some brushstrokes of some initiatives carried out in Spain on the occasion of IYPT2019. They have not attempted to collect all of them, which are innumerable, but they did show a significant sample of the eagerness and enthusiasm with which hundreds of professors, students and scientific disseminators have been involved in highlighting this universal icon of science: the periodic table.

The confinement from mid-March 2020 until the end of the course, caused by the COVID19 pandemic, has been an opportunity to promote online teaching: many teachers have been fully involved in modern educational methodologies. Some of the main problems in this regard have been the inaccessibility of adequate telematics means on the part of the order of 10% of students and the concern of teachers about how to carry out the evaluations in a non-face-to-face mode. During the confinement, primary and secondary education teachers and university lectures have been involved in the design and application of a wide range of online didactic tools, teaching strategies and evaluation methods. It should be pointed out that evaluation has been the most discussed issue by educators during the confinement and it is still a matter of reflection for the next academic year 20-21.

4. Activities of the National Chemical Society

As it is the first time that a report of this nature has been produced by the RSEQ for EuChemS, we briefly introduce a historical note.

The origin of RSEQ dates back to 1903, when the Spanish Society of Physics and Chemistry was founded. In 1928 it added the "Royal" distinction. In 1980 the two current societies (RSEQ-Chemistry and RSEF-Physics) were separated. Both RSEQ and RSEF are divided into different specialized groups and territorial sections. Among the specialized groups, there has been since 1986 the so-called "Didactics and History of Physics and Chemistry Specialized Group" (GEDHFQ), one of the few groups that are common to both societies. In our case, it belongs to both societies due to the peculiarity of the Physics and Chemistry, who, as indicated before, are twofold. In turn, from the beginning it was considered that history and didactics are two highly intertwined areas. However, both issues have given rise to certain tensions and ways of looking at the subject, which is why there is currently also a "Group on the History of Science" only on RSEQ, and another on "Physics Teaching and Outreach" at RSEF.

The GEDHFQ consists of 220 members, 150 from the RSEQ and 70 from the RSEF. Members of the group are professional scholars in science education and/or history of science in different educational levels, including University professors of the Master of Teacher Training (60 ECTS credits, one year long), a compulsory degree to work as a teacher in secondary education in Spain.

With respect to the celebration of the IYPT2019, the RSEQ has developed some web pages within its web portal (<https://rseq.org/>) where, among other information, conferences, courses, workshops, articles and communication programs on the periodic table were included. Some of the most significant actions carried out by the RSEQ have been the financing of contests and conferences on TP through its different territorial sections and specialized

groups, the holding of a specific symposium within the Biennial Meeting (San Sebastián, May 2019, <http://bienal2019.com/>), and the preparation of a special issue of the Journal *Anales de Química*. In this monograph, the characteristics of the 118 known elements and two that are potentially to be discovered (the 119-Uue and the 120-Ubn) are collected, on one page each, as well as the articles: “The periodic table of EuChemS: The table that highlights the scarcity and availability of natural chemical elements”, and “Dimitri Ivanovich Mendeleev: The prophet who ordered the chemical elements”. 120 professors and researchers from nearly 30 universities, various research organizations and various secondary education centers from almost all the autonomous communities collaborated in this monograph. This number served as the basis for developing an interactive periodic table that is considered to be of educational and informative interest. These resources are accessed at <http://analesdequimica.es/wp2/>

As a collaboration between the Technical University of Madrid (UPM), the RSEQ and the European *Scientix* project, several lectures have been given (also in workshop format) under the titles “The periodic table, an achievement by all and for all” and “Live the periodic table”, in different educational centers for students from different educational stages and the general public (<https://bit.ly/30togit>).

Perhaps the most emblematic action carried out by our specialized group of RSEQ was the “Our Periodic Table” School Contest, with the participation of 201 educational centers from all over Spain, involving several hundred teachers and thousands of students, in the development of giant and original periodic tables (<https://bit.ly/2FTjK5d> and <https://bit.ly/2mTsnFH>). We have also organized and celebrated in this context, the Meeting about “The periodic table: an opportunity for didactics and the outreach of science” in Madrid, July 5th 2019, with about 200 attendees: <https://bit.ly/2FTjK5d>.

In July 2019, the GEDHFQ of RSEQ resolved the *Salvador Senent Award* (7th ed.), with the name of the founder of this specialized group, for papers on didactics or the history of physics or chemistry. It is a much-consolidated activity of the group, after which the publication of works on these topics in the two journals published by our societies (*Anales de Química* by the RSEQ, and *Revista Española de Física* by the RSEF). The information is available at: <https://bit.ly/2lIHt0e>. At this time, the awarded work was “*Hacia la igualdad de género en la historia del sistema periódico*” (“Towards gender equality in the history of the periodic system”) by Ana Isabel Morales. In March 2020 we have launched a new announcement for the 8th edition of this Award.

Other activities carried out by the RSEQ through the GEDHFQ were:

- Collaboration in the organization of the III Poster Contest “*Gender Equality in Science? Experiences of students, teachers and scientists*”, organized by the Faculty of Teacher Training and Education, *Universidad Autónoma de Madrid*. <https://bit.ly/2Z7r0Av> (some 300 participants and visitors)
- Organization of the Symposium on “Didactics and History of Physics”, XXXVII Biennial Meeting of the RSEF (Zaragoza. 15-19 July 2019). <https://bit.ly/2RcmDU3> (some 100 attendees), and participation at: *I International Congress on Teaching Innovation and Research in Higher Education*, Scientific Research Society in Sciences of Health, Psychology and Education (Madrid, 20-22 November 2019) (some 100 attendees); VI International

Congress of Science Teachers, Professional College of Education, UCM and Santillana Editorial (Madrid, scheduled: April 2020 but delayed to April 2021).

- Participation of members of the GEDHFQ in specialized teacher training through Teacher Training Masters taught at different Universities.
- Two workshop presentations about the periodic table at the international science festival *Ciencia en Acción*, Science in Action (Alcoy, Alicante, October 2019), and teaching (outreach) about the chemistry of the railway of various workshops for outreach in the *Madrid Railway Museum* and nursing homes.
- A few lectures given for all the people such as: "Live the periodic table at the Science Corner of the 1st Madrid Fair for Science and Innovation at the UPM (Madrid, November 4 and 6 2019)"; "Didactic resources for STEM education", in the presentation of the book "Didactic experiences in the STEM field", Professional College of Education, Madrid, May 22 2019, <https://bit.ly/2wMOMaH>; "The periodic table: a key resource for teaching and disseminating science", University of Salamanca, September 27 2019; "Opening of the exhibition on the periodic table in the UPM books", Madrid, October 14 2019, <https://bit.ly/34cl2Bv>, <https://bit.ly/2qeXHQF> and <https://bit.ly/2BiLOLH>; "Introduction to the periodic table of chemical elements", UPM, Madrid, October 21 2019; Opening of the exhibition "Elemental: the periodic table of the chemical elements", National Museum of Natural Sciences (Madrid, November 5 2019); "The periodic table", Science Forum in the cultural week, Colegio Loreto (Madrid, November 15 2019); "A historical look at chemistry", National Autonomous University of Mexico, UNAM (Mexico City, November 21 2019); "The Periodic Table and its forgotten chapters. From the past and into the future", UNAM (Mexico City, December 6 2019).
- Scientific management and conducting several guided tours in the exhibition "The periodic table in UPM books", UPM, November 2019-March 2020, as informed at: <https://bit.ly/2CCPd8E> and <https://bit.ly/2JYP3wy>
- Preparation of three issues of the Group Newsletter (June 2019, December 2019 and May 2020).

5. Publications

As members of the GEDHFQ, and about different topics of chemical education, we have published among May 2019 and June 2020 the following papers:

- "The Periodic System. A History of Shaping and Sharing". 3 (2.4), 2019. IYPT2019 Special Issue of *Substantia. An International Journal of The History of Chemistry*, edited by B. Van Tiggelen, A. Lykknes and L. Moreno-Martínez. Full issue available here: <https://riviste.fupress.net/index.php/subs/issue/view/35>
- "The Periodic System and the Nature of Science. The History of the Periodic System in Spanish and Norwegian Secondary Education Textbooks". L. Moreno-Martínez and A. Lykknes. *Substantia. An International Journal of the History of Chemistry*, 3(2.4), 61-74. Available here: <https://riviste.fupress.net/index.php/subs/article/view/301>
- "Año Internacional de la Tabla Periódica (2019): Una Oportunidad para Abordar Contextos de Didáctica e Historia de la Física y la Química". G. Pinto, M. Martín, M. A. Calvo Pascual, A. de la Fuente, *Revista Española de Física*, 33(1), 10-18 (2019).

- “Número Monográfico sobre el Año Internacional de la Tabla Periódica”. Various authors. *Anales de Química*, 115(2).
- “Scientix, la Comunidad para la Enseñanza de Ciencias en Europa con Cientos de Recursos para la Formación STEM”. G. Pinto, A. Gras-Velázquez. *Alambique. Didáctica de las Ciencias Experimentales*, 98, 81-82 (2019).
- “Algunas Aportaciones al Año Internacional de la Tabla Periódica desde España”. G. Pinto, M. Prolongo, *Educació Química*, 25, 6-9 (2019).
- “Importancia de la Química en los Vuelos Espaciales: En Recuerdo de las Cinco Décadas del Apolo XI”. M. Martín, G. Pinto, *Anales de Química*, 115(4), 308-314 (2019).
- “El Concurso Escolar “Nuestra Tabla Periódica”: Una Iniciativa para Fomentar la Motivación de Profesorado y Alumnado en Áreas STEAM”. G. Pinto, *Anales de Química*, 115(4), 332-343 (2019).
- “La Tabla Periódica como Recurso Imprescindible para el Aprendizaje y la Divulgación de las Ciencias”. G. Pinto, *Educación en la Química. EdenlaQuim*, 25(2), 17-52 (2019).
- “Iniciativas del Ayuntamiento de Madrid para Resaltar la Labor de Andrés Manuel del Río, el Madrileño que Descubrió el Vanadio”. G. Pinto, *Anales de Química*, 116(1), 38-42 (2020).
- “Química y Vida Cotidiana”. G. Pinto. *Boletín de Divulgación Científica y Cultural*. Edited by the Ilustre Colegio Oficial de Doctores y Licenciados en Filosofía y Letras y en Ciencias, 291, 14-18 (2020).
- “Andrés Manuel del Río: el polifacético madrileño que descubrió un elemento químico en México”. G. Pinto. *Naukas Science Outreach Web*. June 2020. Available here: <https://naukas.com/2020/06/22/andres-manuel-del-rio-el-polifacetico-madrileno-que-descubrio-un-elemento-quimico-en-mexico/>
- “De la Dificultad en la Comprensión del Concepto de Presión de Vapor al Fundamento de la Olla Exprés: Una Aproximación Práctica a la Educación STEM”. G. Pinto, M. Prolongo (pp. 209-217). In *Experiencias Didácticas en el ámbito STEM: Investigación y Didáctica en ciencias, Tecnología, Ingeniería y Matemáticas*, Ed. Santillana, Madrid (2019). Available at <https://bit.ly/2F2GaPT>
- “La Educación STEM: Ejemplos Prácticos e Introducción al Proyecto Europeo Scientix”. M. Prolongo, G. Pinto (451-460). In *Experiencias Didácticas en el ámbito STEM: Investigación y Didáctica en ciencias, Tecnología, Ingeniería y Matemáticas*, Ed. Santillana, Madrid (2019). Available at: <https://bit.ly/2F2GaPT>
- “La Tabla Periódica: Algo más que un Icono de la Ciencia”. G. Pinto (pp. 42-55). Book chapter included in *Ciencia. Y un gran paso para la humanidad*, edited by Q. Garrido. Ed. Apadrina la Ciencia. Madrid (2019). Available in <https://bit.ly/2ud6Fwg> and <https://bit.ly/2GJnYuW>
- “Modelos Atómicos y Propiedades Periódicas de los Elementos Químicos”. G. Pinto (pp. 277-282). Paper included in *Enseñar química: De las sustancias a la reacción química*, edited by Aureli Caamaño. Ed. Graó, Barcelona (2020).
- “Actividades de Identificación y Comprensión de la Estructura y el Tipo de Enlace”. G. Pinto (pp. 331–336). Paper included in *Enseñar química: De las sustancias a la reacción química*, edited by A. Caamaño. Ed. Graó, Barcelona (2020).

- “Los modelos atómicos en los libros de texto. Pensar críticamente la historia de la ciencia”. L. Moreno-Martínez (pp. 258-266). Paper included in *Enseñar química: De las sustancias a la reacción química*, edited by A. Caamaño. Ed. Graó, Barcelona (2020).

6. Liaison with the chemical industry

RSEQ obtains financing through various sponsorships. For example, from the group GEDHFQ, the mentioned “*Salvador Senent Award*” was financed by *Foro Nuclear*.

7. International and European initiatives

A few members of the GEDHFQ participate as:

- *Scientix Ambassadors*, in the European project *Scientix* (the community for science education in Europe, <http://www.scientix.eu/>).
- Participants in the festivals *Science on Stage* (<https://www.science-on-stage.eu/>).
- Translators from English into Spanish of papers that are published at the web of the journal *Science in Schools* (<https://www.scienceinschool.org/>).

8. Other events and activities

The GEDHFQ is specially committed with social communication of science. Hence, we have created a Facebook group and a Twitter profile (@GDHFQ) in order to promote activities, resources and publications of interest for chemistry teachers in Spain and other countries.

9. Name of delegate and deputy

Delegate: Gabriel Pinto.

Deputy: Luis Moreno-Martínez.

10. Contact details of delegates.

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