MENDELEEV EPONYMS IN THE EPOCH OF EDUCATIONAL ETHNOCENTRISM

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Abstract

Eponymous terms play an important role in STEM education. This research focuses on the current state of Mendeleev eponyms in the context of education and ethnocentrism, addressing their usage in various languages, their educational value, cases of questioned priority and copyright violation in Mendeleev major eponyms–periodic table and periodic system. 106 chemistry textbooks in 4 languages including Soviet-time and current Russian textbooks were perused to identify and trace Mendeleev eponyms over 1924-2016. Advanced Google Search with queries in Belarusian, English, Latvian, Polish, Russian, and Ukrainian was conducted to evaluate online presence of eponyms "Mendeleev periodic table" and "Mendeleev periodic system." It was found that while Mendeleev eponyms occur generously on the Internet, periodic table and system with Mendeleev's name attached are seldom used on non-Russian webpages. Most Mendeleev eponyms were made up in the USSR and remain popular and Russia, which can be explained within the framework of ethnocentrism as a ruling tendency. Recognizing Mendeleev's priority, Flinn and Ross's periodic systems can be considered plagiarized; a few factors might favor their emergence, but ethnocentrism is unlikely to be one of them. Mendeleev eponyms remain valuable assets for science education, acting as shortcuts to the history of science and actualizing interdisciplinary connections.

Keywords: *chemical education, eponym, ethnocentrism, Mendeleev, periodic table, periodic system*

Introduction

Eponymous terms (Copernican system, Brownian movement, Faraday the father of electrotechnics, Priestley the father of pneumatic chemistry, Beschamp reaction, Cahn-Ingold-Prelog rules, ampere, hertz, etc.) play an important role in STEM education (Slabin, 2007; Slabin, 2017b) both didactics and axiology wise. In the classroom, eponymous terms act as amazing shortcuts that allow teachers to naturally transition from explaining the subject content to telling engaging stories about scholars, thus implementing principles of humanization and historicism in education (Slabin & Krasitski, 2017; Slabin, 2017a; Slabin, 2019b).

Metonymic transfer of meaning made the words "eponymous term" and "eponym" synonymous. Eponymy as a practice of attaching the scholar's or inventor's name to their discovery or creation is one of the most effective forms of recognition in Western scholarship. This recognition, however, has never happened smoothly. According to Merton (1957), "the gradations of eponymy have the character of a Guttman scale in which those men assigned highest rank are also assigned lesser degrees of honorific recognition" (p. 643). Stigler's law of eponymy (1980) claims that no scientific discovery is named after its original discoverer.

https://doi.org/10.33225/BalticSTE/2023.246

Eponymous terms can arise both in an organized way and unplanned. In some countries such as the former Soviet Union an inventor had the right to assign their name to the invention (law "On inventions in the USSR," 1991). The author of this article utilized that opportunity to patent his own invention, Slabin's necktie (1992). In many fields, especially medicine, eponymous terms arise spontaneously and in large amounts, which prompted the World Health Organization (2013) to actively discourage the use of eponymous terms in medicine. Many factors influence formation and use of eponyms, one of them being ethnocentrism—the leading trend in world education after the universalism of the Renaissance (Slabin, 2017c).

Perhaps, the most frequently used eponymous term in Soviet and post-Soviet school chemistry has been Mendeleev periodic table. Considering the periodic law history, Russian teachers surely heard of the Newlands octaves and the Döbereiner triads, but no one there doubts that the law was "discovered by D. I. Mendeleev in 1969" (the words under the scholar's portrait in a common school version of the periodic table). The professional jargonic acronym "PSM", popular among teachers and students, unambiguously stands for "periodic system of Mendeleev."

Research Problem

Although not always the case, it is a general expectation that a great scholar leaves multiple eponymous terms. Over 154 years that passed after Mendeleev had discovered the periodic law, his biography and scholarly heritage have been exhaustively investigated. However, Mendeleev eponymous terms have not been a particular research object in education. As his heritage extends beyond the periodic law, one can expect more linguistic derivatives associated with Mendeleev. Research on eponymous terms of his name, on their origin and usage, would uncover interesting facts, valuable for chemical and science education.

Research Aim and Research Questions

This research aimed at the current state of Mendeleev eponymous terms in the context of education and ethnocentrism, addressing the following questions:

1. What Mendeleev eponymous terms have ever been made up, which of them are in educational use today and in what countries?
2. Are there any cases of challenged priority or violated copyright with Mendeleev discoveries and Mendeleev eponymous terms?
3. What is the role of ethnocentrism in this situation?
4. What is the value of Mendeleev eponymous terms in science education?

Research Methodology

To find Mendeleev eponymous terms, various texts in print and on the Internet were used. Reviewing literature for a dictionary of chemical eponyms, 106 chemistry textbooks for secondary schools and universities in Belarusian, English, Latvian, and Russian languages were perused and 1642 eponyms were identified including named acids, adapters, apparatus, bases, catalysts, condensers, constants, elements, equations,

https://doi.org/10.33225/BalticSTE/2023.246

filters, flasks, formulas, funnels, intermediates, laws, principles, projections, pumps, reactions, rearrangements, salts, stoppers, theorems, theories, vessels, asf. These data collection started in 1995; the data were used for similar research focusing on Verkhovsky eponymous terms (Slabin, 2017c).

Available Soviet-time (1924-1972) and current Russian chemistry textbooks (2016) were looked through with attention to Mendeleev eponymous terms, Mendeleev's priority emphasized, history of the periodic law covered, Mendeleev's competitors mentioned, and Mendeleev's portrait and biography included.

Advanced Google Search was used to find more Mendeleev eponymous terms and to compare their presence in six languages of the Internet: (a) English as one of the most frequently used in science, (b) Russian as the language of the country for which Mendeleev worked, (c) Belarusian, (d) Ukrainian, (e) Latvian as languages in the former USSR where Mendeleev's scientific achievements were popularized, and (f) Polish as the language of a country of former Soviet bloc where Russian and Soviet scholarship was popularized, too, but with lesser pressure. Table 1 lists concurrent search queries for versions of the four most popular eponyms—"Mendeleev periodic table", "Mendeleev periodic system", "Periodic table/system", and "Mendeleev the father of the periodic system."

"Google results" is a common and loosely used term but actually, without manipulation and interpretation it means "data", not "results." Because the number of those so-called results is known to be a complex function, Google Search was completed on one computer within two hours. The initially obtained numbers were then adjusted by dividing by respective numbers of language speakers (https://en.wikipedia.org/wiki/List_of_languages_by_total_number_of_ speakers) and multiplying by 10000–i.e., recalculated to webpages per 10,000 language speakers ("per capita" numbers were quite minute, 10^{-2}-10^{-4}). These results were used for building charts, comparison, and analysis.

https://doi.org/10.33225/BalticSTE/2023.246

Table 1

Basic Queries in Various Languages for Mendeleev Eponyms in Advanced Google Search

English[a]	"Table of Mendeleev", "Mendeleev table", "Mendeleev periodic table"
	"System of Mendeleev", "Mendeleev system", "Mendeleev periodic system"
	"Periodic table", "Periodic system" (without "Mendeleev"–no eponym)
	"Mendeleev", "father of the periodic table", "father of the periodic system"
Russian[b]	"Таблица Менделеева", "Периодическая таблица Менделеева", *"Периодическая таблица элементов Менделеева", "Периодическая таблица химических элементов Менделеева"*
	"Система Менделеева", "Периодическая система Менделеева", *"Периодическая система элементов Менделеева", "Периодическая система химических элементов Менделеева"*
	"Периодическая система", "Периодическая таблица" (without "Менделеева"–no eponym)
	"Менделеев", *"отец периодической таблицы", "отец периодической системы"*
Belarusian	"*Табліца Мендзялеева*", "*Перыядычная табліца Мендзялеева*", "*Перыядычная табліца элементаў Мендзялеева*", "*Перыядычная табліца хімічных элементаў Мендзялеева*"
	"*Сістэма Мендзялеева*", "*Перыядычная сістэма Мендзялеева*", "*Перыядычная сістэма элементаў Мендзялеева*", "*Перыядычная сістэма хімічных элементаў Мендзялеева*"
	"*Перыядычная табліца*", "*Перыядычная сістэма*" (without "*Мендзялеева*"–no eponym)
	"*Мендзялееў*", "*бацька перыядычнай табліцы*", "*бацька перыядычнай сістэмы*"
Ukrainian	"*Таблиця Менделєєва*", "*Періодична таблиця Менделєєва*", *Періодична таблиця елементів Менделєєва*", "*Періодична таблиця хімічних елементів Менделєєва*"
	"Система Менделєєва", "Періодична система Менделєєва", *"Періодична система елементів Менделєєва", "Періодична система хімічних елементів Менделєєва"*
	"Періодична таблиця", "Періодична система" (without *"Менделєєва"*–no eponym)
	"Менделєєв", "батько періодичної таблиці", "*батько періодичної системи"*
Latvian	"Mendeļejeva tabula", "Mendeļejeva periodiskā tabula", "Mendeļejeva elementu periodiskā tabula", "Mendeļejeva *ķīmisko* elementu periodiskā tabula"
	"Mendeļejeva sistēma", "Mendeļejeva periodiskā sistēma", "Mendeļejeva elementu periodiskā sistēma", "Mendeļejeva *ķīmisko* elementu periodiskā sistēma"
	"Periodiskā tabula", "Periodiskā sistēma" (without "Mendeļejeva"–no eponym)
	"Mendeļejevs", "periodiskās tabulas tēvs", " periodiskās sistēmas tēvs"
Polish[c]	"Tablica Mendelejewa", "Tablica okresowa Mendelejewa", "Tablica okresowa pierwiastków Mendelejewa", "Tablica okresowa pierwiastków chemicznych Mendelejewa"
	"Układ Mendelejewa", "Układ okresowy Mendelejewa", "Układ okresowy pierwiastków Mendelejewa", "Układ okresowy pierwiastków chemicznych Mendelejewa"
	"Tablica okresowa", "Układ okresowy" (without "Mendelejewa"–no eponym)
	"Mendelejew", "ojciec tablicy okresowej", "ojciec układu okresowego"

Note: [a]The author agrees with Jana et al. (2013) that eponymous terms should be used in non-possessive form. However, because both forms occur, the queries with apostrophe ("Mendeleev's") were also included in Google Search for English.

https://doi.org/10.33225/BalticSTE/2023.246

[b]Google Search with and without Mendeleev's initials (D. I.) was done for Russian, Belarusian, Polish, and Ukrainian but not English and Latvian, which is explained by difference in word order in these languages.

[c]Synonyms "tablica" and "tabela" were included in Google Search for Polish.

Research Results

Chemistry Textbook Findings

Of the preliminary found 1642 chemical eponyms, the following 11 related to Mendeleev:

1. Mendeleev periodic table [of the chemical elements].
2. Mendeleev periodic system [of the chemical elements].
3. Mendeleev [periodic] law.
4. Mendelevium, a chemical element.
5. Mendeleev weighing method.
6. Mendeleev hydration theory.
7. Mendeleev pycnometer.
8. Mendeleev scales.
9. Mendeleev altimeter (differential barometer).
10. Mendeleevian lute.
11. Mendeleev-Clapeyron equation.

The new search added 12. "Mendeleev-Geissler (Geißler) pycnometer" and 13. "Mendeleev the father of the periodic table" to the list.

The findings obtained from looking through Soviet and current Russian chemistry textbooks are shown in Table 2.

https://doi.org/10.33225/BalticSTE/2023.246

Table 2

Mendeleev Eponyms in Soviet and Current Russian Chemistry Textbooks

Year the textbook was published	Eponymous terms present	Portrait	Biography	Competitors mentioned
Kablukov, 1924	Mendeleev table[a] of the elements, Mendeleev periodic system of the elements	—	—	Meyer
Pavlov & Semenchenko, 1934	Mendeleev system	—	—	Döbereiner triads, Newlands octaves, Tomsen periodic system of the chemical elements
Verkhovsky, 1940	Mendeleev table, Mendeleev system, Mendeleev periodic system of the elements, Mendeleev law	⅙ page	—	Moseley
Levchenko et al., 1953	Mendeleev table, Mendeleev periodic system of the elements, Mendeleev law, Mendeleev periodic law	½ page	2 pages	—
Khodakov et al., 1960	Mendeleev periodic system	full-page	2 pages	—
Khodakov et al., 1979	Mendeleev periodic law, Mendeleev periodic system of the chemical elements	full-page	1½ page	—
Rudzitis & Feldman, 2016[b]	Mendeleev periodic law, Mendeleev periodic table, Mendeleev periodic table of the chemical elements	—	½ page	Döbereiner triads, Newlands octaves, Chancourtois, Odling

Note: [a]The eponyms (translated from Russian) are shown in non-possessive form as advised in (Jana et al., 2013).

[b]As the latest edition of this textbook was published in 2022, this table spans almost one century (1924-2022).

As follows from the table, eponymous terms “Mendeleev [periodic] table [of the chemical elements]” and “Mendeleev [periodic] system [of the chemical elements]” (the optional terms are indicated in brackets) have been present in Soviet and current Russian’s textbooks for decades.

Mendeleev’s portrait first appeared in the textbooks shortly before WW2. In the next 13 years its size increased thrice, and in the next 7 years it did twice: from ⅙ page bust view in 1934 to full-page full-length in 1960. Triple enlargement of the portrait coincided with the appearance of Mendeleev’s biography and the disappearance of his scientific competitors from the textbooks in 1953.

One more found self-invented Mendeleev eponymous term is “the Mendeleev of biology.” Aronova (2021, p.65) used it to characterize academician N. I. Vavilov, an outstanding Soviet agronomist and geneticist. The contemporaries wrote about Vavilov’s

discovery, “the remarkable repeatability and periodicity [of plant forms] are opening the possibility to predict the existence of not-yet-known forms, just as the periodic table of Mendeleev allowed [chemists] to predict the existence of unknown elements” (Esakov, 1981, as cited in Aronova, 2021, p.68).

Advanced Google Search

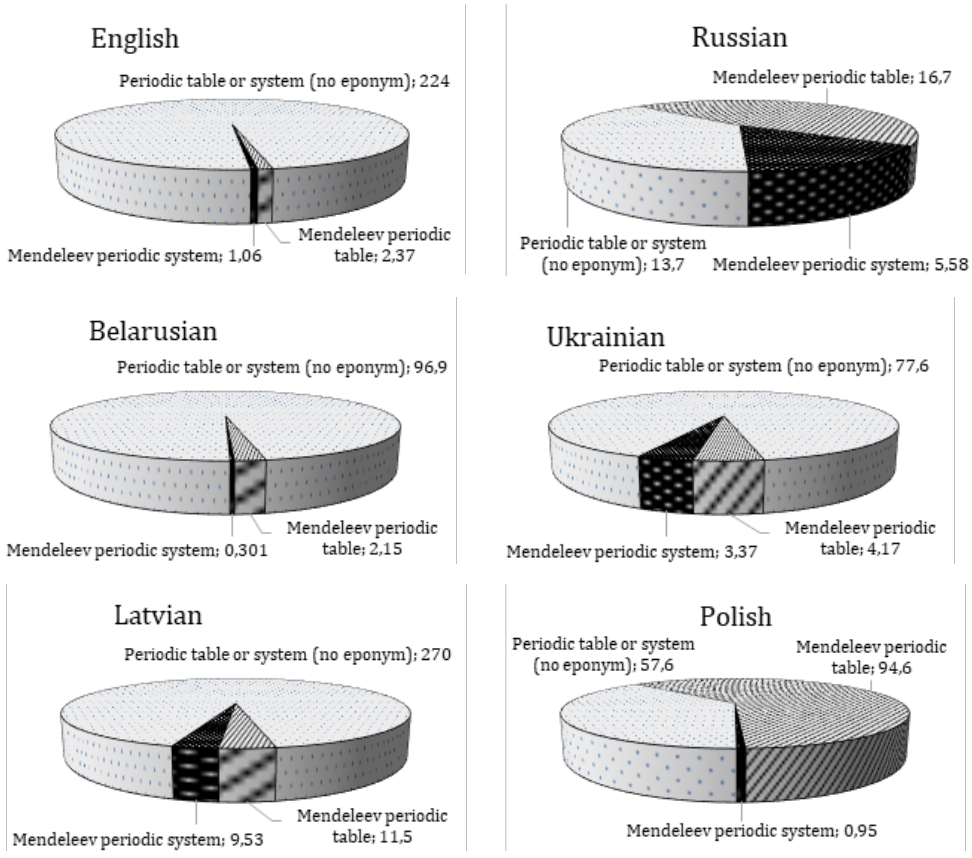
The search revealed that Mendeleev eponyms exist in significant amounts. There are toponyms: astionym *Mendeleevsk* (a town), komonym *Mendeleevo* (a village), metro station *Mendeleevskaya* (in Moscow), ergonym–airport named after Mendeleev, some odonyms. All those objects are found in Russia. Further toponyms include *Mendeleev glaciers* (in Kyrgyzstan and Antarctica), oceanonym *Mendeleev ridge* (on the Arctic Sea bottom), oronyms *Mendeleeva volcano* and *Mendeleev crater* (on the Moon) also known as *Catena Mendeleev*, cosmonym *2769 Mendeleev asteroid*, etc. Machinonyms are represented by the Airbus A321 *Dmitri Mendeleev* (Aeroflot, Russian Airlines) and research ship with the same name. Furthermore, there are university, institute, academy, college, library, oil refinery, Russian Chemical Society named after *Mendeleev*, scholarly journal *Mendeleev Communications*, and a few conferences titled *Mendeleevian Readings* held in Russia, Ukraine, and Belarus.

The search confirmed that major Mendeleev eponymous terms occur unevenly in various languages, which Figure 1 illustrates.

https://doi.org/10.33225/BalticSTE/2023.246

Figure 1

Presence of Mendeleev Eponymous Terms on the Webpages in the Six Languages



Note: The figure shows the numbers of webpages per 10000 language speakers.

As follows from the figure, "Mendeleev periodic table" and "Mendeleev periodic system" prevail only on webpages in Russian and Polish languages, whereas webpages in Belarusian, English, Latvian, and Ukrainian prefer non-eponymous "Periodic table" and "Periodic system".

Vice versa, Mendeleev as "the father of the periodic system" occurs predominantly on English pages: English (30.0 webpages per 1 million language speakers) > Latvian (4.00) > Ukrainian (2.95) > Polish (1.26) > Russian (0.941) > Belarusian (0.143).

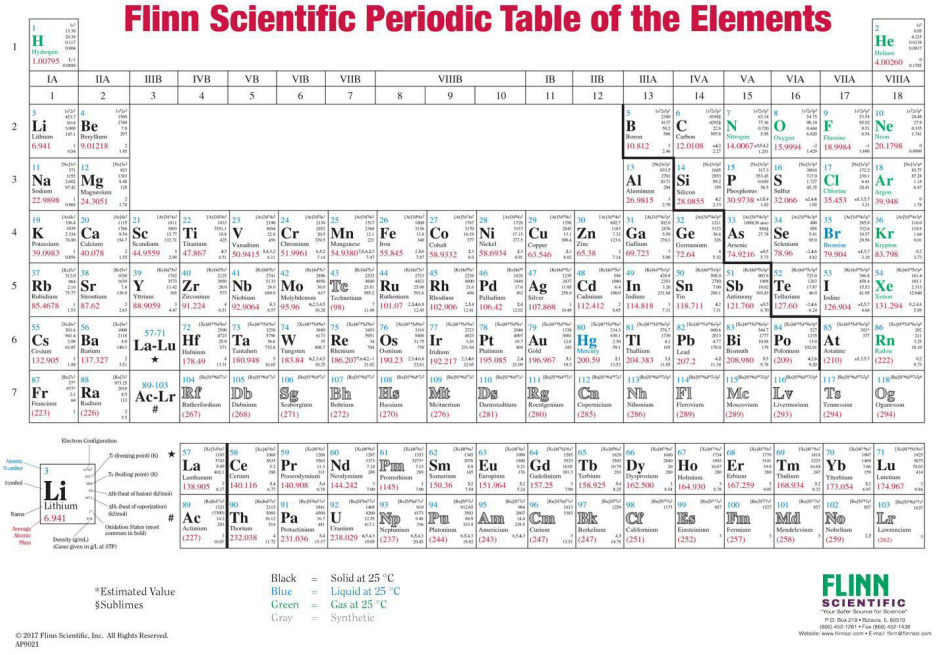
Plagiarized Periodic Tables

Lagerkvist (2012) describes Mendeleev's nomination for Nobel Prize, "Today it goes without saying that the periodic law is perhaps the most decisive progress ever made in theoretical chemistry" (p. 112). If Mendeleev's priority in discovery of the periodic law and building the periodic table has been established and recognized, then the found Flinn Scientific Periodic Table of the Elements (Figure 2) and the Ross Periodic Table

(Figure 3) can be considered a plagiarism. Both tables are produced by Flinn Scientific, they can be ordered on the company's website. Teachers, instructors, and students of U.S. schools, colleges and universities work with these tables, they can be found in classrooms, auditoriums, and laboratories as a visual aid and a handout.

Figure 2

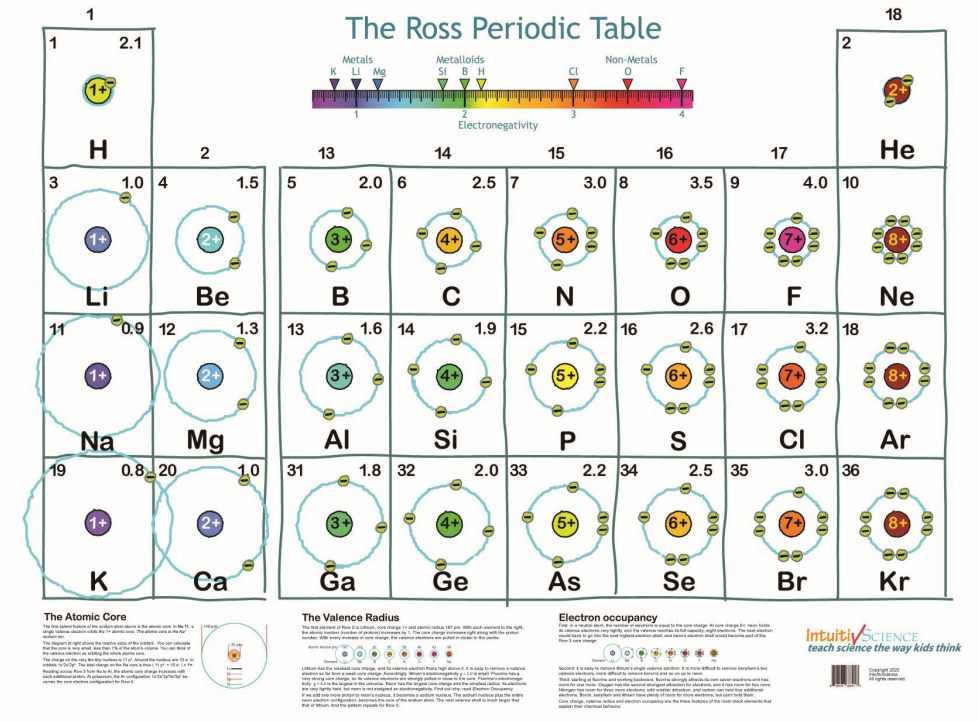
Flinn Periodic Table



Note: From https://www.flinnsci.com/products/chemistry/charts--posters/flinn-periodic-table-charts (May 2023, Flinn Scientific). The company offers other items (mugs, magnets, etc.) labelled "Flinn periodic table."

Figure 3

Ross Periodic Table



Note: From https://www.flinnsci.com/ross-periodic-table/ap11075 (May 2023, Flinn Scientific).

Discussion

The state of Mendeleev eponymous terms resembles that of Verkhovsky (Slabin, 2017c): most of them are either forgotten by now or used predominantly in Russian texts, authored and promoted by Russian chemists (chemistry educators). It is true for both famous eponyms "Mendeleev periodic system" and "Mendeleev periodic table" and less famous. The latter seldom occurs on non-Russian webpages; e.g., Google results for Mendeleev pycnometer show Russian/English webpage ratio 6290:62, for Mendeleev-Clapeyron equation 32500:68 (without "per capita" adjustment). One reason for it can be natural falling out of date; it seems to have happened with the Mendeleevian lute, for which Google returns merely 84 results in original Russian, not to mention other languages. Another reason is common ethnocentrism (Russian in this case), the human tendency to view own group (nation) as centrally important and, in some respect, superior. Eponym "Mendeleev the father of the periodic system" is an exception: such an expression is quite typical in English but sounds not so usual in Russian and the five other languages.

Changing presence of Mendeleev eponyms in chemistry textbooks reminds that over 154 years since the discovery of the periodic law, ethnocentric influence in the case of Mendeleev has not always been consistent. "Many colleagues in Russia had

criticized Mendeleev for being inclined to unsupported speculations" (Lagerkvist, 2012, p. 112). His colleagues had never elected him to the Russian Academy of Sciences and, expectedly, never nominated for Nobel Prize (foreign colleagues did it thrice but unsuccessfully). It might have taken time for Russian chemists of the first half of the 20th century to realize the paramount importance of Mendeleev's discovery, to feel their fault of underestimate the scholar and the compatriot, and to do their best to compensate the loss. This is why chemistry textbooks of 1924 and 1934 mention, along with Mendeleev periodic table, his foreign competitors, and include neither his biography nor portrait. In the textbook of 1940, Mendeleev's portrait appears, in the 1953 his biography adds, and in 1960, the portrait reaches full page. Also, in this evolution, Mendeleev's scientific competitors disappear from the textbooks. In the textbook of 2016, Mendeleev's portrait is missing, his biography is reduced down to half a page and, unlike in previous decades, reads more scientific than personal. Mendeleev's competitors in the textbook are back again, as in 1934. It can mean that by now Russian authors have got rid of the guilt, and ethnocentrism is no longer urgent.

The history of Flinn and Ross periodic tables is shorter and, perhaps, less interesting (Slabin, 2019a). Lawrence Flinn is an American entrepreneur, whose firm is a leading supplier of equipment and visual aids for auditoriums and laboratories in the USA. According to a Texas teacher on the firm's website (www.flinnsci.com), "Flinn alone has done more for safety in the science classrooms of America than legislators and educators combined." What relation, however, does Flinn have to the discovery of the periodic law? It probably doesn't matter. The important thing is that Flinn designed the table with this layout. There is a copyright sign (©) in the lower left corner of his table.

How was it possible? Well, eponyms "Mendeleev periodic system" and "Mendeleev periodic table" are neither registered anywhere as a trademark nor universally accepted. In US chemistry textbooks, the periodic system is presented without the Mendeleev's name. For these reasons, American chemists, teachers, students are neither indignant nor surprised by Flinn and Ross's periodic tables (Ross is a designer). The firm smartly calls its product a periodic table, not a periodic system: Flinn does not claim to be the author of the system (scientific concept), he only offers his own design. The trick hides in ambiguity: "Flinn Scientific Periodic Table of the Elements" can be understood both as "manufactured by Flinn Scientific, a firm" and "scientific table invented by Lawrence Flinn, a person."

If those periodic tables were given the name of an American chemist (say, Pauling), it could be attributed to ethnocentrism. However, it is unlikely that Flinn Scientific marketers were influenced that way. Rather, they were just driven by business strategies. Taking advantage of the market situation, playing on the intricacies of the language and patent law, the firm presented to the American teaching community an interesting new/old visual product.

Mendeleev eponymous terms and their ethnocentrism-influenced history are valuable for science education because they humanize it. Uncovering the history of just one eponym—Mendeleev periodic table of the chemical elements—figuratively invites to classroom a company of committed, intellectual, inquisitive people: Meyer, Döbereiner, Newlands, Moseley, Rutherford, and many others. Educational principles of humanization and historicism get effectively implemented. Another valuable impact of Mendeleev eponymous terms is actualized, by the good will of teachers, interdisciplinary

connections. Studying the periodic law, chemistry teacher can switch from Mendeleev table to the town of Mendeleevsk and show it on the map (chemistry ⇆ Mendeleev ⇆ geography). Likewise, a language teacher can use *odonym* Mendeleevslaya street as a starting point to Mendeleev himself and then talk for a minute about the periodic law (language ⇆ Mendeleev ⇆ chemistry). Training their students on the Mendeleev periodic system, a chemistry teacher can mention Mendeleev pycnometer and say some words about the property of substances to expand at higher temperatures, the reason pycnometer works (chemistry ⇆ Mendeleev ⇆ physics). Eponymous expression "the Mendeleev of biology" (Aronova, 2021) is complex and requires decent knowledge for understanding but it establishes a strong and essential connection: Mendeleev ⇆ chemistry ⇆ biology ⇆ Vavilov.

Conclusions

As a result of this research, new Mendeleev eponymous terms have been found. Their popularity in print and online sources has been evaluated with the perusal of chemistry textbooks and advanced Google Search. Today, usage of Mendeleev eponyms in English texts is decreasing; some become naturally obsolete because the material objects they signify get out of date, others deserve more attention. The popularity of Mendeleev eponymous terms in the original Russian scholarly environment may be due to ethnocentrism, which has been changing over 154 years since the discovery of the periodic law and can be traced and analyzed by chemistry textbooks. With respect to their potential for implementation of principles of humanization and historicism as well as for making interdisciplinary connections, Mendeleev eponymous terms should be kept and creatively applied in chemistry classrooms.

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Received: *April 15, 2023* Accepted: *May 15, 2023*

Cite as: Slabin, U. (2023). Mendeleev eponyms in the epoch of educational ethnocentrism. In V. Lamanauskas (Ed.), *Science and technology education: New developments and innovations. Proceedings of the 5th International Baltic Symposium on Science and Technology Education (BalticSTE2023)* (pp. 246-258). Scientia Socialis Press. https://doi.org/10.33225/BalticSTE/2023.246