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Facilitating Conceptual Change in Students' Understanding of the Periodic Table

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Abstract

Periodic table forms part of almost every high school and introductory university level chemistry textbook published on this planet. Despite its usefulness as a conceptual tool for organization of the chemical elements, understanding their properties, predicting new elements and a corrective device, most students consider it to be a difficult topic. The objectives of this study are: (1) Review of various aspects in the development of the periodic table based on a history and philosophy of science (HPS) perspective; and (2) Design of a teaching strategy based on the historical aspects in order to facilitate freshman students' conceptual understanding of the periodic table. Following historical aspects were considered to be important for the design of the teaching strategy: Role of the Karlsruhe Congress of 1860, accommodation of the chemical atoms in the periodic table, prediction of elements that were discovered later, corrections of the atomic weights, periodicity in the periodic table as a function of the atomic theory, and accommodation of argon in the periodic table. This study is based on two groups of freshman students enrolled in a Chemistry I course at a major university in Latin America. In order to avoid possible interactions, control group students received instruction in a semester prior to that of the experimental group. Both groups were asked to look for information on the periodic table from the Internet and traditional textbooks found in the university library. Following this, control group students discussed and solved problems found in the textbooks. Experimental group students were then exposed to the following phases of an experimental treatment: (a) Discussion of various aspects related to HPS; (b) Construction of concept maps; (c) Evaluation based on Posttest 1 (Items 1–4); (d) Classroom discussions based on students' responses on Posttest 1; (e) PowerPoint presentation by the instructor based on various HPS aspects; (f) Construction of new concept maps; (g) Discussion and comparison of the two sets of concept maps; (h) Evaluation based on Posttest 2 (Items 5–7); and (i) Five volunteer students participated in semi-structured interviews. Control group students were also evaluated on Posttests 1 and 2 and spent the same time in solving traditional problems, as the experimental group used to receive the treatment. Experimental group students provided conceptual responses on all items. Item 1 dealt with atomic theory as the criterion used by Mendeleev to order the elements, and 19 % of the students responded conceptually. Item 2 dealt with the relationship between the periodic

table and the early atomic theory, and 47 % responded conceptually. Item 3 dealt with the question as to how Mendeleev could elaborate the periodic table before the modern atomic theory, and 28 % responded conceptually. Item 4 asked if the idea of ordering the elements originate with Mendeleev and 13 % responded conceptually. Item 7 referred to periodicity as a function of the chemical atoms (atomic theory) and 13 % responded conceptually. It was not expected that control group students would respond conceptually. Nevertheless, one student on Item 1, two students on Item 2, and one student on Item 3 responded conceptually. This is an interesting finding and shows that given the opportunity to reflect even some control group students can go beyond and improve understanding. Based on the results obtained, a teaching strategy is designed for high school and freshman students, which can facilitate students' conceptual understanding.

Keywords History and philosophy of science • Historical reconstruction • Periodic table • Dalton's atomic theory • Gay-Lussac • Avogadro • Karlsruhe congress • Cannizaro • Newtonian method • Mendeleev • Meyer • Moseley • Periodicity • Accommodation • Prediction • Atomic mass (weight) • Atomic number • Valence • Physicochemical properties • Correction of atomic weights • Noble gases • Modern atomic theory • General chemistry textbooks • Concept maps • Conceptual understanding • Teaching strategy