Teaching Efficiency
Ефективност на обучението

TEACHING AIDS IN PRESENTING THE TOPIC OF „THE PERIODIC TABLE OF ELEMENTS BY DMITRI IVANOVICH MENDELEEV“ AT THE PRIMARY SCHOOL

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Abstract. This paper presents the theoretical basis, construction process, practical usage of teaching aids – a whiteboard with magnets and funny text, as well as the process of the lesson realization – in presenting the topic of Periodic Table of Elements (PTE) by D. I. Mendeleev. Moreover, the implementation of new ideas, derived from teaching experience, is presented with the aim to introduce chemistry curriculum in an amusing way, adapting it to the interests and needs of students through creative and innovative work of the teacher.

Keywords: chemistry teaching, teaching aids, Periodic Table of Elements, primary school, students

Introduction

Chemistry teaching, regardless of whether it originates in Serbia (theoretical-encyclopedical) or Germany (practical) – basically two conceptually different educational (European) systems – demonstrates need for constant search of simple, efficient and applicable teaching methods in presenting curriculum (topic: Periodic Table of Elements). Unlike the high level of equipment of German schools, the difficult material situation of the school system in Serbia dictates the use of alternative teaching models and means in chemistry teaching. Technically less demanding and accessible teaching aids (e.g. easy to construct) may successfully be applied in presenting the theme of "Substance Structure", which includes the topic "Periodic Table of Elements" (PTE) (Vukotić, 2004). Certain modern electronic aids (computer, computer programs and Internet) may be applied as supplementary aids. In this case, however, the computer must not be attributed the role of the most frequently used teaching aid, disregarding other traditional teaching aids. This principle can be applied when one must, due to the lack of other means, give priority to the computer (Stojkovic & Kostic, 2009).

Choice and application of teaching aids

Modern chemistry teaching offers a plethora of possibilities for presenting the topic of "Periodic Table of Elements", from the use of various teaching aids (traditional and modern, or combination of them), through different models and procedures in explaining ideas which led to the construction of PTE and formulation of the law of periodicity.

It is therefore necessary to briefly present the history of the PTE development when presenting the given topic – from the works of the scientist Leopold Gmelin[1)] (Renatus, 1983), through the work of Johann Wolfgang Döbereiner[2)] (Renatus, 1983; Prandtl, 1956), to the Periodic Table by Dmitri Ivanovich Mendeleev, and the universal importance of PTE and the Law of Periodicity (Mandić et al., 2005) – in an original and innovative way, without digressing from basic teaching and general educational objectives.

Experience has shown that the choice of teaching aids and models is practically unlimited: *teaching or method tools* (Methoden-Werkzeug), including: *partner's cards* (Partnerkärtchen), *playing cards* (Kärtchentisch), *chain quiz* (Kettenquiz), *dominoes* (Domino), *structure, process and current diagrams* (Struktur-, Fluss- und Prozessdiagramm), *dialogue* (Dialog), *picture story* (Bildergeschichte), *concept-map* (Concept-Map), etc. (Thomas & Schlieker, 2001) then, *3D structural paper models* (Dreidimensionale Strukturmodelle) or paper atom models made of small pieces (Papiermodelle aus Ausschneide-Klebe-Bögen), which are used when explaining the structure of atoms and bonds in molecules (Voigt, 1993). Model balloons – balloons for making figures (Modellierbare Luftballons) are used when describing atom orbitals in the atom (Becker et al., 1992). *Cartoons* (Cartoons) are used when explaining complex and abstract contents in chemistry and physics (Braun, 1992). *Chemistry photo-story* (Chemie-Foto-Story-Gruppe), i.e. chemistry comics, as a supplementary means, is used to explain procedures and phases when performing laboratory experiments (Tomcin & Reiners, 2010).

For instance, the above mentioned aids may be useful when explaining alternative ideas which come from the original works of D. I. Mendeleev (three-dimensionality of PTE) (Djukić & Rakočević, 2002) of course, with the obligatory reduction of the content, adapted to the age and knowledge of students.

The choice of teaching aids depends primarily on material and technical possibilities, the means the school possesses, necessary working conditions, ideas, interests as well as theoretical and practical knowledge and experience of the teacher (Levine, 2002).

Motivation, intellectual abilities and interests are also factors which determine the adoption and understanding of the curriculum. It is, therefore, necessary to offer an alternative, which consists of a variety of ways of presenting the curriculum.

It is important to motivate and develop intellectual abilities with students by exploring the areas they are interested in, and within which they can develop and train various abilities, when studying and understanding certain contents from chemistry (most students have more difficulty in learning and memorizing certain concepts and laws than in reaching the conclusion themselves with the help of a model, or through figures and numbers) (Stojkovic, 2010).

Description of teaching aids and the structure of school hour

White board with magnetic tiles: the foundation (board) is made of iron sheet, dimensions (50 cm x 30 cm), covered on both sides with tracing or simple white copy paper. Each magnetic tile represents an element from PTE (group I: H, Li and Na ; II: Be and Mg; III: B, Al; IV: C, Si; V: N, P; VI: O, S and VII: F and Cl).[3)] The board can be hung on the school board or wall, framed, made a stand or put on a desk. If necessary, a box for keeping the board and cardboard tiles can be made. The cards are of the same dimensions (5 cm x 7 cm); there are 15 cards. They are made of cardboard containing the symbol of an element and its mass number (A) on the front cover. The symbols and mass numbers are in different colors (for example, Na is marked in blue, while its mass number (A), which is 23, marked in black; C is colored in red, its mass number (A=12) in black; boron, B, with mass number (A=11) is colored in dark yellow or ocher; etc.). Blue color represents metals, red or pink represents nonmetals, while metalloids are colored in yellow or ocher (in numerous versions of PTE: metals are colored, apart from blue, in red or green; nonmetals in yellow or green; metalloids in brown, green or blue). Word or Paint programs were used for writing symbols and numbers. There are round magnets, taken off advertizing magnets (metal badges), and glued to the back side of the card. Such magnet tiles are easy to move across the suface of the metal board. In case a tile is lost or broken, they can be remade, since they are easy to make (students make them at school or at home).

Funny text for the chosen elements of PTE with the basic data on their physical-chemical characteristics. On the upper part of the paper sheet (size A4), there is a colored square (in the shape of the card) (Freimann, 1996), which contains the symbol of the element, the atomic number (the protons number, Z), group and period in which the element is located. The lower part of the sheet (the other half), contains a short (funny) text with the most important information: on the origin of the name of the element, date of discovery, the discoverer, the place of discovery, position in PTE, use, specific chemical behavior, etc. Here computer programs (Word or Paint) may be used to write the text. One funny text corresponds to each magnetic tile – element (15 texts in all).

The combination of the teaching aids, a board with magnetic tiles and funny text, is best used in group or pair work (e.g. a group of 2 or 3 students represents metals of group I, the next one represents group II, then group III, group IV, group V, group VI, and finally group VII of nonmetals). Experience has shown that it is the most efficient to use from 10 to 15 cards and the same number of texts. It is, though, hard to set the participation of more than 15 students, divided in groups, due to the time limit of the class (unless the teaching is conducted in block classes).

Grade: VII

Type of lesson: presentation (Figs 1 – 4).

Lesson aim: (1) Bringing closer the concept of the formation of PTE to students; (2) Understanding the Law of periodicity and importance of the universality of PTE; (3) Developing cooperation among students through group and pair work; (4) Exploration of various sources (textbook, Internet); (5) Developing IT literacy through the use of the computer and computer programs; (6) Developing the ability to improvize, creativity and logical thinking of the students.

Material: Whiteboard with magnetic tiles (15 pieces), sheets of paper size A4 (15 sheets) – a funny text containing information on the elements, table of PTE.

Procedure

Step 1: At the beginning of the class students are introduced with the basic information on the life and work of D. I. Mendeleev, the history of PTE and its universality. The choice and way of presenting the information are left to the teacher (for example, text written on the board, overhead foils, in Word, or a short Power Point presentation). The Figures of the old PTE, files from the original work of D. I. Mendeleev, as well as the portraits of the scientists dealing with the formation of PTE, may be found in school encyclopedias or downloaded from Internet sites.[4)]

Step 2: By moving the cards (15 elements) on the metal board, starting with the elements of the lowest mass number to the elements with the highest mass number (A), a horizontal line is formed (Fig. 1). Then, the cards with elements colored in blue (metals) are arranged in vertical rows (groups) according to the recurrence of their physical-chemical characteristics in the given row. The procedure is repeated with the rest of the elements – nonmetals and metalloids. The layout of all the cards on the board represents a model or example of the formation of PTE (with groups and periods), as well as the idea which guided D. I. Mendeleev (Fig. 2) when formulating the Law of periodicity (the old and modern version of the law).

Step 3: The students are then divided into groups, each group being given a suitable text (the group that represents metals is given the texts for Na, Li and K). They are given 5 – 10 minutes to read the trexts. After that, each group introduces the others with basic characteristics of the elements of their group (they do this one group after another, from group I, group II, etc.), using their funny texts (see Figs 3 and 4). The idividual presentations being finished, students from each group take their places in the classroom according to the position of the elements they represent in the PTE (Fig. 2). The last group of students form the PTE, along with all the other groups of students. Finally, all groups, according to the short sentence (which is at the end of each funny text), say: “*We are a big happy family of elements of D. I. Mendeleev*” (Figs 3 and 4).

Step 4: At the end of the class the students are assigned homework: to make several additional magnetic tiles of the elements they have not mentioned and tackled in class. They are also supposed to write a short funny text for each element using Word or Paint programs, or alternatively make a short Power Point presentation, using data from the Internet.

Conclusion

What is important for modern chemistry teaching is above all: an overall improvement of chemistry teaching, simplified curriculum presentation, adjusted to the needs and interests of students, general popularization of natural sciences, openness for realization of new ideas and complete freedom of method and procedure choice. The specific role of the teacher, as the motivator and atmosphere creator, is reflected in the application of new ideas, the ability to improvize and implement, innovate and cooperate, work creatively, and their personal interests and abilities to introduce students with natural phenomena in an interesting, funny and popular way. It is necessary to constantly probe and actualize students' interests and needs, coordinate and shape them through innovations on both theoretical and practical fields.

Moreover, the latest teaching aids are not necessarily the most suitable in each situation in explaining concepts, phenomena or laws in nature. The use of simple teaching aids often simplifies the presentation of scientific ideas, complex theoretical contents and abstract models in chemistry teaching. It also stimulates creativity, imagination, cooperation, precision, and develops social skills, communication and motor skills with students.

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NOTES

1. Leopold Gmelin (1780 – 1849), professor of chemistry, pharmacy and technology at the University of Jena, from 1810. In 1843 he published his classification of elements, which is among the oldest image presentations of the Periodic Table of Elemetns (Renatus, 1983).
2. Johann Wolfgang Döbereiner (1780 – 1849) was a professor of chemistry, pharmacy and technology at the University of Jena. He is the creator of the so-called "*Triade*", a precursor of the PTE by D. I. Mendeleev. He discovered the catalytic powers of platinum, and was

among the first in Germany to introduce the chemical-practical oral examination for students of chemistry and pharmacy. He was a friend and counselor of Johann Wolfgang von Goehte (1749 – 1832) (Renatus, 1983; Prandtl, 1956).

3. Precious or inert gases have not been taken as examples, in order to present the original PTE (published on March 6, 1869). In the period from 1868 to 1898 the following precious gases were discovered: helium (He), krypton (Kr), neon (Ne) and xenon (Xe), during the life of D. I. Mendeleev, http://cdn.preterhuman.net/texts/science_and_technology/The.Scientific.American.Science.Desk.Reference/Ch3.htm

   The student are presented with the fact that Mendeleev predicted the spots for the elements which were about to be discovered: gallium, Ga (Eka-Aluminium); scandium, Sc (Eka-Bor); germanium, Ge (Eka-Silizium) (Mandić, Korolija and Danilović, 2005).
4. Wikipedia-The Free Encyclopedia, http://en.wikipedia.org/wiki/Portal:Science

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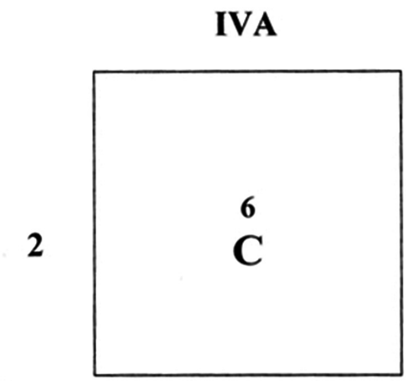
H 1	Li 7	Be 9	B 11	C 12	N 14	O 16	F 19	Na 23	Mg 24	Al 27	Si 28	P 31	S 32	Cl 35.5

Fig. 1. Magnetic cards of elements with numbers on the board (horizontal line)



Hello! I have been known for ages. I have asked everybody, but no one remembers. The **Latins** used to call me **carbon or coal**. Some still call me **kalkoal,** out of which others created similar names. I like being friendly with all **nonmetals**.

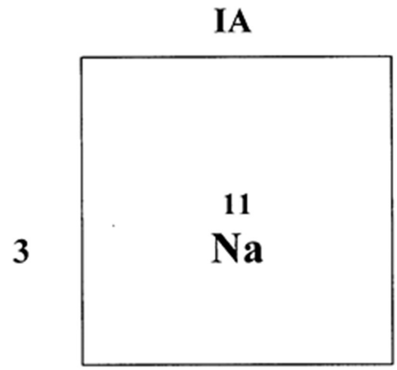
While we were playing, many famous **compounds** appeared, without which there can be no **nature** and no **man**. I firmly hold my **6th place**, next to my dearest brother, **nitrogen**.

*Having formed the PTE, all the elements say loudly:
''We are a big happy family of elements of D. I. Mendeleev".

Fig. 2. Layout of magnetic cards according to PTE

H 1	**Be** 9	**B** 11	**C** 12	**N** 14	**O** 16	**F** 19
Li 7	**Mg** 24	**Al** 27	**Si** 28	**P** 31	**S** 32	**Cl** 35.5
Na 23						

Fig. 3. Data on the element: Carbon



Hello! I am the second among my blue (metal) brothers. My name is of **Greek origin-nitron**. They also call me **sodium**, after the rocks from which they discovered my brother, lithium.

Today I am known as **natrium (the Latin name)**. I was discovered by the famous English scientist **Humphry Davy** in **1807**, in turbulent times, while **Napoleon** was at war with the whole Europe.

I was assigned **11th place** amongst my brethern by **Mendeleev**, I was a bit dissatisfied. I have a **peculiar nature**, just like all my **alkaline brothers**. When I drink **a little water**, I get upset, and I immedialtely – **explode**!

*Having formed the PTE, all the elements say loudly:
''We are a big happy family of elements of D. I. Mendeleev".

Fig. 4. Data on the element: Sodium (the upper part of the paper sheet – data on the element: symbol, group, period and mass number) and a funny text (the lower part of the paper sheet)

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