Bulgarian Chemical Communications, Volume 50, Special Issue 00, (pp. 75 – 78) 2018

The role of using educational tasks in teaching chemistry

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Received: July 17, 2017; Revised: October 25, 2017

One of the main purposes of modern education is building scientific literacy in students. Teaching chemistry provides a variety of opportunities for achieving this. An appropriate tool for acquiring literacy is the use of educational tasks. Research was conducted on implementation of such tasks in learning of chemical processes in the 10th grade. The results showed that systematic and purposeful application can lead to increased interest, development of skills for self-studying and building scientific competence.

Keywords: Chemistry, Education, Using educational tasks, Scientific competence.

INTRODUCTION

An important goal of modern education is to develop and improve science literacy among students. Numerous studies of this concept and definitions proposed by Pella *et al*. [1], Miller [2, 3], AAAS [4], NRC [5], Hazen *et al*. [6], Bybee [7], DeBoer [8], OECD [9-11], Tafrova-Grigorova [12], NGSS [13], Kolarova *et al.* [14] allow us to summarize that a natural-literate person is the one who understands the scientific concepts, principles and processes, which helps in the understanding of scientific and technological achievements, as well as of the phenomena in the living and inanimate nature. A scientific literate society must be able to assess the impact of science and technology on people's lives and environment.

EXPOSURE

Natural science literacy is undoubtedly related to the acquisition of knowledge, skills and competences that can address real life issues.

According to most authors, **competence** is *a quality of personality based on the presence of a significant amount of knowledge and skills obtained through system training and practical experience in a certain theoretical or practical field.* Educational competence is achieved thanks to the continuous efforts of the participants in the education [15].

It can be summed up that the individual competences are set in the educational targeting, and the general educational competence is manifested as a personal characteristic, "the ability to form and exercise in a unity well-structured knowledge, value engagement and effective actions, optimally and necessarily manifesting itself in a specific application through adequate skills" [15].

In this sense, the expected results in the State educational requirements for curriculum and syllabuses can be considered as elements of the overall general educational competence. The set of competences related to scientific literacy, acquired, conceived and practicable in real situations, leads to the formation of specific science competences for student 1, student 2, etc. (Fig. 1).

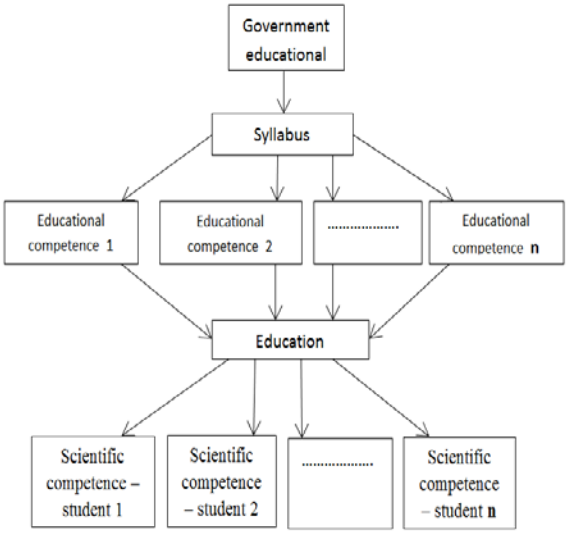

Fig. 1. Integration map - State Educational Requirements – Scientific Competence

A new type of specialists - symbol analysts who have basic skills: abstraction, systemic thinking, experimentation and collaboration are of particular importance to modern society. The formation of such skills is a factor that will be the basis of the success of society [16]. Unfortunately, the analysis of the results of the national and international surveys shows that Bulgarian students do not have systematic thinking, cannot extract and convert information from texts, graphics, tables and images, cannot find regularities and draw

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conclusions from given results. The lessons learned in school are forgotten for a few weeks. This is only the visible symptom of a deep illness that is rooted in the previous programs. The training in scientific disciplines is no longer suitable for the society, which citizens should be prepared for [17].

Bulgarian teachers say: "The curriculum and the syllabuses are 'overloaded' compared to the planned schooling time, which leads to a small number of hours for consolidation. As a result, pupils' knowledge, skills and competences can be limited to SER because they are superficial and chaotic" [12].

One of the possible options for overcoming this condition is the use of **active and interactive methods** in learning, which, unlike the traditional approach, saves time for teaching new learning content. It is presented through certain assignments, which the student independently attains, making the necessary comparisons, analyzes and generalizations. **Learning tasks** can be considered to be such a type of assignment. These are the tasks through which students learn new knowledge, rediscover and create scientific truths [18]. In solving them, previously acquired theoretical knowledge is applied, which stimulates and develops cognitive activity and autonomy, creates a constructivist learning environment.

According to J. Bruner, the constructivism-based learning is an active process in which learners construct new ideas and concepts based on their previous knowledge, with new cognitive structures (mental, logic constructions) providing new experience and enabling a person "to take action beyond what is available" [19].

In a survey of pupils' opinion on chemistry training at school a large number of respondents declare willingness to study in a constructivist learning environment by solving tasks and case studies based on real life situations. Half of the students share the opinion that the hours for practical tasks, including laboratory exercises, should be increased. 93% of the students say they approve of the use of additional tasks besides the content of the textbook they are taught at school. In their view, this is the way to acquire more long-lasting and in-depth knowledge [20].

All mentioned above directed our attention to studying the possibilities of applying teaching-cognitive tasks to chemistry education, the requirements for their compilation and the conditions for solving in order to improve students' learning achievements.

The aim of this paper is to highlight some opportunities for the role of learning-cognitive tasks in chemistry training for the formation and development of natural science competences.

First of all, we should highlight the expected results set in the legislative documents - State Educational Requirements for Educational Content and Syllabuses. Accordingly, the learning content is determined, which is appropriate for presentation through learning-cognitive tasks. A task specification is drawn up and only then follows its compilation with regard to Bloom's taxonomy for expected natural-science competencies. Learning tasks include elements of textbooks containing facts, concepts or laws, data in tabular or graphical form, substance or process models, apparatus diagrams, and more. The tasks are formulated clearly and unambiguously, independently of each other. Depending on the level of the expected result, the points for each assignment are determined, which allows an adequate assessment and self-assessment of the student's achievements. For example:

Section: "Solutions and chemical reactions in aqueous solutions"
Topic: "Electrolyte Solutions"

Evaluated expected results:	Knowledge level
To explain the acidity and alkalinity of aqueous solutions with a concentration of hydrogen and hydroxide ions in them and relate them to the pH value.	Understanding Application
To evaluate the importance of acidity and alkalinity of aqueous solutions for the flow of life processes.	Application
To analyze data from a chemical experiment to determine pH of solutions.	Analysis

Task:

According to the theory of electrolytic dissociation, acids are electrolytes that dissociate in aqueous solution to hydrogen cations and acidic anions.

A. Express the electrolytic dissociation of HCl, HNO_3 and H_2SO_4. Which ions are their common properties due to?

B. Express the electrolytic dissociation of NaOH, KOH and $Ca(OH)_2$. What are the common

ions in the aqueous solutions of these compounds? Define the concept of bases under the theory of electrolyte dissociation.

The number of moles of hydrogen cations which are removed from one mole of acid determines its alkalinity, and the number of moles of hydroxide anions that are removed from one mole of base determines the valence of the base.

C. The substances are: HBr, NaCl, $Ba(OH)_2$, H_2SO_3, LiOH, $MgCl_2$. Determine which ones are acids and which are bases. Indicate one monovalent base and one dialkali acid.

The properties of the aqueous solutions of the electrolytes are determined by the concentration of the hydrogen cations. These values are very low and it is not convenient to work with them. It is accepted that the acidity of the medium is expressed not by the concentration of hydrogen cations itself but by the negative logarithm of it, called pH indcator.

For example:

$c(H^+) = 10^{-4}$

$pH = -\lg c(H^+) = 4$

At $c(H^+) = c(OH^-) = 10^{-7}$;

pH= 7 → neutral environment

D. To one glass of clean water acid is gradually added, while to another glass of clean water base is gradually added. After each added portion, the pH value is measured. Using the experimental data shown in Fig. 2, determine which chart to which glass corresponds.

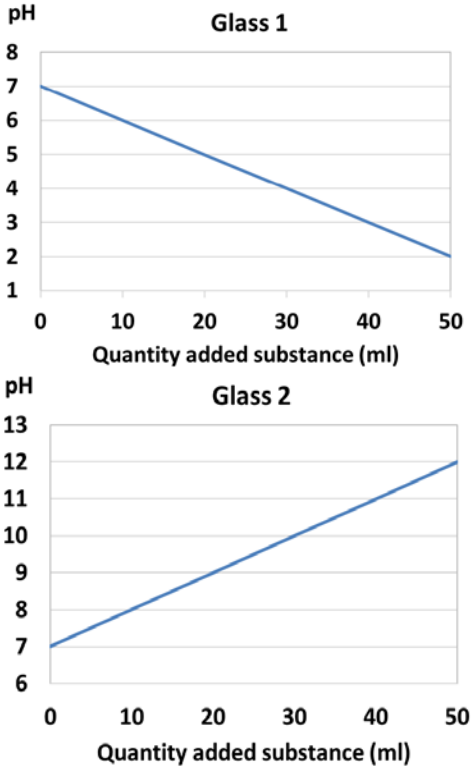

Fig. 2. Change in pH with addition of acid or base.

Figure 3 shows the pH values of some solutions.

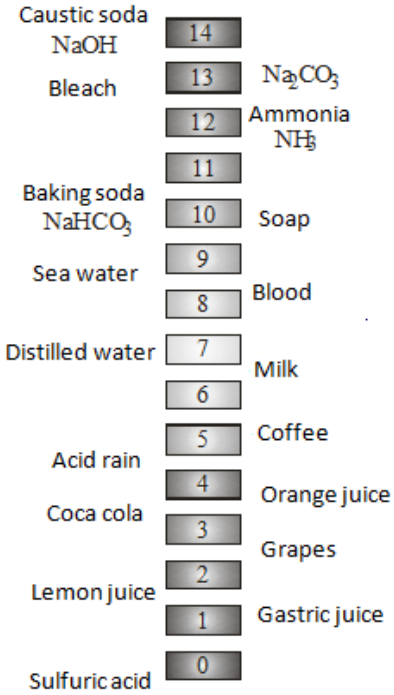

Fig. 3. pH values for some solutions

E. How is the violet litmus colored in orange juice? What environment does the reported change show?

F. How is phenolphthalein stained in a bleach solution? What environment does the reported change show?

G. Which of the two substances - coca cola or baking soda solution should be taken with increased acidity of gastric juice?

H. The pH value for normal human skin is about 5.5. Is it convenient to use soap for its daily hygiene? Justify your answer.

Tasks of this type are primarily designed for classroom work. Students work in pairs without the use of aids. The teacher is their mentor. Tasks requiring additional data or more time for responses are appropriate for extra-curricular work. It lacks teacher's support and teamwork, so they must be as clear as possible with precisely defined assignments. In both cases, the student actively learns, formulates knowledge and develops his / her skills to work with texts, graphics, tables, images, patterns, schemes, etc.

Searching for the answer, students teach themselves by discussing different options for reaching the decision. They clarify the relationship between the given and the sought-after and construct a plan, draw a scheme by which they reach the ultimate goal.

In the implementation of the plan the pupils predecode the given information. As a result, they de-

velop practical and mental activities, modelling skills are formed [21]. The transformation of the given data leads to reflexive skills as the students "go through conscious intermediate judgments" [22]. In this way, practical and mental activities are developed leading to a final result resembling real life situations.

These actions effectively lead to "embedding" the most essential information "in the value-meaning sphere of the students' consciousness and become a permanent personal knowledge" [23].

CONCLUSION

It can be summed up that the use of learning-cognitive tasks in the training allows for:

- Increasing the interest in natural sciences;
- Active and interactive learning;
- Application of constructivist method;
- Development of:
  - Reflexive skills;
  - Modelling skills;
  - Skills to deal with life problems;
  - Evaluation and self-evaluation skills.

As a result of the present study on the role of the cognitive tasks in chemistry and environmental protection to develop students' natural sciences, the following findings can be made:

- ✓ In order to meet the educational requirements, learning and cognitive tasks must be compiled in accordance with the normative documents.
- ✓ The development of pupils' scientific competence should be accomplished through gradual formation and improvement of individual educational competences.

It is appropriate to develop learning-cognitive tasks for different purposes: for part-time individual work in class; for self-employment outside the classroom; for entirely independent work in class - through worksheets, interactive boards or the use of computer presentations. Learning assignments can be used in different chapters in chemistry education and in combined science lessons.

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