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KNOWLEDGE OF AND ATTITUDES TOWARDS WATER IN 5TH, 6TH AND 7TH GRADE STUDENTS

Antoaneta Angelacheva, Kalina Kamarska
University of Plovdiv

Abstract. Pupils of grades 5, 6 and 7 are asked about their knowledge and attitudes concerning water as a basic factor of nature and environment. A variety of posters and multimedia presentations (147 in total), designed by students and devoted to "Water Day – 22 March", are carefully examined. Using the content analysis method, this research seeks correspondence between the education targets, marked in the curriculum, and the cognitive results from teaching the school subjects "Man & Nature" (in the 5th and 6th grades) and "Chemistry & Environment" (in the 7th grade). The statistical analysis of the empirical results shows that teaching of the above-mentioned subjects creates a good basis for the integration of knowledge and students' attitudes towards the substance of water.

Keywords: water, ecological understanding, environmental education, chemistry education, content analysis

Introduction

Water is the most wide-spread liquid on Earth. Knowledge about it and the related attitudes are components of students' ecological understanding; both are formed and enriched through the teaching of the natural sciences. That is why we are interested in establishing how studying the substance of water allows for the integration of knowledge and values in the students' consciousness.

The aim of this article is to seek conformity between education targets, postulated in curricula, and the cognitive results from education in the natural sciences in the 5th, 6th and 7th grades.

Research context

The contemporary state strategy for education in Bulgaria focuses natural science education on forming and developing individuals with strong understanding of health and ecology. State regulation and recommendations define the educational field "Natural sciences and ecology" with an emphasis on the relationship "man-nature". In the context of educational strategy, the school subject "Man and nature" is taught from 3rd to 6th grade, and its contents integrate Physics, Chemistry and Biology knowledge about the substances and processes. Building on this knowledge, the subject "Chemistry and protection of the

environment" is taught from 7th to 12th grade. In accordance with the curricula of these subjects, the main educational aims are associated with: (a) acquisition of a system of knowledge about objects, processes and phenomena in nature; (b) development of a system of skills for the observation of objects, processes and phenomena and the performance of experiments; (c) construction of a system of attitudes towards the environment.

The Chemistry module of the school subject "Man and Nature" reveals the essential characteristics of the concepts pure substances and mixtures in the 5th grade, and in the 6th grade develops the concepts chemical element, substance and chemical reaction. The school subject "Chemistry and Environment" emphasizes the enrichment of the knowledge about elements, substances and chemical reactions as well as the importance of this knowledge for solving the problems of environment pollution and restoration.

In the 5th grade, knowledge about pure substances and mixtures is expanded by acquainting students with the most wide-spread substance on the planet – water. A certain idea about water in nature is developed in the 3rd and 4th grades when studying the subject

Table 1. Expected results (concepts relating to the substance of water), fixed in the curricula of the 5th, 6th and 7th grades

Signs for the description of the substance water	Expected results
• Composition, structure, properties of water	homogeneous mixture; aqueous solution, solvent, dissolved substance, substance solubility; water in nature, clean water; simple substances, chemical compounds, hydrogen compounds; elementary particles (atoms, molecules, ions), molecular structure, atomic mass, molecular mass; gases, liquids and solids; physical properties, chemical properties (interaction with alkali metals, with basic oxides); chemical reactions (chemical substitution, chemical addition, neutralization); the pH of solutions (acidic, neutral, basic), chemical symbols (chemical signs, formulas, equations).
• Use and presence in nature	areas of application, importance of aqueous solutions, hydrosphere
• Biological importance of water	water cycle
• Pollution, purification and protection of the water	pollutants, impact of the pollutants, water purification from harmful substances, filtration, activated carbon, acid rain

"Man and Nature". In the 5th grade, the lesson "Water and aqueous solutions" enriches the knowledge of water in the following aspects: properties of water (as a pure substance); properties of aqueous solutions (as a type of mixture); conservation of water in nature.

The knowledge about the composition, structure, properties and importance of water is enriched in the 6th grade and throughout the whole education on the school subject "Chemistry and Environment" by learning specific simple substances, chemical compounds and chemical reactions.

The expected results (terminology and concepts related to the substance of water) from the national standard, which are included in the educational programme "Man and Nature" (5th and 6th grade) and "Chemistry and Environment" (7th grade) are presented in Table 1. This table is used later as a benchmark in the presentation and interpretation of the empirical data.

Description of the research

On 22 February 1993, the UN General Assembly declared 22 March the World Water Day. The aim is to attract the attention of humanity to the problems associated with the scarcity of drinking water, the need for conservation and the rational use of water resources.

In connection with the International Water Day, the Center for Chemical Demonstrations (Faculty of Chemistry, University of Plovdiv) organized a competition on the topic "22 March – Water Day". The object of the competition was the preparation of a poster, multimedia presentation, drawing or story by students from the 5th, 6th and 7th grades. The competition was held in the school years 2011/2012 and 2012/2013. The competition involved a total of 175 students. Posters were presented by 70 students, a multimedia presentation – by 77, a drawing – by 15, a story – 13.

Our attention is directed to the submitted posters and multimedia presentations (147 in total) because the information about water in the form of text, tables, charts, photos, drawings and others is most abundant in them.

Research methodology

The research examines content of posters and multimedia presentations of students from the 5th, 6th and 7th grades. The choice of this age group is determined by the fact that this period of education marks the beginning of the systematic study of the basic concepts and ideas related to the substances in nature and in human activity.

The research methodology used is content analysis, where the text content is analyzed, described and examined in order to find meaningful and valid links and influences between the text and its use (Cohen et al., 2007).

Content analysis uses its own methodology of information research, on which inferences and conclusions regarding the content are made. The implementation of the

method is associated with determining the categories of analysis – the most common key concepts which correspond to the research tasks. In the experiment which is described in the article, the signs for the description of water are defined as the analysis categories (table 1). For each category a key-classifier is defined – a list of words, terms, concepts which are in that category. With the help of this list, objects are individualized and separated from the aggregate. In our case, the key-classifiers are the expected educational results presented in the curricula (Table 1).

In content analysis, the text is divided so that its smallest unit carries in it the properties of the whole. In the text, this unit can be words (terms, symbols, names), ratiocinations or complete thoughts, and whole fragments of text. The units of analysis can are examined with respect to: time-space, frequency of occurrence of the category's characteristics in the text, presence/absence of the category etc (Иванов, 1999).

In this research, the students' cognitive results (knowledge and attitudes towards the substance of water) are compared with those set out in the curriculum (Table 1). The experimental results are examined with respect to the absolute and the relative frequency of incidence of individual words, whole expressions and specific figures, which are related to a characteristic for the description of the substance water. It is considered that the frequency of occurrence of an indicator in the text is a measure of its importance (Бижков & Краевски, 2007).

Results and discussion

The analysis of the content of the posters and multimedia presentations allows us to present the most common words, expressions and figures in them (Table 2). The comparison of the results from Table 2 and the expected teaching results (Table 1) shows the efficiency of learning the concepts related to the knowledge about water.

On the basis of the methodology discussed, the analysis has determined the absolute and the relative frequency of occurrence of units (words, expressions and figures) from the corresponding sign for description of water in the materials developed by students (Table 3).

The analysis of the empirical data shows the following: (1) About half of students (51.7%) describe the composition and structure of the water molecule and present it with the appropriate models. A relatively large proportion of students (62.6%) know the three states of water and illustrate them with pictures. The physical properties of water are presented in a full and detailed form using text and figures. The frequency of occurrence of the sign chemical properties is low, which can be explained by te prevailing number of participants from the 5th and 6th grades. At this cognitive level, students still do not know the chemical symbols of the elements, the chemical formulae of the substances and the chemical equations which reflect the presence of water in various chemical reactions. The results of the contest show that students are aware of the link which exists between composition, structure

Table 2. Content analysis results

Signs for description of the substance water	**Units of analysis (words, expressions, figures)**	
	in the text	**in figures**
• Composition and structure of the molecule	two atoms of hydrogen and one atom of oxygen, chemical compound of hydrogen and oxygen; types of water according to composition: soft, hard, distilled, holy, underground, mineral, heavy, super heavy, fresh, salt water	model of the water molecule
• States of matter	ice, liquid, water vapor	pictures of icebergs, oceans, seas, clouds
• Physical properties	a transparent liquid, no color, no smell, no taste, water anomalies – boils at 100°	pictures of water drops, drawings
• Chemical properties	the chemical formula H_2O, chemical reactions involving water – neutralization, with some metals and non-metals, with basic oxides	chemical equations, pictures
• Presence in nature	hydrosphere, seas, oceans, rivers, lakes, swamps, clouds, glaciers, springs, groundwater; distribution on the Earth's surface; natural waters (% fresh water, % salt water), an importance of ocean currents in the Earth's climate	photos of the Caspian Sea, Titicaca, Niagara, Victoria; drawings of the globe with depicted continents and oceans; paintings of rivers, trees, flowers
• Use	importance to human activity – household, lifestyle, agriculture, construction, industry, transport, tourism, energy	photos, drawings which show the application of water
• Biological importance	ions in water and their importance for the human body; living environment, a necessary condition for life; living matter, which can be influenced and transformed; water content in the human body; part of biochemical processes, metabolism, maintaining a healthy body weight – accelerates metabolism and regulates appetite; eliminates toxins and waste products from the body; the natural water cycle (evaporation, condensation, precipitation); participates in the formation of the relief, minerals, mineral springs and Earth's climate; animate and inanimate nature.	informational memory of water – photographs of water crystals with different shapes obtained under the influence of different words, music; paintings of the water cycle

Signs for description of the substance water	Units of analysis (words, expressions, figures)	
	in the text	in figures
• Pollution	water pollutants – oil, oil products, wastewater from industrial factories, agriculture, washing liquids and detergents	pictures of dead fish, drawings which show the sources of water pollution – oil rigs, oil platforms, canals for wastewater, factories
• Purification	methods – distillation, filtration, percolation, precipitation, neutralization, water treatment plants, chlorination, ozonisation	photos of wastewater treatment plants
• Protection	ways to save water; endangered natural sights	photos of endangered natural sights – the rivers Amazon and Yan Zi, the polar ice cap on Mount Kilimanjaro, the ice of Antarctica, the lake Baikal, etc.; drawing of a scale which weighs pollution versus protection of water

Table 3. Frequency of occurrence of the signs of the categories in the text and in the figures

Signs for description of the substance water	Absolute frequency	Relative frequency, %
• Composition and structure of the water molecule	76	51,7
• States of matter	92	62,6
• Physical properties	65	44,2
• Chemical properties	22	15
• Presence in nature	127	86,4
• Use	105	71,4
• Biological importance	132	89,8
• Pollution	89	60,5
• Purification	24	16,3
• Protection	16	10,9

and properties of the water; (2) The high percentage of the frequency of occurrence of the signs biological importance, presence in nature and use indicates a high efficiency of mastering the system of knowledge about water and a developed attitude towards it. The materials developed by students show that the latter understand and realize the importance of water for the animate and inanimate nature, and for human activity. Students consider water as a living environment and as a necessary condition for life; (3) A big proportion of pupils (60.5%) know the main water pollutants and realize the consequences of their impact on the environment. A small number of students have knowledge of the methods for the water purification, which can be explained by the mental abilities of the target age group of students – the essence of these methods is difficult to master for the students; (4) Water preservation is associated mainly with ways to save water in daily life and with water bodies endangered by irrational use and pollution. The sign protection of water is the least common in the students' materials, which reflects the existing contradiction between the requirement of the curricula for a value-comprising education and the lack of meaningful content for this requirement. Therefore a recommendation can be made for more depth of information concerning water protection compared to what is present in the natural science textbooks in the 5th, 6th and 7th grades. This in turn is a prerequisite to create positive attitudes towards the environment and to enrich students' understanding of ecology.

Conclusion

The content of the materials developed by the students reflect the basic requirements of the curricula of "Man and Nature" (5th and 6th grades) and "Chemistry and Environment" (7th grade). The data show that the education in relevant school subjects creates a good basis for the integration of knowledge and attitudes towards the substance of water in the students' consciousness.

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✉ **Dr. Antoaneta Angelacheva (corresponding author)**
Plovdiv University "Paisii Hilendarski"
24, Tsar Assen Str.,
4000 Plovdiv, Bulgaria
E-mail: angel@uni-plovdiv.bg