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Conceptual Maps as the Lucrative Way Showing Integrate Characteristic of the Energy Concept In School Environment

JINDROVÁ Terézia (1)

Department of Physics, Constantine the Philosopher University in Nitra, Slovakia (1)

Abstract

Energy as an integrating concept is currently a widely discussed subject in didactics of physics among its representatives. Many theoretical works and book publications related issues have been published in various didactic teaching approaches. Our work also concerns the same subject. We are focusing on an innovative, however not frequently used, method in evaluating teaching process, which uses graphical depiction - conceptual mapping. The conceptual mapping belongs to strategies leading to meaningful learning. Based on conceptual maps, it is possible to look into the pupils' minds, in which they create their own structure, made up of familiar as well as new concepts. Comparison of complex conceptual maps of related concepts can provide an image of their hierarchical structure. Conceptual maps are investigated using the methods of analysis of semantic networks. Using this method, we were detecting whether a selected group of pupils from elementary school perceived terms related to energy from its integrative point of view, or primarily from one perspective, only within the subject of physics. The aim was to find out whether pupils are able to connect meaning of the terms related to energy in science (physics, biology, chemistry) and also in technology. The integrating role of the concept of energy have to be reflected in the hierarchical structure of the conceptual maps.

Keywords: *Energy concept, Concept maps, Energy integration characteristic;*

1. Introduction

The concept mapping is one of the modern teaching methods. Its main task is to guide pupils to improve memorisation skills as well as lead to make connections and relations between already created knowledge. Student is led to higher cognitive form of learning than the level of memorising by Bloom‘s taxonomy of educational objectives. The concept maps are an interesting method in didactics, which shows an interdisciplinary character of the particular topic in physics. Some topics have an interdisciplinary attribute. This attribute shows integrate character of the some significant and fundamental concepts. Those concepts are for instance matter, energy, particle, mass, amount of substance, electric charge, motion. In this article we are focusing to the concept of energy and its extent of integration in the mind of students. In the past, the science has been divided into definite subjects. That caused separation of concepts of knowledge and resulted in the deficiency of the understanding of the meaning of some of the integrating elements of topics such as the concept of energy. That is the reason why we focused our research on finding out the rate of the integration of this concept.

Energy is the concept blending within the science spheres such as chemistry, biology, physics, technics. It appears in the common themes like photosynthesis, respiration, the source of energy, renewable and unrenewable sources, consumption of energy, transformation energy etc.

Therefore it is important to mediate the concept of energy from various points of view, which enables students to acquire comprehensive perspective. We cannot consider energy to be exclusively matter of physics. Energy characterizes both inanimate systems as well as animate systems. Therefore it is relevant also in sciences concerned with animate systems (biology, chemistry). One of the goals of our research was to find out to what extent can students interconnect the knowledge of concept of energy from various subjects. Another goal was to find out whether students perceive the hierarchical organization of the concepts.

2. Research methodology

By realization of the research we aimed to find the answers to following questions:

1) How many concepts and in what quantity of the physics, biology, chemistry and common experience have been used by how many students?

2) Can students hierarchically organize the concepts of energy (students of 6th year of study)?

We focused the research on the students of the elementary school, specifically of the 6th year of their study. Thirty-six students in total took part in our research work. Students have been divided into smaller groups, one group constituting of approximately twelve students.
In Slovak schools, the students of this age category have the knowledge of these subjects: technology, biology and introduction to physics.
Currently all the knowledge about energy that they acquired comes not only from their own experience and observation of the surrounding life. The learning structure is apart from the mentioned subjects influenced by the subject – natural science, which is taught in the first grades of elementary school. We wanted to find out what vocabulary bank related to the content of the concept of energy students have. We have identified which specific concepts will occur to students according to their previous knowledge of energy. After that, they created concept map describing the connections and coupling amongst the concepts. Since we worked with students who had no previous experience with concept mapping, it was necessary to instruct them how to create concept maps at first. That is why we spent one lesson with students, where we informed them about this learning method. We started with concept, which is well known and frequently used among students within their everyday vocabulary – applications see Fig.1. Firstly, students themselves wrote down on the paper concepts that came to their mind. Next task was to use circles and different colours to separate those having the same particular attribute. After that, they determined hierarchical organisation to arrange them by numbers according to their importance. This method was chosen because we wanted to lead the students to become conscious of connecting the relations behind concepts such as hierarchical structure too. In third step, we prepared a picture on the board, where we together created the concept map. We went through the terms of biology, after that the terms of physics and the end we let the students create concept maps by themselves, which was oriented to the concept of energy. At the end students presented their results. We divided the concepts that students stated in their concepts maps into following groups: physics concepts, technical concepts, biological concepts, chemical concepts and common concepts. A lot of mentioned concepts have interdisciplinary character. That was the reason to consider how to assign it to the correct group. We proceeded with studying the concepts by their classification in the specific scholarly dictionaries [1,2] and books for elementary school [3,4,5] and methodical guides [6,7].

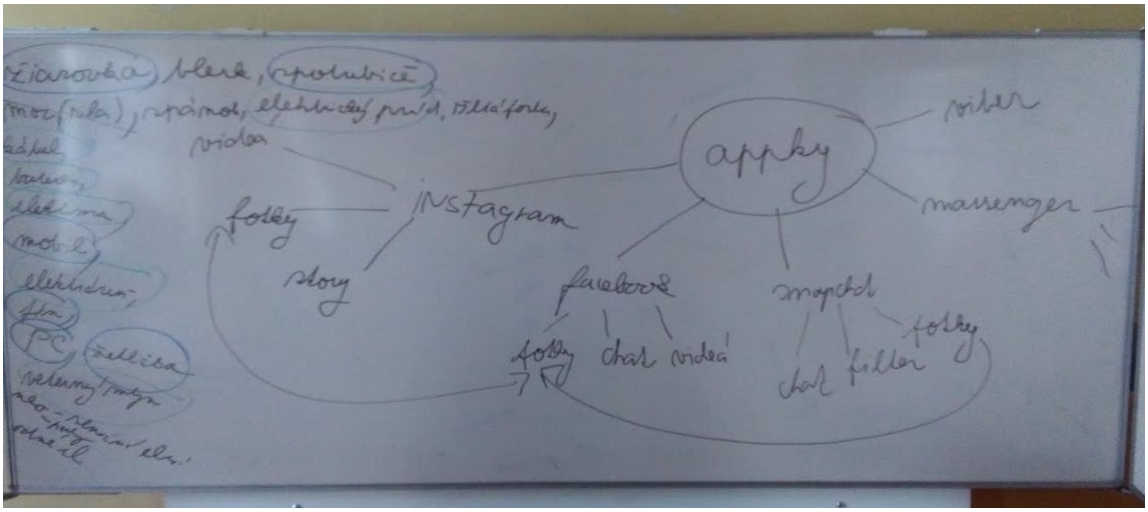


Fig.1. Concept map (mobile application)

3. Results

In this part we introduce the concepts, which students used in their created concept maps. The students used these physics concepts: electricity, power station, current, hydroelectric power plant, solar station, heat station, wire, force, power, lighting conductor, lighting, heat, motion, wind power plant, light, physics, physical inventors, core of atom, flowing of water, speed, Sun, universe, planets, solar energy, Volt, source, windy energy, flowing electricity, discharge, water energy, electric energy, temperature.
The students used these technical concepts: Wind mill, wall plug, battery, bulb, appliance, Tesla, Edison, solar panels, electronics, charger, artificially energetic supply, propeller, dam, production,

gaining energy, car, tablet, device, factory, X – box, playstation, iron, radiator, reproducer, train, television, mobile, PC, PS 4, hair dryer, charging
The biological concepts: energy of human, human, life, colony, air, water, wind
The chemical concepts: ion, atom, molecule, sugar, chemistry, chemical experiment
The students used these common concepts: sleep, control, yellow colour, Victory Royal, film, good mood, good feeling, bad feeling, hyperactivity, football, basketball, sport, supernatural things, dimension, turistic, temperament, drink, chocolade, redbull, coca-cola, positive energy, negative energy, religion, hockey, dance, social networks, application, games, home, Peter, David, sweets, candys, energetic bars, food, household, fruits, vegetables, tolerate, energetic drinks.

The Graph 1. shows how many concepts of physics, chemistry, biology, technics and how many common concepts have been used by one student. Given data are in table 1. and table 2.

Graph 1. The count used concepts (physics, technology, common, biology, chemistry) by students

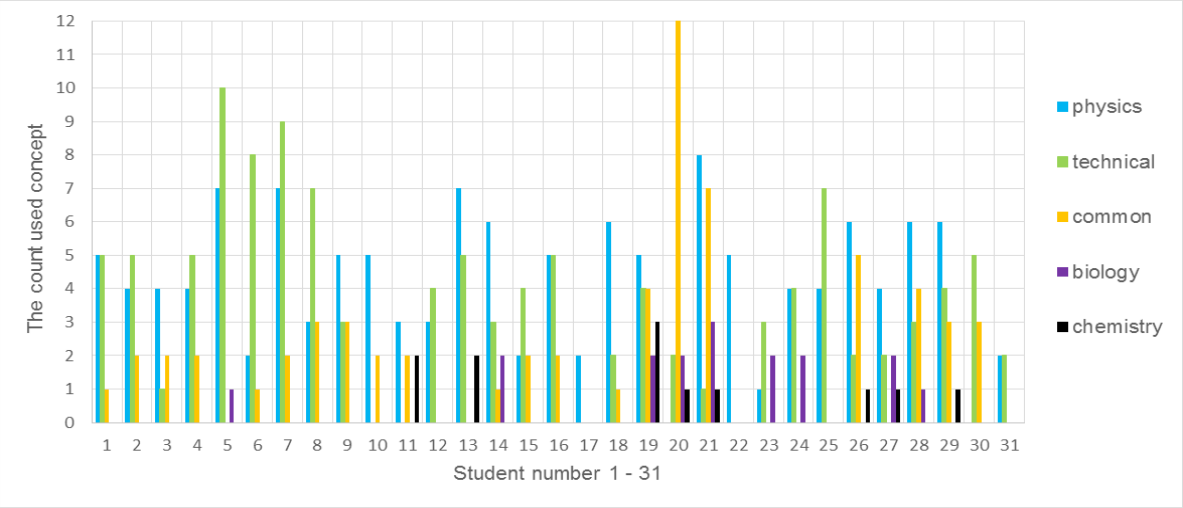


Table 1. Types of concepts used by students number 1 – 15

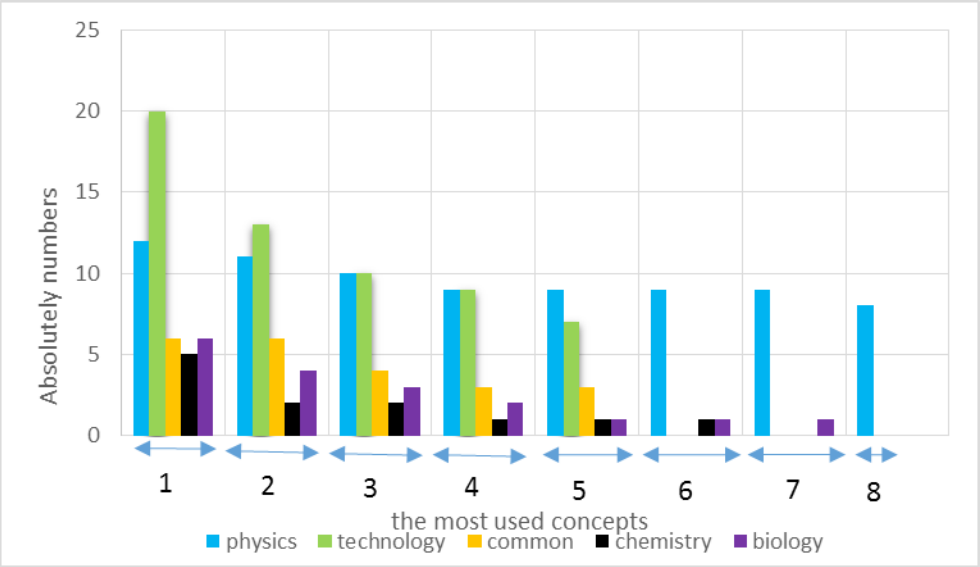
	Student number														
concept	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
physics	5	4	4	4	7	2	7	3	5	5	3	3	7	6	2
technology	5	5	1	5	1	8	9	7	3	0	0	4	5	3	4
common	1	2	2	2	0	1	2	3	3	2	2	0	0	1	2
biology	0	0	0	0	1	0	0	0	0	0	0	0	0	2	0
chemistry	0	0	0	0	0	0	0	0	0	0	2	0	2	0	0

Table 2. Types of concepts used by students number 16 – 31

	Student number															
concept	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
physics	5	2	6	5	0	8	5	1	4	4	6	4	6	6	0	2
technology	5	0	2	4	2	1	0	3	4	7	2	2	3	4	5	2
common	2	0	1	4	12	7	0	0	0	0	5	0	4	3	3	0
biology	0	0	0	2	2	3	0	2	2	0	0	2	1	0	0	0
chemistry	0	0	0	3	1	1	0	0	0	0	1	1	0	1	0	0

The graph 2. shows the most frequently used concepts of the specific subjects by the students. We marked physics concept by the blue colour, technology concepts by green colour, common concepts by orange colour, biological concepts by violet colour and chemical concepts by black colour. The amount of students who used the concepts is stated in the brackets. There are eight groups in the graph 2. The first group contains the most used concept of physics by students - power station (12), technology – mobile (20), biology - water (6), chemistry – saccharide (5) and common concept – sleep (6). The second group contain concepts, which used like second frequent: physics – electricity (11), technology – battery (13), common – sport (6), biological – life (4), chemical – chemistry (2). The third group contains concepts, which are used like third frequent in the specific sphere: physics – light (10), technology – computer (10), common – chocolate (4), biological – air (3), chemical – chemical experiment (2). Fourth to seventh group contain physics concepts, which have been used with the same amount of students (9). Fourth, fifth and sixth group contains the same amount in biological concept (1) and fifth, sixth and seventh group contains the same amount of chemical concepts (1). The fourth group: physics – electric power (9), technology – bulb (9), common- sweets (3), biological– colony (2), chemical – molecules (1). The fifth group: physics – wire (9), technical – car (7), common – power (3), biological – human energy (1), chemical – atoms (1). The sixth group: physics – force (9), biological – wind (1), chemical – ion (1). The seventh group: physics – motion (9), biological – human (1). The eight group: physics- hydroelectric power plant (8).

Graph 2. The most used concepts of subjects (physics, technology, biology, chemistry) and common concepts by students.



4. Discussion and conclusion

The students of the 6th year of the elementary school have the most frequent occurrence of the concepts of commonly used vocabulary. They listed overall 40 examples from the common life. They connected energy with specific meal, drink, feeling, religion. The concepts of physics occur more frequently (33 concepts), technology (31 concepts), biology (7 concepts) and chemistry (6 concepts). The physics concepts are connected with the electric energy, renewable source of energy, universe. Students listed technology concepts according to household appliances or sources of energy in the house. Biological concepts were listed as geological factor, energy of human. None of them wrote concept like photosynthesis or respiration. Despite of the fact that they were taught them on the biology class. One of the students during her concept map presentation said, that energy is connected with yellow colour. When we asked her: „ *Why do you think that*? “ She said: „ ...*sun is yellow, that's the reason*.“ Interesting is, that she did not write sun to her concept map. The students wrote the chemical concepts as the particle structure of the matter and saccharide. They connected saccharide with the source of energy, which humans get from the food intake. Students could not comprehend this concept as building particle biogenic structure, which is understandable according to the degree of their study. The students did not create concepts structure of the energy connected with chemistry.

The reason is that the students of 6th year of the elementary school did not pass the subject - chemistry.
We can say that the students of sixth grade of the elementary school did not fully comprehend the phenomenon of integration. The concepts like photosynthesis, respiration, unrenewable sources of energy should have been listed in their concept maps. The students knew how to hierarchically organise the concepts, to the centre they wrote energy and marked it as the level one. They determined concepts of the central concept energy like level two. Specific concepts were considered as subordinate to level two, therefore determined like level three. Research shows that 32 students of the 6th year of the elementary school can hierarchically organize. Four students had a problem with hierarchical organisation.
The result of the research shows the need to introduce the concept of energy by teachers from the chemical point of view and its significance for life and surrounding environment. That is why we would recommend to chemistry and biology teachers to further emphasize the meaning and content of the concept of energy in their lessons.

Acknowledgement

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