ASPECTS REGARDING THE USE OF THE MODELLING METHOD IN BIOLOGY LESSONS

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Abstract. *Considering the importance and necessity of stimulating logical thought, creativity and originality in pupils, it is necessary to use active and activating didactic strategies and learning methods. This paper presents some specific modalities to use the modelling method in secondary school biology study. We discuss aspects regarding the methodology of using some models for the observation and exploration of living organisms, processes and phenomena from the living world and we present examples of modelling application in biology lessons. Also, we discuss the benefits of applying this method to the study of biology in secondary school***.**

Keywords*: teaching strategy, modelling method, biology lesson*

INTRODUCTION

In accordance with the continual changes of today's society, in accordance with the evolution and its more and more diverse requirements, young pupil generations also impose the renewal, rethinking and modernization of the educational system and process, in general. In this context, the biology teacher is permanently facing new challenges in order to establish those efficient didactic strategies, adapted to the young people's learning requirements, which should insure the achievement of major biology study objectives in secondary school, considering the formation and development in students of certain attitudes, values and competencies specific to biology.

Through its specificity, the study of live organisms, of the relationships among them and between them and their environment, of natural processes and phenomena, is characterised by the possibility of direct observation and/or concrete actions upon these organisms, the analysed processes and phenomena or by using their substitutes, models, when it is not possible. Thus, methodologic options for the organization of learning during biology lessons will include active and interactive methods allowing for the stimulation of the pupils' spirit of observation, their creativity, independence of thought, formation of critical, scientific, biologic thought pattern, as well as the formation and development of abilities to explore and investigate the living world, to evaluate situations and make decisions regarding themselves and their environment.

Getting to know and understanding the living world, of the mechanisms and law which govern it, facilitates the formation of desirable aptitudes, values and behaviours regarding their personal relation with the living world, under any form and manifestation regarding environmental issues.

Modelling is a largely used method of scientific research, but it is also a method applied in the general study of sciences and in the particular study of biology, based on deductive learning strategies, through construction of rationales by analogy, regarding structural or functional similitudes between two objects, processes or phenomena from the living world (JINGA., I, ISTRATE ELENA, 2008, pg. 340, LAZĂR, V., CĂPRĂRIN DANIELA, 2008, pg. 172). Numerous studies demonstrated that the modelling method is used successfully and they recommend that it be capitalized in learning at all levels, starting with nursery school

(CLEMENT, 1989; HESTENES, 1992; LEHRER&ROMBERG, 1996a, b; SCHAUBLE et al., 1995, quoted by BRANSFORD J.D.(et al.), 2000, pg. 170, POP-PĂCURAR, IRINA, TIRLA, FELICIA-DOINA, 2010). The method involves not only the construction and use of physical models (for instance the DNA model, the Donders apparatus or the scale model of a forest, pasture, lake, etc. ecosystem) but also of abstract ones (for example, the floral formula, Mendelian chess, the chemical photosynthesis equation). It is evident that the most efficient methods used in the description and learning of the characteristics of living organisms natural live or preserved models, which, aside from the possibility of direct observation, and the formation of correct and rapid concepts and ideas, also have an emotional impact on the pupils.

KILLERMAN, W. (1998, pg. 7) underlines the fact that living organisms used as models in biology lessons stimulate the formation and development of positive attitudes in pupils, regarding the preservation of the environment and the protection of living organisms. Depending on the purpose they serve, models can be explicative, predictive and functional (HOSKINSON et al., 2014, pg. 438).

Model based learning possesses a high formative character, with a specific heuristic aspect, the pupils having to observe and analyse various living systems or processes, phenomena, to collect data, information, to elaborate/build new models, to use models for the description of some processes, the elaboration of some explanations through analogy and the highlighting of causative relationships, to evaluate and revise models.

Next to other heuristic learning methods (learning through research and discovery, the project, the experiment) modelling contributes to the formation of competencies for the scientific investigation of the living world, pupils acquiring scientific research skills and aptitudes (WINDSCHITL et al., (2008) quoted by BRYCE C.M. (et al.), 2016, pg. 37).

MATERIAL AND METHODS

Active and interactive teaching and learning during biology lessons is achieved by organising learning activities based on various didactic strategies which allow for the capitalization of the pupils' learning potential, capitalizing a serious of active and interactive didactic methods with high formative value, among which modelling occupies an important place alongside heuristic learning methods.

We discussed aspects regarding the methodology of using some different types of models in biology lessons, we analysed the benefits of using the modelling method for the acquisition of biological knowledge and the formation of scientific thinking in students.

Also, concrete examples are presented and discussed, regarding the use of modelling when teaching the respiratory system and function to 6^{th} graders.

RESULTS AND DISCUSSIONS

In our opinion, the biology lesson is best taught in nature and in the biology laboratory, where students can benefit from direct observation, exploration and investigation of living organisms, natural processes and phenomena, with the possibility to use a representative intuitive didactic material for most lessons.

The pupils have thus the opportunity of direct perception of the vegetal or animal organism characteristics, as well as the study of processes and phenomena occurring in the living world. The correct formation of biologic concepts, their organization in cognitive hierarchic structures and the students' understanding of the principles, laws and mechanisms governing the living world are the result of active, logic learning, making sense of the things one learns. According to AUSUBEL (1981) quoted by COCORADĂ ELENA (2010, pg. 153) aware learning is conditioned by the logic meaning of new information and the existence of clear

prior knowledge organised systematically and sufficiently, to which the new information can be logically and intentionally related by the pupil.

Biological knowledge organised in cognitive schemata will integrate new knowledge so that concept understanding is deepened (for example, initial formation of the concept of a living organisms, followed by the formation of the concepts of plant and animal, and then, gradually, the formation of concept such as gymnosperms, angiosperms, invertebrates and vertebrates, etc.) or the new knowledge will lead to the reorganisation of older information (for instance, the explanation of physiological processes such as cellular membrane transfer achieved by using an important biological, chemical and physical knowledge volume, which will be reorganized and integrated in a new cognitive structure).

When teaching biology teacher use metaphors and analogies in the explanation of living world characteristics and relations; WANDERSEE, J.H., (2002, pg. 103) underlines the fact that in agreement with Piaget's research, the student's ability to use metaphors are usually formed around 8-9 years of age, when they observe mostly physical resemblances of objects pertaining to the living world and less the functional relationships between them, focusing on using explanation through analogy later on.

The modelling method is applied by using given models, reconstructing given models or building new models, which involves, according to BOWEN & ROTH (2005, p. 1064) quoted by GILBERT, J.K., MIRIAM REINER, MARY NAKHLEH (2008, pg.6), the gradual reduction of sensorial perception of the tri-dimensional living world, towards simplification in a bi-dimensional representation to the formation of abstract concepts, one-dimensional symbols. For instance, in order to understand the formation of the angiosperm flower, a natural tri-dimensional model is used, the apple flower, directly observed by the student, who operates on it, dividing it into its parts and reconstructing it by gluing the component elements on a sheet of paper in the correct order and corresponding position, which he then names and describes, specifying their role, then drawing the natural model, thus performing a bi-dimensional representation of the angiosperm flower. The next is the representation of the floral diagram and formula with the help of conventional symbols.

The choice and use of various types of models (objectual, figurative, symbolic, similar or analogic) must take into consideration the objective of the learning activity, former experiments, the pupils' age and psychoindividual particularities, the technical characteristics of the models, so that the maximal informative-formative potential of the model used for the learning process would be capitalized, thus facilitating information acquisition regarding the object, process or phenomenon studied, with the help of their general and essential characteristics or transformations and evolution type. Computer aided learning offers multiple opportunities to use the modelling method during biology lessons and to develop the students' abilities and knowledge for the investigation of the living world systems, processes and phenomena (CRISTA, NARCISA & ISVORAN, ADRIANA (2015, pg.107); CIORSAC, A., CRISTA, NARCISA, ISVORAN, ADRIANA, 2015, pg.41).

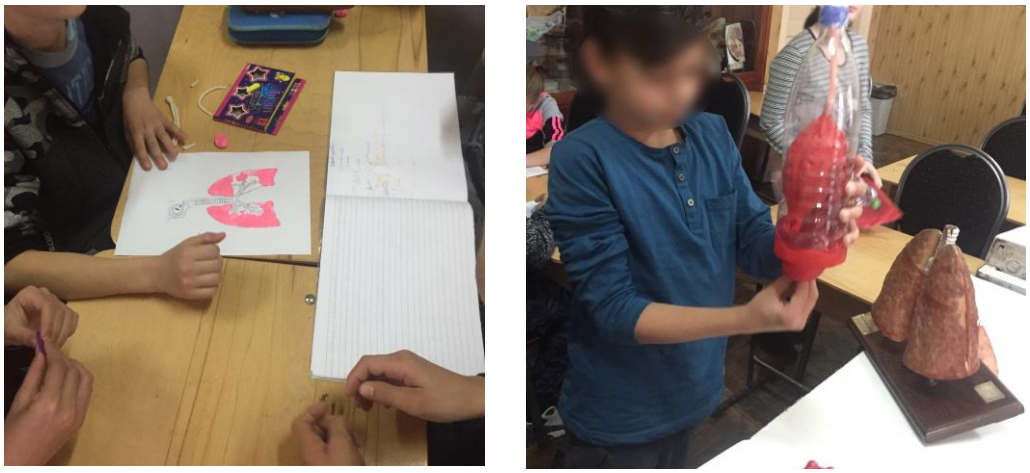
Secondary school biology teaching uses a series of models pertaining to all types of models, with various didactic purposes: stimulation and development of the observation spirit and facilitation of discovery/acquisition of new information, development of abilities to operate those information (analysis, comparison, synthesis, systematization, abstractization, generalization, application in new contexts), development of abilities to use models in learning and investigation.

Modelling can be used for the acquisition of new information, for the formation of skills and aptitudes in the exploration and scientific investigation of the living world, for the establishment and consolidation of knowledge, skills and aptitudes or in their evaluation.

For the study of zoology in secondary school, it is possible, as well as recommended, to permanently capitalize informative-formative valences of the modelling method, by organizing intuitive-practical learning activities which involve the pupils directly in the monitoring and research of animal organisms, in the explanation of the relationships among them and between them and their environment, the argumentation of the idea of evolution in the animal world, in identifying the relations between structure – function and the explanation of the organisms' adaptation to their environment and feeding way, etc.

For example, we used the modelling method in designing a 6th year lesson regarding the general organisation of a mammal and the animal organism functions, namely the respiratory system and the respiration. The model is that of the wild rabbit, the pupils being in a way familiar with this animal by now.

For the explanation and acquisition of knowledge regarding the respiratory system by the pupils, several models have been used, each with varying characteristics and attributes, thus contributing to the formation of a correct representation of the respiratory system anatomy. In order to attract the pupils' attention because of its visual impact, we first used the respiratory system model used by pupils to get to know the morphology and structure of the organs making up the respiratory system. After recognizing the organs on the model and describing them, the pupils together with the teacher proceeded to draw the respiratory system, putting down the name of each organ. To this end, the students followed the drawing found in their textbook. For knowledge consolidation, students modelled the respiratory system with the help of modelling clay on a handout. With the aid of the drawing and arrows indicating the direction of the air circulation in inspiration and expiration and the gas exchange at the level of lung lobes, the teacher explained the gas exchange between the organism and the environment (Fig.1A).



A B

Figure 1 - Using the different types of models in teaching respiratory system and the respiration in mammals

For the explanation of the respiration mechanisms, the teacher draws attention to the role of the ribcage, muscles and pleura, thus underlining the relationship between structure and function. Respiratory mechanism modelling is achieved with the help of the Donders apparatus. We opted for the pupils to build their own similar model, with simple materials:

plastic glass, two straws, three balloons, duct tape. Upon building the model, the teacher underlined the analogy between the used materials and the anatomical elements they represent, so as to avoid any misunderstanding. Simulating inspiration and expiration by manipulating the balloon which substitutes the diaphragm and observing in their own organism how the ribcage volume changes during respiration helped pupils understand the repertory mechanism (Fig.1B).

The lesson thus organized is characterized by the pupils' active and interactive participation in the learning process, by accentuating its intuitive-practical character, through the formation of clear and correct concepts, through stimulating the observation spirit and the pupils' interest in investigating the living world.

CONCLUSIONS

The scientific research and education in the field of life sciences is achieved efficiently with the help of modelling, the method contributing to the exploration of the living world, to the explanation of phenomena and processes and to formulating predictions regarding the future development of the studied phenomena.

Correct acquisition and frequent practice of modelling in the study of secondary school biology, alongside other heuristic learning methods specific to biology, constitute a first step towards the formation of the pupils' scientific thinking, towards the formation and practice of competencies in the field of scientific observation, investigation and explanation of the living world.

We need to underline the fact that the modelling method offers the opportunity of stimulating and forming of metacognitive abilities, the pupils being able to exhibit and explain the steps of learning, the reasoning, the way to make an argument, with an important role in insuring a meaningful, logical and sustainable learning.

Alongside traditional models we can use in biology lessons, we find that the development of informational technology and communication offers various opportunities to capitalize the modelling method valences absolutely necessary for the modernization of secondary school biology teaching.

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