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Students' cumulative linking of life cycle phases of exemplary organisms

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ABSTRACT

The aim of this study was to determine the acquisition and conceptual understanding of the concept of life cycles in elementary school and high school. In order to achieve the objective of students are handled imaging tasks to apply knowledge and conceptual understanding of the online system, e-learning MoD. Analysis of student responses included the coding and interpretation of biological response meanings. Featured are explained problems and misunderstandings related to the concept of life cycles and analyzes the performance impact of cumulative verification. The average commitment for 10 % different from medium-determination test in biology at the national level. Inadequate selection of images for individual phases within the life cycle indicates insufficient visualization of the biological content by the pupils, because the teachers did not use the universal patterns or instructed them in teaching. Less orientation students in universal pattern is the result of the absence or insufficient use of graphic organizers throughout the learning skills and insufficient emphasis on the principles and link in teaching life cycles of different organisms. On solving problems related to the life cycle in a cumulative sequence of learning affects the complexity of the tasks, as well as better familiarity of the organisms that are checked in connection with the learning experience by level of education. The established misunderstandings and problems point to the need to introduce teaching techniques such as cumulative learning, with a more pronounced need for visual and experimental support and the establishment of causal relationships in learning.

Keywords: *elementary school; high school; life cycles concept; conceptual understanding; cumulative learning and assessment*

INTRODUCTION

The basic idea of cumulative learning is that a student is solvings a series of related tasks in a particular order, which accelerate the solution and understanding of the next set of tasks using the learned information (Gagné, 1985). Furby (1972) explains that each task can be broken down into sub-skills are necessary for its successful implementation, therefore each task can be cumulatively learned. Students come to school with different ideas and explanations of the world around them. Different experiences, conversations with peers, older people and the media can significantly impact their view of the world. Such thoughts often differ from the views of scientists and are described as misconceptions. In general, misconceptions correspond to concepts that have individual interpretations and meanings in student's articulations that are non-scientifically correct (Bahar, 2003).

The concept of *Life Cycles* belongs to the macro concept ***Reproduction and Development of the organism***, and is represented in the biology learning for students from the fifth grade of elementary school to the fourth grade of high school. The key concept of *Life Cycles* includes two concepts, the *Lifecycle of Cells* and the *Lifecycle of the Organism*. At the end of elementary and high school the student is familiar with the life cycles of all the representatives of the living world. With the help of the template, the student should be able to describe all life cycles as well as possible specifications for each of them. The aim of this study was to analyse students' answers to on-line questions prepared according to cumulative learning principles in order to determine the adoption and misunderstandings of the *Lifecycle* concept in primary and high school students.

METHODS

The survey was conducted by analysing responses from around a 100 primary and high school students on the online e-Learning MoD system (SRCE, 2018). The students were supposed to fill the basic universal scheme of the life cycle with drawings depicting phases of life cycles of exemplary organisms. The examining tool consisted of conceptual lifecycle schemes, which were repeatedly supplemented by students for various organisms with the appropriate pictures or by entering the required data.

The student's responses were analysed metrically after the previously performed coding with the assignment of absolute values that enable the statistical analysis of the collected data with their quantification. Each response was further evaluated according to the criteria of accuracy, level of understanding and presence of problem and misunderstanding according to the custom methodology Radanović et al. (2016). For the purpose of the interpretation of the answers in the context of biological conceptual understanding, the methodology of the specific coding of the biological meaning of the correct or incorrect student's responses according to Radanović et al. (2016). The methodology for classifying students in 10 classes of success according to their overall success was used to compare the cognitive levels, based on which we can talk about the existence of misinterpretation when it comes to answers in most classes of solving (Lukša et al., 2016).

Spearman's correlation coefficient (ρ) established the correlation of image tasks in the cumulative sequence of checks that contained the learning element by compiling tasks and their connection to a previously solved task. For the interpretation of the results a scale, according to Hopkins, was used. (2000). Multidimensional (ALSCAL) scaling of quadratic distances and dendrograms based on an analysis of the average correlation between the cumulative problem-solving tasks in the on-line environment, the links and the reason that could affect the resolution of those tasks was established. The analyses were carried out using Microsoft Excel spreadsheets, and statistical calculations were made using the program of the SPSS 22 (IBM, 2013) program of the Centre for Research and Development of Education (CIRO) of the Institute for Social Research in Zagreb (IDIZ).

RESULTS

193 students participated in the online e-learning system. Out of this, 97 were primary school pupils and 96 secondary grammar school students. Of the 97 elementary school students, 95% attend the seventh grade, 3 % the sixth grade and 2 % the eighth grade of elementary school, and all secondary school students attended the second grade. The average amount of checks for elementary school is 31.86 %, while for high school it is 27.48 %.

The differences in average test results range from 0.02 to 0.20 for individual cycles, where it can be seen that the tasks are better resolved, and the differences of results are less in those often-checked cycles, which are often explained in textbooks and during teaching or are the organism closer to the student's experience (chicken, apple, euglene, butterfly, frog and urchin). Lifecycle of moss is least likely to be solved by high school students, probably because of the fact that the diploid or haploid number of chromosomes should be properly deployed except for phase, sex, and division. Life cycles of methyl and juniper in the cumulative view are poorly solved (about 20 %) of both groups of students, with grammar students solving roughly 10 % better than primary school students.

In the case of students who have taken the task solving seriously, it is noticeable that the least weakened life cycle cycles for moss (M = 0.08 ± 0.28) are solved by 3 % better and the mushroom life cycle of which the interested students solve as much as 20% better than the poor solvency of high school students (M = 0.19 ± 0.39). In order to solve the life cycle of fish, high school students retain their solvency (Msample = 0.26 ± 0.45 and Correct = 0.28 ± 0.44), while in elementary school pupils the result has risen to students who correctly solve the entire check with 0.36 (± 0.48) at 0.45 (± 0.50). Such observation of small differences in sample size and correct underutilization, despite the perceived need for 20 % to 30 % of correction of results due to unresolved tasks, confirms and recorded the almost complete correlation of problem-solving tasks along the life cycle of the whole population of the elementary school respondents as well as in the subset that correctly solved all tasks ($\rho = 0.99$; $p < 0.05$). There is a similar correlation between the two groups of pupils with regard to the verifiability of the checking observed in the case of the students of the gymnasium ($\rho = 0.97$, $p < 0.05$).

DISCUSSION AND CONCLUSION

When analysing students' answers to questions and tasks from the on-line verification, a subjective assessment found that a large number of responses of students from the same schools coincide. Most of the tasks and questions the students solved by applying knowledge, and a smaller share of issues by reproducing adopted facts. The questions and tasks for verification are in line with the national plan and program for primary school (MSES, 2006) and the exam of the state mature exam (Radanović et al., 2015).

In the task of filling the phases of the life cycle of the selected organisms, elementary school pupils had the most problems with the determination of male and female sexual organs. A large number of elementary school students believe that the plant's fruit is used for pollination, which corresponds to the results of Lukša et al. (2013) and the predictions of teachers who set out the concept of "mixing concepts of pollination and fertilization". Pupils of both levels of education believe that "eugenics are reproduced by sexuality". The existence of misconceptions "do not understand the term life conditions" has been established in elementary school and gymnasium students, which corresponds to Lukša et al. (2013). Primary and secondary school students do not associate the living conditions of habitats, lifestyles, the body and function of the organism with the specifics of its life cycle.

All in all, we can say that the students have a fine conceptual understanding of the meiosis and mythos process, which confirms that teachers have recognized the concepts of divisions as very important and tried to explain them well in their teaching, but also to check the ability to apply students' knowledge and their understanding. With this research as an exception, the student's misunderstanding of both levels of education has been established that "from sexual gametes to sexual intercourse the sexual organs are created" which cannot be classified into any of the predicted misconceptions of teachers Lukša et al. (2013) because of its specificity. A large number of students had problems with determining the phase in the life cycle of the fluke. It is established that there is a lack of awareness among primary school pupils that " the fluke imultiplies by self-fertilization" and that "the adult fluke enters / exits from a domicile or interdependent", while in high school students they stay with a smaller number of pupils considering the class of solving, so we cannot talk about the existence of a misconception. The existence of misconceptions "do not understand the change of mushroom generation" has been established in high school students. A very small number of students correctly labelled phases in the life cycle of mushrooms pointing to the total conceptual misunderstanding of the life cycle of mushrooms.

A large number of students did not respond to most of the tasks and questions, which suggests student insecurity in applying principles and life cycle patterns to different organisms. It can also be related to the time of the research, i.e. at the end of the school year, when students have other responsibilities and are not motivated enough and patient in solving additional checks. The solving and severity of the approach to solving was also significantly influenced by the preparation of the student to solve, which teachers did very differently. Primary school pupils solved their tasks in a biology or computer science class, while high school students were more prone to do it at home. The results point to the need for more detailed and continuous research involving pupils of all levels of education in order to verify whether and how the observed misconceptions are corrected during the verticals of biology learning.

The results of the research can be linked to the completion of Jung (1964) that the cumulative learning does not have great success with students who are taught during training traditionally and who have accepted this way of learning. It should be emphasized that in this case it was not the complete form of cumulative learning in which the teachers lead the pupils during the learning and systematization of the cumulative form in new examples but were based on the checking of pupils' knowledge and their understanding by applying the form and compiling the assignments along with the cumulative knowledge assessment.

In total, we can talk about matching the results obtained with previous researches, where many problems occur with the *Lifecycle* concept (Lukša et al., 2016). The results of the research can be linked to the completion of Jung (1964) that the cumulative learning does not have great success with students who are taught during training traditionally and who have accepted this way of learning. There is also a large impact on problems in building lifecycle concepts, and there is a lack of use of graphic organizers that will enable students to cumulate the principles and systematize causal relationships during the life cycle of a particular organism. Maton (2009) stresses that students need to develop certain skills and reflective thinking about their use in everyday context in order to successfully transfer their knowledge from one concept to another. According to this explanation the students should be taught in a way to realize the significance of learning and its applicability, which can be achieved using graphic organizers knowledge as pillars of learning different principles, including the one on which rests the life processes of different organisms. In doing so, it should enable students to meet the organisms on which they learn by observing and exploring, if not in their natural environment then on scientifically based research activities in simulations related to the life cycle of a particular organism.

According to the research conducted, it is possible to conclude that primary and secondary school students show an equal understanding of the life cycles of different organisms given the scope of the examined content. The existence of problems with the adoption of the *Lifecycle* concept has been identified and there have been some characteristic misunderstandings that are conditioned by the identification of presentations and names on the basis of everyday speech, the replacement of the process sequences and names, and the misunderstanding of inadequately close organisms, their lifestyle and characteristics. Difficulties are more pronounced with life cycles than organisms that are not interesting or very abstract. Yew et al. (2011) point out that although the cumulative learning proven successful in many aspects of human life, until today, are rare examples of cumulative teaching biology in the classroom as they submitted Freiman et al. (2001). Teachers themselves can improve the cumulative learning and checking if encouraging the use of graphic organizers to support cumulative learning despite the constraints of the curriculum.

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