Ninth grade students' difficulties in understanding the gene expression process: characterization and classification using knowledge organization tasks

Shlomit Hadad, Abstract of MSc Thesis, submitted March 2003

Abstract

Learning genetics at the Junior-High School level (9th grade) was previously reported as a very difficult task, mainly due to difficulties to distinguish between the various levels of organization within living organisms or difficulties to understand central genetic concepts. Within the discipline of genetics, understanding the cellular process of gene expression is essential for establishing meaningful micro-macro relationships. However, there are only a few reports in the literature about the influence of studying the gene expression process on students understanding of genetics.

The potential usage of concept mapping as a tool for knowledge organization was suggested in numerous studies. A variety of tools (both paper and pencil and computerized) for building concept maps are available. Those tools usually lack feedback to the user, which means that the user have less opportunities to reflect upon their own thinking and this may reduce the beneficial effects of constructing a concept map on the learning process.

In order to develop a computerized environment which will provide a feedback during construction of concept maps in genetics, I initially analyzed 9th grade students' understanding of the gene expression process. Subsequently, the influence of feedback, which was given during construction of concept maps was examined, in order to prepare the content basis of such a computerized environment.

Students' understanding of the gene expression process was analyzed using questionnaires, which were given to 9th graders (n=158) from two junior high schools. It was found that the majority of the students do not understand the sequence of events which occur during the gene expression process, the relationships between the components which participate in the gene expression process and the resulting phenotype and are unable to form correct sentences using some of the main concepts which participate in the process (gene, protein and character). In addition, it was found that both the structural and the functional levels of the process are problematic to comprehend. The data obtained from the teachers questionnaires (n=17) revealed, that not enough time is dedicated to the instruction of genetics, and

that the emphasis teachers give to various concepts is partly consistent with the results obtained from the students' questionnaires.

A tool which enables to simulate computerized concept mapping environment, which includes feedback during the construction of the concept maps, was developed here. Using this tool 21 interviews with 9th grade students were carried out. Difficulties were found in understanding the concepts: character, RNA, amino acids and protein while the concepts: DNA, gene and chromosome were found to be less difficult to comprehend. Similar comprehension difficulties were identified at the functional and the structural content levels. The influence of feedback, which was provided during the formation of sentences, was found to be meaningful, since feedback helped in more than half of the cases which were provided with feedback and it was found to help make a certain change in students' understanding. However, the question remains whether it will be assimilated for a longer period of time.

The comprehension difficulties which were identified here can originate from a lack of knowledge, from problems with 'word association' or from rote learning which may occurred instead of meaningful learning. The lack of knowledge may stem from the fact that teachers start the instruction of genetics with Mendel's law and finish with the gene expression process. It is possible that the gene expression process is not well organized by teachers during the instruction of genetics. Although an emphasis is given to the micro and the macro organization levels, students find it difficult to relate both levels as was demonstrated in the current research. The 'word association' problems may stem from a strong semantic link which is established between some terms in the students' mind and may trigger selection of a wrong answer. Finally, rote learning may appear when students try to learn new knowledge in a domain where they know little about.

The fact that I found here that feedback can help to improve students abilities, may justify the development of a computerized environment which will contain feedback during construction of concept maps in genetics. According to the findings presented here I suggest that the sequence of instruction of genetics during Science & Technology studies at 9th, grade be organized differently. I suggest to start the instruction of genetics with the gene expression process. I also suggest that more time be dedicated to the instruction of the gene expression process. I suggest that during instruction the following components will be emphasized: the components which participate in the process at the structural and at the functional levels, the relationships between the macro and the micro organization levels and the relationships between components which participate in the gene expression process.