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Paper Title: **Promoting students' conceptual development on toxicity**

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## **Promoting students' conceptual development on toxicity**

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### **\* Statement of purpose**

The aim of this research project is to design teaching strategies in order to improve students' understanding of the concept 'toxicity'. This implies the improvement of students' understanding of the interplay of body processes.

### **\* Reasons for initiating this research**

- 1 Educational research at the Department of Biological Education focuses on conceptual development of highschool students. These research-activities are aimed at improving the learning and teaching of key concepts in biology, specifically concepts regarding regulation and homeostasis. Substances, when toxic, can cause a disturbance in the balance of the body.
- 2 The Ministry of Education and Science in the Netherlands has imposed new final examination requirements for biology. Toxicology is one of the new topics which have to be elaborated.

### **\* Research questions**

- 1 How can students be stimulated to reconstruct their own ideas on toxicological concepts?
- 2 How can toxicological concepts be used to lead students to a better understanding of how body processes are interrelated?
- 3 How can students be stimulated to apply their knowledge in new contexts?

### **\* Methods**

In this research project three phases can be distinguished. Methods used during these stages are in brackets:

- Orientation-phase. In this phase students' prior-knowledge has been explored (**interviewing**) and the subject matter for the new series of lessons has been selected (**method of ideawriting** with experts).
- Pilot-study. Teaching materials have been designed based on the results of the orientation phase. These teaching materials have been tested with 25, 10<sup>th</sup> grade (average age 16 year old) pre-university students. During this try-out, which took 13 lessons, data have been collected (by **classroom-observations, audio-vidiotaping** and **interviewing**). Conceptual development has been assessed three times, before, during (half way) and after the series of lessons (by using **concept maps**). The results of the pilotstudy have been used to revise the educational design and the methods for data-collection and analysis.
- Main study. This time 45 students were followed during 13 lessons (by **classroom-observations, audio-vidiotaping** and **interviewing**). Conceptual development has been measured twice, in pre and post-tests (by using **concept maps** and **cases**). In this phase the students had to solve three cases also.

## \* Results

Results of the successive phases are presented as far as they have been analyzed to date.

- Orientation phase.
  - \* The participating students were not familiar with general toxicological concepts such as 'ADI' ( Acceptable Daily Intake), 'MAC' (Maximum Accepted Concentration) and 'maximum admissible concentration'.
  - \* Most students think that substances can be divided into toxic and non-toxic substances. They consider toxicity as a quality of a substance and do not relate it to aspects as quantity, exposure time and bodyweight. They are not aware of functions of the liver and kidneys with regard to elimination-processes of toxins, although these topics have been taught to them when they were 13 years old.
  - \* The subject matter, selected for the teaching materials includes: risk assessment, body processes (intake, transport, metabolism and storage), dose-effect relationships and the determination of toxicological standards (e.g. ADI). The subject 'food' was chosen as the central theme running through the chapters.
- Pilot study.
  - \* The designed teaching materials proved to be, generally

speaking, useful.

- \* Analysis of the concept maps revealed that students had a notion of the separate body processes, but they were not able to integrate these processes.
- \* The concept map appeared to be a useful evaluation-instrument to explore students' knowledge on certain concepts and their interrelations. However the concept map seemed to be unsuitable for the measurement of knowledge application. Therefore we have designed cases in addition to the concept map, which will give us information on the ability of students to use knowledge in new contexts.
- \* The outcome of this pilotstudy was used to improve the teaching materials and methods of data-collecting and analysis. In the teaching materials the integration of body-processes was stronger emphasized by special group-assignments .
- \* More group-assignments were designed to stimulate an active learning process.
- \* In the pilotstudy each student had to prepare a concept map, on the same subject, three times, using 33 concept labels. It appeared this construction reduced students' motivation and that the amount of 33 concept labels was too large. Therefore in the main study students had to make only two concept maps, using 20 concept labels.

- Main study.

- \* This phase was completed at the end of June 1993, so the data collected during this research period have not yet been analyzed. Nevertheless, our first impression is that as a result of our teaching materials students' understanding about toxicity has improved and that our intention to stress integration of body-processes in order to improve students' understanding of the function of the human body is successful too.