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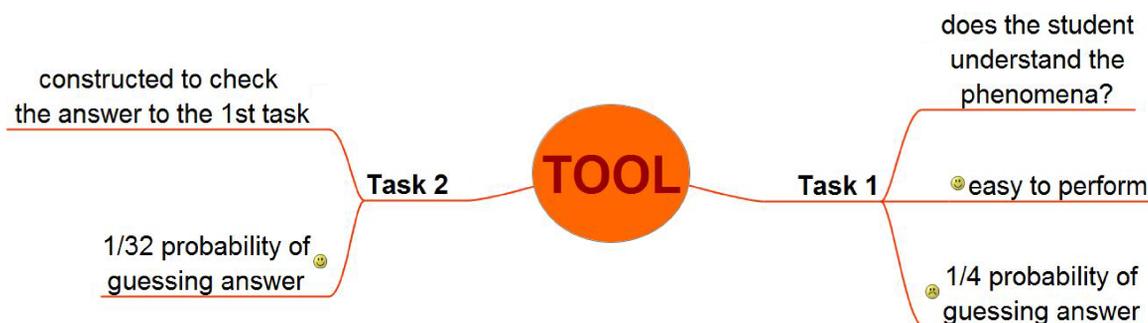
Is The Multiple Choice Question Tool (MCQ) Able to Assess Students Experimental and Thinking Skills?

The New Polish Science Curriculum emphasizes the role of experiments and observations in development of complex student skills.

Aim of the work:

To develop assessment tools for students' knowledge in chemistry.

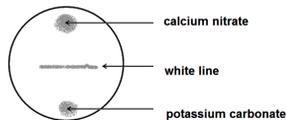
To check the quality of these tools, both large scale tests and cognitive labs in Polish schools were performed.



Statements: tasks 1 and 2

During the lesson dedicated to salts students performed an experiment described as follows. Students filled a glass dish with water and subsequently put a small amount of calcium nitrate $\text{Ca}(\text{NO}_3)_2$ powder on one of its endings and a small amount of potassium carbonate K_2CO_3 powder in another ending. After a while a white line could be observed to appeared in the solution. The experiment effect is depicted in Figure 1.

Fig. 1: Results obtained during the experiment



Multiple choice question version (MCQ)

Task 1

What could be reason why a white line appeared in the experiment?

- a) contamination of salts with some other chemical substances
- b) scratches in the glass which appeared with the presence of water
- c) an insoluble salt was created during the process
- d) the dish was put on a slanted surface

Task 2

Choose which processes took place during the experiment.

- a) dissolution
- b) sublimation
- c) diffusion
- d) melting
- e) dissociation

The mark is constructed in the way that both two tasks have to be completed correctly to obtain the good grade in his exercise.

Open version

Task 1

What could be reason why white line appears in the experiment?

Task 2

Name the phenomena that took place during this experiment.

ANSWER	CORRECT ANSWER	PERCENT OF CORRECT ANSWERS
a) contamination of salts with some other chemical substances		14.4 %
b) scratches in the glass which appeared with the presence of water		10.6 %
c) an insoluble salt was created during the process		69.2 %
d) the dish was put on a slanted surface		3.3 %

2.5 % of students gave no answer to that question

The last distractor was chosen only by 3,3 % of students which means that this answer should be replaced by a different one. Trudel and Métioui [1] showed that in exercises constructed similarly to the first task, a good distractor is one that has 15 % probability of being chosen as the correct answer by students and this probability should be lower for good students and higher for weaker ones.

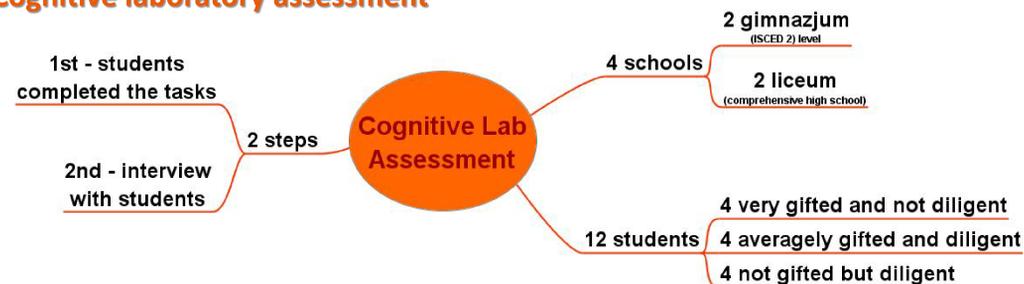
ANSWER	CORRECT ANSWER	PERCENT OF CORRECT ANSWERS
a) dissolution		28 %
b) sublimation		19.8 %
c) diffusion		20 %
d) melting		3.9 %
e) dissociation		18.1 %

10.2 % of students gave no answer to that question.

task number	innovativeness of the task content criterion	attractiveness of the task content criterion	pertinence of the skills assessed criterion	mistakes contained
1	2.64	2.79	2.64	0
2	2.14	2.15	2.69	0

Results of the questionnaire filled by teachers. The maximum number of points which teachers could give in each section was 3

Cognitive laboratory assessment



The general observations and conclusions

1. It was difficult for students to describe what processes and reactions exactly took place during the experiment but most of them gave the correct answer in the first task. This may lead to the assumption that the distractors designed for the first task are not equal.
2. In the second task students tried to find an answer which could confirm the answer they had given in the first one.
3. Students had problems explaining the phenomena given in the second task (MCQ version).
4. There are no significant differences between results acquired by students in the open and in the MCQ version of the exercise.
5. The construction of the first task in the exercise was not entirely appropriate in the sense that students chose the correct answer not because they understood it was correct but because all the other answers "looked like they were not in fact related to chemistry", they "did not seem chemical enough".

Summary

The construction of a tool assessing complex skills is a multifaceted process. Such an exercise has to meet many requirements: not only does it have to conform to the School Curriculum and to have a well-defined complex skill to be assessed, but it also has to be attention-grabbing for students and developed in such a way that minimizes the probability of guessing the correct answer. All the distractors should be equally chosen by students. The last feature along with the difficulty level of the exercise can only be found after a preliminary research having been performed.

[1] Louis Trudel, Abdeljalil Métioui, Identification of the misunderstandings of students revealed by their choice of answers to test of understanding of concepts of motion in: Research in Didactics of the Sciences, Pedagogical University of Kraków, 2010, pp. 371-376

Fieldwork assessment

