THE PROOF OF THE PUDDING

Tools and Strategies for Assessment of an IBSE lesson

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Introduction

This unit was developed for 14-16-year-old students. The content is related to groups of nutrients, colloidal systems, and healthy nutrition. The fostering of IBSE skills here focuses on planning an experiment, formulating hypotheses, searching for information, and several types of debating and thinking.

The unit was tested in two groups:

- In a class consisting of 24 members, 15-16-year-old students during a science class. This is a heterogeneous group in terms of interest and ability.
- This group consist of 10 members, 17-18-year-old students learning biology. This is a heterogeneous group as well.

The aims of the study

Firstly the purpose of the study was to work out and try out the formative assessment tools and strategies of learning with the help of IBSE. Secondly the goal was to create an appropriate supportive way of learning. As a part of This work we could define the skills whose assessment was paid the greatest attention during teaching the unit. The goal was to define the levels of performance in these skills, which can provide feedback for the students, and help them with further studies. In order to diagnose the students' thinking and progress we had to compile a set of questions. During the lesson the students answered the questions in writing and at the end of the task we discussed their answers. A further purpose was the enhancement of teachers' questions and questioning technics, since these immediate oral interactions are very important for supporting the learning.

Methods

I. Teaching and learning methods

We compiled the plan of the unit on the basis of non-structured or half-structured problems using our experiences with the PRIMAS project. We had to find a topic interesting for students and encouraging them to have individual research. The topic is appropriate for using practical and manual skills, and is linked to everyday experiences.

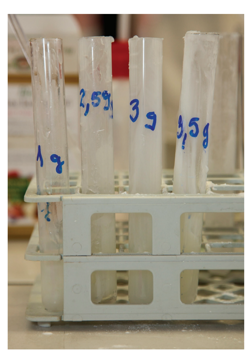
Learning sequence of the lesson

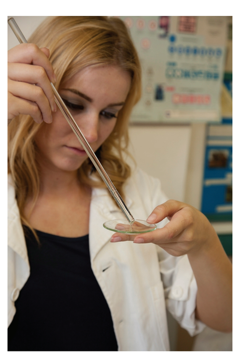
Preparation of inquiry

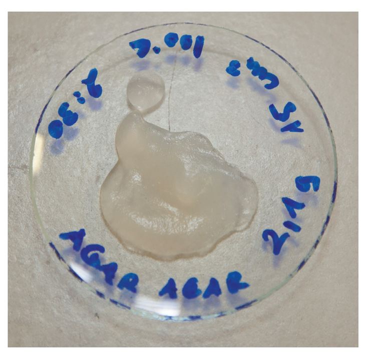
Student learning activity	Supportive teacher questions
Warming up Rising the interest and enthusiasm, looking out the bakcground of the task Theoretical introduction Emerging, arranging and complementing the conceptual knowledge linking with the task Forming inquiry question with students, e.g.: *How can we make really good pudding?*	What makes the pudding good or bad – which positive features or quality problems could you define? What kind of main nutrient groups do you now? What kind of advantages or disadvantages of those nutrients groups are there?

Planning investigation -
creating and examining a modell system

Student learning activity	Supportive teacher questions
Construction of a model that enables the formulation of the desired state. Students' task: 1. Choice of a suitable condenser, 2. Defining the addition rate, 3. Planning an experimental system ('a pudding model') 4. Making and analysing dilution series.	How could you define when the pudding is in an appropriate state? What methods could you find in order to define the differences between the thickener materials? How could you find out the proportion of compounds of the model?





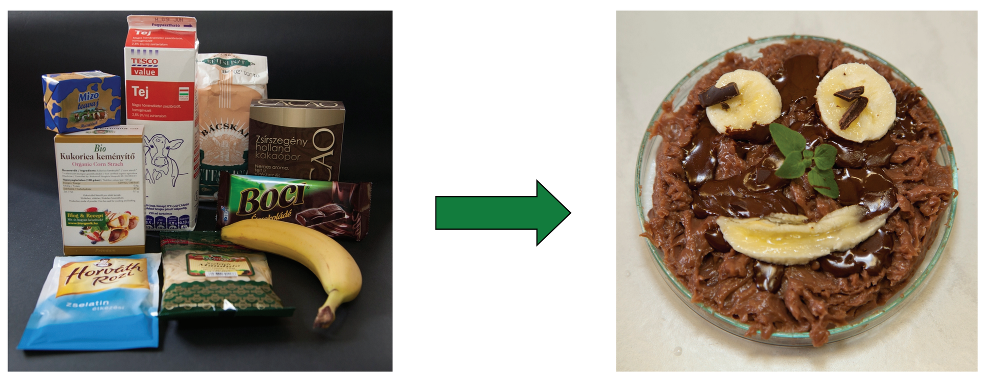


Planning investigation - applying the model to make a real pudding

Student learning activity	Supportive teacher questions
On the basis of common concepts agreed by the group plan the making of real pudding according to the following instructions: 1. The weight must be exactly 500g, 2. It must have a jelly-like consistency, 3. It must contain as many nutrients as possible, 4. It has to have as little energy content as possible.	– What kind of quality can pudding have, how could you rank these criteria? – On the basis of what considerations could you define the proportion of compounds? – Which ingredients could be minimised or maximised? – How can you calculate the energy content of the pudding?

Evaluation, feedback

Student learning activity	Supportive teacher questions
Presenting and examining the products Self assessment, group assessment	– On the basis of which aspects could you evaluate the end product? – How can you evaluate your own work and the groups' as well, what were your strengths and weaknesses?



II. Formative assessment methods

The main tool of formative assessment is the teacher's oral feedback. We used different written assessment tools in both student groups. In science class we used rubric method representing student's performance. Some examples:

Skill: Planning investigation

Acceptable	Needs improvement	Poor/NA
You are able to investigate a problem or to solve it and to formulate independent suggestions. On the basis of testing the suggested method you are able to revise your original ideas. You can independently recognise the variables even if they are not identified in the task.	You can start investigating and solving the problem on the basis of given instructions but you are able to find solutions independently to emerging problems. You are not able to recognise the variables independently but on the basis of given instructions you are able to comprehend and control them.	You can hardly understand the purpose of investigating the problem but you can complete the given instructions. You are not able to recognise the variables independently, you can hardly understand them on the basis of the instruction.

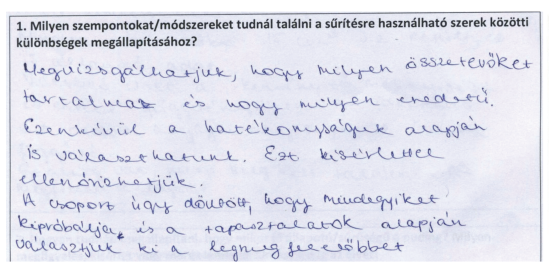
Skill: Reasoning

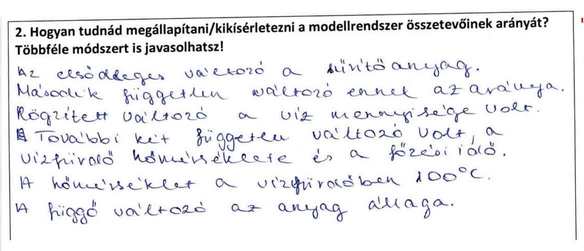
Acceptable	Needs improvement	Poor/NA
You are able to draw conclusions on the basis of experimental results examining and measuring variables. You can transfer the results of experiment or model to real problems.	You record the results of the experiments properly but on the basis of them you are not able to draw conclusions. You can be led to the connection between the experiment, the model and real problems.	You are not able to draw conclusions on the basis of experimental results and observations. You cannot transfer the results of experiment or model to real problems.

We constructed a questionnaire to assess the biology group. It included the key elements of inquiry, the thinking steps and skills. At the end of the lesson every students completed the questionnaire. During the next learning period we discussed the answers.

Results

The students' answeres given to the questionnaire



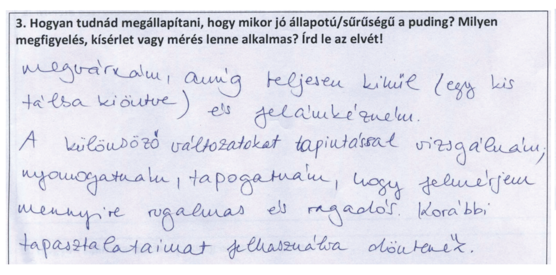


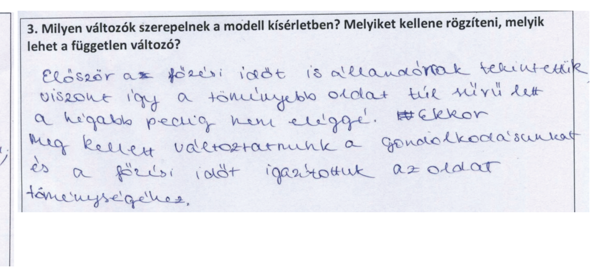
1) What methods could you find to define the differences between condenser materials?

'We can examine the compounds and its origins. Also, we can choose them on the basis of effectiveness. We can control it with a test. The group decided to try all of them and on the basis of the results to choose the most appropriate one.'

2) How could you define/test the rate of the compounds of the model?

'The first variable is the type of the thickener. The second independent variable its proportion. The fixed variable is the quantity of water. Further two independent variables were the temperature of water bath and the heating time. The temperature of the water bath was 100°C. The dependent variable is the consistency of the mixture.'





3/A How could you define the appropriate consistency/density of the pudding? Which observation, test or measurement is appropriate?

'I would wait for it to cool down and I would test it (put a little on a small glass plate). I would examine the different samples by touching and pushing to measure how flexible and sticky they are. I would decide using my previous experiences.'

3/B Which variables are in the model experiment? Which ones should you fix and which might be an independent variable?

'Firstly we considered the heating time as a constant but the concentrated solution became too dense, while the less concentrated was not dense enough. Then we had to change our mind and to adjust the cooking time to the concentration of the solution.'

Conclusion

Teacher's instruction with oral questions and feedback help to avoid mistakes noted by critics of the IBL methods (Kirshner, Shweller & Clark, 2006), help to concentrate on the relevant topic and to maintain effective timing. These rubrics can contain sentences written in advance and they are appropriate for the assessment of science learning generally. The assessment tools should be compiled as elements of the unit connected to several critical points and thinking steps of the inquiry. In our science class we used fairly general assessment sentences since the students had completed similar tasks, and we have ideas about their skills and knowledge. In the future we would like to compile rubrics connected to a certain unit. In the biology group the students completed this questionnaire during the learning session or immediately after it. We received answers from each student in contrast with the oral questions during group work. We analysed in detail the questions and answers during the next lesson, so the students could think about thinking in a metacognitive way. The metacognition can help self-directed learning of science (Schraw, Crippen & Hartley, 2006).

On the basis of students' answers collected through the questionnaire method our previous picture about the heterogeneity of student group is confirmed. The best students were able to make the most of the IBSL method, they formulated hypotheses independently, and used their own methods to test them. Being able to modify the methods indicates flexible thinking and creativity. The students who need further assistance were not able to do this independently, they could only solve the emerging problems with help. During the debate with peers these two types of students could cooperate, so instead of teacher's support they could often help each other.

References

Kirschner, P. A., Sweller, J., & Clark, R. E. (2006). Why Minimal Guidance During Instruction Does Not Work: An Analysis of the Failure of Constructivist, Discovery, Problem-Based, Experiential, and Inquiry-Based Teaching. *Educational Psychologist*, *41*(2), 75-86.

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