IS YEAST ALIVE?
THE EXPERIENCES OF TESTING AN INQUIRY TASK

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Introduction

The living being is a central notion of the science of biology, thus the formulation and development of the concept is one of the important objectives of science education. This deeper interpretation is the task of biology instruction (Nagy, 1999). Inquiry-based learning may help the understanding and lasting acquisition of scientific notions (Nagy, 2010). The biology curriculum offers numerous opportunities to apply IBL tasks in classes (Kontai & Nagy, 2011a, 2011b).

The aim of the study

The case study presents the experiences of trying out the guided IBL task 'Is yeast alive?'

The aim of the task is to enrich and deepen the scientific notion of life throughout the biology studies in secondary school.

The implementation of the task allows the students to demonstrate through a scientific experiment that a seemingly inanimate thing (yeast bought in the shop) is alive. During the inquiry process the students interpret and define the scientific notion of life based on the already acquired knowledge and their connection with the results of the experiment, as well as on drawing conclusions.

Besides promoting the development of notions, a **further aim of the task is** to foster the following inquiry skills:

- developing hypothesis,
- planning and setting up experiments,
- interpretation of the role of control,
- using lab equipment and microscope,
- observing experimental processes,
- recording and interpreting data,
- recognising connections,
- drawing conclusions,
- cooperation in the group,
- self-control,
- taking responsibility.

Methods

The task was tested in a Waldorf secondary school with 9th graders (N=14) in connection with the topic of fungi.

As the students had little prior knowledge and were inexperienced in experimenting **we chose the guided version** (Colburn, 2000) **and helped the implementation of the inquiry process with a worksheet** (Bán, 2011; Lénárd, 1992). We provided the research questions: Is yeast capable of growing, utilizing energy and producing carbon dioxide in the presence of sugar? The students' task was to develop hypotheses, plan the experiment to obtain evidence for metabolism and growth, implement the investigation, describe the experience and draw the conclusions. The worksheet contained questions that required the integration of the subject knowledge about experiments, or required explorations in the library or on the internet.

The students worked in groups of 4-5, the selection of the groups was random. **Three 45-minute class periods were provided for the implementation of the task.** During the first class period, the students completed the first and second parts of the worksheet, during the second class they did the third and fourth parts. During the third class, the sharing of experiences and conclusions took place in the form of 10 minute presentations, and the students' performance was evaluated.

Results

I. Motivating questions

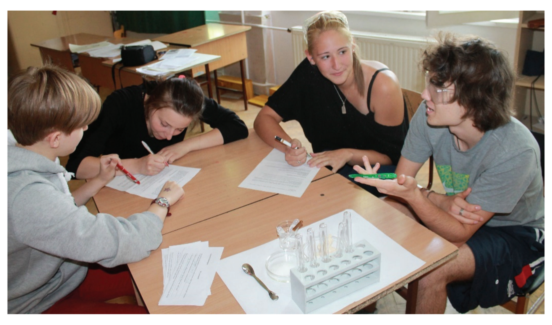
Half of the groups thought that yeast was not alive, the other half thought it was.
They based their answers on their everyday experiences.
'Yeast is not alive because:

- it does not change,
- it must be kept in the fridge and can be frozen,
- it does not need water.'

The task of defining the notion of a living being proved to be difficult. The following criteria were mentioned in the students' definitions:

- 'it moves',
- 'it breathes',
- 'it is able to exist independently',
- 'it perishes once',
- 'it needs energy',
- 'it changes with time'.

Answering the motivating questions independently



Discussing the answers given to the motivating questions

II. Experiment to demonstrate metabolism

Each group correctly completed the sentences about the human metabolism.

Most groups could develop the hypothesis by answering the helping question.

'In the presence of sugar gas will develop.'
'If there is no sugar available no gas will develop.'

Two groups developed wrong hypotheses.

'Gas will develop if sugar is present.'
'Gas will develop if sugar is not present.'

Planning the experiment proved to be the most difficult task.
One of the groups neglected the hypothesis during the planning of the experiment. They missed that step of the experiment during which they had to prove that gas does not develop without sugar. This required the teacher to intervene.
Helping question from the teacher:

'How can you prove that the presence of sugar is inevitable for gas development?'

Planning the steps of the experiment proved to be difficult for two groups.
They defined too complex steps and they could not divide them into smaller ones, and/or they left out certain steps.
One of the groups left out the addition of water from the experimental plan.

'We put the yeast and the sugar into the test tubes and pull the balloon onto the tube.'

Helping instruction from the teacher:

'Divide this into steps what you will do after what in the experiment!'

During the implementation of the experiment the proportions of the necessary materials caused problems.
Teacher's helping call:

'Be careful about the proportions.'

One of the groups tried out more than one yeast-sugar proportion. **Finally everybody carried out the experiment successfully.**

Implementing the experiment to demonstrate metabolism

The results of the experiment to demonstrate metabolism

The recording of observations and experiences took place in very simple, everyday language. The description lacked scientific terminology.

'Above the test tube the balloon grew big, it rounded out in the test tube in which there was sugar.'

Only one group used the expression '*gas develops*'.

Without the teacher's help only one group managed to interpret the role of the control.
For one group understanding the question itself caused some difficulty.
Teacher's helping instruction and question:

'Think through what the first experiment demonstrates and what the other one does. Why do we get a more exact result if we interprete the two experiments together?'

For some groups connecting the everyday experiences, the experimental observations and the previously learnt scientific knowledge caused difficulties.

III. Experiment to demonstrate growth

In this case the planning of the experiment was much smoother than in the case of studying metabolism. To help the students we provided the materials and tools needed for the experiment.

The use of the microscope proved to be the biggest problem. However, teacher assistance was unnecessary, as in each group there was a student who was experienced in using a microscope, who took up the leading role in this task.

Implementing the experiment to demonstrate growth

IV. Drawing conclusions

Each group drew the proper conclusion.

'Yeast is alive, because with sugar around it produces carbon-dioxide.'
'Yeast is a living material because it is able to grow with sugar.'

When needed the groups could appropriately modify or complete their original definitions of the notion of the living being as reflected by their experimental results.

Conclusions

The implementation of the guided IBL task complemented with the worksheet proved to be a good decision in the experimental class. We managed to fulfill the aims of the task. For future student experiments and for learning regular subject matter in the future we can rely on the students' acquired skills and knowledge.

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Sample materials used in this case study:
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http://serendip.brynmawr.edu/sci_edu/waldron/pdf/IsYeastAliveTeachPrep.pdf

SAILS Strategies for Assessment of Inquiry Learning in Science

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