

## Introduction

Inquiry based learning is becoming more and more important in science classes. This teaching approach provides a learning environment that builds upon the students' natural curiosity and interest. In this environment the students define the process of investigation and plan the steps of the research themselves. The poster shows an IBL activity in which the students study the factors affecting the activity of an enzyme in saliva and discover the role of control in an experiment. The experiment is easy to carry out, the change can be observed quickly and digital tools can be used to record and present results.

## The aim of the study

The aim was to test how our devised activity works; whether the students are able to design an experiment to study three variables (temperature, enzyme concentration and reaction time).

A further aim of the method was to test assessment methods that are suitable for the assessment of students at the group's level.

## The features of the session

In a science class the 14-15 year-old students studied the structure and the functioning of the digestive system. The aim of the lesson is to get to know the process of the functioning of enzymes, to recognize and identify the factors affecting this process, to develop a hypothesis, design an experiment and test the hypothesis.

In heterogeneous groups of 4 the students tried to find the answer to the question of what factors affect the activity of the amylase enzyme. In the form of an unstructured activity they demonstrated that the digestion of starch begins in the oral cavity.

As there are a number of students with disabilities or with Hungarian as a second language in the class, we used a short guide during the activity.

### Worksheet

#### The decomposition of starch in saliva

Carbohydrates are the essential nutrients of the human body. These are the prime source of energy in our body. Their digestion begins in the oral cavity. Let's examine the decomposition of starch in the saliva! How could one prove that enzymes in the saliva begin digestion to simple sugars?

#### What factors affect the function of enzyme activity?

Plan an experiment to examine the different factors! The following tools are available:

#### Required equipment:

- 0,1% starch solution
- Lugol's solution
- white ceramic
- 3 pipettes
- 2-3 glass sticks
- distilled water
- 2 beakers
- 4 test tubes, a test tube holder
- funnel
- filter paper
- measuring cylinder



During the planning don't forget the different variables: the independent variable (that changes); the dependent variable (that you observe or measure) and the constant variable (that you choose to be constant during the observation).

After formulating the research questions:

- Consult with the teacher.
- Prepare a plan for the implementation, plan the steps.
- Perform the experiments and write down the observations.

#### What environmental conditions are required for the enzyme to work efficiently?



How does temperature affect enzyme functions?

## The methods of assessment

At the beginning of the inquiry activity the teacher, consulting with the students, devised the criteria of assessment. These were the following:

- planning and implementing the experiment
- formulating the research questions
- cooperation with group members

The main focus of assessment was the groups' work.

When planning the test session a system of assessment criteria was developed to facilitate the formative assessment of the students' work, which was given to the students. We assumed that with the help of the system of principles the students will be able to define the steps of their own progress.

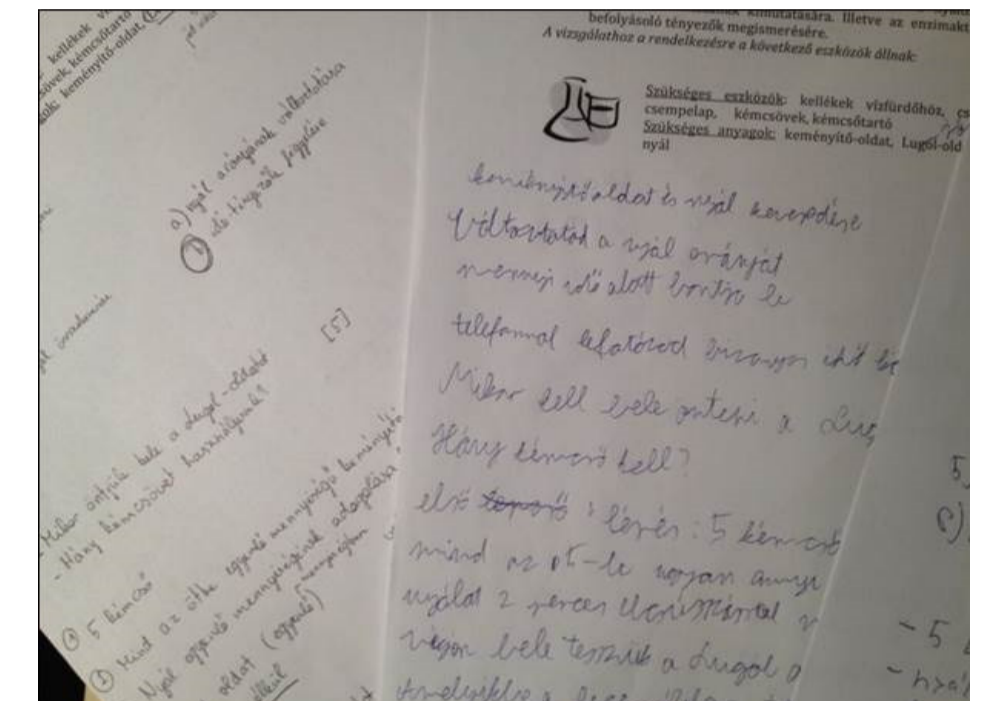
### The system of the principles of formative assessment

| Topics of assessment                           | Good  | To be improved   | Weak  |
|--|---|--|---|
| Formulating inquiry questions /Oral expression | Applies professional terminology appropriately and confidently.   | Usually knows the professional terminology, but does not always use it.                                  | Does not use the professional terminology.  |
| Planning and implementing the experiment       | Is able to carry out experiments alone and to record the results accurately.  | With some help the student is able to implement experiments and record results with minor imprecisions.  | Is not able to carry out the experiments on their own, nor to record the process and the results of the experiment. |
| Formulating hypotheses                         | Is able to formulate their hypothesis and support it with arguments.  | Is able to formulate their hypothesis and support it with some help.                                     | Is not able to formulate the hypothesis, but is not able to support it with arguments.                              |
| Argumentation                                  | Expresses their opinion logically, in case of a debate the student defends their position with appropriate arguments. | Occasionally is not able to express their opinion logically, in case of a debate argues with difficulty. | Is not able to formulate their opinion, in case of a debate is not able to defend their position.                   |
| Cooperation                                    | Pays attention to peers, takes part in the work enthusiastically.   | Pays attention to peers, finds their place in the work.  | Cooperation   |

Using on the first two rows of principles of formative assessment about half of the students were able to estimate their level correctly. Some underestimated their abilities; in these cases their peers supported them by boosting their self-confidence. As expected for the students' age group, the opinions of their group members were important to them. Looking at the principles of argumentation and formulating hypotheses, the students had most difficulty formulating their own assessment. These fields of skills must be taken into account during future classes. For the row of principles of cooperation, the children estimated their own position well.



The result of the experiment



The inquiry worksheets

In the table we summarized the most important activities in class and the teacher's guiding questions that helped hesitant students to move on. During the work half of the groups needed the teacher's presence and reinforcement.

In the results column it can be seen that besides the specific subject skills, social competences (social cognition, orderliness, helping one another, leading) and self-regulative skills (self-management, self-control, cooperation with peers) also developed.

| Activities   | Helping questions  | Results   |
|--|--|---|
| Discussing the factors affecting the functioning of enzyme activity        | What environmental conditions are required for the enzyme in the saliva to work effectively? How can you detect that the decomposition of starch begins in the saliva? | The groups easily recognized the changing of enzyme concentration and the time factor. They used the terminology confidently.   |
| Developing the hypothesis  | How many kinds of experiments are to be carried out if we want to test all options?  | They actively took part in the group work and supported one another in it.  |
| Putting together and implementing the experimental plans.                  | How can you demonstrate that the decomposition of starch has started in the saliva? Does temperature affect the work of the enzymes?                                   | Each group completed the design of the experiment; there were differences in the addition of details and thoroughness. Due to measurement inaccuracies two of the groups did not get the expected results in all experiments. |
| Gathering and analyzing substantive data, drawing appropriate conclusions. | What conditions affect the enzyme activity? How fast is the decomposition of starch?   | There were minor differences in the drawing of conclusions. Future instruction requires further attention.  |
| Discussing experiences with the group.                                     | How can you illustrate your results?   | They did not put emphasis on highlighting the connections. With the exception of two groups, they could express their opinions.   |

## Results

The students worked in six groups. The groups recognized the variables and every group chose a variable the experiment based on which they designed.

The groups worked actively throughout the whole activity, they were motivated, as everyone examined the variables they were interested in.

They economized their time for themselves, this way the implementation of the experiments was possible even for students who worked slower.



Designing experiment

During the experiments every group could set the variables themselves, this way they could repeat the experiments more than once, from the results they got they could determine themselves why or why not the experiment was successful.

If the experiment supported their hypotheses, they recorded the results in a register and presented them to the other groups. If they did not manage to support their hypotheses, they thought through every single step and corrected the experiment.

## Conclusions

The groups needed reinforcement throughout the activity. The system of assessment principles helped them to assess their work. Special emphasis was placed on the discussion of emotions and personal impressions in the groups' self-assessment. The three-level scale is not detailed enough to evaluate the students' work appropriately, but this simple system is the clearest for students of this age.

The system of assessment principles provided great help for the students with disabilities, it gave them a visual aid for identifying the fields they needed to focus on.

Most of the students were motivated by the possibility of getting to the next level and they saw the differences between the levels.

Contact: [nadasdizs@gmail.com](mailto:nadasdizs@gmail.com)