The Role of Inquiry Activities in Physics Education at Lower Secondary School

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Temperature and Investigation of phase transition are the main topics for the physics curriculum at 7th grade of the lower secondary school. Within the national educational achievement standards for these topics, the following pupil`s competences are required: description of observed phenomenon, recording of temperature vs. time dependences, discovery of factors influenced on experiment results, realization and evaluation of observations, presentation of own experimental data. The inquiry activities are indicated as one of the possible ways how to help pupils to obtain such competences. The role of inquiry activities at lower secondary school is discussed and explained by examples of computer based measurements in the topic Heat and Investigation of phase transition. For each activity the competences are defined, with focus on core elements of inquiry. The authors present first experiences with tools for formative assessment of inquiry activities.

INTRODUCTION

Information society brings new challenges for implementation of changes in the educational system. Instantaneous availability of information decreases the importance of memorising, however, at the same time it requires improving of skills needed for searching, understanding, processing and interpreting the findings. We have to make sure that all stages of education are interconnected in order to ensure effective acquiring of these skills and choosing the right tools. All our activities aim at developing certain parts of Science literacy of primary school students in Physics. Our determination stems from the desire to catch our students' interest in science and to lay a foundation stone of their scientific literacy that could be developed during their subsequent studies at a secondary school. One of the options seems to be applying inquiry activities in computer based laboratory.

PRIMARY SCHOOL PHYSICS AT SLOVAKIA

The content of Science curriculum is defined by the State Educational Programme according to ISCED 2. It specifies content standard and educational objectives for each theme. Physics (along with Biology and Chemistry) is part of a subject group called Man and Nature. The emphasis is on a constructivist approach, active learning, solving problems, group work, and creating a positive attitude towards science. Each school creates its own School Educational Programme, which enables the school to identify its own specialization.

Since our primary school puts special emphasis on foreign languages, Physics is taught for a recommended minimum of 4 years, 198 hours altogether. The topic that we chose is called Heat and Investigation of phase transition and is part of 7th grade Physics curriculum. Physics is taught 1 lesson a week in a class of about 25 students.

Currently we are engaged in the national project Workshop whose aim is to equip Physics classrooms with modern educational tools such as interactive whiteboard, computers for students, and measurement systems with sensors. This way we can create even better environment for inquiry activities and make use of computers and measurement systems.

OUR SELECTION OF INQUIRY SKILLS FOR INQUIRY ACTIVITIES

During the performing of selected activities that are conducted as guided inquiry process we try to develop some basic scientific skills in the 7th graders, such as observing, realizing and describing of experiments. During the activities Boiling of a liquid, How heat is measured the students acquire the following skills:

1. **Defining a problem**. Students think about their task and its importance and analyse the key physical quantities.
2. **Stating a hypothesis**. Students propose an explanation based on what they already know about the problem and thus demonstrate their understanding of the fundamentals of the examined physical quantity.
3. **Measuring**. Students take measurements with a computer with the system CoachLabII, with sensors of temperature and with the help of software Coach 6. The above stated environment does not require any specific preparation, it is easy to operate. With regard to the skills it is crucial that students find out and realise how to scale a range of a temperature sensor and not to exceed it.
4. **Data evaluation**. Students compare their graphic prognosis with the real results and explain their findings orally. It is important to interpret a graph and the relationship between the temperature and time.
5. **Peer discussion**. Pair work is more suitable for those students who are not familiar with inquiry activities or measure temperature for the first time because it increases students` self-confidence. Once the students gain confidence, it is possible to measure temperature individually.
6. **Implementation of the knowledge**. Assembling of the devise enables our students to develop manual dexterity needed in everyday life. During the measuring of the temperature our students found out that different sources of warmth (spirit burner, gas burner, stove) reach a different temperature at a different time. Constructivist approach helps us to explain the meaning of power as the rate at which work is performed or energy is converted.

INQUIRY ACTIVITIES AT LOWER SECONDARY SCHOOL PHYSICS

Inquiry activities were tested on a sample of the 7th graders aged 13-14. Within the topic Investigation of phase transition we tested activities *Boiling of a liquid, measuring of the boiling point of water* and from the topic Heat we tested the activity *How the bodies warm up*. Both above mentioned activities were conducted with a group of 12 students who worked in 6 pairs as guided inquiry activities. Each pair received a worksheet and completed all tasks with an occasional teacher`s help. Each of the activities lasted for 2 forty-five minute lessons.

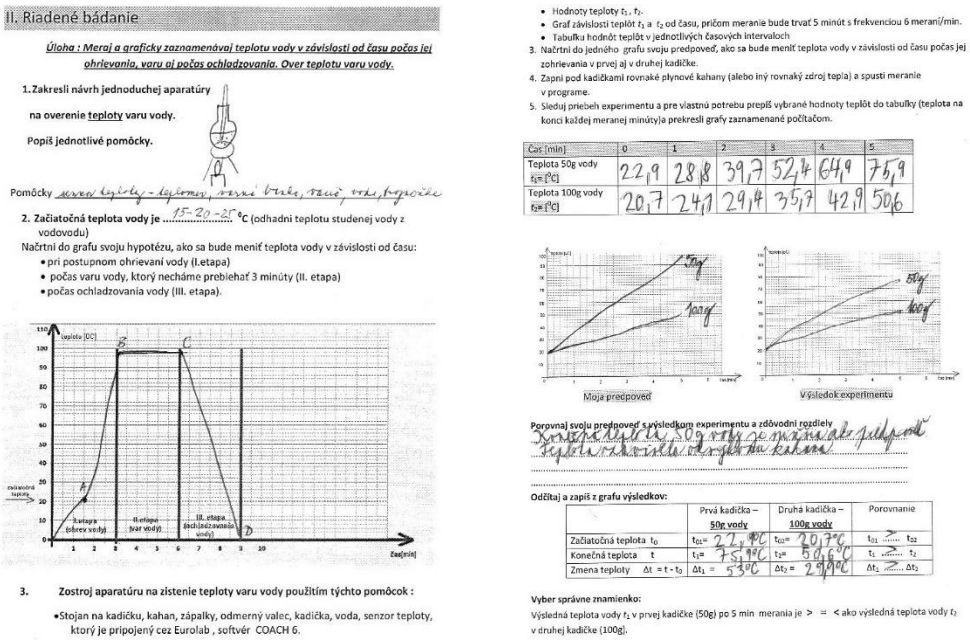

Figure 1: Students` worksheet for guided inquiry activity

Student`s worksheet contains: instructions, list of tools, and method. Before each practical activity students marked their graphic prognosis onto their worksheets. Students set all the required parameters in software COACH 6 – temperature, table with data, graph showing the relationship between temperature and time. After launching the experiment they were watching the results of measurement on the monitor. Then they compared their prognosis with results of the experiment and interpreted the graph showing the relationship between the temperature and time by completing the activities in the worksheet.

Figure 2: Guided inquiry activity during physics lesson at lower secondary school

HOW TO ASSES INQUIRY ACTIVITIES

During designing these inquiry activities it is important to think about assessment tools. Since students are subjected to a guided inquiry activity where the stages of the

lesson are assigned we propose to assess the task with the graph in activity *Boiling of a liquid, measuring of the boiling point:*

Predicting a graph showing the relationship between temperature and time in which we can evaluate four possible statements:

- the beginning of the graph – at what temperature students began to draw their prognosis, that is the initial temperature of water
- graph curve at the boiling point, the constant temperature
- slope showing the heating up and cooling down of water, when both phases take the same amount of time, we expect the slower cooling down to be marked,
- the end of graph – the prognosis of the final temperature of water,

Interpretation of graphic results of the experiment in the given tasks – reading the graph, noting down the temperatures, changes of the temperatures, identifying of individual parts of the graph – warming up, boiling point, cooling down of water.

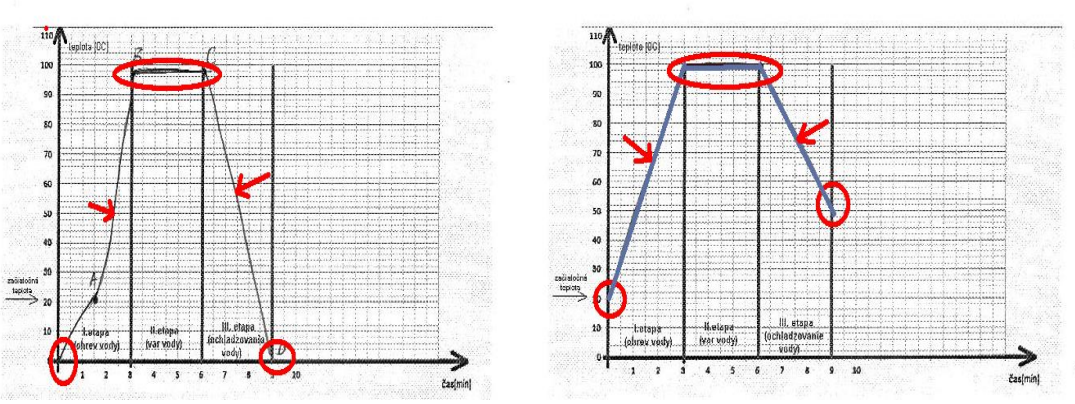

Figure 3: Temperature vs time graph, the typical students` prediction and final results

BENEFITS FROM INQUIRY ACTIVITIES FOR PUPILS AND TEACHERS

Inquiry activities with the help of a computer in teaching Physics at a primary school brought students these advantages:

- braking down Physics fundamentals into playful activities,
- developing manual dexterity,
- interconnecting a Physics experiment with digital technologies that are suitable for the tested age group ,
- increasing motivation to discover different natural phenomena,
- creating a positive attitude towards Physics.

Unfortunately, preparing these inquiry activities involves completing a considerable amount of time-consuming tasks for the teacher. He has to consider a suitable content and outcome of the activity as well as prepare some worksheets, tools needed for the experiment and evaluate students` work at the end. Other difficulties that have to be dealt with include classroom management, explaining different methods and introducing essential health and safety requirements. However, teacher can also gain a lot from running the experiment. Teacher takes the role of a guide who asks questions,

observes students, leads discussions, and pays individual attention. Once students become familiar with the process of measuring temperatures and know how to work with software COACH 6, it is necessary to pick interesting content that will still motivate students.

CONCLUSION

Our goal was to perform a pilot test of guided inquiry in a laboratory equipped with a computer within chosen Physics topics in the 7th grade at a primary school. Students had a chance to conduct guided inquiry and measure with the help of a computer for the very first time. This experiment was a valuable experience for the teacher who put the knowledge gained in Lifelong Learning Programme in IBSE into practice. The aim was to observe individual work and to prepare topics for implementation and evaluation of designed inquiry activities. Positive feedback received from our students as well as successful completing of the tasks are a reason for creating new activities and testing method IBSE in Physics at a primary school.

References

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