

Combining a pen tablet and eye-tracking to analyse calculations procedure in physics

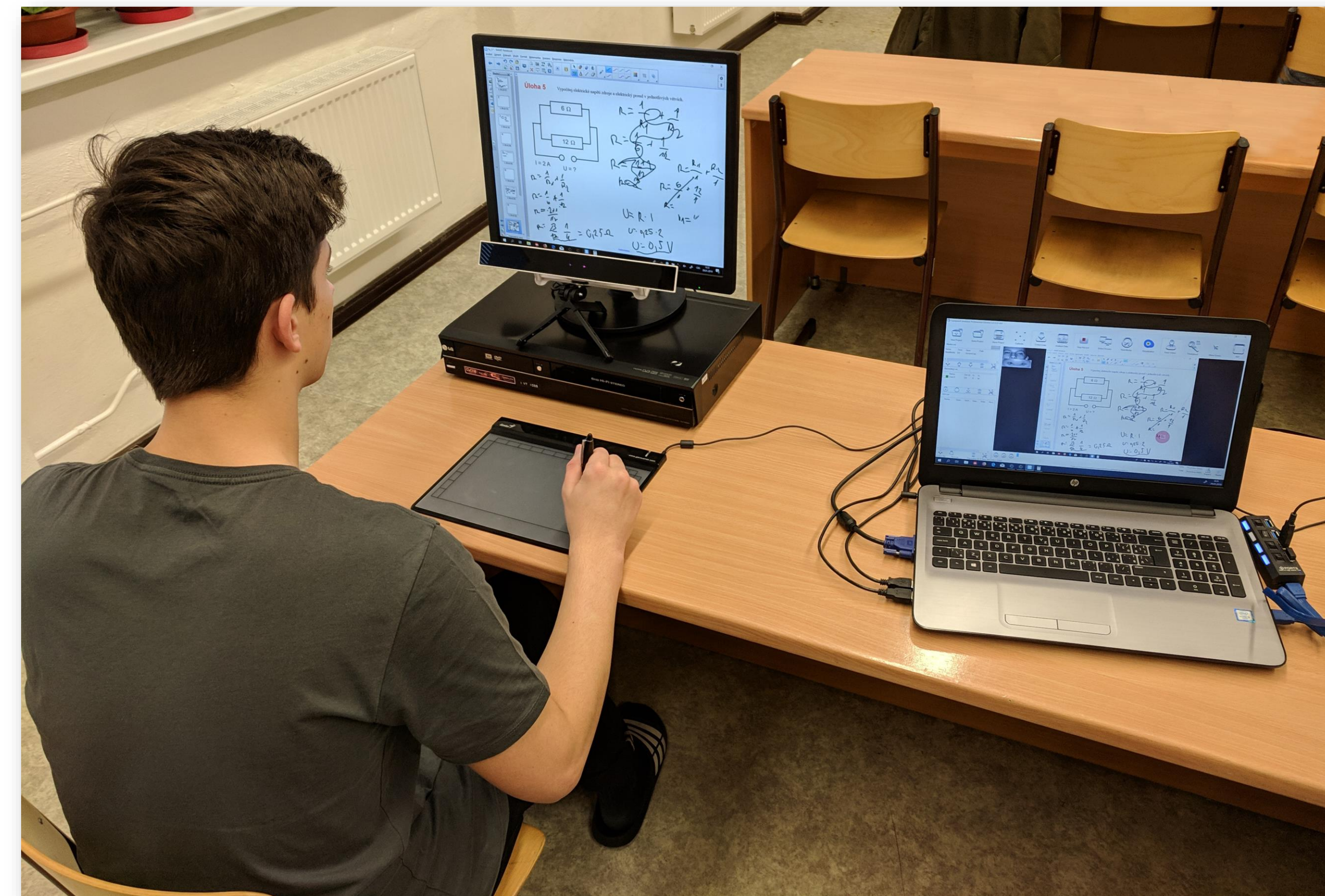
peer-reviewed poster

Stanislav Popelka – Palacký University Olomouc
Patrik Kočí – University of Ostrava
Jana Škrabánková – University of Ostrava

Abstract

The contribution introduces a new approach to analyse learners' strategies of calculations in physics. Three students were working with the newly created worksheets focused on the problematic of direct current. These worksheets were presented on the computer screen. Under the screen, the GazePoint eye-tracker has been placed for the recording of student's eye-movements. Students were able to write calculations and remarks directly into the worksheet using a pen tablet. The study aimed to prove if the combination of the pen tablet and eye-tracker will work. It showed that the system works very well. After a few minutes, the students get acquainted with the pen tablet control, and eye-movement recording also worked well.

With the use of this combination of technologies, it was possible to recognise what students were doing during 45 minutes of working on the worksheet tasks. The qualitative analyses show that students return very often to the assignment, still verify their decisions, and return to them several times. The results proved the designed system functionality, and it might be used for the analysis of students' work not only in the field of physics but in any subject where it is beneficial to record eye-movements during the writing task.



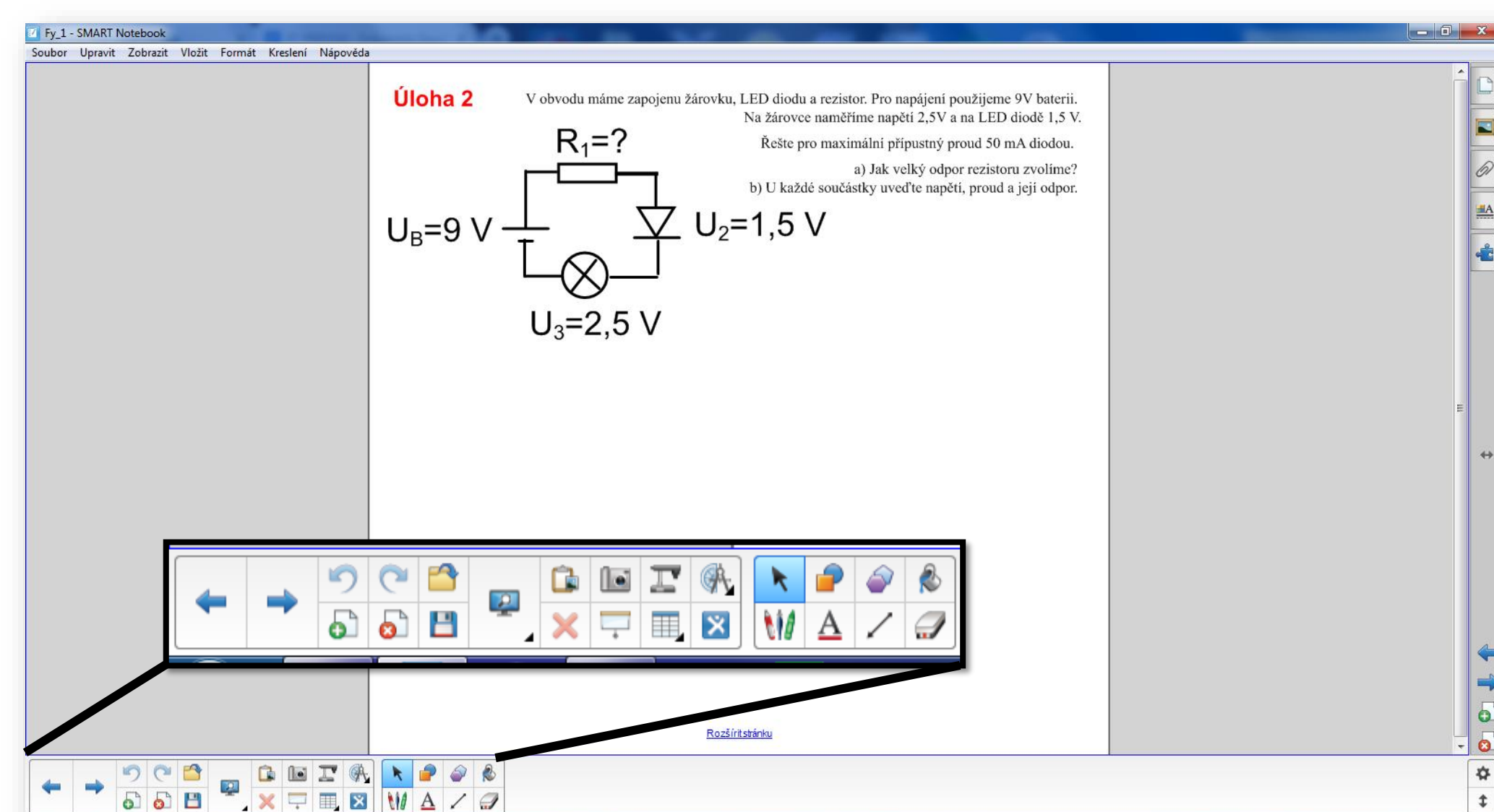
Methods

Eye-tracker allows to record the gaze position and analyse where the respondents are looking. For the evaluation of physics worksheets, it will be beneficial to understand the student's strategy in solving the task. However, in many tasks, students need to read the assignment, solve calculations, use the calculator, draw electrical circuits etc. Classic eye-movement measurement with remote eye-tracker is not sufficient. Objects that would interrupt the signal (hand with the pen) cannot be inserted between the student and eye-movement camera. From various ideas and solutions, how to allow eye-movement measurement and drawing at the same time, the proposed method seemed realistic:

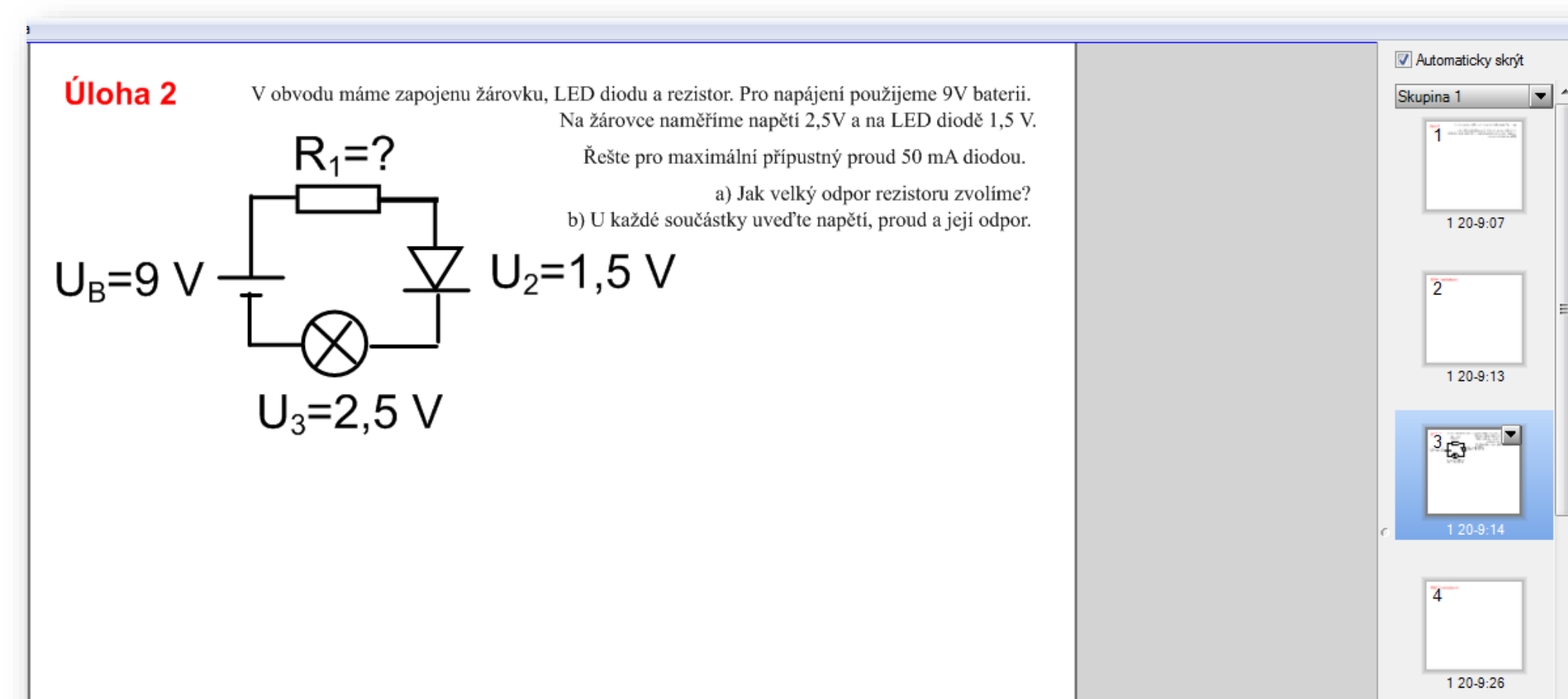
- Pen tablet with electric pen will be used
- Students will undergo training in pen-tablet usage
- Worksheet will be converted into appropriate software
- Eye-tracker will be connected and calibrated
- Screen-recording type of stimuli will be used
- Eye-movements are recorded during students work, calculations, drawing etc.



Preparation of worksheets

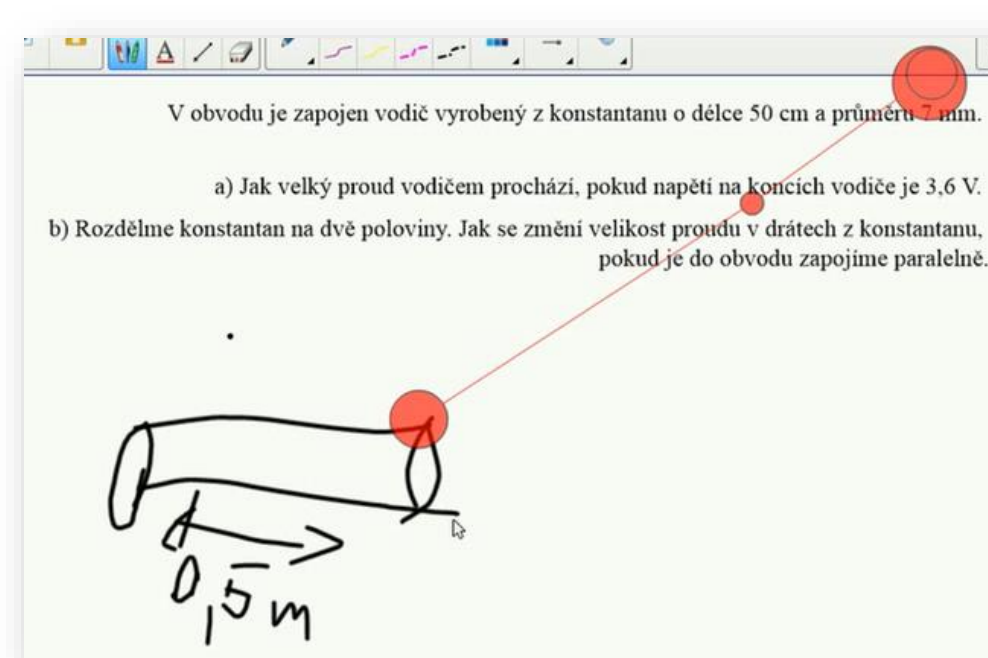


Worksheets were converted into Smart NOTEBOOK software which offers all necessary functionality (draw, erase, etc.) We modified the worksheet to contain enough free space for calculations.

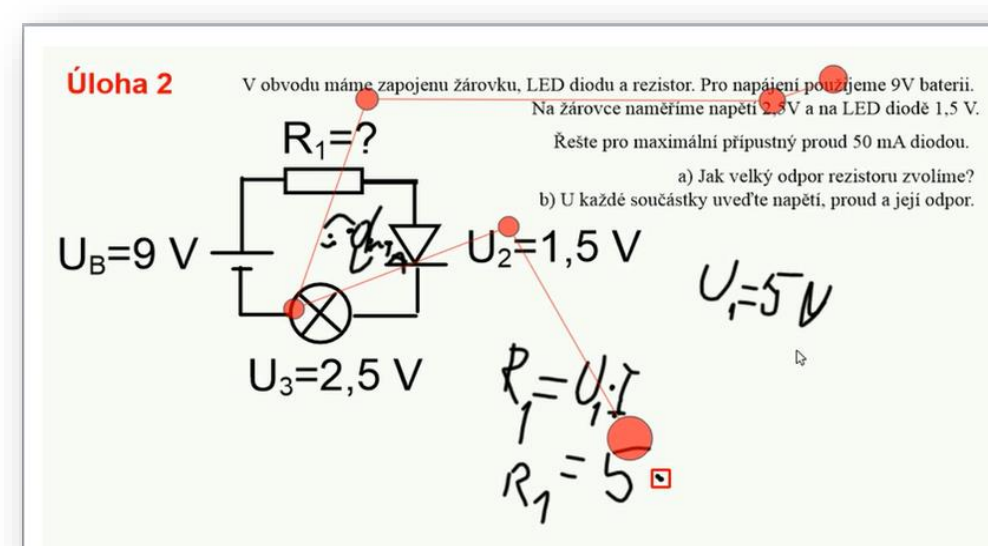


On the right side of the Smart NOTEBOOK, the student can switch between tasks.

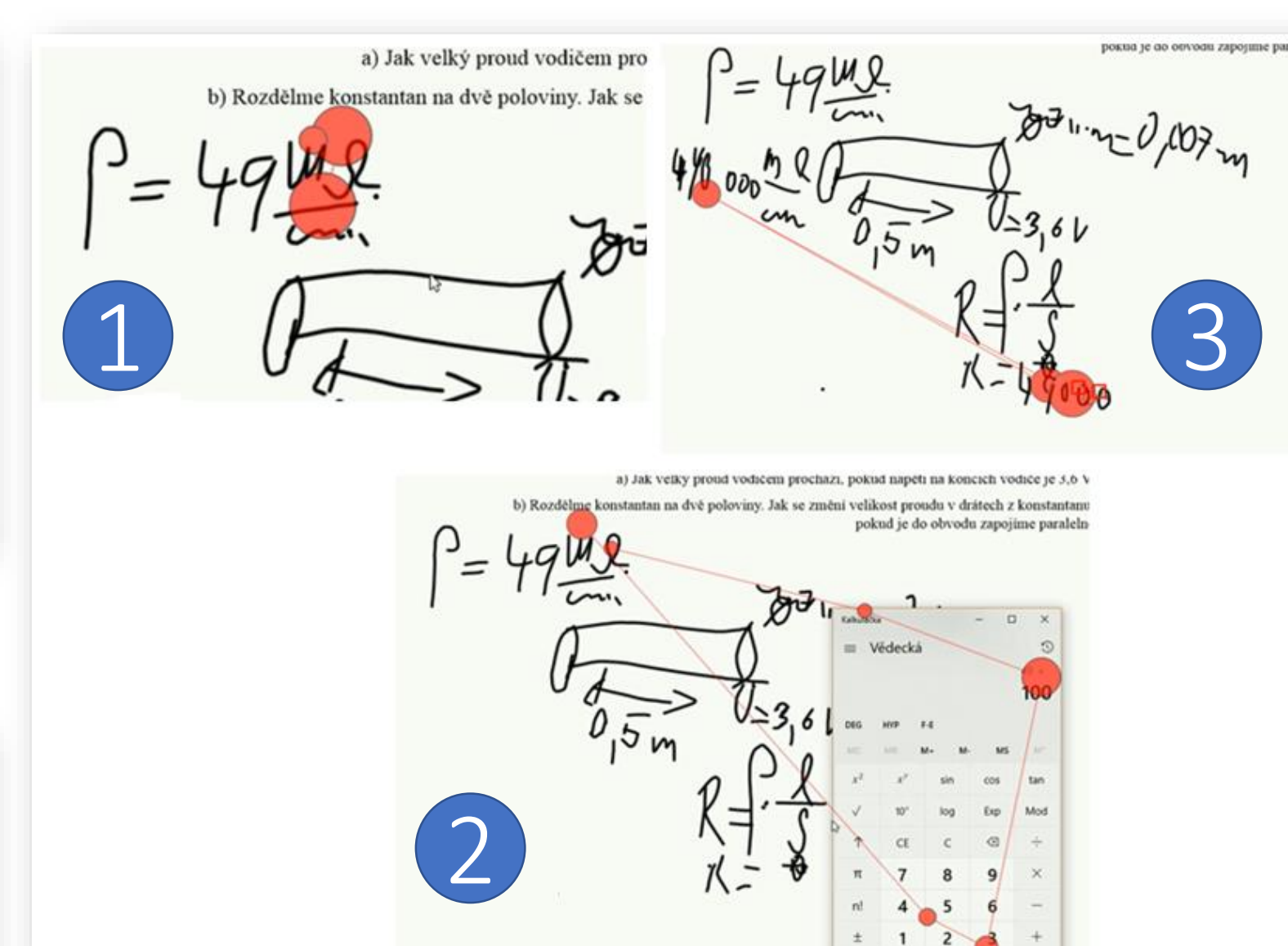
Results



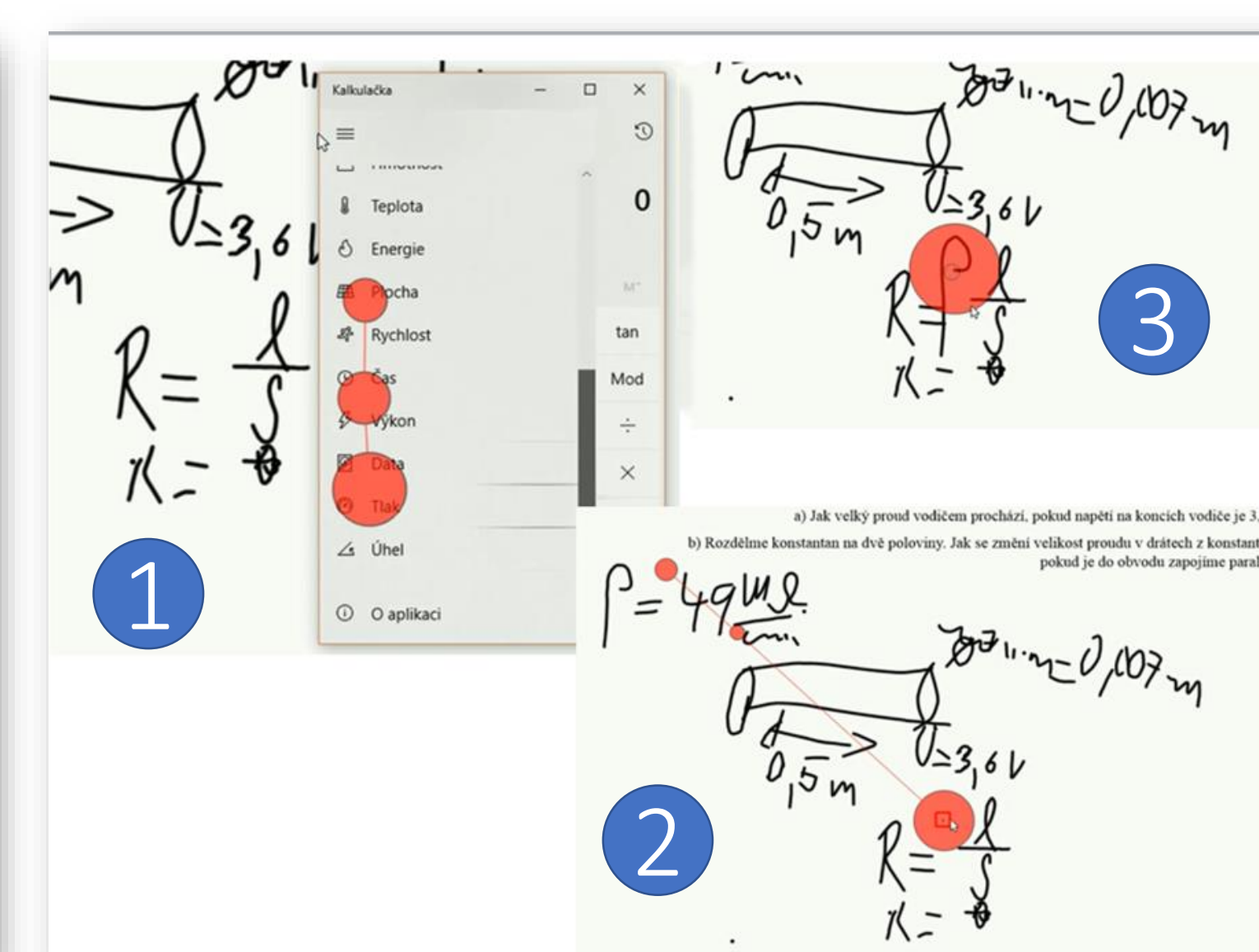
Correct connection of the data in the assignment with the student's own drawing.



Interconnection of information in the assignment, information in the electrical circuit and the physical formula.



Following the process of the unit conversion without the student taking notes.



First, the student gives a wrong formula for the resistance of the conductor (1) and looks for a formula on the calculator. Then he notices that there was information about the specific conductivity (2) in the assignment, so he changes the formula by adding the specific conductivity (3).

Conclusion

By applying a new method of connecting the pen tablet and eye-movement recording, the strategy of solving physical problems was effectively and efficiently verified. From the qualitative analysis of recorded videos, it was possible to recognize what exactly the student was doing during the 45 minutes of work on the worksheet tasks.

Qualitative analyzes show that students very often return to the assignment, constantly verify their decisions, work on the multiple parts of the task and then to them several times. The common procedure, when the student reads the whole assignment, did not appear. On the contrary, after reading part of the assignment, the students immediately threw themselves into the solution, if they did not know how to deal with it, then they moved on to the next task.

Thanks to the applied method, several types of student's errors were recognized – use of the calculator, deleting and rewriting calculations, adding parameters to formulas, incorrect formulas corrected after reading of the next assignment, etc.

Although the analysis is time-consuming, the mentor will gain a large amount of information about the causes of errors that the students are making.

Resulting videos

