How to evaluate students' answers and build on them? – the workshop for physics teachers

Danijela DODLEK (1,3), Eugenia ETKINA (2), Gorazd PLANINSIC (3)

(1) Josip Juraj Strossmayer University of Osijek, Department of Physics, Trg Ljudevita Gaja 6, HR-31000 Osijek, Croatia
(2) Rutgers University, 10 Seminary Place, New Brunswick, NJ 08901, USA
(3) University of Ljubljana, Faculty of Mathematics and Physics, Jadranska ulica 19, 1000 Ljubljana, Slovenia

Abstract. We present the workshop we developed and conducted with the physics teachers using the findings of our previous study regarding the teachers' interpretation of and responses to students' explanations. We explain how the goals of the workshops stemmed from the research findings, present the details of the workshop procedure and participants' activities and discuss how the outcomes of the workshop relate to the research findings.

Introduction

Responding to students' explanations is one of the most important tasks in which teachers engage [1]. By continuously assessing students' explanations, teachers can monitor their learning in real time, make informed instructional decisions, and adjust their teaching strategies accordingly. Identifying problematic aspects in students' explanations helps teachers provide effective feedback that allows students to correct their mistakes, deepen their understanding, and refine their thinking. Identifying productive ideas in students' explanations (even when the explanations are not completely correct) allows teachers to build on these strengths and design instruction that effectively supports and extends students' learning [2], and also it allows teachers to alter their lessons based on what students are saying.

With this in mind, we investigated physics teachers' abilities to interpret and respond to students' explanations by analysing their responses to students' answers to a difficult physics problem [3]. The findings of our study inspired us to organise a workshop for physics teachers in which they practised attending to students' needs similar to the ones described in our paper [3]. This project is an example of a research-informed approach to professional development.

The goals of the workshop

In the study described in [3], we found that teachers successfully identified productive and problematic students' ideas in the explanations that students provided when solving a difficult problem. While teachers' responses engaged the students in metacognition, the *feedback* that the teachers provided to the students was deficient. The teachers focused more on the *problematic* aspects of student reasoning than the *productive* aspects of reasoning and were more successful in addressing problematic aspects of student reasoning than in building on students' productive ideas in their feedback.

A year after we collected and analysed data for the above-mentioned study, we developed and conducted a workshop for physics teachers. The goal of the workshop was to help teachers learn how to provide effective feedback and how to simultaneously build on productive aspects of students' ideas and address problematic aspects. We wanted teachers to practise identifying productive and problematic ideas in students' responses and giving effective feedback to the students. Most importantly, we wanted the teachers to learn the importance of attending to students' ideas, especially building on those ideas. The workshop and the results are described below.

Workshop structure

In the workshop, the teachers in groups of 4 worked on 3 activities which included examples of physics problems and students' solutions to these problems (an example is shown in Figure 1). The workshop's activities built on each other.

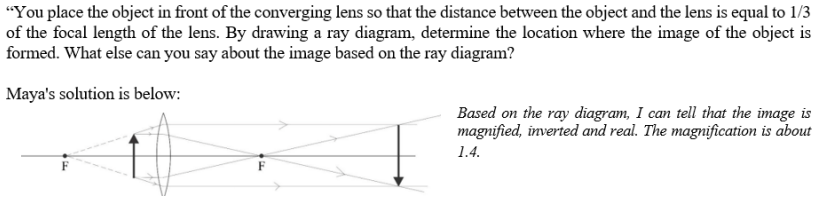

Figure 1. The problem and student's response used in Activity 1.

In every activity, the teachers had to identify students' productive and problematic ideas and provide a response to students. At the end of each activity, we shared model (expert) responses with the groups. The differences between activities 1 and 2 (and 3 since it had the same structure as activity 2) are summarised in Table 1:

Table 1. The differences between activities 1 and 2.

Activity 1	**Activity 2**
1. Teachers individually identify problematic and productive ideas 2. Discussion among their group and writing on the whiteboard 3. All groups discuss identified ideas 4. All groups talk about how they would respond to students	1. Teachers individually identify problematic and productive ideas and respond to students 2. Discussion among their group and writing on the whiteboard 3. All groups discuss identified ideas and responses to students

At the end of the workshop, the teachers reflected on what they learned in the workshop and explained why it was useful for them.

Findings of the workshop

Similar to the findings of our study [3] that used a written survey, during the workshop, we found that while the teachers were rather successful in identifying productive and problematic elements in students' explanations, the feedback that they provided to the students was somewhat deficient as it almost exclusively focused only on the incorrect/problematic aspects, often ignoring the correct ones. Similar to our study findings, the teachers who participated in our workshop often posed metacognitive questions, prompting the students to think about their thinking. During the workshop, we noticed that the teachers rarely built on students' productive ideas but had no difficulties addressing the incorrect/problematic elements that they identified. However, group work improved their answers compared to the survey findings in [3].

References

[1] L. Shepard, The Role of Assessment in a Learning Culture, *Educ. Res.* **29** (2000) 4.
[2] S. Dehaene, *How We Learn: The New Science of Education and the Brain*, Penguin Publishing Group, 2021.
[3] D. Dodlek, G. Planinsic, and E. Etkina, How to Help Students Learn: An Investigation of How in- and Pre-Service Physics Teachers Respond to Students' Explanations, *Phys. Rev. Phys. Educ. Res.* (in press).