Report from the FP7 project:

Assess Inquiry in Science, Technology and Mathematics Education

ASSISTME

Assessment method description for 'investigations in science' competence

Peer-feedback on lab-journal entries

Regula Grob, Anne Beerenwinkel, Olia Tsivitanidou, Peter Labudde

In cooperation with

Hilda Scheuermann, Silke Rönnebeck, Mathias Ropohl

the German Teacher Expert Panel: Ulf Bachmann, Thorsten Erdmann, Alexandra Melsbach, Britta Stäcker, Hans Teetzmann, Thilo Wünscher

the Upper Secondary - Teachers of the Swiss Teacher Expert Panel: Mario Gerwig, Stefanie Jess, Anja Renold

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Lead participant	University of Applied Sciences and Arts Northwestern Switzerland FHNW School of Teacher Education Center for Science and Technology Education
Contact person	regula.grob@fhnw.ch
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1. Summary

This descripiton will introduce a method for peer-assessing students' lab-journal entries. There will be a descripition of what students and the teacher are expected to do (their task) and how the working process could be formatively assessed.

Peer-feedback certainly could be used in many fields of competence. Here, the focus lies on carrying out an investigation which includes taking down notes, results, etc. in a notebook or in a lab-journal.

The students are asked to conduct experimental work or an investigation. When doing this, they should collect measurement results from this experimental / investigational work. The measurement results should be written down, e.g. in a lab journal, in a way that they can afterwards be further processed, plotted and evaluated. The students should exchange their lab journals after having taken a few measurements but before they have completed the process of data collection. The peers should try to process and plot the data from the students' lab journal and based on the peer's questions, the students should recognize (1) where it is difficult to understand the organisation of the data and how the layout in the lab journal could be improved and (2) where the experimental design might have flaws. Then, the students complete and improve the measurement data and their notation.

Subject	• Assessment method generally adaptable to all science subjects (investigations and experiments) • Paradigmatic example in physics; topic: Ohm's law
School level	• Assessment method generally adaptable to all levels • Paradigmatic example in upper secondary school
Assessed competences in the paradigmatic example	• Plan and carry out investigations (in science) Basic standard grade 12: "[…] Students can conduct investigations and experiments with a certain degree of independence. When doing this, they are able to form founded estimates of results, to systematically take measurements, to collect, to organise, and to appropriately plot data (e.g. in a table, a graph)." (taken from ASSSIT-ME report D4.7)
Data collection about student learning	• Lab journals
Feedback method	• Peer-feedback
Combination with summative assessment	• Description, guidelines and paradigmatic example for formative assessemnt, task and assessment criteria also usable for summative assessment.

Table 1. Main characteristics of assessment method "Peer-feedback on lab-journal entries ".

2. Description of the assessment method with guidelines how to use it

"Peer-feedback" describes formative assessment which is conducted by student peers. This chapter will provide a description of the principle along with short summaries of different varieties.

In both self-and peer-feedback, it is of central importance that the goal of a task and the criteria of evaluation are understood well by the students (Sadler, 1989; Black et al., 2003). Black et al. (2003) suggest supporting this understanding by showing examples.

Both self-and peer-feedback allow the teacher to freely move between the students and concentrate on individual problems since she / he does not carry the responsibility to do all the assessment of the whole class.

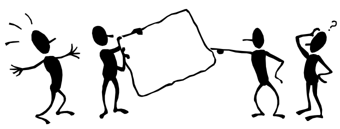
The process of peer- and self-assessing pieces of work from time to time should help the students to bear in mind the aims of their work and therefore assist them in becoming independent learners (Black et al., 2003).

Why you should do this

Peer-feedback follows the idea of "activating students as instructional resources for one another" (Leahy et al., 2005). Peer-feedback is seen as particularly powerful since *"students may accept criticisms of their work from one another that they would not take seriously if the remarks were offered by a teacher. Peer work is also valuable because the interchange will be in language that students themselves naturally use […]"* (Black et al., 2004, p. 14). The same authors find evidence that *"when students do not understand an explanation, they are likely to interrupt a fellow student when they would not interrupt a teacher." (Black et al., 2004, p. 14).*

However, Black et al., 2003, also mention that before being able to assess their peers' work, they have to learn how to behave in groups (listening to others, taking turns) and how to communicate their feedback usefully.

In reciprocal peer-assessment, students undertake both the role of the assessor and the assessee, by assessing each other's work. Performing the peer-assessor role requires students to have and practice their assessment skills, namely: *defining criteria, judging the performance of a peer, and providing feedback* (Sluijsmans, 2002). Students could be supported through the provision of scaffolds while performing each one of these assessment skills. For example, if students are novices in peer-assessing and have no prior experience on how to define assessing criteria or what has to be measured in the learning process and thus compose assessment criteria, they could alternatively be provided with those criteria from the teacher, in order to better execute their task.



3. Paradigmatic example: Physics, upper secondary level

In this chapter, the use of a method for formatively peer-assessing students' competence to collect data and organise them in a lab-journal when carrying out an investigation or an experiment will be illustrated by an example.

The example of using the method of peer-assessment is presented for a unit where the students are asked to confirm Ohm's law, with which they are already familiar, empirically. Thereto, they work in pairs and they are given a voltage source (with variable voltage), an Ampère-meter, several resistors, and several pieces of wire to connect everything to a circuit according to a given circuit diagram.

The students plan their investigation, take measurements and collect the results in a lab journal so that they are able to confirm the law U/I=R. They should also document thoughts on possible sources of error. They are not told what to measure, how to vary voltage and resistors, how many measurements and test series to take, or how to take notes of their results. They know, however, that they will have to exchange their lab journals with other students later on.

Before the students have finished their work, they are interrupted. They should merge with another group of two students and exchange their lab journals. Both teams should now try to confirm the law U/I=R based on the lab journal entries of the other group. The four students should then discuss (1) what could be improved in the experimental design (systematic variation of U and R) as well as (2) in the organisation of the data in the lab journal so that they can be used by other people. This discussion can be structured by the guidelines provided in the next chapter.

The second lab journal should be discussed in the same way afterwards.

Then, the students go back to their work in their initial groups of two and complete and improve the measurement data and their notation.

At the end of the lesson, the teacher should lead a whole-class discussion on potential sources of error that prevented confirmation of the law (e.g., internal resistance of the measurement devices, humidity of the air, etc.).

4. Assessment criteria and guidelines for peer-feedback on lab-journal entries

The following paragraph provides guidelines for students' peer-feedback on the lab-journal entries.

A) Documentation: how the measurement results are labelled and organized
   a. Is it clear at first sight, when the measurements were taken and which question was examined in the experiment / in the investigation?

   b. Should there be any improvements in the lab journal so that peers understood better what was done in the experiment and how it was done?
      (In the example described in chapter 1: how the voltage source, the Ampère-meter, the resistor(s), were connected to a circuit, which voltage was set when, which value the resistor(s) had, what was measured)

   c. Should there be any improvements in the lab-journal so that it would be easier to understand what variables are represented by the measurement values?
      (In the example described in chapter 1: whether the measurement value "0.2" refers to the voltage which is measured in Volts, or to the amperage, or to some other variable, and if it was measured in mV, in V, in °C, or in some other unit)

   d. Should there be any improvements in the lab-journal so that it would be easier to recognise which measurement values belong to the same test series?
      (In the example described in chapter 1: Imagine there were several measurements of the amperage, always with the same resistor in the circuit but with varying voltage. It would be good if all these measurements of the amperage could be easily recognisable as a test series.)

   e. [Criteria added by the students or criteria that were developed together with the students]

B) Experimental design and conduction of the experiment: usability of the measurement data to prove the law (in this case: U/I=R)
   a. Should there be any changes in the collection of the data so that it was possible to prove the law U/I=R?
   b. There are different variables that could be manipulated. Was this taken into account?
   c. In case there are unexpected results (e.g. U/I not constant): are there any hints on possible sources of uncertainty in the lab journal?
   d. [Criteria added by the students or criteria that were developed together with the students]

References

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