Report from the FP7 project:

Assess Inquiry in Science, Technology and Mathematics Education

Assessment Method Description for 'Engineering Design in Technology' Competence

On-the-fly and Self-Assessment of Written Answers

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1. Introduction and summary

This description presents a possibility of applying and combining on-the-fly and self-assessment by means of an example from a general technology class.

In a role play depicting a purchase situation, two bicycles – a BMX bike and a city bike – are compared and their differences in terms of functionality are analysed. What follows are several assessment phases carried out by the students. The main focus of this lesson is thus an evaluation of and reflection upon technology. The students record the results of their observations, their findings and their conclusions in a so-called learning catalogue.

Subject	• Assessment method generally adaptable to all technological subjects (reflection upon technology, evaluating artefacts/products etc.) • Paradigmatic example in technology; topic: thinking about and reflecting upon technology
School level	• Assessment method generally adaptable to lower and upper secondary level • Paradigmatic example in upper secondary school
Assessed competences	• Identifying constraints and criteria • Evaluating prototype/ technical object against criteria, reasoning (taken from ASSIST-ME report D4.7)
Data collection about student learning	• Written data; written answer to open question
Feedback method	• On-the-fly; self-assessment
Combination with summative assessment	• Paradigmatic example and feedback method for formative assessment, but task generally usable for both formative and summative assessment

Table 1. Main characteristics of assessment method "on-the-fly and self-assessment of written answers".

2. Description of Feedback Method with Guidelines How to Use it

On-the-fly assessment

Interactions on-the-fly are an informal formative assessment of individual students or small groups of students. In general, on-the-fly assessment cannot be planned beforehand but takes place spontaneously when the teacher recognises an opportunity.

Principle of interactions on-the-fly

"On-the-fly formative assessment arises when a "teachable moment" unexpectedly occurs, for example, when a teacher circulating and listening to the conversation among students in small groups overhears a student say that, as a consequence of her or his experiment, 'density is a property of the plastic block and it doesn't matter what the mass or volume is because the density stays the same for that kind of plastic.' The teacher recognizes the student's grasp of density and challenges the student with other materials to see if she or he and her or his group-mates can generalize the density idea" (Shavelson et al., 2008, p.300).

Self-assessment

Self-feedback describes reflections on the students' own learning. It is important that the students clearly understand the criteria of success.

The feedback method "self-assessment" is a formative assessment which is conducted by the learner him/herself. This chapter will provide a description of the principle along with short summaries of different varieties.

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

Self-feedback allows the teacher to move freely between the students and concentrate on individual problems since she / he does not carry the responsibility of doing all the assessment of the whole class.

Why you should do this

The process of 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).

Principle of self - assessment

Self-assessment means that each student reflects on the quality of his / her own work, or on his / her understanding of a topic that is discussed, or on his / her performance, or similar.

Varieties of self-assessment (non-exhaustive list)

Self-assessment rubrics (Burke, 2006; Arter & McTighe, 2001; Moskal, 2003; Smit & Birri, 2014)

The system is exactly the same as with scoring rubrics: again, the rubric consists of a list of relevant criteria indicating what it is that students should show to demonstrate various levels of performance. However, this time, it is not the teacher who decides on the level of performance but the student who assesses himself / herself.

Traffic lights (Black & Harrison, 2004)

Traffic lights are a very fast way for the students to show if they understand what is being talked about: Each student has a green, a yellow, and a red card. The colours symbolize good, partial or little understanding of what the teacher is talking about. So if many students are showing the green card, the teacher knows she/he can carry on. Several cards tell the teacher that the work needs to be revisited for the students to gain a better understanding. A similar colour code also works, for example, when students give short talks on specific topics to their peers - and the peers then judge the talk as green (better than what the listening peer could have done), yellow (about the same quality as the listening peer could have done), or red (some parts missing or incorrect).

3. Paradigmatic Example: Technology, Upper Secondary Level

Conflicting motivations, in particular, often turn a purchase decision into a complex and paradox matter which necessitates a detailed functional and non-functional analysis of technological products such as bicycles. Depending on the intention, subjectively perceived – and thus interpreted - characteristics can greatly influence the assessment of a technological product's functional usefulness. Is the main purpose of the bicycle to be a means of transportation (e.g. to ride to school), or is it more relevant that it has certain prominent features, which would then bring social, non-functional aspects into play? This lesson is designed to introduce students to the often highly complex assessment of technological objects/products. For this purpose, two different bicycles (realia) are compared with each other in a role play depicting a purchase situation.
The lesson is divided into three phases. In phase 1 the two bicycles are presented to the students. They are asked to compare them, take notes and write down answers in the learning catalogue.
Phase 2 is the information phase. The teacher introduces and explains *Maslow's* pyramid of needs. It is also possible for students to learn about the most important aspects of this psychological model on their own by means of specifically designed self-learning material.

Figure 1: Maslow's Pyramid of Needs (1987)

In addition to transporting people, bicycles can also transport goods, which would correspond to the basic needs of the first level. Furthermore, needs relating to sports and leisure can be met by a bicycle. As a *BMX* bike offers surfaces which can be used for labelling, it is possible to anticipate meeting various other

needs. For example, using a BMX bike to display social symbols relates to the social needs of belonging and appreciation. Moreover, technological objects such as the bicycle must often also feature certain aesthetic characteristics. The symbolic nature of the bicycle and the possibility (if known) to place it in many different categories of needs can thus be physically emphasized.

In phase 3, the students are asked to compare the two bicycles again, now applying the newly acquired knowledge. The result is an assessment “at second glance”. Again, students record their answers in the learning catalogue.

4. Description of the Learning Catalogue

The learning catalogue can be handed out to individual students or to (small) groups. The learning catalogue's purpose is to aid the learning progress. Students answer questions and complete assignments in written form. It is divided into two parts, the first of which relates to a part of the lesson prior to an information phase ("at first glance") while the second relates to parts of the lesson after an information phase ("at second glance") .

The first part of the assessment revolves around observations, assumptions about possible connections, functionalities, and not yet scrutinized statements about the technological object in question. It is all about assumptions and an assessment "at first glance". In order to arrive at a watertight analysis from this first interpretation of the technological object, an information phase can be inserted at this point, depending on the students' level of abstract reasoning. The information phase could potentially be carried out by students independently. However, a didactically suitable preparation of the information and a close monitoring by the teacher is necessary. It is also possible for the teacher to initiate an informative course of instruction. The information phase of the lesson can, but does not have to be, assessed.


The second part of the assessment is supposed to relate to the statements made by the students during the first part. It is now an evaluation of technology "at second glance". Therefore, the second part of the learning catalogue refers to these earlier statements and adds more complex statements about differences and functionalities of the technological objects, aspects of need satisfaction, transfer to contexts of usage, and examples from everyday life. The learning catalogue is to induce students to make exact observations and assumptions concerning technical objects. It further gives structure to the students' observations and assumptions.

In principle, the learning catalogue can be applied to a comparison of any two technological objects. The predesigned focal points of the observation (differences, connections, functionality of technological objects etc.) are basic aspects of technological objects and can therefore be projected to the examination of other objects. If need be, some adaptations might have to be made depending on the situation or the objects to be investigated.
The learning catalogue at hand has been designed for a relatively short sequence of instruction, e.g. one or two lessons/units.

The teacher receives feedback before and after an information phase and can compare the students' statements from the beginning and the end of the lesson. The teacher selectively provides feedback (on-the-fly) on the level of the students by referring to the completed learning catalogues which contain the necessary information. The students moreover keep a record of their progress for themselves and can compare their own

statements made before and after the information phase. Thus, self-assessment and on-the-fly feedback are both applicable feedback methods.

Learning Catalogue

AT FIRST GLANCE

At first glance, I noticed/observed the following:

! _____

! _____

! _____

I notice the following differences:

! _____

! _____

! _____

I assume the following connections:

! _____

! _____

! _____

I assume the following functionalities:

! _____

! _____

! _____

I have the following questions:

Relating to the technological object:

? _____

? _____

? _____

In general:

? _____

? _____

? _____

I prefer this product because…

! _____

! _____

! _____

Information Phase:

conducted by students themselves using the prepared material or a course of instruction initiated by the teacher

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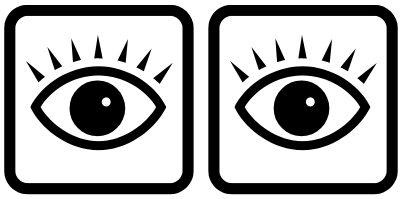

AT SECOND GLANCE

I now notice the most obvious differences because…

! _____

! _____

! _____

The reasons for the differences are…

! _____

! _____

! _____

The functionalities of the products are…

! _____

! _____

! _____

The following needs could be met by the products:

Product 1	**Product 2**
! _____	! _____
! _____	! _____
! _____	! _____

I would use the products in the following instances:

Product 1	**Product 2**
! _____	! _____
! _____	! _____
! _____	! _____

I can think of other products/pairs of products which are very similar:

! _____

! _____

! _____

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Illustrations

Figure 1: from: http://integralhero.com/der-ruf-nach-sinn-und-erfullung/maslow_pyramide_8-stufen