

Report from the FP7 project:

Assess Inquiry in Science, Technology and Mathematics Education



ASSISTME

Assessment Method Description for 'Argumentation' Competence

On-the-fly Assessment of student arguments from a given case study

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Introduction and summary

This description outlines one possible way of incorporating the on-the-fly assessment method in technology education classes or technology-related subjects.

As part of a case study, students are confronted with a scenario which poses a specific problem. A company of the secondary sector requires specialised personnel in order to overcome a staff shortage. The students approach this case from different angles; they develop and test arguments, and receive formative teacher feedback concerning their argumentation during numerous phases of the lesson.

Subject	<ul style="list-style-type: none">• Assessment method generally adaptable to all technological subjects• Paradigmatic example in technology; topic: argumentation in technology education
School level	<ul style="list-style-type: none">• Assessment method generally adaptable to lower and upper secondary level• Paradigmatic example in upper secondary school
Assessed competences	<ul style="list-style-type: none">• Constructing arguments• Analysing arguments• Communicating arguments (taken from ASSIST-ME report)
Data collection about student learning	<ul style="list-style-type: none">• Various assignments and oral presentations of the students
Feedback method	<ul style="list-style-type: none">• On-the-fly assessment
Combination with summative assessment	<ul style="list-style-type: none">• 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 assessment of student arguments from a given case study".

Description of Feedback Method with Guidelines How to Use it

The feedback method "interactions on-the-fly" describes informal formative feedback.

"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).

Ruiz-Primo and Furtak (2004), Ruiz-Primo and Furtak (2006a), and Ruiz-Primo and Furtak (2006b) describe typical assessment conversations as a four-step cycle, where the teacher elicits a question, the student responds, the teacher recognizes the student's response, and then uses the information collected to guide and assist student learning (see figure 1). 'Eliciting' means evoking, educating, bringing out, or developing. To describe a teacher's actions as eliciting during informal formative assessment is thus an accurate description, as teachers are calling for a reaction, clarification, elaboration, or explanation from students. Typical examples of such eliciting questions include "Why do you think so?" or "What does that mean?" (Ruiz-Primo & Furtak, 2006b). During informal formative assessment, teachers must react on the fly by recognizing whether a student's response is a scientifically accepted idea and then use the information from the response in a way that the general flow of the classroom narrative is not interrupted (e.g., calling students in the class to start a discussion, shaping students' ideas).

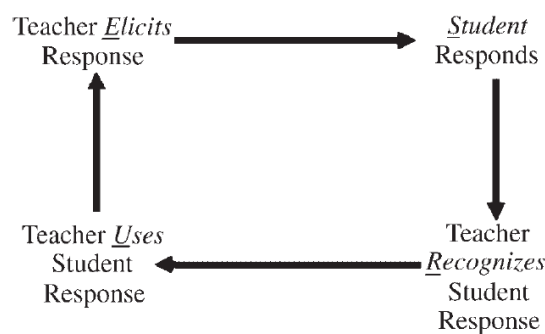


Figure 1: The ESRU model of informal formative assessment (taken from Ruiz-Primo and Furtak (2006)).

Paradigmatic Example: Technology, Upper Secondary Level

The method of the lesson sequence described here is that of a case study. Further details concerning this method are presented in the info box below.

INFO: The Case Study in Technology Education

The case study teaching method (also case method) is an "analytic process creating awareness of correlations and strategies of industrial production and consumption. In a case study, a situation which poses a problem, e.g. a work place situation in the office or a household, a situation involving labour law or sales, is clarified or resolved by gathering and evaluating additional information. By means of an example students can thus learn how to handle specific situations in real life, [...] gather and collect information, and reach an appropriate decision" (Schmayl & Wilkening 1995; see also Schmayl 2013). The main topic of a case study can be drawn from many fields, e.g. labour law, economy, vocational education, consumer policy, engineering etc.

Case Study Procedure

A case study follows a set sequence of phases (see Table 1). These phases can be used as the framework for lesson planning. Depending on the scope of the case in question the teacher can adjust the sequence of phases to either fit in one unit (one lesson) or in two or more units (more than one lesson).

Standard Sequence of Case Study Phases	
<i>Phase</i>	<i>Description</i>

1. Introduction to the case	Students are confronted with the case.
2. Case analysis	The individual problems underlying the case are determined.
3. Information phase	Additional information needed for decision-making is gathered and evaluated.
4. Development of decision alternatives	Alternative solutions are considered.
5. Decision and justification	The decision taken is justified.

Table 1: Standard Sequence of Case Study Phases according to Schmayl & Wilkening 1995

The Classroom Scenario

The sales department of a medium-sized, metal-processing company informs its human resources department that due to an increase in sales more qualified workers are required. However, the time factor is difficult to estimate. Examples could be typical craft- or industry-related jobs, such as the job profile of a so-called “polymechanic”, a combination of various engineering jobs such as mechanic, precision mechanic and toolmaker.

How can the problem of the not yet predictable staff shortage concerning adequate and qualified personnel be solved?

Generally there are various ways to tackle the shortage of qualified workers. Here are three examples:

One option would be to identify suitable qualified workers by means of an application and selection process, and permanently employ them. Another would be to resolve the shortage by leasing staff. Further, the problem could be solved by offering temporary contracts to skilled workers from related trades. In order to reach a justifiable decision, the students first have to become aware of the individual problems. In the classroom, this can be achieved by sharing work among students. Information concerning the (general) organisational structure of companies, the job profile of a “polymechanic” and general recruitment processes needs to be gathered and analysed. The situation of the future employees needs to be taken into account as well: Does it make a difference whether employees are offered a temporary or a permanent contract, if they are employed by a work agency, or if they do not perfectly fulfil the job requirements? These and other questions need to be answered.

The table below illustrates two such ways of argumentation.

	Assumption	Justification	Example
Argument 1	To solve the shortage of qualified workers it is helpful to permanently employ qualified workers after an application and selection process.	Because this ensures long-term bonding of suitable, motivated and qualified staff.	The company could, for example, recruit the polymechanics needed through posting job advertisements in local newspapers.
Argument 2	To solve the shortage of qualified workers, employing staff which can be used for a variety of tasks (i.e. leased workers) is necessary.	Because it is difficult to estimate how long the situation will last. At the moment the number of orders is high, but what about two years later?	It would be counterproductive to employ polymechanics today and let them go again tomorrow because the situation in the company has changed.
...

Table 2: Possible Student Arguments (selection)

At this point, inquiry-based learning strategies can be implemented, in which case students formulate hypotheses in relation to the staff shortage before conducting their research and devise a suitable research plan. The role of the teacher would then merely be that of a moderator, while student activities exhibit a high degree of independence throughout the research plan.

As soon as the students have constructed arguments and a variety of possible decisions, the teacher can invite them to write down or to present to the class two or three of their most powerful arguments (an argument consisting of assumption, justification, example). At this point, feedback could be provided.

It seems crucial to initiate a detailed discussion concerning the students' arguments. The arguments need not necessarily tackle all dimensions of this complex case. It is more important for the students to be given the incentive to begin an extensive discussion, which the students enrich with self-constructed, verbalised arguments and in which they analyse arguments of others in relation to their comprehensibility.

The Formative Assessment

In this classroom scenario, the formative assessment is to be carried out by means of on-the-fly assessments. On-the-fly describes informal interactions between teacher and individual students and/or small groups of students for formative purposes.

Ruiz-Primo and Furtak (2004, 2006a, 2006b) describe typical formative on-the-fly assessments as four-step cycles, in which the teacher first asks a question based on student observations, the students provide answers, which are then followed by the teacher trying to improve the students' knowledge on the basis of what s/he has just heard. Typical examples of such questions are "Why do you think that?" and "What does that mean?" (Ruiz-Primo & Furtak, 2006b). In the course of this informal formative assessment the teacher has to react spontaneously to what can be observed and heard, establish links between the students' input and the lesson objectives and resume discussions based on the students' statements.

Due to the spontaneous nature of on-the-fly assessments, requirements as to when exactly they need to take place in a lesson cannot be specified. Nevertheless the table below, which shows the standard sequence of case study phases in a lesson, indicates that some phases are especially feasible, requiring a higher amount of feedback (highlighted). The text passages in italics are recommendations for formative assessment for each phase.

Possibilities of On-the-fly Assessments (highlighted)	
Phase	Explanation
1. Introduction to the case	Students are confronted with the case.
2. Case analysis	The individual problems underlying the case are determined. <i>During on-the-fly assessments, the teacher could make sure different perspectives are taken into account.</i>
3. Information phase	Additional information needed for decision-making is gathered and evaluated. <i>During on-the-fly assessments, the teacher could pay special attention to which media are used and what their respective scope is.</i>
4. Development of decision alternatives	Alternative solutions are considered. <i>The teacher could help in case of undetected possible solutions.</i>
5. Decision and justification	The decision is justified. <i>The teacher could provide feedback and offer assistance in relation to the solution finding process and the argumentation.</i>

Table 3: Sequence of Case Study Phases according to Schmayl & Wilkening 1995; on-the-fly phases are highlighted, possible teacher involvement is written in italics.

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