Report from the FP7 project:

Assess Inquiry in Science, Technology and Mathematics Education

ASSISTME

Manual for Teacher Expert Panels

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Summary

In each of the participating countries a Teacher Expert Panel will be established so as to determine whether the suggested assessment foci that will emerge in the project fit the national educational systems and the common practice of daily teaching and learning.

This manual seeks to provide background information about the project and also about key concepts that hold a central position in the project. It therefore consists of an overview of the project for the teachers, a brief description of fundamental concepts and a terminology section for teachers. All project partners are invited to translate the respective sections of the manual to their national language for the teachers. This should ensure a common basis among the Teacher Expert Panels from the different countries.

The manual is also intended to contribute towards facilitating and structuring the work that will be undertaken by the teacher expert panels. Towards this end, the two last sections of this manual include a list of tasks and deadlines for project partners and Teacher Expert Panels as well as a set of questions that should be answered by each the Teacher Expert Panel. The questions all refer to Deliverable D4.3, the revised version of assessment foci. All project partners are therefore invited to translate the following chapters of the first part of deliverable D4.3 (written by FHNW) for the teachers: chapter 4 (terminology), chapter 6 (assessment foci), chapter 7 (exemplary materials). Chapters 2 and 3 of the first part of deliverable D4.3, on formative assessment and on inquiry, were brought to a more "teacher-friendly form" in this manual. So, as stated in the paragraph above, it is suggested to refer to the chapters of the manual when introducing the understanding of formative assessment and inquiry in this project at the Teacher Expert Panel meetings. From the second part of deliverable D4.3 (written by Pearson), all partners are kindly requested to translate chapter 3.6 on the E-assessment approaches and to discuss these with the teacher expert panels as well.

The Teacher Expert Panels are expected to meet twice in the first half of 2014. The report summarizing their feedback (deliverable D4.6) should be handed in before 10th June 2014. The feedback should be structured according to the questions provided in the last chapter of this manual. See next chapter for details.

What project partners and teacher expert panels should do now

Each of the partner countries will establish a Teacher Expert Panel (TEP). The main responsibility of TEPs will be to adapt locally the assessment foci (translated in the national language) that will be identified as part of WP4. The development of locally informed assessment foci will be the first stage in the process of validating the assessment methods.

Each TEP should preferably include (a) at least three teachers from each subject area that have been assigned to the corresponding country and (b) at least two teachers from each of two different education levels: primary, lower secondary and upper secondary.

The Teacher Expert Panels are expected to meet twice in the first half of 2014. The report summarizing their feedback (deliverable D4.6) should be handed in before 10th June 2014. The feedback should be structured according to the questions provided in the last chapter of this manual.

The Teacher Expert Panels will evolve into Local Working Groups that will undertake the implementation of the assessment methods.

deadline	task
Dec '13	• Establish Teacher Expert Panel (this is Deliverable D4.5)
Before the first TEP meeting	• Translate relevant background information (introduction to the project, terminology) from this manual D4.4 to the national language and send it to Teacher Expert Panels • Translate the following chapters from D4.3 (revised version of assessment foci & analysis and design document by Pearson) to the national language and send it to Teacher Expert Panels: chapter 4, written by FHNW (terminology), chapter 6, written by FHNW (assessment foci), chapter 7, written by FHNW (exemplary materials); chapter 3.6, written by Pearson, on the e-assessment approaches definitions.
Before 10th June '14	• Organise and hold two meetings with the TEPs and gather feedback on D4.3 (revised version of assessment foci).
Original deadline in the proposal: April '14 New deadline: 10th June '14	• Send feedback report from TEPs to FHNW. The feedback should be structured according to the questions provided in the last chapter of this manual.

Table 1: Tasks for project partners with deadlines.

Introduction for teachers: what this project is all about

ASSIST-ME focusses on assessing students' inquiry-based learning formatively and summatively. The project is funded by the European Union and it involves several partners: University of Copenhagen (leader), University of Kiel (IPN), University of Cyprus, University of applied Sciences and Arts Northwestern Switzerland, French National Center for Scientific Research Lyon (CNRS), King's College London, University of Jyväskylä, University Joseph Fourier Grenoble, University of South Bohemia, Pearson Education International. The last one is not a university but a British publishing company which specializes in electronic assessment.

One of the aims of the project is to develop and implement instruments for formative and summative assessment in Science, Technology and Mathematics education. These instruments will be illustrated with examples but should generally be adaptable to primary, lower and upper secondary levels. Figure 1 gives an overview of the subprojects (called workpackages) and allows positioning the work of the teacher expert panels within the whole project.

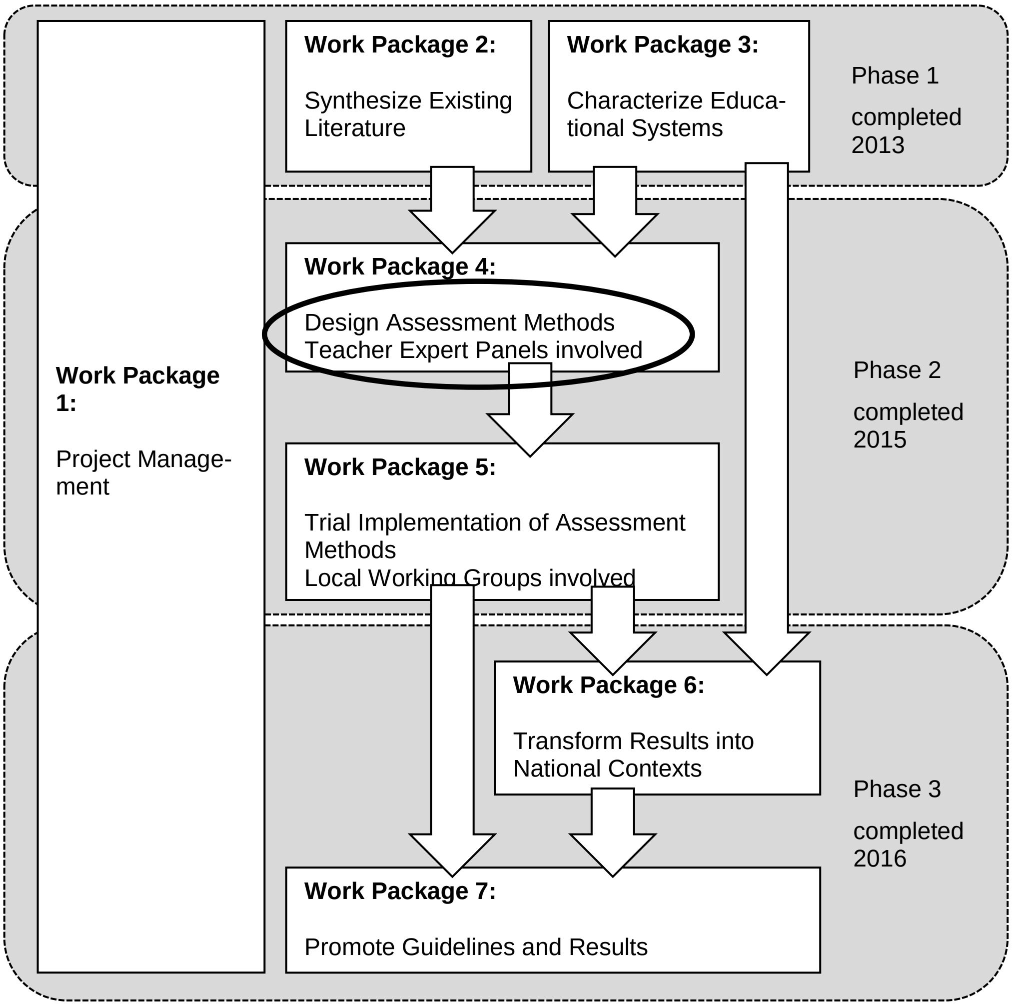

Figure 1: assist-me overview and work packages (work packages are subprojects). The Teacher Expert Panels' work is part of work package 4. Modified from Dolin, 2012.

In brief, the project proceeds through three phases as outlined in Figure 1. The **first phase** focuses on producing the knowledge base for making a research-based design and trial of assessment methods (Phase 2) and for creating strong relations to stakeholders in every participating country (Phase 3). This knowledge base secures strong relations between ongoing and ended projects on STM education and a common reference for the project participant. **The second phase** involves the design and testing of procedures and specific foci for formative and summative assessment in Science, Technology and Maths education. These instruments/foci will be illustrated with examples but should generally be adaptable to all levels (Primary, lower and upper secondary level). In order to support the real large scale uptake of formative assessment it is not enough to give theoretical evidence. Methods must be tested in real classrooms by real teachers and be combined with existing summative assessment. This will produce evidence on how to implement new forms assessment relevant for other countries with similar characteristics. The work of the Teacher Expert Panels is embedded in this second phase of the project. **The third phase** targets at the transformation and communication of the research results (Work Package 6 and 7) so as to enable diffusing them in the discourse of policy and increasing the probability that they could be used for actual decision making in educational policy.

Teacher Expert Panels (TEP): Each of the partner countries will establish a TEP, which will assume a significant role in the project. The main responsibility of TEPs will be to adapt locally the assessment foci (translated in the national language) that will be identified as part of WP4. The development of locally informed assessment foci will be the first stage in the process of validating the assessment methods.

Each TEP should preferably include (a) at least three teachers from each subject area that have been assigned to the corresponding country and (b) at least two teachers from each of two different education levels: primary, lower secondary and upper secondary.

The Teacher Expert Panels are expected to meet twice in early 2014. The report summarizing their feedback (deliverable D4.6) should be handed in by April 2014. The feedback should be structured according to the questions provided in the last chapter of this manual.

The Teacher Expert Panels (TEP) will evolve into Local Working Groups (LWG) that will undertake the implementation (and evaluation) of the assessment methods.

Local Working Groups (LWG): Each partner country will establish 2 LWGs. Each will consist of 2 researchers and approximately 10 teachers from local schools. Teachers in each LWG, at the collective level, should possess adequate expertise in the subject domain that will be associated with the assessment methods they will undertake to implement and test. The LWGs will undertake classroom based research which will involve the trial implementation of the (selected) assessment foci. The trial implementations will primarily concentrate on the teachers (rather than on the students) who will be implementing the various assessment methods.

Terminology for Teachers

The following paragraphs are intended to help create a common understanding among the teachers of the Teacher Expert Panels of some of the key concepts of this project. The paragraphs were written based on the reports from work package 2 (Bernholt et al., 2013, Rönnebeck et al., 2013, Ropohl et al., 2013) and the grant agreement for the project.

Competence

A competence can be described as a combination of skills, knowledge, characteristics and traits that contribute to performances in particular domains.

Formative assessment

The following paragraph seeks to provide an overview for teachers of what is meant by the term "formative assessment" in contrast to "summative assessment" within this project.

Introduction of formative assessment

The figure displays the relation between formative and summative assessment: assessment is understood as a continuum between more formative and more summative use of data on student achievement. The main characteristic of the two antipodes are shown in figure 2. The next paragraph will give an idea of what is meant by the keyword "interactive feedback".

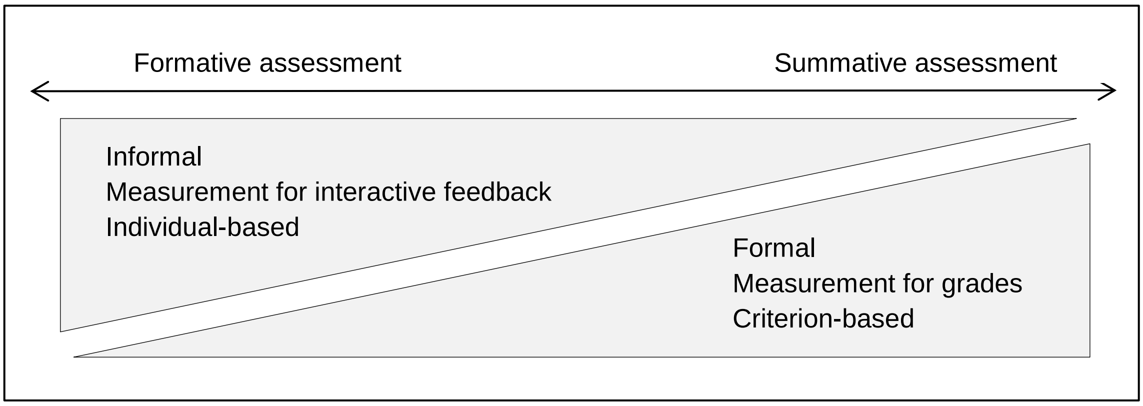

Figure 2: formative and summative assessment.

Interactive dialogue as a key component of formative assessment

Written by Paul Black

A teacher ought to start by questions or broader tasks designed so that the pupils' responses will show the starting point from which learning might proceed, whether by extension or by challenge to produce change. This often involves either asking follow-up questions ("Why did you say that?") or questions to draw other students into the discussion ("Does anyone disagree with that explanation?" or "Does anyone have a different idea?"). A direct response to the first pupil to answer any question may sometimes be justified, but it is usually better to enrich the elicitation and interpretation by involving other learners and their peers in the process. Such an approach serves the immediate aim of ensuring that the interpretation of the evidence, and a more fundamental aim of drawing all into the process of learning through involvement through dialogue.

Interactive dialogue is the core process in formative assessment. It can involve oral interaction, as in classroom discussion, or interaction through writing. In the latter case, a pupil's written work may be returned, or with a comment: if the comment guides the pupil on how to improve the work and further work follows, then there is a learning dialogue. Marks alone give no clear guidance - the teacher has to interpret the pupils writing in order to make a decision about how best to guide that pupil: alternatively, if many pupils show the same weakness, the teacher may open a classroom dialogue to identify the reasons for the difficulty. If pupils can look at, and compare one another's written work and discuss how to identify and improve the weaknesses, such peer dialogue helps develop meta-cognition, i.e. an understanding of the criteria for achievement, developed through interpreting concrete examples.

Pupils' responses to written tests can be used in the same way, either through dialogue based on teacher comments, or through peer assessment. Any test may be used for formative purposes, or for formative purposes, or for both. The key distinction between formative and summative lies in the purpose to which the assessment's information is used.

Formative interactions can thus occur in a variety of ways, and over a range of time scales. A formative interaction in a classroom can take only a few minutes, an interaction with written homework may extend over a week or more, interaction with summative tests may cover the several weeks of work which the test is designed to assess. The common and underlying aim is to help each pupil to become an effective and responsible learner.

Main Characteristics of formative assessment

On the level of everyday-classroom practice, the main characteristics of formative assessment are

- involvement of the students: in discussing the goals of the lesson, in the common understanding of the criteria of assessment and in students' participation in decisions (where appropriate) (Harlen, 2013).
- judgement of student performance which is based both on discipline standards (criterion-references; pointing at summative assessment) and on student criteria (student-referenced; pointing at formative assessment) (Harlen, 2013).
- integral nature in the process of decision-making that takes place all the time in teaching (Assessment Reform Group, 2002).
- procedural character: formative assessment is considered to be a cycle of student's activities, collection of evidence relating to goals, interpretation of that evidence, a decision about next steps, the decision about how to take next steps and the subsequent student's activities (Harlen, 2013).

Scientific definition and very un-scientific illustration

Probably the most cited authors, Black & Wiliam, 2009, (in Bernholt et al., 2013) bring together the main features of formative assessment:

"Practice in a classroom is formative to the extent that evidence about student achievement is elicited, interpreted and used by teachers, learners, or their peers, to make decisions about the next steps in instruction that are likely to be better, or better founded, than the decisions they would have taken in the absence of the evidence what was elicited." (Black & Wiliam, 2009, p. 9)

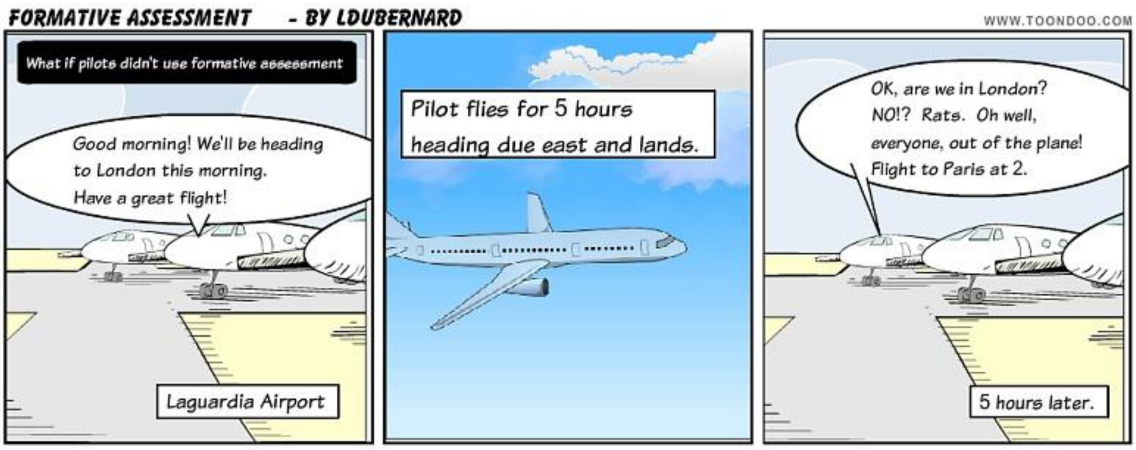

Figure 3: Illustration of missing formative assessment. Taken from www.doondoo.com.

Inquiry based education (IBE)

The following paragraph seeks to provide an overview for teachers of what is meant by the term "inquiry based education" within this project. It is based on the reports from work package 2 (Bernholt et al., 2013, Rönnebeck et al., 2013, Ropohl et al., 2013).

Inquiry-Based Education (IBE) is an umbrella term, encompassing a wide range of teaching approaches that have the potential to enhance both students’ learning and motivation. IBE in Science, Technology and Mathematics education includes students’ involvement in questioning, reasoning, searching for relevant documents, observing, conjecturing, data gathering and interpreting, investigative practical work and collaborative discussions and working with problems from and applicable to real life contexts.

Different vocabulary used in different subjects

The term "inquiry" is not used very commonly in all the domains relevant to this project: whereas inquiry has been popular for the last 20 years in Science, the terms 'engineering design' and 'problem solving' are used more frequently in the fields of Technolgoy education and Mathematics, respectively (Ropohl et al., 2013).

Definitions

In Science and Technology, the definition of inquiry considered most useful by Ropohl et al., 2013, within the assist-me project originates from Linn, Davis and Bell (2004, p. 4):

“[Inquiry is] the intentional process of diagnosing problems, critiquing experiments, and distinguishing alternatives, planning investigations, researching conjectures, searching for information, constructing models, debating with peers and forming coherent arguments.”

For inquiry in Mathematics, the definition from the FIBONACCI project is considered most useful by Ropohl et al., 2013:

„… mathematical inquiry starts from a question or a problem, and answers are sought through observation and exploration; mental, material or virtual experiments are conducted; connections are made to questions offering interesting similarities with the one in hand and already answered; known mathematical techniques are brought into play and adapted when necessary. This inquiry process is led by, or leads to, hypothetical answers – often called conjectures – that are subject to validation.“ (Artigue & Baptist, 2012, p. 4)

Typical activities involved in inquiry-based education
Ropohl et al., 2013, enlist typical characteristica in inquiry-based science teaching:

- authentic and problem based learning activities where there may not be a correct answer,
- a certain amount of experimental procedures, experiments and "hands on" activities, including searching for information,
- self-regulated learning sequences where student autonomy is emphasized,
- discursive argumentation and communication with peers ("talking science"). (Jorde, Olsen Moberg, Rönnebeck, & Stadler, 2012)

Below, a few examples are provided so as to convey a sense of possible activities that could fall under the "inquiry" umbrella.

Example 1: KieWi & Co. – Ways into the Microscopic World: “What happens to the ice cubes in my soft drink?”
(A module developed by Sabine Streller, Claudia Benedict, Claus Bolte within the PROFILES project; http://www.profiles-project.eu/de/Downloads/PROFILES_Modules_FUB_English/index.html)

In this module “Ways into the Microscopic World” the children are confronted with an everyday phenomenon (melting an ice cube in a glass of apple juice) and are asked to observe and describe exactly what they see. Only after watching the phenomenon the question arises what actually happens with the melt water. The children formulate different assumptions: The melt water sinks, collects at the surface or mixes equally with the juice. Having voiced these opinions the children start independently planning experiments to test their assumptions. Some children suggest using an ice cube of coloured water to be able to follow the melting process in more detail. After carrying out their experiments the children’s observations are collected and plausible explanations are discussed. It seems certain that the cold water sinks to the bottom of the glass. However, the result is doubted by some children. The cause for the melt water sinking to the bottom of the glass could be the higher density of the dye used.

The children question their own experimental findings and are asked to plan and carry out a new experiment to test their hypothesis: If cold water sinks to the bottom in warm water, then warm water should rise to the top in cold water. Yet if the dye was the reason for the sinking of the cold water then the coloured warm water should remain at the bottom of the glass.

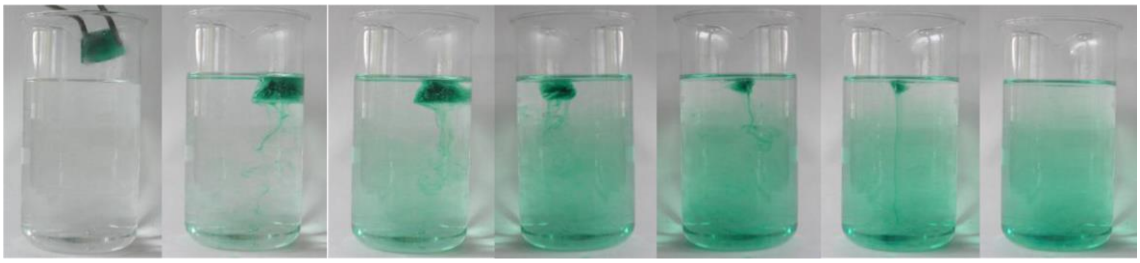

Figure 4: Melting a coloured ice-block (picture taken from the PROFILES project pages).

This example shows how children can and want to learn scientific ways of thinking with these supposedly “unspectacular everyday procedures”. It also shows how questioning and doubting of their own findings can work towards encouraging a scientific mindset in the children. Scientific work in a course requires a high degree of self-determination, autonomy and competence experience since the children have to be able to follow and discuss their own ideas and do not receive prefabricated experimental procedures, which they simply have to follow step by step.

Example 2: Speed glider – who builds the fastest boat?
(A module developed by Peter Labudde and Claudia Stübi within the PROFILES project; http://blogs.fhnw.ch/profiles/modules/speedglider)

In the Profiles-module Speed Glider, the students are to experience the process of productive search and critical verification, learn how technological creation leads to questions and insights into the field of physics, and develop the willingness to ask, experiment and theorize.

In pairs, the students build a boat made of styrofoam with the best possible gliding properties. This boat should contain half a liter of water, which propels it while flowing out. Experience of working styrofoam is a prerequisite. During or, at the latest, after the “boat parade”, where all students are shown all models, we reassess our own actions and sum up important insights; this may happen in a plenary discussion, a short lecture or by means of a board.

Figure 5: Speed-gliders (picture taken from the PROFILES project pages).

Example 3: Holiday planning

(An exercise developed in PISA 2003, problem solving part)

This problem is about planning the best route for a holiday.
Figures 1 and 2 show a map of the area and the distances between towns.

Figure 1. Map of roads between towns

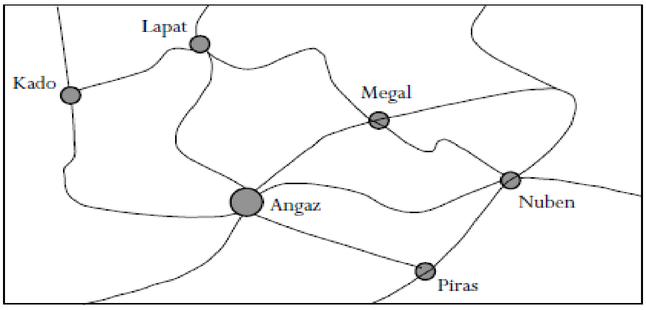

Figure 2. Shortest road distance of towns from each other in kilometres.

	Angaz	Kado	Lapat	Megal	Nuben	Piras
Angaz						
Kado	550					
Lapat	500	300				
Megal	300	850	550			
Nuben	500		1000	450		
Piras	300	850	800	600	250	

HOLIDAY – Question 1

Calculate the shortest distance by road between Nuben and Kado.

Distance: .... kilometres.

Figure 6: planning holidays (picture taken from OECD, 2004).

Questions that should be answered by teacher expert panels

Teacher expert panels are kindly asked to provide feedback on the following questions. These comments will be integrated in the final version of the assessment foci. Some of the questions are very similar to the ones asked in deliverable D4.2. Nevertheless, the questions should be answered from the perspective of the teachers this time.

1) Who is part of the teacher expert panel?
   Who is the researcher to be contacted in case of questions?

2) Do you expect the assessment foci described in deliverable D4.3 likely to be easily integrated in your (teacher) everyday-teaching and in the everyday-teaching at the school-level in your country in general? Please refer to the first as well as to the second part of the deliverable D4.3.

3) Which specific suggestions on possible amendments/adaptations to the given assessment foci/methods in D4.3 could you offer that could increase the applicability of the foci/methods to the local context and the likelihood of being employed by teachers?

4) Is there any assessment method missing in the very short descriptions in chapter 6 of the first part of the report and in chapter 3.6 of the second part of the report you (teachers) would consider important to be included?

5) Will you (teachers) be able to adapt materials such as provided in D4.3, chapter 7, for different topics / different subjects / different school levels?

6) What other materials do you (teachers) need in order to work with the assessment foci (apart from templates and illustrative examples such as in D4.3, chapter 7)? Do you need more training materials, more examples, more theoretical background or anything else?

7) Which comments on the draft assessmenr foci from D4.3 should be mentioned? Which further ideas could help for the next steps in the development of the foci?

   7a) comments, ideas and advice on assessment focus 1
   7b) comments, ideas and advice on assessment focus 2
   7c) comments, ideas and advice on assessment focus 3
   7d) comments, ideas and advice on assessment focus 4
   7e) comments, ideas and advice particularly on the e-assessment approaches in chapter 3.6?

8) Does the planned use of e-assessment match the availability of computers and mobile electronic devices in the average classrooms of your country? If not, could project partners make some arrangements for the trial implementation phase of the project?

References

Artigue, M., & Baptist, P. (2012). *Inquiry in Mathematics Education* (Resources for Implementing Inquiry in Science and in Mathematics at School). Retrieved from http://www.fibonacci-project.eu/

Assessment Reform Group (ARG) (2002). *Assessment for Learning. 10 Principles.* Retrieved from http://assessmentreformgroup.files.wordpress.com/2012/01/10principles_englise.pdf

Bernholt, S., Rönnebeck, S., Ropohl, M., Köller, O., Parchmann, I. (2013). *Report on current state of the art in formative and summative assessment in IBE in STM-Part 1.* Kiel.

Black, P., Harrison, C., Lee, C., Marshall, B., Wiliam, D., 2003: *Assessment for Learning. Putting it into practice.* Berkshire: Open University Press.

Black, P. and Wiliam, D. (2009). Developing the theory of formative assessment. *Educational Assessment, Evaluation and Accountability*, 21 (1). 5-13.

Cowie, B., and Bell, B. (1999). A model of formative assessment in science education. *Assessment in Education*, 6(1), 101-116.

Dolin, J. (2012). *Assess Inquiry in Science, Technology and Mathematics Education: ASSIST-ME proposal.* Copenhagen.

Harlen, W. (2012). On the relationship between assessment for formative and summative purposes, in: Gardner, J., (ed.), *Assessment and Learning*. London: Sage pp. 87-102.

Harlen, W. (2013). *Assessment & inquiry-based science education: issues in policy and practice.* Global Network of Science Academies (IAP) Science Education Programme (SEP). Retrieved from http://www.interacademies.net/File.aspx?id=21245

Jorde, D., Olsen Moberg, A., Rönnebeck, S., & Stadler, M. (2012). *Work Package 2: Final Report*. S-TEAM Project. Trondheim.

Labudde, P., Stübi, C., (n.d.). Speed glider – who builds the fastest boat? A module developed within the PROFILES project. PH FHNW, Basel. Retrieved from http://blogs.fhnw.ch/profiles/modules/speedglider.

Linn, M. C., Davis, E. A., & Bell, P. (Eds.). (2004). *Internet environments for science education*. Mahwah: Lawrence Erlbaum Associates Publishers.

Looney, J. W. (2011). *Integrating Formative and Summative Assessment: Progress Toward a Seamless System?* (OECD Education Working Papers No. 58).

OECD, (2004). *Problem Solving for Tomorrows World. First Measures of Cross-Curricular Competencies from PISA 2003.* OECD.

Rönnebeck, S., Ropohl, M., Bernholt, S., Köller, O., Parchmann, I. (2013). *Recommendation report from D2.1 - D2.6 to be used as a foundation for WP4 and 5 (No. D 2.7).* Kiel.

Ropohl, M., Rönnebeck, S., Bernholt, S., & Köller, O. (2013). *A definition of inquiry-based STM education and tools for measuring the degree of IBE (No. D 2.5).* Kiel.

Streller, S., Benedict, C., Bolte, C., (2007). KieWi & Co. – Ways into the Microscopic World: "What happens to the ice cubes in my soft drink?" Department of Chemistry Education, Freie Universität Berlin – Germany. Retrieved from *http://www.profiles-project.eu/de/Downloads/PROFILES_ Modules_FUB_English/index.html.*

Wilson, M., & Sloane, K. (2000). From Principles to Practice: An Embedded Assessment System. *Applied Measurement in Education*, 13(2), 181–208.