



**Policy Guidelines: National, regional and EU policy
guidelines for the provision of approaches to the raising of
achievement in mathematics and science education**

Deliverable D6.2

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**FaSMEd: Improving progress for lower achievers through Formative Assessment in Science
and Mathematics Education**

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Introduction

This Deliverable is part of Work Package 6, which builds on the results provided by the research activities conducted in the previous phases of the project. The purpose of this Deliverable is to draw upon evidence to make national, regional, and EU policy guidelines for the provision of approaches to the raising of achievement in mathematics and science education.

FaSMEd is a collaborative development project, which adapted the principles of design research (Swan, 2014) in its methodology. A consortium of international partners researched the role of technologically enhanced Formative Assessment (FA) methods with the view to developing a toolkit that would inform teachers of emergent FA pedagogies in mathematics and science education. By introducing innovative technology, we created environments which enhanced connectivity and feedback to assist teachers in making more timely formative interpretations.

The FaSMEd Project

Formative Assessment (FA) strategies may be understood as follows:

‘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 that was elicited’ (Black & Wiliam, 2009, p.9).

As such, they have been evidenced to impact on student learning (Black & Wiliam, 1998; Wiliam & Leahy, 2015). Hence there is a strong argument (and this is the rationale for the approach of FaSMEd) that embedding formative assessment strategies in teachers’ classroom practice will have a significant impact on students’ achievement. The professional development of teachers focused on FA is, therefore, a crucially important factor in the raising of achievement for all students and gives a clear direction of educational policy for leaders at institution, regional and national level.

The TIMSS seven-nation comparative study shows that high achieving countries (Hiebert et al., 2003) adopt approaches which preserve the complexity of concepts and methods, rather than simplifying them. FaSMEd partners were thus encouraged to create and adapt research-informed FA activities. Since these approaches increase the cognitive load for students we

recognised that it was important that the learning environment was engineered to support students and FaSMEd included technology as part of the design of the environment to provide such support. Hence, FaSMEd partners were encouraged to develop resources, processes and technological tools which would allow all students to engage with complex concepts and methods successfully and to improve motivation. The FaSMEd project case studies¹ provide examples of where this approach has worked successfully with lower achieving students.

Partners developed the FaSMEd framework (Figure 1) as a conceptual tool to represent the three main dimensions which characterise technologically enhanced FA processes: (1) the five key **strategies of FA** introduced by Wiliam and Thompson (2007); (2) the three **agents** that intervene in the FA processes and that could activate these strategies, namely the teacher, the student and the peers; (3) the **functionalities of technology**.

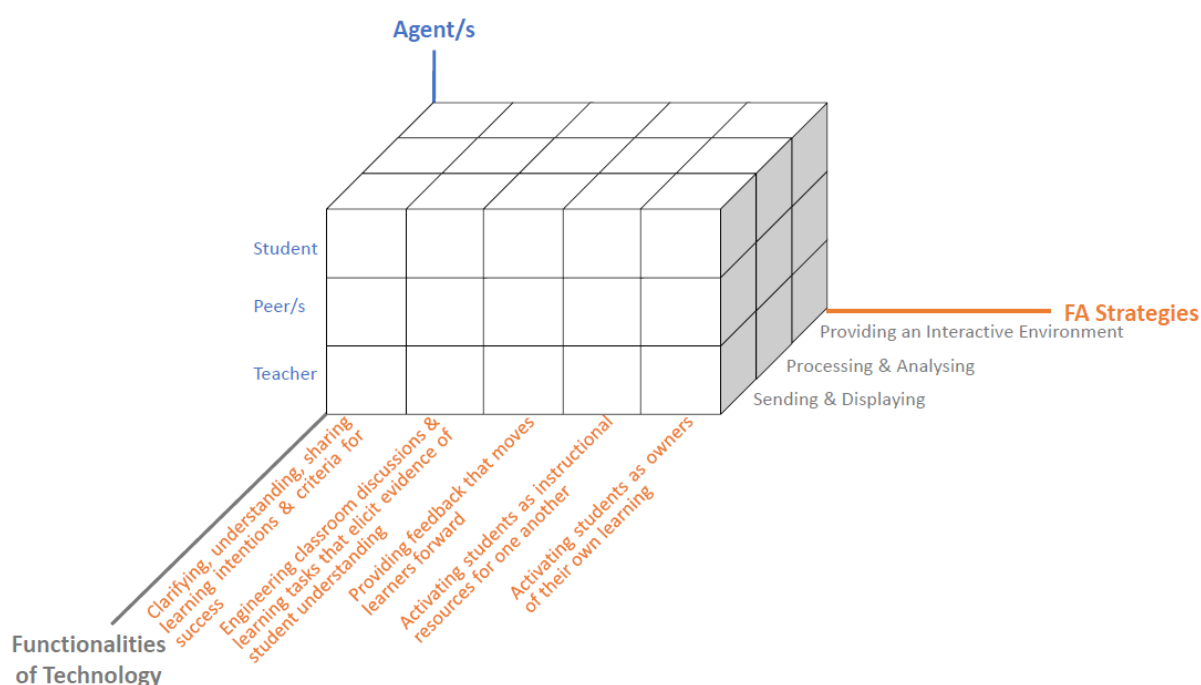


Figure 1: The FaSMEd framework

We introduced the third dimension **Functionalities of Technology** with the aim of highlighting how technology could support the three agents involved in FA processes when they activate the different FA strategies. The functionalities of technology are subdivided into three categories: sending and displaying, processing and analysing and providing an interactive environment. This subdivision was based on the FaSMEd partners' experience in the use of technology to support FA processes².

¹ <https://research.ncl.ac.uk/fasmed/deliverables/>

² For further details see Deliverable D6.1 <https://research.ncl.ac.uk/fasmed/deliverables/>

Challenges of innovation

FaSMEd required many of the teachers to adapt to some fundamental innovations. The adoption of any innovation in education is challenging. Many of the FaSMEd resources required a pedagogy of engagement, which emphasized reflection over productivity and maintained a level of complexity, rather than the simplifying approach frequently adopted for lower achieving students. Adapting to a pedagogy of contingency in order to respond to the minute-by-minute feedback from their students and the integration of technological tools in their practice was demanding.

Recruiting schools that were willing to take risks in the process of innovation was not always straightforward. Those schools that did participate tended to have an established relationship of trust with the partners and therefore had the confidence to try something new. Such confidence and trust on the part of both teachers and the school leaders is important in implementing change.

In addition, change on this scale is likely to necessitate a significant amount of time. Wiliam (2016) warns that it is common to find that a significant impact on standardized test scores might only materialize after two to three years of implementation of a particular innovation. Policy makers, therefore, must be prepared to plan for and sustain change over an extended time scale.

FaSMEd findings: What makes a difference?

Technology facilitating Formative Assessment

FaSMEd researchers reasoned that a key element of teaching using FA and intervention relates to the quality of the information generated by the various feedback loops that exist in the classroom setting and the involvement of the students within this process. The introduction of innovative technology to create a digital environment which enhances connectivity and feedback between students, peers and teachers can assist teachers in making more timely formative interpretations. This further has the potential to amplify the quality of the evidence about student achievement, both in real-time and outside the classroom, for access by both students and teachers.

Through the case studies there is evidence of teachers using technologies to gain information about their students' thinking, as well as to facilitate opportunities for students to learn from their peers. In the FaSMEd Framework (Figure 1) this represents providing feedback that moves learners forward by means of the *Sending and Displaying* functionality of technology, as well as potentially *Activating Students as Instructional Resources* for one another and, as a result of the activation of these strategies, *Activating students as owners of their own learning*. In interviews, students identified these practices as particularly beneficial in making their learning visible to the teacher, themselves and their peers.

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In addressing the needs of lower achievers in particular, a number of interventions used technologies that could be more easily accessible and did not demand high levels of literacy. Using polls and/or pictorial representations were shown to be useful in some circumstances. Polls had the further advantage of *Processing and Analysing* data in real time.

Where technologies were able to *Provide an Interactive Environment*, students could access a variety of tools to scaffold their learning. This enabled lower achieving students to engage more fully in tasks and therefore *Activating students as owners of their own learning*³. Further, at the FaSMEd Final Meeting (Deliverable D8.4), it was argued that FA practices provide a meaningful reason for using technology in the classroom. Fullan & Donnelly argue:

“Up to this point, technology has not impacted schools. We agree with Diana Laurillard (2012) that technological investments have not been directed at changing the system but only as a matter of acquisitions. Billions have been invested with little thought to altering the learning system. There are also potentially destructive uses of technology on learning; we must beware of distractions, easy entertainment and personalisation to the point of limiting our exposure to new ideas. We focus not simply on the technology itself but on its use.” (Fullan & Donnelly, 2013, p.10).

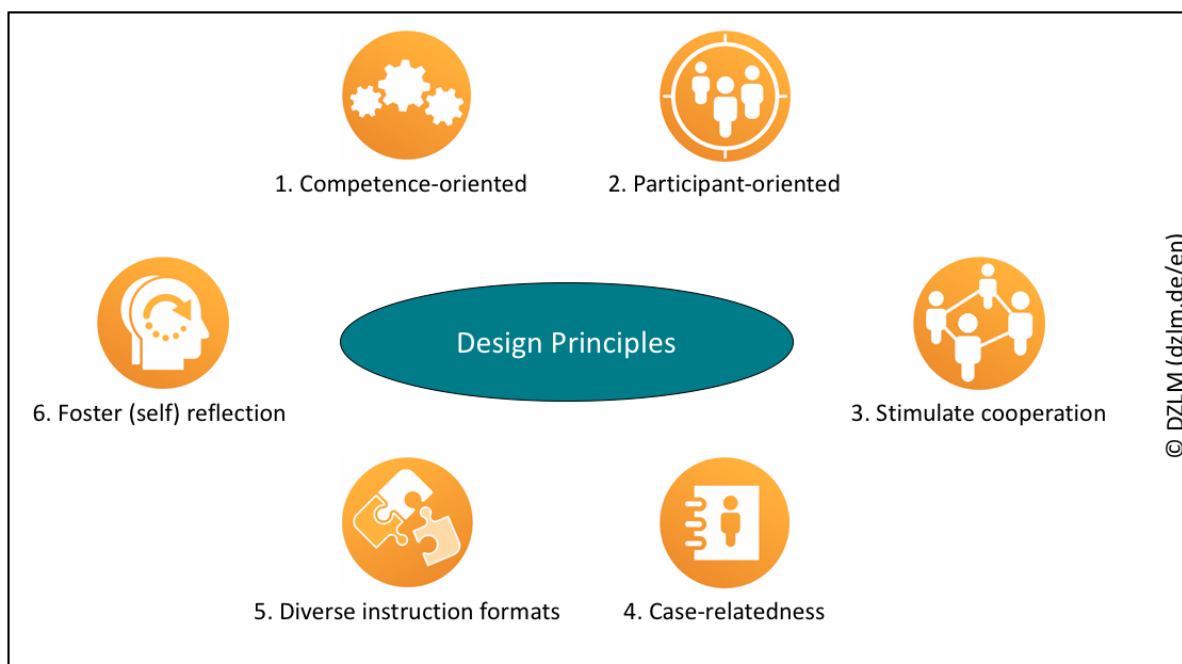
Our case studies show that most teachers opted for technology tools which were accessible and/or easy to learn how to use and apply in their classrooms. The case studies recognised that a limiting issue for a number of teachers was the ergonomic environment which produced connection difficulties in the system, increasing the time taken for the feedback to arrive from and to the students and therefore forming a potential obstacle to the adoption of the technology. Investment in the networking and wireless systems (and technical support available) in schools would seem to be a priority and a pre-requisite for the implementation of this technology on a larger scale.

Investing in teacher learning

It has been strongly argued that in order to bring about real change within schools, investing in the building of the capacity of teachers, with teachers being the key agents of change (Fullan, 2010), should be the main emphasis of schools' policy (IPPR, 2013).

A detailed analysis of Continued Professional Development (CPD) by the DZLM (Deutsches Zentrum für Lehrerbildung Mathematik/German Centre for Mathematics Teacher Education, Barzel & Selter, 2015, p. 259–284) identifies the following design principles for effective CPD:

³ <https://microsites.ncl.ac.uk/fasmedtoolkit/theory-for-fa/the-fasmed-framework/>



Principles for effective continuing professional development (CPD)

The FaSMEd case studies demonstrate how professional learning was facilitated through a number of structures: courses, direct work with individual teachers and/or teacher learning groups. These are exemplified through the Professional Development package⁴. Our work with teachers has highlighted that where teachers were able to work as professional learning communities, conditions were effective in enabling them to feel safe to experiment, examine the impact of their innovations, to talk openly and to establish principles about effective student learning⁵. As argued in our position paper on Professional Learning of teachers⁶, we note that *Professional Learning Communities* (PLC) (Wenger, 1998) emerge as one of the most promising structures for professional learning, particularly when these involve collaborative inquiry (e.g. OECD, 2013; Ermeling, 2010; Nelson et al., 2008). *Professional Learning Communities* (PLC) emerge as one of the most promising structures for professional learning. FaSMEd teachers expressed the positive value of creating these environments, which are not always readily available in schools across Europe and South Africa.

⁴ <http://fasmed.eu/professional-development/approaches/>

⁵ Deliverable D4.3 <https://research.ncl.ac.uk/fasmed/deliverables/>

⁶ <https://research.ncl.ac.uk/fasmed/positionpapers/>

FaSMEd conclusions and policy guidelines

- The FaSMEd project found that the introduction of innovative technology to create a digital environment (between students, peers and teachers) can assist teachers in making more timely formative interpretations. We recommend the use of such technologies within classrooms to further enhance FA practices.
- Through the case studies there is evidence of teachers using technologies to gain information about their students' thinking, as well as to facilitate opportunities for students to learn from their peers. In interviews, students identified these practices as particularly beneficial in making their learning visible to the teacher, themselves and their peers. We recommend that technologies are utilised within classrooms to facilitate making learning more visible to all 'in the moment'.
- Our FaSMEd case studies show that most teachers opted for technology tools which were accessible and/or easy to learn how to use and apply in their classrooms. We would therefore recommend that when embarking on new technological innovations, the usability of tools is considered.
- FaSMEd found that where existing infrastructures supported the use of technology, schools were able to make considerable progress in their use of technology to support FA practices. We would recommend investment in the networking and wireless systems, together with technical support in schools. FaSMEd believes this is a priority and a pre-requisite for the implementation of this technology on a larger scale.
- Where teachers were able to work as professional learning communities, conditions were effective in enabling them to feel safe to experiment, examine the impact of their innovations, to talk openly and to establish principles about effective student learning⁷. FaSMEd would therefore recommend that schools (wherever possible) facilitate time and space for teachers to plan, and reflect on their practice. A commitment to this from school leaders is crucial.

⁷ Deliverable D4.3 <https://research.ncl.ac.uk/fasmed/deliverables/>

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