Future research:

Recommendations for future research

Deliverable D6.3

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Introduction

This deliverable sits within Work Package 6 – Final Synthesis – which builds upon the results provided by our research activities conducted in the previous phases of the project. Based on the experiences gained through the project, D6.3 focuses on identifying the needs and opportunities for further research.

The FaSMEd project

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. FA 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 FA strategies in teachers' classroom practice will have a significant impact on students' achievement. By introducing innovative technology, we created environments which enhanced connectivity and feedback to assist teachers in making more timely formative interpretations.

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**.
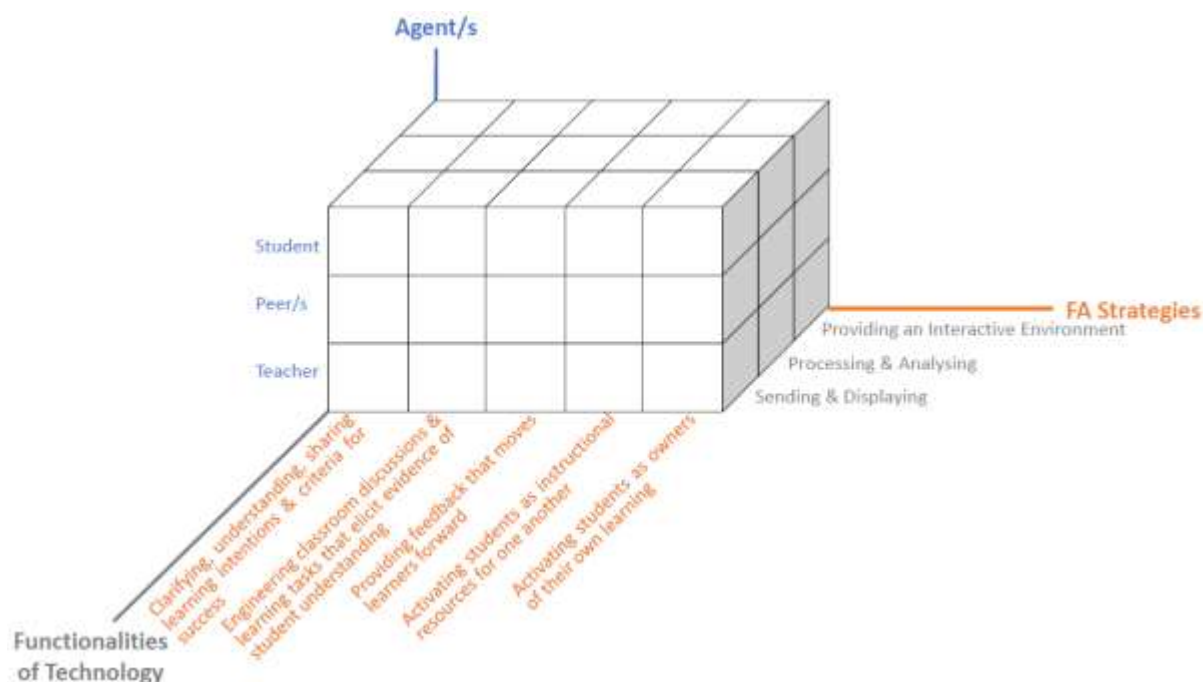
Figure 1: The FaSMEd framework

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 processes[1], but could be expanded through further research and experimentation.

The FaSMEd framework provides a conceptual model for understanding the interactions within the classroom between agents (teachers, students, peers), FA strategies and functionalities of technology. The three categories can help researchers to think about the role of technology within FA and learning processes rather than using technology for the sake of it alone. We would recommend that future research should carefully consider how, and for what purpose, the technology is used in the classroom.

Future technological developments

The FaSMEd project explored the potential of technology to facilitate FA in mathematics and science classrooms. By introducing innovative technology, we created environments which enhanced connectivity and feedback to assist teachers in making more timely formative interpretations. A key element of teaching using assessment 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 potential of the technology to represent knowledge in a meaningful way was perceived to be especially

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[1] For further details see Deliverable D6.1 https://research.ncl.ac.uk/fasmed/deliverables/

beneficial to lower achieving students, as it allowed them to represent their learning pictorially. Students could make sense of images and videos within a particular application (e.g. iPad application Popplet). We recommend that future research explores further applications that enable visual representations in mathematics and science.

Many of our teachers used technology with polling systems in order to gather evidence of student learning. Multiple choice questions have become one of the ways teachers seek out feedback on the understanding of their students, but these need careful framing, interpretation and response by the teacher. One possible problem is that single response multiple choice questions may not give a very accurate indication of students' understanding if a significant number choosing the right (or wrong) answer at random. A more accurate use of multi-choice would be to design questions where the correct answer is to select two (or more) choices simultaneously – thus reducing the probability of random choice being correct and a richer selection of information. Further research of these tools and possibilities is needed, the Bear Centre, UC Berkeley[2] (USA) are currently working in this area.

Another issue is that current assessment and polling software often aggregate the data from groups of students, but do not do any further processing. Interpreting and reacting to such data is one of the major challenges for teachers. We recommend that future research into technology that can work intelligently with student responses, recognising common errors and suggesting strategies and/or feedback is needed. The potential for this is possible through drawing upon mass datasets of student learning behaviours that could exist and be utilised. The work done by the University of Duisburg-Essen (Germany) in FaSMEd goes some way towards this goal, albeit directed towards giving feedback to individual students. Also the DAE system developed at Utrecht University (Netherlands), which at the moment is used for teacher FA, could conceivably be enhanced to interact with the student responses in this way. We believe that future technologies have the potential to facilitate complex and authentic mathematical and scientific tasks and recommend future research to investigate these possibilities.

Learning from research findings

The main objective for FaSMEd was the development of a Toolkit for teachers and a Professional Development package to support it. In the course of the three year project a prototype toolkit was developed and evaluated leading to the production of the final toolkit. However, this resource has not been evaluated and it remains an open question about the extent to which a website incorporating the resource will be used or valued by teachers. Hence it is clear that, in order to ensure that the FaSMEd toolkit is fit for purpose, a further iteration would be required, including feedback from teachers on the use of the resources. Additionally, further research is needed to explore the FaSMEd case study schools and teachers to discover whether there has been any sustained impact of the project. We believe that investigation into whether teachers use resources such as online Toolkits, PD packages,

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[2] https://bearcenter.berkeley.edu/

classroom materials, etc., and if used, how and why they engage with such materials to support teaching is necessary.

The FaSMEd Toolkit now sits alongside the resources developed by other EU funded projects:

- SAILS[3]: a collection of 19 SAILS Inquiry and Assessment Units which showcase the benefits of adopting inquiry approaches in classroom practice, exemplify how assessment practices are embedded in inquiry lessons and illustrate the variety of assessment opportunities and processes available to science teachers.

- MASCIL[4]: an online collection of classroom materials and professional development materials that encourage and support teachers to implement inquiry-based learning (IBL) and make effective connections to the world of work (WoW) in their mathematics and science classrooms. The mascil project has developed two on-line toolkits. These are for use with (i) groups of in-service teachers and (ii) pre-service teachers who are on courses leading to becoming a teacher.

- PRIMAS[5]: Professional development materials; Classroom materials for direct use by pupils; A range of professional development courses and other opportunities for teachers to explore effective teaching methods.

- ASSIST-ME[6]: provides a research base on effective uptake of formative and summative assessment for inquiry-based, competence oriented Science, Technology and Mathematics (STM) education and formulates guidelines and recommendations for policy makers, curriculum developers, teacher trainers and other stakeholders in the different European educational systems.

In relation to mathematics and science education, then, there is clearly a great wealth of research and knowledge generated across Europe (and beyond). Whist at project level there has been some knowledge exchange and collaboration, more needs to be done to ensure that cross-project findings are integrated and translated into research, policy and practice. We recommend that such meta-analysis is essential for future research.

Working collaboratively

Throughout the FaSMEd project we were committed to a socio-technical approach, characterised by iterative, collaborative, process-focused activities and the engagement of participants in systematic reflection and evaluation at all stages of development[7]. We believe that this approach has been particularly valuable as it provided the basis for collaborative research between practitioners and university researchers. Building on the principles of co-

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[3] http://www.sails-project.eu/
[4] http://www.mascil-project.eu/
[5] http://www.primas-project.eu/
[6] http://assistme.ku.dk/
[7] Deliverable 10.3

production[8] this has been important in developing a Toolkit (Deliverable 3.3) and a Professional Development Package (Deliverable 3.6) that have emerged through practice. We were keen to place teacher agency at the heart of our methodology, recognising that any change in practice advocated by FaSMEd should be situated in the contexts of teachers, schools and existing educational environments. Throughout the project we tried to ensure that relationships between teachers, students and researchers were negotiated so that teachers and students could develop a genuine sense of agency and ownership of the research. This process is documented through the partner case studies (Deliverable D4.3) which provide a narrative of the experience together with the re-designed classroom activities and tools. The FaSMEd Toolkit website and Professional Development package (www.fasmed.eu/) are designed for teachers and/or teacher educators to actively engage with the FaSMEd tools and activities. We would recommend that this methodological approach to knowledge exchange and production is crucial for future classroom research.

Finally, we recognised from the start that the student perspective in FaSMEd was important. To this end, all partners interviewed students about their experiences and perspectives of the FaSMEd lessons, the activities and tools used, their attitudes towards mathematics and/or science and the use of FA and technology. Newcastle University also engaged with one class to design and produce a reflective FaSMEd Comic[9]. The student view is not always adequately explored and represented, and we believe more should be done to facilitate this. In particular, we would argue for the design and co-production of student guides in future research.

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[8] http://www.n8research.org.uk/media/Final-Report-Co-Production-2016-01-20.pdf
[9] https://research.ncl.ac.uk/fasmed/disseminationactivity/FaSMEd%20Comic.pdf

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