Deliverable D1.5 Professional development: An agreed approach to professional development

What do we know about teacher professional learning in mathematics and science education and how can we apply it to FaSMEd?

David Leat, Lucy Tiplady, Jill Clark and David Wright, *Newcastle University, UK*

There is a fair degree of agreement about the nature of effective professional development for teachers. This paper will reflect upon some of these findings in relation to the FaSMEd project, primarily drawing from:

- Best Evidence Synthesis provided by Helen Timperley and colleagues from New Zealand (2007);
- The OECD (2009) Teaching and Learning International Survey (TALIS);
- National Council of Teachers of Mathematics (NCTM, 2010) Research Brief on Mathematics Professional Development
- The review of Professional Development for Science Teachers (Wilson, 2013);
- A range of more specific articles both relating to science and mathematics professional development and more general articles on the intricacies of professional development;
- The consultancy work of Dylan Wiliam, one half of the Black & Wiliam partnership which put formative assessment firmly on the educational agenda.

In doing so it is not intended to give a comprehensive review of professional learning for teachers of science and mathematics, but to highlight some of the most significant findings that will shape our understanding and approach to professional learning as FaSMEd develops across the partner countries.

One of the most obvious conclusions from the literature, particularly TALIS, is that professional development (PD) is perceived and experienced differently across countries. It is important therefore not to assume too much about expectations and norms in other countries. What is also clear is that where teachers do engage in high quality PD they are very positive about the experience and report multiple benefits. Further PD is linked to the mastery of a 'wide array of methods' in the classroom. Over half the teachers in the TALIS survey (20,000 teachers in 27 countries) expressed a desire for more PD. Indeed many teachers pay for their own CPD through certificated courses.

Timperley et al. (2007) present a synthesis of teacher professional learning and development studies in which there was evidence both of positive outcomes for students and the nature of professional development provided for the teachers involved. In analysing these important studies, the following were found to be significant and are discussed here with reference to additional research from across the world:

Leadership

Effective professional development generally starts with school leaders providing supportive conditions, which included for example: creating a supportive environment by encouraging classroom experimentation, engaging in innovation themselves, providing a vision or target for student outcomes and generally encouraging distributed leadership.

Time

Good professional development takes time and is not achieved through one-off workshops (Heck, 2008). Instead there needs to be frequent contact with the provider/organiser. Some of the productive interplay between factors detailed below takes time. So according to Kazemi & Franke (2004) changes in mathematical knowledge, beliefs, dispositions and the development of collaborative structures take place in small increments in response to changes to other factors. So it is not just time in itself, but the processes that need sustained engagement over time that are important.

External expertise

Access to external expertise was a feature of nearly all the successful studies. External expertise is one of the features of a Chinese adaptation (Huang & Bao, 2006) of Lesson Study called Keli (Ker-Lee). The purpose of the external expertise is to 'upgrade' teacher ideas. Keli is a somewhat 'top down' theory-into-practice model, but expertise can be offered more contingently. The importance of expertise and theoretical understanding is also evident in the review of the development of the outstanding teachers of numeracy (Askew et al. 1997).

Teachers' engagement

Teachers do not have to be volunteers but it is important that at some point they engage and become motivated by the process. Spillane's work, and concept of *zone of enactment* points to one of the important processes that generates engagement. They investigated teachers who did change their practice spurred by a state reform in the direction of constructivist teaching and compared them with those that did not. The critical factor was the opportunity to engage in discussion with colleagues (Spillane, (1999) p 171).

Theory and practice

Integration of theory and practice was a key feature of successful work, as theory provided the basis for making planning and curricular decisions. Teachers needed some support to translate theory into classroom practice and they also needed inquiry skills to sustain innovation. Part of the 'theory' is subject knowledge as, for example, in mathematics, knowledge of subject correlates with improved student outcomes (Jacob et al., 2007), which can be developed through analysing classroom practice and resultant student work. Solving mathematical problems together (Lachance & Confrey, 2003), or using new curricular materials (Horn, 2005) are successful models of teachers collaborative PD.

Challenge to existing beliefs

Successful innovation often came from teachers being forced to examine their beliefs and assumptions about the potential of particular groups of pupils. This was achieved by iterative cycles which involved analysis of student response to/learning gain from changes in teaching. This element of PL encourages teachers to focus more on and analyse students' mathematical thinking rather than just their answers (van Es & Sherin, 2008). This in turn sensitises them to the strengths, weaknesses and individuality of particular students' methods and understanding which helps them differentiate work and support more effectively (Kazemi & Franke, 2004).

Collaborative working

Nearly all the successful studies included teacher participation in some kind of community of practice, this paper will return to this theme more fully later. What appears to be important in such communities is the cumulative and dynamic development of articulation of practice, inter-subjectivity (the construction of shared meaning), trust and strong personal relationships (see Horn, 2005 for example).

Systemic Support

The NCTM report identifies both the importance of commitment of the school principal and the importance of the alignment of the PD messages and those of the local and national system about mathematics teaching and learning. Priestley (2011) go further in conceptualising this importance as refer to ecological agency. Agency is typically regarded as the individual's capacity to bring about change, whereas ecological agency sees capacity for change as residing in the environment. While individual agency is still critical, the ecological perspective puts a strong focus on the conditions or setting for teachers' professional learning.

Successful models of CPD

There is a high degree of convergence in descriptions of successful professional learning. Typically these include securing interest and engagement from the teachers, providing a theoretical framework for understanding of the innovation/strategy/programme and offering some practical tools to apply to classroom practice. Evidence was gathered of the impact (often through diagnostic assessment of the student work) and this was discussed with supportive peers providing the basis for further reflection and development, with the aid of a facilitator. As a consequence of a focus on student perspective there was often a marked improvement in teacher-student relationships and the dialogue could lead to substantial shifts in perceptions of students and their learning.

Whilst there is this degree of convergence in descriptions of factors contributing to powerful professional learning, there is still considerable debate as to appropriate explanatory and predictive models. In other words how does one turn this into helpful guidance for leaders of professional learning? One of the most quoted explanatory models is provided by Clarke & Hollingsworth (2002) – the *Integrated Model of Teacher Professional Growth (IMTPG)*, in which enactment and reflection mediate interactions between four 'domains': personal, external, practice and consequence. This has been influential in a number of studies e.g. van Driel (2014) in science.

The IMTPG provides a sound foundation for planning for professional learning which takes account of dynamic interaction between factors. However the earlier reference to ecological agency is an important reference to socio-cultural theories of learning, which lay stress on the part that context plays. Contextually personal relationships matter, and Hedges (2010) provides some valuable insights into the care that facilitators have to apply in developing working relationships with teachers, not least in terms of establishing credibility. In addition Horn and Little (2010, p.211) in a study of separate 'math' and literacy focused teacher study groups, in which the former was more successful, noted that the groups:

> *differ in the opportunities for learning they constructed through the micro-level discourse routines they employed in responding to expressed problems of practice (normalizing and related moves) and the meso-level participation routines they used to organize major parts of their work together (check-in and lesson walk-through).*

There are important skills gradually being teased out of qualitative and ethnographic studies of professional learning. However as we explore below there is no exact blueprint for how to create collaboration between teachers.

Assessment

Finally Timperley et al. (2007) make specific mention of assessment as a stimulus for focusing teaching and encouraging professional learning. *Approximately half the interventions in the core studies included assessment for one or more of the following purposes:*

- *Providing a catalyst for initial and ongoing engagement;*
- *Identifying professional learning needs;*
- *Identifying student learning needs through assessment of their understandings and skills in order to focus teaching;*
- *Inquiring into the effectiveness of practice with particular students for the purpose of confirming or refining practice* (p. xxxii).

Professional learning and mathematics

Timperley et al. (2007) looked specifically at those studies that met their criteria on student outcomes and professional development and had an explicit focus on promoting student learning and raising achievement in mathematics.

Interventions that met these criteria all had a balance of theory and practice, with most seeking to develop teachers':

- content knowledge of mathematics;
- understandings of how students learn mathematics;
- and skills to assess students' understanding of mathematics.

Where interventions had focused on the implementation of pedagogy without a mathematical focus, outcomes had not been improved for students. Many of the successful interventions were seen to challenge 'traditional' prevailing discourses about teaching and learning mathematics. The shift typically involved was from procedures and memorisation to mathematical inquiry and conceptual understanding. Significant external support and some form of collegial support from other participants was important. Huang et al. (2011) identified four benefits from collaborative 'exemplary lessons' in China: better understanding of content knowledge; becoming more skilful in handing difficult content; better organisation of problem sequences and developing more comprehensive and realistic instructional objectives. It seems likely that teachers find participation in a group in which they can develop a shared sense of purpose and motivate and support one another highly conducive to professional learning when substantive change is required. Many of the studies made explicit reference to the importance of this environment and achieving a balance between support and challenge. Skills to assess students' understanding were important in convincing teachers of the learning that was taking place and thus embedding new approaches in practice.

Most of the studies focused on developing students' conceptual understanding of mathematics and, for the teachers, creating dissonance with the current position, mirroring the processes for successful student learning.

> *The professional development promoted an approach in which students were supported to be much more responsible for monitoring their own learning, whereas previously the teacher had been the sole arbiter of what constituted a right or wrong answer. Teachers learned to encourage students to consider multiple approaches to solving a problem, rather than believing that there was one 'right way'. Because the process of problem solving was considered more valuable than the product, students were taught the metacognitive skills they needed to monitor their own progress as they problem-solved. In cases where their answer was incorrect they would be guided by their teacher but would be expected to identify where they went wrong and be responsible for finding a method of solving it correctly.* (Timperley et al. 2007, p. 76).

Professional learning and science

There is also a parallel section on science professional learning in the Timperley report. They concluded that all studies that met the selection criteria took a student focused, inquiry based approach, promoting problem solving strategies over memorisation of scientific facts. In some cases this was in opposition to the prevailing discourses of attending teachers, although this was not as prevalent as had been reported in the mathematics focused studies, and in only two studies was teacher dissonance explicitly discussed.

As was important in the mathematics studies, all interventions that met the criteria were focused specifically in a science context, both in terms of professional learning goals and theoretical concepts, with an integration of both theory and practice. Most of the core studies did develop teachers' content knowledge of science, alongside pedagogical understanding, and new assessment methods closely aligned to the new learning approach led to a general shift from summative to formative assessment.

In contrast with the mathematics core studies, most of the science interventions provided teachers with detailed materials (in the form of unit, lesson plans and activities), although importantly these were never regarded as sufficient without the professional development intervention. Many of the studies used modelling or demonstrations through video to exemplify good practice of the approaches advocated. Again in contrast to the mathematics studies, information about how students learn in science was only explicitly reported in a minority of core studies, but the fact that all studies promoted an inquiry based approach meant that an implicit understanding would have been likely. The existence of support from an external source combined with internal collegiality within the group was a feature of all the successful interventions.

Professional Learning Communities

Professional Learning Communities (PLC) emerge as one of the most promising formats for professional learning. This is because the conditions for powerful professional learning, fundamentally require teachers to feel safe to experiment, examine the impact of their experiments, to talk openly and to get down to established principles about effective student learning - and PLCs can deliver on these requirements.

However, although PLCs are often described it is less clear how they are created. Dylan Wiliam currently mainly works as a consultant to schools, advocating **teacher learning communities**. The following selected summaries taken from PowerPoint slides (available at www.dylanwiliam.net), give the bare bones of his approach to professional development for teachers. The degree of overlap with Timperley's conclusions and the work of other researchers (e.g. Cochran-Smith & Lytle, 1999, Meirink et al., 2010) on professional learning are considerable, except that he makes no specific mention of theory, and in addition different political and socio-cultural contexts may require some adaptation.

Teacher learning communities

Plan that the TLC will run for two years. Identify 8 to 10 interested colleagues

- Composition
- Similar assignments (e.g. early years, maths/science)
- Mixed subject/mixed phase
- Hybrid

Secure institutional support for:

- Monthly meetings (75-120 minutes each, inside or outside school time)
- Time between meetings (2hrs per month in school time)
- Collaborative planning
- Peer observation
- Any necessary waivers from school policies

Every TLC needs a leader

The job of the TLC leader(s)

- To ensure that all necessary resources (including refreshments!) are available at meetings
- To ensure that the agenda is followed
- To maintain a collegial and supportive environment

But most important of all …

- Not to be the formative assessment 'expert'

The importance of dialogue

Cordingley et al.'s (2003) meta-analysis listed processes to encourage and structure dialogue as one of the key characteristics of collaborative professional development. Dialogue is often equated to talk and talk does not sound too difficult to encourage – teachers talk all the time. However Horn & Little (2010, p.182) provide a long list of reasons, as to why teachers just talking might not lead to teacher learning:

> *Research suggests a number of possible explanations for why talk about teaching, even among teachers who are attracted to collaboration and committed to reform, may not add up to much: the difficulty of making tacit knowledge explicit (Eraut, 2000), the challenge of confronting well-established norms of privacy and non-interference (Little, 1990) or contending with disagreement and difference (Achinstein, 2002; Grossman, Wineburg, & Woolworth, 2001), insufficient structural and social supports (Louis & Kruse, 1995), taken-for-granted language and frameworks that reify*

assumptions about learners and learning (Coburn, 2006; Horn,2007), and the urgency of the immediate and multiple tasks to which teachers must attend (Kennedy, 2005; Little, 2003).

Conclusion

While there is considerable agreement about effective CPD for pedagogical change, we cannot assume that following this advice will guarantee success. Loucks-Horsley et al. (1998) in their review of professional development for teachers of science and mathematics concluded that whilst there are undoubtedly factors that are likely to influence success, 'each situation that calls for teacher learning requires a unique design that combines elements of effective professional development in different ways' (1999, p. 268).

Further evidence suggests that there are real skills required to lead teacher study groups (community of practice), so that there is sufficient structure and expectation to make colleagues commit to action whilst also establishing high levels of trust and collaboration. Relationships are fundamental and this is unpacked in Rathgen (2006, p. 584), who recounts the confidence that Graham Nuttall in New Zealand gave teachers in his projects through suggesting that it was a privilege to be in their classrooms. Other teachers in the project reported the importance of the classroom teaching experience of the research team that allowed them to provide ideas for teaching; discuss teaching sessions and develop rapport with the children.

Newman & Mowbray (2012, p. 464) found comparable admiration amongst teachers for their university lead partner:

> *I think the support of the leader of the group … her expertise, research skills as a practitioner and as an academic was absolutely invaluable. Having it facilitated by an academic was particularly invaluable given her experience in the field and her academic knowledge.*

Adding flesh to these bones and detailing the way in which FaSMEd partners engage with their teacher collaborators (and in some cases students) may be one of the most productive outcomes of FaSMEd.

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