Factors influencing the developing effectiveness of early career teachers’ mathematics teaching – initial findings

Alison Godfrey

University of Leicester, United Kingdom; ag384@le.ac.uk

Early career primary school teachers in the UK enter a varied and complex situation in terms of professional development opportunities and support for their ongoing career progression as teachers of mathematics. Literature suggests that the professional development a teacher receives impacts on both their subject knowledge for teaching and their beliefs and attitudes to the subject. This multiple case study looks to fill gaps in the research undertaken in this area through detailed analysis of the personal perspectives of the participants over a two year period. This paper reports on the initial findings of a comparative analysis of the trajectory of two teachers to date. These teachers were in seemingly similar contexts for their first year of teaching, yet had very different experiences and held very different perspectives on their development.

Keywords: Teacher characteristics, professional development, elementary school mathematics

Introduction

Students start a primary teacher education course in England with a range of academic qualifications in mathematics, a range of experiences in school mathematics and a range of attitudes and beliefs about the subject. During the course student teachers develop their subject and pedagogical knowledge and gain experience in mathematics teaching. They then enter a complex and changeable situation in schools in terms of provision for their ongoing development (Advisory Committee on Mathematics Education, 2013). Using a multiple case study approach, the aim of this study is to gain a deeper understanding of how the effectiveness of early career primary school teachers’ mathematics teaching develops and what impacts on this development, with a particular focus on each teacher’s own perspective. In this paper I will introduce the theoretical background that underpins my research, describe my methodology, discuss some of my initial findings by comparing and contrasting the experiences to date of two of my pilot participants and finally outline my initial conclusions.

Theoretical Background

The notion of effectiveness as applied to mathematics teaching is complex and ideas vary about what this looks like and even what its impact should be (Cai, 2007). Although generally agreed that teaching can only be considered effective if there is an impact on those being taught, i.e. effective teaching leads to effective learning and gains in understanding (Bryan, Wang, Perry, Wong, & Cai, 2007), the notion of ‘understanding’ is complex. Skemp (1976) made a clear distinction between instrumental understanding, simply knowing rules and procedures at a shallow level, and relational understanding which enables pupils to build conceptual schemas. Most mathematics educators agree that this second type of understanding is the most desirable and teachers internationally agree that an indicator of mathematical understanding is that pupils can use this understanding to problem solve flexibly in a range of situations (Byran et al., 2007). The significance of understanding the
connected nature of mathematics is very apparent (e.g. Askew, Brown, Rhodes, Johnson, & Wiliam, 1997) and is consistent with the notion of relational understanding. The concept of effective learning in mathematics being based on this type of understanding within the context of appropriate intellectual challenge is endorsed by current policy makers and teacher inspection systems in the UK (DfE, 2013; Ofsted, 2012) and is the definition used in this study.

The literature suggests that teachers’ effectiveness is impacted by their subject knowledge and by affective dispositions including beliefs, attitudes, motivations and emotions. Definition of these constructs are debated in the literature and indeed there are a range of ideas as to how they overlap and directions of influence (Lewis 2016). In agreement with Hannula (2011) I consider beliefs are both cognitively and affectively situated. As a starting point for discussions of attitude and emotion, I am adopting the three dimensional model of attitude from Di Martio and Zan (2010): emotional disposition towards mathematics, vision of mathematics (relational/instrumental) and perceived competence in mathematics.

Many studies, e.g. Ernest (1989), Askew et al. (1997), have looked at teachers’ beliefs about the nature of mathematics and the impact these beliefs have on their teaching. Ernest (1989), for example, argues that a teacher who sees mathematics as “an accumulation of facts, rules and skills” is likely to see themselves as an Instructor; a teacher who sees mathematics from a “Platonic” perspective as a “static but unified body of knowledge” would see themselves as an Explainer and a teacher who believes that mathematics is a dynamic, creative, problem solving subject would adopt a teaching approach as a Facilitator (p. 250). To Ernest, this creates a hierarchy in the effectiveness of the teaching, with the last being the most effective.

Teachers’ attitudes to the subject, including their emotional disposition, also impact on effectiveness. Particularly in primary teaching, teachers and student teachers find themselves teaching subjects that they have not necessarily enjoyed or been particularly successful at learning themselves. Many feel insecure with their subject knowledge in mathematics and recount their experience of mathematics at school as a subject that caused difficulties and even “real emotional turbulence” (Brown, 2005 p. 21). For many teachers therefore, mathematics is linked with negative emotions, particularly anxiety, and this can impact on their wider attitudes to it. It seems that teachers even protect pupils from mathematics and, in seeking to simplify it, emphasise the step by step procedures that are likely to lead pupils into developing instrumental understanding and potentially negative attitudes (Hodgen & Askew, 2007), reducing their effectiveness.

A further influence on the effectiveness of teaching of mathematics is subject knowledge. Indeed, evidence suggests that the impact of beliefs and attitudes and subject knowledge are interdependent (Askew et al., 1997). Most recent research on teachers’ subject knowledge for mathematics uses Shulman’s (1986; 1987) seminal papers as a starting point. Others have applied his ideas to mathematics teaching, debated which aspects are most essential and relevant, and sought to measure or evaluate them. Ball, Thames & Phelps (2008) argue that there is knowledge that is specific to teachers of mathematics and that might have an identifiable impact on the effectiveness of their teaching; Specialised Content Knowledge. This includes, for example, the understanding needed to be able to explain procedures, to analyse errors and strategies, and to consider appropriate
examples. Baumert et al. (2010) conclude that pedagogical content knowledge (PCK) makes the greatest contribution to pupil progress, but weaknesses in mathematical content knowledge are not offset by greater PCK. Askew et al. (1997) found that it was not the formal qualifications or the amount of subject knowledge that the teachers had which was significant in the effectiveness of their teaching, but rather the connectedness of their subject knowledge “in terms of the depth and multi-faceted nature” of the meanings and uses of concepts in mathematics (p. 69). Other authors highlight the importance of pupil voice and the ability of the teacher to choreograph classroom discourse as key characteristics of effective teaching in mathematics (Clarke & Mesiti, 2013; Schoenfeld, 2013) and Barwell’s (2013) discursive psychology perspective emphasises that knowledge is contextual and can be changed or reconstructed accordingly. There is much critiquing of Shulman’s and Ball’s ideas but there seems to be general agreement that the subject knowledge needed for effective teaching goes further than just having a strong conceptual knowledge of the subject being taught.

There is considerable evidence that a teacher’s depth of reflection and their beliefs and attitudes towards mathematics are a crucial influence over their trajectory of development (Di Martino & Zan, 2010; Turner, 2008). Hodgen and Askew (2007) and Schoenfeld (2013) suggest that the development of some teachers is hindered by their linking of mathematics with emotion and that, for some teachers, professional development activities and goals should be much more about changes in their beliefs and attitudes than about improving their subject knowledge.

Teachers’ work is within a social context, (Levine, 2010), and this can have a significant impact on the nature of a teacher’s professional development. The community within the school might have a range of different foci and agendas and there seems to be a wide variation in practice between schools. The very structured collaborative approach to teacher development in China seems high effective although dependent on the considerable time given to teachers to discuss, prepare and analyse their work (Paine & Ma, 1993). In contrast Ball, Ben-Peretz &Cohen (2014) consider that in the US most teachers work in isolation and the potential benefits of sharing good practice are lost. In England, although the need for quality on-going professional development opportunities for primary teachers is recognised and highlighted by Ofsted (2012), the current context is of variable provision in formal professional development (ACME, 2013).

In summary, the literature suggests that a teacher’s trajectory as a teacher of mathematics is influenced by the interaction of their beliefs and attitudes, their subject knowledge and the professional development they receive, through both formal education opportunities and personal reflection, and these factors therefore influence the effectiveness of their teaching and the effectiveness of their pupils’ learning. My study sits within this theoretical framework and seeks to extend the existing literature particularly though highlighting teachers’ own perspectives on this process.

**Methodology**

A multiple case study approach is being employed to follow the trajectories of a small sample of teachers with a range of mathematical backgrounds as they progress into their first two years as a qualified teacher. Four participants were chosen for the pilot study, two with mathematics
qualifications beyond GCSE, the minimum qualification required for primary school teachers in England. An initial interview at the end of their one year postgraduate teaching course focused on their relationship with, and attitude to, mathematics and their progress in teaching the subject as a student teacher. To facilitate discussion, Lewis’s (2016) idea of a graphic display was adopted; participants were asked to draw and explain their relationship with mathematics over time. The graphs proved to be a very useful means of facilitating discussion and gave insights into participants’ attitudes to mathematics and their perspectives as learners of the subject as well as in their student teacher role. Participants were able to reflect on how their relationship with the subject influenced their current teaching approaches. Twice yearly interviews, including further graphing at the end of each year, and discussion of documentation related to their progress as early career teachers provide evidence of on their ongoing development as teachers of mathematics. Interview questions have been designed to probe about the participants’ beliefs, attitudes and subject knowledge for teaching mathematics, what they perceive to be the characteristics of effective teachers of mathematics and their perspectives on their development as teachers of the subject. Within each interview they also describe two particular lessons: their chosen ‘best’ and ‘most challenging’ lessons since the previous interview, providing insights into what they consider to be effective and ineffective teaching and their subject knowledge. In addition, they keep records of their professional development in teaching mathematics and share any written observation feedback they have received.

A thematic approach using coding of data has enabled me to begin to identify concepts and themes, such as ‘awareness of self as a mathematician’ and ‘priorities in teaching mathematics’, and to begin to search for themes and patterns across the data set as well as for individual cases. In regard to their relationship with mathematics and their development as teachers of the subject, the participants have stories to tell and thus narrative analysis techniques are being used to support analysis of these stories.

**Results and Discussion**

In this paper the focus is on the early findings of a comparative analysis of the trajectory in the first year of the study of two of the teachers, Gina and Rama (pseudonyms), who in their first year as qualified teachers were in seemingly similar contexts: they both taught children aged 5-6 years in schools with a two class entry, working alongside more experienced colleagues and teaching mathematics to their own, mixed attainment, classes. Rama has a stronger mathematics background and also chose to study a mathematics specialism as part of the teaching course, but both students achieved the highest teaching course grade in all areas of the Teachers’ Standards (DfE, 2011). In their interviews, both were able to identify many ways in which they had evolved as teachers of mathematics to date, but they answered questions in ways that revealed very different perspectives on their development. In addition, their professional development records indicated that they received very different opportunities and approaches to their professional development. This raises questions about why these are so different and the extent to which this is school dependent or dependent on the approach and philosophy of the teachers themselves.
Descriptions of each participant’s relationship with mathematics and how this had evolved over time revealed interesting and complex relationships (Figure 1) and it was clear that past experiences impacted their current thinking. Whilst the graphs drawn are not directly comparable as the interpretation of the vertical scale was left open, the trajectories illustrated and discussion of these provide some scope for comparison. The two peaks in Gina’s relationship with mathematics indicate two different perceived aspects of success in mathematics. Firstly she recalls being successful in the subject in Year 9 (aged 13-14) when she felt she responded well to the high expectations her teachers had of her. The second period of success, during the teaching course, was due to her own development of the conceptual understanding that the literature suggests is essential for learners to gain for long term, secure understanding of mathematics. This enabled her to reflect on her previous period of ‘success’ which she then realised was based on superficial learning:

Gina: I could do the methods, but I didn’t understand them.

![Figure 1: Gina and Rama’s relationship with mathematics, drawn at end of teaching course](image)

Gina’s personal experience seems to have given her a particular focus in her own teaching of mathematics, particularly how strategies she is aiming to use in her teaching could prevent the children taking the path of superficial learning that she had followed. Discussing how she developed her teaching in her first few months as a qualified teacher, for example, she identified the use of representations as significant and something that she perceived as missing in her own learning:

Gina: And the pictorial things, definitely. I don’t think I’ve ever done that as a maths learner myself and I think maybe if I had it would have been much more easy.

Rama’s mathematical background also seems to have impacted on her priorities in teaching mathematics. Although she finished her studies with a degree where she used mathematics, she finished primary school not enjoying the subject and lacking in confidence. She seems to have been a shy and hesitant learner, fearful of getting the wrong answer in a subject she saw as right or wrong. At secondary school she was initially placed in lower sets but talked with great enthusiasm about her GCSE class (aged 15/16), a top set, where the environment of the classroom was such that she felt she could make mistakes without fear. She described too a change at this point from memorising how to do certain methods to taking ownership of her learning and finding her own ways of solving problems. Priorities identified by Rama in her teaching include the importance of children enjoying mathematics alongside gaining conceptual understanding, both aspects that for her were missing until the later stages of her schooling.
It seems that Gina and Rama entered two very different teaching communities with different agendas which also impacted on the nature of their professional development (Levine, 2010), and graphs drawn at the end of their first year of teaching revealed very different perspectives on their year (see Figure 2). Rama’s saw her journey as a teacher of mathematics as a smooth upward trend, with occasional dips when she taught poorer lessons. Whilst having few formal professional development opportunities, she indicated that she is confident in her own subject knowledge and in independently planning and teaching the subject. Gina described a much more structured and intensive programme with regards to the support she received. However, her graph illustrates her perspective that she had a turbulent year and narrative analysis revealed, interestingly, that the intense involvement of her school in her professional development seems to have led to a crisis in her confidence and a turbulent second half of her first year of teaching.

Figure 2: Gina and Rama’s relationship with mathematics during their first year of teaching

This analysis highlights the emotional impact on Gina of the series of intervention events that followed on from a formal observation of her teaching that she labelled several times as a ‘disaster’, and then her subsequent recovery. In her story particular emphasis is evident of the impact on both the perceived competence and emotional disposition aspects of her attitude (Di Martino and Zan, 2010), with a consequent impact on her confidence in her ability to teach mathematics:

Gina: It seemed no matter what I was doing to change, I was still getting negative feedback and it was disheartening. There was a big period of time when I literally dreaded every single lesson, because you just think “What could happen? I don’t know what I’m doing”

The records of professional development kept by Gina and Rama over the year confirm that Rama’s in school support has been much more informal and she places a high priority on targets she generally sets for herself, seeking to improve the quality of her teaching through a reflective approach (Turner, 2008). In contrast to Gina’s record of events, her record is a series of targets. Contrasts in their priorities in planning and teaching of mathematics, and indications of their subject knowledge have been evident through different ideas about the characteristics of effective teachers and descriptions of their best and most challenging lessons. It seems that both teachers are seeking to teach with a relational approach, with Rama at this stage in a stronger position regarding subject knowledge.

It is interesting that end of year assessment information indicates that children in both Rama and Gina’s classes progressed well in their mathematical understanding over the year; this seems to have contributed to Gina finishing the year in a more confident frame of mind.
Conclusion

The findings of these case studies confirm my analysis of the literature in that there are two related and interwoven, but distinct, categories of factors that might influence an early career teacher’s trajectory in relation to the effectiveness of their mathematics teaching - those that are related to the teacher themselves, in terms of beliefs, attitudes and subject knowledge and those that are related to their teaching context. Gina’s experience during her first year of teaching provides a particularly interesting example of professional development that impacts in complex ways on beliefs and attitudes to the subject. Although it is too early to draw more than very tentative conclusions, it is interesting to ponder to what extent Gina and Rama’s trajectories would have been different had they been in one another’s school, and this leads to potential implications for initial teacher education.

These case studies align with current professional documentation (ACME, 2013) to suggest that there is a lack of uniformity in teachers’ professional development experiences despite there being systems in place in the UK promoting uniformity. The existence of these issues has implications for the preparation of student teachers in Initial Teacher Education (ITE) and suggest that ITE providers could seek to more explicitly discuss differences and similarities in primary school approaches to teacher development and further strengthen their policies of students gaining experience in a range of contrasting placements, within which they can not only participate in whole school professional development events, but also talk with teachers about their development experiences.

This study is still in the early stages and next steps are to extend the study with more participants, to give more consideration to the analysis methods used and further extend the scope of the literature reviewed, particularly regarding aspects of affect in mathematics.

References


