Deconstructing 'good practice' teaching videos: an analysis of pre-service teachers' reflections

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Video clips of mathematics lessons are used extensively in pre-service teacher education and continuing professional development activities. Given course time constraints, an opportunity to critique these videos is not always possible. Because of this, and because pre-service teachers make extensive use of material found during internet searches, much of it purporting to exemplify 'good' practice, we were interested to know what sense they make of such material. By encouraging pre-service teachers to reflect and comment on the practices being promoted in this way, we wanted to hear what they focused on, their initial views of the teaching and learning shown in the video, and how their views were formed and affected by engaging in discussion. Findings indicate that pre-service teachers' responses to the material were dominated by their beliefs about mathematics and that engaging in discussion enabled them to appreciate the interpretations of others.

Keywords pre-service teachers · teacher beliefs · video analysis · mathematical knowledge for teaching ·

Introduction

In the UK a new National Curriculum was implemented in September 2014. Prior to this, the most recent radical change to the primary mathematics curriculum was in 1999 with the introduction of the National Numeracy Strategy (Department for Education, 1998). Although not statutory, all primary schools received an additional five days of in-service training in the year preceding its implementation and it was widely acknowledged that schools would have to justify any decision not to implement it. In this strategy there was a significant emphasis on mental calculation, so much so that teachers were instructed not to teach any formal written method of calculation until pupils could add and subtract any pair of two digit numbers mentally (Department for Education and Employment, 1998). Although not without critics (for example Brown, Askew, Baker, Denvir & Millet (1998) the aim of this strategy was to ensure pupils had a "range of computational skills and an inclination and ability to solve number problems in a variety of contexts" (Department for Education and Employment, 1998, p. 4).

When the coalition government came to power in 2010 a new review of education was called for and it became clear that the education secretary was looking for radical change. As draft material was released and it became apparent that the new curriculum was likely to favour procedural fluency, the mathematics community was called on to present the Secretary of State for Education with research indicating the benefits of flexible approaches to calculation (Advisory Committee on Mathematics Education, 2012). There has been considerable criticism in the UK regarding the new National Curriculum which some would say is almost the extreme opposite of the 1999 curriculum. Children as young as eight and nine are required to be fluent

in using long multiplication and division algorithms, using up to four digit numbers. One of the aims of the new National Curriculum is to enable pupils to

> … become fluent in the fundamentals of mathematics, including through varied and frequent practice with increasingly complex problems over time, so that pupils develop conceptual understanding and the ability to recall and apply knowledge rapidly and accurately (Department for Education, 2013, p. 3).

However there are many mathematics educators who are concerned about the emphasis on procedural approaches to calculation, which may be taught at the expense of conceptual understanding (Askew, 2011; Thompson, 2012).

Teacher training courses have had to respond to this change in curriculum and focus of mathematics sessions have had to ensure that pre-service teachers are equipped to deliver this curriculum. One year post-graduate teacher training courses in the UK usually run between September and June with the majority of the centre-based training taking place during the first term. Universities are required to ensure that pre-service teachers spend 120 days training in schools. This leaves little time spent in university, which is split amongst the primary national curriculum subjects and 'general professional studies'. All pre-service teachers are expected to have at least a grade C at GCSE (General Certificate of Secondary Education) and a prerequisite from September 2013 was that they had also passed a government 'numeracy skills' test (for more information about these tests see McNamara, Roberts, Basit and Brown, 2002).

Sessions at the university where this study took place aimed to address subject knowledge and mathematics specific pedagogy simultaneously. For example sessions on standard formal written calculation methods made extensive use of base-ten material to explore these methods, whilst extending subject knowledge by exploring decimals. Mathematics teaching sessions included a range of two hour lectures with the whole cohort of pre-service teachers (approximately 150) and smaller group, one and a half hour workshops (about 30 pre-service teachers). The structure of the course was that pre-service teachers would spend an initial period of two weeks in a primary school at the beginning of the course, with some specific activities to focus on. For mathematics the activities included reviewing the mathematics and calculation policy of the school, observing a series of mathematics lessons with specific foci and a reading, after which they had to write a reflective response to. Pre-service teachers then spent a period of 9 weeks at the centre which included thirty six hours of mathematics. The majority of the remainder of the year was spent in schools.

The Study

Our theoretical position is grounded in the conviction that a key goal of teacher education is to nurture critical and reflective attitudes towards teaching and learning, and therefore ITE "should emphasise questions, investigations, analysis and criticism." (Ball and Cohen, 1999, p. 13). Author (2014) proposed that novice teachers find it difficult to identify the specific ingredients of more successful lessons, and that they learn more about the work of teaching by critical evaluation of 'regular' instruction. This study arose after discussion with a group of researchers in the UK involved with mathematics pre-service teachers. We became interested in our approaches to using video material with our pre-service teachers so we decided to select one example to do some focused work around. We met as a group to identify a clip that would be suitable for this work and would be of benefit to the pre-service teachers in an already tight timetable. Each of us brought examples of clips that we had used or were considering using with our pre-service teachers to a meeting to agree on a suitable clip for the study.

We selected a clip which was freely available on the internet and promoted by the UK government's sponsored mathematics agency. It had been specifically prepared to support the delivery of the new National Curriculum and although relevant for pre-service teachers, this was not its main purpose. The clip focused on supporting pupils to make the transition from informal multiplication methods, specifically the grid method (see Figure 1.) to the formal written method for multiplication (see Figure 2).

x	20	3	Totals
40	800	120	920
5	100	15	115
			1035

Figure 1. Grid method of calculation.

		2	3
	x_1	4_1	5
	1	1	5
+	9	2	0
1	0	3	5

Figure 2. Formal written method of calculation.

Our rationale for this selection was that this was widely promoted in the UK to support teachers implementing the new National Curriculum (Hanson, 2013) and we felt it was important that pre-service teachers had some experience of 'critiquing' material which is promoted in this way. Many of us make use of video material to support and extend our teaching so a further potential benefit of this study was to ensure that our pre-service teachers were routinely prepared to critique this sort of material. The rationale for this was that to support their professional development, pre-service teachers were likely to review video material available on the internet and elsewhere during their training year and beyond, and because of this we wanted to ensure that they were able to make reasoned judgements about its quality.

The research questions for the study were:

- What sense do pre-service elementary mathematics teachers make of video material of 'good' mathematics lessons?
- What role does discussion have on reflections relating to the use of video material of mathematics lessons in university teaching sessions?

The use of video in pre-service teacher education

In the late 1980s Jaworski's work on the use of video to support the professional development of mathematics teachers identified that although video material was regularly used for this purpose, there was limited research published in this field (Jaworski, 1990). More than two decades on, an extensive body of literature on the use of video to support teachers' professional development is now available, although exactly how video material is used is varied. Blomberg, Renkl, Sherin, Borko and Seidel (2013) have produced a useful list of research studies that have focused on the use of video material in pre-service teacher education and Herbst and Kosko (2014) discuss the benefits and limitations of video use in supporting mathematics teaching specifically. For the purpose of this study, we are particularly interested in the literature on supporting pre-service mathematics teachers.

Video material has been used in a range of ways and for a variety of purposes in pre-service education. For example it can be used for interaction analysis, to model expert teaching, to micro-teach and to critique teachers' own practice (Sherin, 2007). It can be used to support professional development of teachers by reflecting on videos of themselves teaching and this may then be used for individual or group reflection (Coles, 2013). Others use video material to identify components of effective mathematics teaching (Clarke, Hollingsworth and Gorur, 2013). What follows below is an overview of these approaches before we come on to considering the purpose of the use of video in our study.

Star and Strictland (2008) suggest that the use of video is helpful for pre-service teachers because the same pieces of teaching can be shared and discussed. This can be helpful because initially, pre-service teachers have limited experience and they are 'quite weak in the critical skill of noticing classroom events' (Star and Strictland, 2008, p. 124). Sherin and can Es (2009) identify the difference between noticing and interpreting elements of a lesson and they stress the importance of delaying the interpretation of these events until after they have been identified, or noticed.

> While teaching certainly involves making judgments about what went well or poorly in a lesson, we believe it is critical for teachers to first notice what is significant in a classroom interaction, then interpret that event, and then use those interpretations to inform pedagogical decisions (Sherin and van Es, 2009, p.247).

However Coles (2013) argues that having a pre-conceived idea about what is significant is detrimental to the process of discussion and that the role of the facilitator should be to respond to the discussion about what is noticed. Videos of teaching are regarded as a means of deepening learning by pre-service teachers (Llinares and Valls, 2010) and using video with pre-service teachers may therefore be more effective if they first give an account of what they have seen before going on to account for it (Jaworski, 1990; Coles, 2013). There may be greater potential for this approach when working with pre-service teachers as they have had limited experience in the classroom and may therefore be less likely to jump to conclusions about what is 'significant' and focus on 'noticing'.

Pre-service teachers have been found to change their opinion about mathematics teaching following a discussion about a clip of teaching because this opportunity provides unique access to teaching and learning that they would not otherwise have had (Lampert and Ball, 1998). Several studies have found that watching videos of mathematics teaching helped to bridge the gap between theory and practice (Lin, 2005; Taylor, 2002) because it gave pre-service teachers an opportunity to observe classroom situations which they would not have otherwise gained. Video material has the potential to provide access to pupils' mathematical thinking within the context of a classroom which is important because teachers are more likely to be able to relate to a classroom that they can imagine themselves in (Sherin and van Es, 2009). However, a potential

drawback of the use of video material is that teachers may dismiss it if they don't feel that it is relevant to the context of their own classrooms (Blomberg et al, 2013) or, as Sangata and Guarino (2011) suggest, because the teaching ability of the teacher in the video is too distant from their perceived ability:

> Although many choose video exactly because of its closeness to the complex reality of the classroom, teachers' past experiences and beliefs about what is possible and not possible in teaching may turn even video into an artificial representation of teaching that teachers can easily dismiss (Sangata and Guarino, 2011, p. 143).

Several studies focus on using video with in-service teachers to improve their practice in school. Coles (2013) used video for professional development and found that video watching in a group with follow-up discussion was more useful than individual lesson observations. Videos can allow the participants to construct their own interpretations of the classroom depicted and to attend to those aspects they consider important. The role of facilitator is therefore crucial to encourage teacher discussion (Clarke, Hollingsworth and Gorur, 2013) and this can assist pre-service teachers to appreciate alternative viewpoints and to think more critically (Lin, 2005).

Coles (2013) suggests five key aspects to consider when working with video to support teachers' professional development: selecting the video clip, setting up discussion norms, re-watching the video clip, moving to interpretation and metacommenting. Setting up discussion norms, as described in the study, is done rigorously and regularly, and the approach is adopted consistently. Whilst an entirely valid approach, this is not easily feasible in an elementary teacher training course when time available for specific mathematics teaching is limited. However, the purpose of research by Santagata and Guarino (2011) was using video to teach pre-service teachers to learn from teaching videos. Their research project focused on encouraging approaches to analyze video material which would 'generate knowledge for improvement' (Santagata and Guarino, 2011, p. 133). This was part of the 'Learning to Learn from Mathematics Teaching' project at the University of California, and aimed to study the role of a disciplined analysis of teaching for mathematics teacher preparation. As part of the project two courses were developed to make extensive use of video. Their premise was to go beyond the teaching of general reflective practices and provide opportunities to reflect in disciplined and structured ways. They developed a framework to guide their analyses of teaching and found that video-based activities supported pre-service teachers' learning to attend to details of pupil thinking and of teachers' instructional moves that make pupil thinking visible. The video–based activities also supported pre-service teachers' learning to reason about teaching in an integrated way by considering the impact of the teacher's decisions on pupils' learning. In half of the cases studied, video-based activities also promoted the pre-service teacher's ability to spontaneously propose alternatives to what they had observed in the video. There was a particular stance taken toward video as a representation of teaching. They did not let the videos speak for themselves but they highly scaffolded pre-service teachers' viewing and analysis experiences by alerting them to specific aspects displayed in the videos.

Responses to video material can assist pre-service teachers in making their beliefs clear (Philipp, Ambrose, Lamb and Sowder, 2007). It is the experiences that observers have had previously, either in real classrooms or on video, that they draw on in response to video material. This may include their own experiences of learning and teaching; their knowledge of the subject, of pedagogy and of students and their own beliefs, all of which influence their experience of the subject and how it is taught and learned (Beswick and Muir, 2013). The teacher's conception of the nature of mathematics is influenced by his or her belief system concerning the nature of mathematics as a whole. Such views form the basis of the philosophy of mathematics, although some teachers' views may not have been elaborated into fully

articulated philosophies, particularly before they become practicing teachers. Their conceptions of the nature of mathematics by no means have to be consciously held views; rather they may be implicitly held philosophies (Ernest, 1991) which begin to take shape in response to video material. Philipp et al (2007) found greater change in beliefs after watching video than in lectures and in school experience. In this experimental study, prospective elementary school teachers enrolled in a mathematics course were randomly assigned to (a) concurrently learn about children's mathematical thinking by watching children on video or working directly with children, (b) concurrently visit elementary school classrooms of conveniently located or of teachers who were thought to be specifically good at teaching mathematics, or (c) a control group. The control group followed the course but did not have any extra field work experiences. Those who studied children's mathematical thinking by watching children in video clips developed more sophisticated beliefs about mathematics, teaching, and learning and improved their mathematical content knowledge more than those who were in school or the control group. Interestingly the subject knowledge did not change as much as their beliefs. The conclusions of this research were that it was the opportunity offered by the videos that prompted the pre-service teachers to reflect more deeply on what they observed that was critical (Philipp et al 2007).

There seems to be little discussion in the literature about how pre-service and indeed in-service teachers use the widely available video material on the internet. There is discussion about whether training should draw on 'best-practice' or 'typical' practice (Blomberg et al, 2013) but when teachers are at home, researching how to approach teaching a mathematical topic, little is known about how they consider whether the clips they find are 'good' examples. The study reported here attempts to address this gap.

Methodology

This study took place in a university located in west London in October 2013. The pre-service teachers on the programme were typical of many postgraduate teacher training courses in the London region. There were 141 pre-service teachers, just over three quarters of whom were female. Half of the pre-service teachers had an ethnicity other than white British and the next biggest ethnic group in the cohort was Asian Indian. Two thirds of the group were under twenty five when they enrolled.

The timing of the study was approximately a third of the way through the centre-based training element of the course and prior to any extended periods of school experience. Student teachers had received a session entitled 'Mathematical understanding' which explores Skemp's (1978) ideas of relational and instrumental understanding and a session on 'Progression through calculation' which had focused predominantly on informal calculation strategies. Video clips had been used in the training prior to this session but no significant opportunities were provided to critique the material.

This study took place during a workshop session entitled 'Conceptual Understanding versus algorithms' and was repeated by the same tutor five times, with each group of approximately 30 pre-service teachers. The broad aims of the session were:

- To consider progression through multiplication
- To consider appropriate resources to support progression
- To discuss the purpose of algorithms in mathematics
- To discuss how to balance conceptual understanding with procedural fluency

The session aims and a broad overview of the study were shared with the pre-service teachers. The British Educational Research Association (BERA) ethical guidelines were

followed (BERA, 2011) and ethical approval was granted by the university's ethics committee. It is recognised that there were potential issues of power relating to the study, given that the regular mathematics tutor was carrying out the research but great effort was made to ensure that participants did not feel pressured to be included. Only data from those providing their consent to participate in the research were included in the study.

The video clip was shown to the group as a whole and the following prompts were provided to facilitate smaller group discussions (between 4 – 6 pre-service teachers):

1. What do you think is good about the teaching in this session?
2. What do you think isn't so good about the session?
3. How has the video helped you to think about your preparation for teaching?

Pre-service teachers had approximately twenty minutes to discuss the video clip and respond to the prompts, before coming back for a general discussion with the whole group where pre-service teachers shared feedback from their small group discussion. Towards the end of the session a further prompt was given for pre-service teachers to respond to which was:

- *How has engaging in this discussion and critique of the video helped you in preparing for teaching?*

At the university where this study was carried out, the UK's core subjects of English, mathematics and science were taught in blocks where pre-service students received dedicated days of teaching in each subject. The expectation was that after each day, pre-service teachers wrote a short reflective comment about their learning. Although eighty three pre-service teachers completed the ethics form and gave permission to include their responses in the study, some did not reflect on this activity so their responses have not been included. A total of fifty four gave permission and reflected on the activity which is our complete data set.

In analysing the qualitative data that stemmed from 54 written reflections we adopted elements of grounded theory analysis. On the basis of grounded theory principles and practices coding is conducted as an emergent and comparative process that helps the researcher to construct "an interpretive portrayal of the studied world" by defining what is happening in the data and beginning to understand what it means (Charmaz, 2007, p.10). In line with this central premise of grounded theory we conducted emergent coding with the view to shaping an analytic frame and direction.

At an initial phase, the same five randomly selected reflections were coded separately by each member of the research team. In applying sentence-by-sentence coding and comparing each of those reflections with each other, each researcher identified key issues that appeared to define what was happening in that part of the data and proposed initial coding ideas. A subsequent meeting and discussion of our individual coding resulted to a set of codes that each of us applied to code another three, randomly selected reflections, with the view to checking whether the codes that had emerged from the first five reflections captured ideas that were expressed in a different fragment of our data and whether new, additional codes would emerge. At this initial phase we aimed at staying close to the data and be open to exploring and discerning different possibilities (Charmaz, 2011).

A following meeting had the objective of developing a set of agreed codes that represented the range of ideas expressed in pre-service teachers' written reflections. We selected the most significant and frequently occurring codes to shape our focus of analysis and grouped them into categories. The categories captured recurring themes in pre-service teachers' reflections and encompassed comments related to the teacher's pedagogy in the video clip, comments that related to pre-service teachers' beliefs about learning and teaching mathematics, comments about what pre-service teachers felt that they had learnt and comments associated with the value of watching and discussing the video as a group. Having established a direction of analysis, we proceeded to sentence-by-sentence coding of the remaining data using the agreed

codes. Following this, the process of analysis was a comparative, interpretive process whereby we explored commonalities and differences within each category with the aim of identifying what pre-service teachers make of watching a government-sponsored video, what they predominantly focus on and how watching a video as part of a process of group discussion impacts on their reflections.

Findings

The table below summarises the codes and categories of codes that emerged from the analysis of the data and presents illustrative examples of extracts that were coded under each category.

Table 1
Emerging codes and examples of corresponding extracts

Code	Description	Examples of comments.
T	**Reflection on the actions of the teacher in the video clip**	
TMP	**Mathematics Pedagogy** Comments about pedagogy relating to mathematics.	I like how the teacher in the clip built on the existing knowledge of the children and referred to the grid method for multiplication (A3) I also felt that the teacher jumped into a more complex example straight away and did not ever fully explain the step-by-step process (5)
TGP	**General pedagogy** Comments about pedagogy in general.	The teaching style, key words, breakdowns and open questions showed how good teaching should be. (E13) It was not very engaging, particularly for those who need a lot more stimulation. (E9)
B	**Pre-service Teacher Beliefs**	
BLM	**View of learning mathematics** Comments about the pre-service teacher's views about how mathematics should be/is learnt.	Tried and tested methods are likely far more accurate and efficient that constantly considering which method to use. I'm not sure I agree therefore with her premise. (E8)
BTM	**View of teaching mathematics** Comments that the pre-service teachers make about how they believe mathematics should be taught.	I feel children should also be explicitly taught facts in order to provide a secure base for exploration of different strategies within counting and problem solving. (C8)
L	**Pre-service Teacher Learning**	
LSMK	**Subject matter knowledge** Specific comments about mathematics that the pre-service teacher learnt from the video process.	The video also helped me extend my subject knowledge. More specifically, develop a better understanding of the gridding method and its connection with algorithms. (B8)
LPCK	**Pedagogical content knowledge** Comments about mathematics pedagogy that the pre-service teacher has learnt.	One positive aspect of the video that I learnt was that using open ended questions helps children with their conceptual understanding. (E9)
V	**Reflection on video stimulated task**	
VVD	**Valuing discussion** Reference to the benefits (or otherwise) to sharing	Although the video itself was useful, the discussion that entailed afterwards was more beneficial. (B2)

	opinion/feedback on the video.	
VAL	**Authenticity of the lesson** Comments about the content of the video and the nature of the lesson viewed.	The whole thing seems to be staged, the children appear to pick up the algorithm method quite quickly which makes me think that they may have had some instruction before…as a trainee teacher I would like to see how the teacher would deal with a student who didn't understand the method as well. (E2)
VEP	**Evaluation of the process** Comments about how useful the process of critiquing a video clip as a group was.	I feel that it is beneficial to watch a video showing a classroom environment during a week of lectures and workshops. Ignoring the actual content of the video, a video showing a class based environment can contextualise the academic theories that are being discussed. (C1)
VCE	**Critical evaluation** Critical judgement about what is seen in the video, as opposed to noting it.	It would have been beneficial if all the children had not got the new method straight away and had not been able to immediately spot the differences and the connections so that those watching could see how the teacher would help that child, if they would break down or explain it differently. (E5)

The following sections present our findings in relation to each of the identified categories and the nature of comments that pre-service teachers included in their individually written reflections following the group discussion.

Reflection on Teacher

Comments related to general as well as mathematics-specific pedagogy were the most prominent across pre-service teachers' written reflections. These comments mainly focused on two elements: the ways in which the teacher supported progression and the teacher's use of questioning.

Reflection upon the teacher's approach to teaching mathematics (TMP) focused on the way in which she supported children's progression from a method of calculation that was familiar to them (i.e. the grid method) to the standard algorithm for long multiplication which involved a compressed way of recording calculation steps. Extracts such as the following are indicative of positive comments on the way in which the teacher made connections between the already 'known' and the 'new'.

> I think that the video was a great example of a constructivist approach of learning, as the teacher was using children's previous knowledge and skills e.g. gridding method to build on the new concepts presented e.g. algorithms. This consistency in learning helped the students to make better connections between the two methods and consequently develop a better and quicker understanding of the new one presented (B8).

Comments such as the above seemed to point particularly to the teacher's efforts to make children see and understand the conceptual connection between the two methods. Her use of questioning was seen by some as being fundamental in supporting this aim. The extracts below

highlight positive comments about the way in which the teacher encouraged children to compare the two methods, think about and explain similarities and differences.

> I also thought the language that she used in her questioning of the pupils was highly appropriate, "What was the same?" and "What was different" for example (C3).

> I really liked the fact that after the teacher showed them how to do the standard algorithm, the children were asked to compare the strategies and noticed it was a quicker approach to multiplications and involved less working out. (C4)

In introducing the standard algorithm the teacher referred to this, new for the children, method as 'her' method ("my way") and to the grid method as ' 'the children's' method ("your way"). The language of 'my' and 'your way' triggered both positive and negative comments.

> I liked the way the teacher explained the algorithm as 'her' way of doing long multiplication, each child learns differently & likes a different method so calling it 'her' method doesn't make the children feel like they have to use it (E2).

> In this instance the use of the word 'my' was powerful in that it implied that this was not the correct method but simply another way in which you may tackle the multiplication. She demonstrated that even though they had used two different methods they had both gained the correct answer. (E5).

In the two extracts above the use of the words 'your' and 'my' is considered as a choice of language that precluded assumptions about 'wrong' or 'right' and allowed children to reflect upon the procedural differences between the two methods as well as the conceptual links between the two different ways of recording multiplication steps. This was also seen and interpreted as part of a pedagogy that respects children's preferences in learning. Some pre-service teachers saw the teacher's approach as one that allowed children to be flexible, reflect on the affordances of the two methods and choose the one that they preferred.

However, there were also comments that noted how the teacher was working towards a specific teaching aim. Her questioning aimed at supporting children's reflection on the similarities and differences between the two methods and the effectiveness of each of the two methods but ultimately leading children to recognise and accept the standard algorithm as the most effective way of written calculation; the method that they should adopt from then on.

> It highlighted the new method was perceived as 'quicker' and only involved 'two steps instead of four', again adding to the column method's positive view in the children's eyes. (E12)

> The main issue I had with this was her use of 'my way' (being the column algorithm), seemingly over writing the pupil's way. The lesson seemed heavily weighted towards proving her way to be the best way…. The teacher clearly had a strong understanding of what she was trying to achieve and how she felt it would be best to go about it (B5)

The above extracts take a slightly different position than the previous ones in seeing the teacher's approach and use of language as specifically serving the aim of introducing and establishing the standard algorithm as the most effective method. The second extract makes a critical point in seeing the use of the words 'your' and 'my' as the teacher's conscious choice of language that aimed to support the specific teaching objective rather than encourage flexibility in learning and empower children's preferences.

Apart from the above critical point, comments on the teacher's use of language and questioning were predominantly positive and seen as a way through which the teacher encouraged children to think. Comments on the use of open-ended questions such as the ones shown below often seemed to stem from the trainees' reflection on issues of general rather than mathematics-specific pedagogy.

> It showed how the teacher effectively communicated the task with her pupils (e.g. clear instructions and guidance). (A4)

> I also really liked how much she allowed the children to try out for themselves rather than telling them how to do it. (E12)

Reflections that clearly referred to mathematics-specific pedagogy also included critical comments upon the teacher's demonstration and explanations of the mathematics concepts and procedural steps involved in the newly introduced algorithm.

> I also felt that the teacher jumped into a more complex example straight away and did not ever fully explain the step-by-step process. (F5)

> I personally think she did explain the method but it could have been more thorough for example to explain how we carry the numbers or why the zero is added in the units' column when looking at two digit numbers. (C10)

In comments such as the above the critical stance towards the teacher's mathematics teaching approach focused on identified points of weakness in how the teacher demonstrated the algorithm and in the thoroughness and clarity of her explanations.

Pre-service teacher Beliefs

Positive or negative comments of what was shown in the video were often presented alongside statements that appeared to reflect individual views and beliefs about how mathematics should be learnt and taught. Such statements often referred to pre-service teachers' previous experiences in learning and teaching mathematics. Beswick and Muir (2013) point out that classroom and video observations and interpretations are dependent upon previous experiences and beliefs.

Extracts such as the following appeared to be geared more towards beliefs about what mathematics learning (BLM) should be about and the benefits of flexibility in learning mathematics.

> Children are less likely to make mistakes while using algorithms if they understand it- if they are simply following steps they are more likely to miss one out and make errors in their work. (A1)

> If a child is given many options and tactics in how to approach a problem, they will not give up so easily, but try and try again. (C7)

Other comments reflected particular beliefs about the teaching of mathematics (BTM); what should be taught and how. The following two extracts provide examples of positive comments about teaching that introduces learners to more than one way of calculation and allows the development of conceptual understanding.

> I believe it is a positive approach to teaching if a child has more than one strategy to use when answering an equation. (C4)

> I have encountered many children and peers that have learnt the algorithm but have very little understanding of why it works. This has highlighted to me how important it is to ensure that the algorithms are not taught rote, but rather they are taught alongside other methods. In this way I believe the algorithm can be taught with a conceptual understanding (D2).

In contrast to the above the extract below presents a critical comment of the teaching approach that is depicted in the video and which is seen in this case as an approach that is 'dictating' children to adopt the standard algorithm rather than supporting flexibility and choice. This is based upon an expressed strong belief about how mathematics should be taught.

> I felt that the lady in the clip, was almost forcing the children to see the written algorithms as being the most convenient method to use. However, this method may confuse some individuals, who grasp multiplication using partitioning. I am a strong believer, of giving the tools to help children find a method that works for them. Rather than dictating a 'convenient' method that they have to use. (D7)

In many cases beliefs on learning and teaching seemed to interweave as pre-service teachers formulated their reflections upon different aspects of the video. Many extracts were coded and analysed as reflecting both. For example, the extract below, similar to the above, is very critical of the teaching style and approach shown in the video but the criticism seems to be associated with particular beliefs about the importance of freedom in learning and the value of exploration. The video is criticised for depicting an approach that does not really support personal preference.

> Is this a teaching style that could be differentiated and work for children of a lower ability or a SEND or EAL child? I don't think that it would be. I understand the pressure on a teacher to be 'efficient' in their teaching with the new expectations from the government, but it concerns me that we are removing the freedom for children to explore and understand maths. I believe that as long as children can understand all methods and are happy with the way that the algorithms work, it should not matter which they prefer to use. Maybe that is a wrong view on my part, but I certainly don't think that they should be told that their way is wrong and have a method that they have spent time learning be dismissed so quickly. (D3)

In another example, critical comments on the video are formulated on the basis of very different beliefs on mathematics learning and teaching than those expressed in the above extract.

> I would question this latter point on flexibility: if a child is able to get the correct answer does it matter what method they use to do this. Tried and tested methods are likely far more accurate and efficient that constantly considering which method to use. I'm not sure I agree therefore with her premise…. I know when we learnt how to do this at school we were not given a variety of options as to how to work this out, we were just taught the column method from the outset. I think in some instances having too many variations and ways to calculate results in confusion for the child. I think so long as you know a way that works it does not matter what this way is. (E8)

The views expressed here point out the pre-service teacher's perceived disadvantages of "too many variations" when it comes to learning methods of calculation. The criticism in this case does not focus on the teaching approach as much as on *what* the teaching of mathematics should include. Analogously though, it is strongly based on a particular view about what mathematics is about and how it should be taught. This seems to be influenced by previous, personal experience of learning mathematics at school.

Extracts such as the above and statements such as:

> Having never learnt the grid method at school I much prefer the formal algorithm and am glad that it is being reintroduced (E6)

indicated how, on many occasions pre-service teachers' own learning experiences seemed to shape particular beliefs on learning and teaching mathematics which in turn informed and perhaps influenced their viewing and interpretation of the teaching and learning situation that what was shown in the video (Philipp, Ambrose, Lamb and Sowder, 2007).

Pre-service teacher learning

Written reflections included references to what pre-service teachers thought that they had learnt from watching the video as well as from the process of discussing it with their peers.

Explicit comments on learning referred to gains associated with subject knowledge (LSMK) as well as pedagogical content knowledge (LPCK).

Reflections associated with subject knowledge included comments such as the one below that referred to a direct effect that the video seemed to have on improving subject knowledge.

> The video also helped me extend my subject knowledge. More specifically, I develop a better understanding of the gridding method and its connection with algorithms. (B8)

Most comments referring to subject knowledge indicated how watching the video increased pre-service teachers' awareness of the areas of their subject knowledge that needed to be strengthened rather than a direct effect on subject knowledge.

> This was the first time I have seen a grid used to complete an equation. For me this shows that I need to increase my subject knowledge, because there will be children who use this method. (B6)

> Although I think the column method is a really good technique, I personally feel worried about the prospect of teaching it due to a worry of my own understanding of the concept. I feel I need to go away and revise the column method on the website 'maths is fun', which explains methods clearly and has questions to check my understanding. (E12)

Reflections on learning associated with pedagogical content knowledge included comments such as:

> It has reinforced for me the importance of explaining to the children 'why' they are doing something and to ensure that each step is fully understood before moving onto worksheets/assessment. (F5)

> I realised that using resources is important and teaching children in a way that they understand and using the correct terminology is really important. (B9)

Such comments mainly indicated the emergence or reinforcement of realisations related to the importance of teaching for understanding and the actions that a teacher can take to best support children's conceptual understanding in mathematics.

Reflection on Video-stimulated task

The process of using video as a vehicle for discussion and reflection provoked a wide range of comments (VVD). The importance of peer discussion associated with the video was regularly noted and the collaborative approach it had enabled was considered useful.

> The workshop also worked well because it gave us the opportunity to discuss how we felt about the video, allowing us to listen and see new points of view from different people that I know myself I would not have thought about without the discussion. (B1)

In comments such as the above reference to the value of listening to each other's observations and reflections suggested that the opportunity to discuss and critique had enabled pre-service teachers to access the content of the video in a way that they would not have been able to if watching it alone. Additionally, joint viewing and discussion drew elements to their attention that they may not otherwise have considered. The opposing opinions within groups were frequently mentioned and the opportunity to review the video from a range of perspectives was considered useful.

> I found that I noticed negative and positive points that others may not have and others also found other negative and positive opinions that I had not thought of. Through the discussion it allowed me time to understand the video and its whole picture. (B3)

> Through the group I had the chance to reflect on the video and develop my thinking through talking. (B8)

The authenticity of the video (VAD) was questioned and whilst pre-service teachers valued the opportunity to observe at close hand the teaching of a targeted group; many felt it was "staged" (B4) or "not a true reflection" (E11). There was also the understanding of the purpose behind the video as shown by the following comment.

> I think we should be able to appreciate the fact that most of these situations are set up for recording therefore it has to be direct, concise and pacey. (D1)

A common perception was that the children seemed to have understood the algorithm very quickly, perhaps suggesting some rehearsal of the process. These types of observations prompted suggestions that the pre-service teachers felt would be useful additions. These comments (VCE) predominantly fell into two main categories: firstly, the inclusion of children who did not understand so readily in order to show how difficulties may be overcome and how small steps may be explained, as typified by the comment below.

> As a trainee it would have been beneficial to show a lower ability group being taught the same concept and learning from the mistakes they made whilst figuring out the links between the two methods. (E6)

Secondly, the view that including the whole class would have been beneficial to show how this would be undertaken in a normal primary setting so it could be seen how it may be differentiated.

> I think that the video would have been even more valuable to us if we had seen the planning for the whole class. For instance, what activities were the other children doing? (E7)

Some comments indicated a view that the video had been provided as a model of good practice. This was a fair assumption given that it is available in the support materials of the 2014 National Curriculum on the government sponsored website and that video is often used this way in Initial Teacher Training. One such example is below,

> All in all, I think that through the workshop we were exposed to good teaching practices that are not only useful for Maths but can be used and transferred to other lessons as well. (B2)

This assumption may have affected the tone of some commentaries, if they perceived that this was being provided as a model, which they might be expected to emulate in their own teaching. The comment below considers the provenance of the approach advocated within the video and appears to accept it on the premise that it depicts evidence-based practice.

> I think that if pupils are taught well by a good teacher and they are actually convinced that the algorithm really is easier and faster, then they will use it. I know I will and I hope I am right by thinking that the government came to this decision after a well-conducted research. (D1)

Within their reflections pre-service teachers considered the value of using video as part of a process, as a means of providing shared experience enabling individual critique and group discussion (VEP). The provision of such materials, which could give an insight into different aspects of teaching and learning in a quick, accessible way was considered as a useful part of their professional development. The opportunity to,

> …objectively critique or reflect on various issues without offending anyone. (E6)

was considered valuable and some felt that working with their group had provided a model for considering other similar materials. For example,

> This exercise has made me realise that I shouldn't merely accept and adopt strategies that are said/shown to be best practice but to always critically appraise and think for oneself. (C6)

Although there were some reservations about the authenticity of the video, the comments of the pre-service teachers generally indicated that they valued the process of using video to promote group discussion and the opportunity to reflect about its implications for their own practice.

Summary and Conclusions

The research reported in this paper was motivated in part by shared professional concerns in our role as mathematics teacher educators working with pre-service elementary teachers. Primary mathematics policy in England has swung between reform and reaction over the last 3 to 4 decades (Brown, 2010) and it is fair to say that we had (and have) some misgivings about the direction of travel in the latest iteration of the English National Curriculum for primary mathematics. At the same time, our professional responsibilities (not to mention national teacher education inspection regimes) require us to prepare our pre-service teachers to 'deliver' the curriculum in force at the time, irrespective of our own opinion of some of the detail. This is not a new situation, and it is one that we accommodate as best we can. In this case, we were faced with the online government-sponsored video resources, designed to 'support' teachers' implementation of the new curriculum. We could ignore them, but it would be irresponsible to do so; in any case, our web-aware students would locate these materials themselves if we did not bring them to their attention.

Irrespective of our views of the relative merits of alternative written multiplication methods, we had two further concerns. First, even though we respect the integrity and commitment of the teacher (unknown to us) in the video, we did not view the instruction portrayed as 'exemplary' in some respects, and we were worried that our students might commit to what was portrayed without reservation – the video was, after all, officially sanctioned. Secondly, as we remarked earlier, we had come to the view that novice teachers can sometimes learn more from reflecting on 'flawed' teaching than from attempting to imitate 'exemplary' practice (Blomberg et al, 2013). Ironically, in fact, we had available video of a novice teacher working on exactly the same transition (from grid multiplication to formal column algorithm; Author, 2014). So our enquiry starting point was to investigate whether our fears (uncritical alignment with questionable policy) would be realised, and to set up conditions (group reflection and whole-class discussion) likely to activate a more questioning climate. We should make it clear that it was neither our wish nor our purpose for our students to think in the same way that we do; rather, we wanted them to come to a considered view, and one that they could defend having considered alternatives. This is in keeping with our stance, stated earlier, that a key goal of teacher education is to nurture critical and reflective attitudes towards teaching and learning.

These considerations form the backdrop to our evaluation of the research in terms of our stated questions:

- What sense do pre-service elementary mathematics teachers make of video records of 'good' mathematics lessons?
- What role does discussion have on reflections relating to the use of video material of mathematics lessons in university teaching sessions?

Regarding the first question, our findings are mixed: our grounded theory analysis organised the complexity of the student teachers' responses, but also brought to light the variety in responses. In particular, the evaluation of the teaching and the prioritising of the traditional column algorithm ('my way') elicited a spectrum from enthusiastic acceptance to questioning and evident distaste. It presented us with more positive perspectives on the 'my way' approach to mathematics didactics, in terms of possible alternatives rather than imposed

strategies. Unsurprisingly, the pre-service teachers' beliefs (coded BLM, BTM), most likely formed by their own experiences as learners, frequently underpinned their evaluation of the teaching portrayed in the video. This serves to remind us that such beliefs mediate everything that we (and others) offer to our students, and it would be naïve to imagine that it were otherwise. This, in turn, causes us to reflect on the importance of identifying such beliefs at strategic points in our pre-service programs (Beswick and Muir, 2013).

Many of our participants identified aspects of the teacher's pedagogy, both subject-specific and general, that they found instructive; not only for the young students in her classroom, but also for themselves as novice teachers. This included aspects of the management of the lesson, as well as building on and linking to existing knowledge ("a great example of a constructivist approach of learning"). But in addition to this appreciative appraisal of what they saw, at times they demonstrated their capacity for critical evaluation. One participant, for example, questioned the choice of example used to demonstrate the column method – an aspect of instruction analysis which has attracted renewed attention in recent years (e.g. Zaslavsky, 2014). As we have remarked, evaluation of the 'my way' approach to motivating the shift from grid to column method received mixed reviews, but opinion in both directions was backed by thoughtful rationales.

With regard to our second research question, it was evident that the opportunity for pre-service teachers to engage in discussion about the video had, for many, resulted in either a changed opinion about the content, or an appreciation of others' interpretations. Perhaps this is particularly relevant to pre-service teachers, with limited experience of the classroom (Coles, 2013), but seeing "new points of view" that they would "not have thought about" was a typical comment, even following discussion with their peers. However, despite the activity being set up in such a way to encourage critical reflection, some comments indicated that pre-service teachers assumed that the video clip portrayed exemplary teaching. Although we were initially surprised by the apparently naive comment that governments draw on 'well-conducted research' for curriculum design (there is extensive evidence that this not being the case e.g. Brown, Askew, Baker, Denvir and Millet (1998) and Thompson (2009), it is perhaps not unreasonable that this is what our pre-service teachers would assume.

It is clear that video material has significant potential for professional learning opportunities but it seems evident that pre-service teachers (and indeed in-service teachers) benefit from opportunities to reflect and discuss the material with colleagues. In a climate in England where teacher education is being pushed further away from time spent in Universities to in-school training, this may prove difficult.

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