Researching Primary Trainees' Choice of Examples: The Findings

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This paper reports on the findings of a doctoral study exploring primary trainee teachers' choices of mathematical examples and the relationship between this and their mathematical subject knowledge. Through a combination of interview analyses and lesson plans gathered from the final school placement of one cohort of Bachelor of Education trainees, some approaches appear to be commonly held by trainees about the nature and purpose of examples in the planning and teaching process. This paper presents the research design and summarises the outcomes from the data.

Keywords: Primary, Trainees, Examples.

Introduction

When teachers plan to teach mathematics, they draw on many examples to either demonstrate a concept or provide opportunities for learners to practise skills and procedures. The examples used by primary trainee teachers, it is suggested, are often chosen without suitable consideration of learners' strengths, weaknesses or misconceptions. Whilst there has been research on the choice of examples by teachers in secondary mathematics, detailed empirical research of primary mathematics or for trainee teachers is relatively scarce. In this study, two cohorts of final year trainee primary teachers were invited to submit lesson plans for analysis and a sample group was interviewed to try to identify the theoretical frameworks trainees use for planning mathematics and their approaches to choosing examples for learning. The data collected were then analysed using a multiple case study approach against a conceptual framework based on the Knowledge Quartet research of Rowland et al. (2009) and the development of the notion of example spaces by Watson and Mason (2005). The analysis sought to identify commonalities in the way the group of trainees approached planning mathematics and draw insights on their rationales for choosing mathematical examples. Each trainee's planning was scrutinized against the theoretical background in the literature and conclusions were drawn regarding the methods of planning adopted, the examples chosen and the possible links between these actions and the trainees' levels of mathematical subject knowledge.

Literature

Teachers' knowledge for classroom practice was conceptualised in a seminal work by Shulman (1986) in which he sets out categories of teacher knowledge. His work has been used widely in developing approaches to developing and assessing teacher knowledge, particularly in work arising from the implementation of Circulars 10/97 and 10/98 (DfEE 1997, 1998). In these documents, curricular coverage for Initial Teacher Training (ITT) in the United Kingdom was set out. Three of Shulman's seven

categories focus directly on what can be called content knowledge, these being subject matter knowledge, pedagogical content knowledge and curricular knowledge.

The role of knowledge in the development of a primary trainee teacher has been examined by mathematics educators and government alike, each arguing for the content of a teacher education curriculum in mathematics. The concern with subject knowledge, particularly for primary trainees, has been growing since Alexander, Rose and Woodhead (1992) felt that strengthening teachers' subject knowledge would contribute to the aim of improving standards in mathematics. A later evaluation of the first year of the National Numeracy Strategy in England (Ofsted 2000) located weaknesses in teachers' mathematical subject knowledge.

This study examined the examples chosen by a number of final year Bachelor of Education (B.Ed) primary trainee teachers. The types of examples were analysed during consideration of the lesson plans, but it was helpful to have a typography and an understanding of the possible types of example that may be encountered. In order to analyse trainee teachers' examples, it was necessary to have a clear categorisation, or framework, against which to relate the trainees' choices. For this purpose, one such categorisation is that presented by Watson and Mason (2005). Whilst they focus on the role of learner-generated examples and the advantages of using such examples to enhance mathematical learning, they set out a number of definitions of examples which help to clarify the differences between types of examples that might be constructed and used by teachers or their pupils.

Using the notion that mathematics is about making general statements regarding the "actions carried out on objects" (Mason 2010), the categorisation of examples which Mason and Watson set out considers that all examples are used to enable a learner to generalise from them. They present the following types:

- Illustrations of concepts and principles
- Placeholders instead of general definitions and theorems
- Questions worked through in textbooks or by teachers (worked examples)
- Questions to be worked on by students (exercises)
- Representatives of classes
- Specific contextual situations

These types can be used in the process of exemplification, that is:

> to describe any situation in which something specific is offered to represent a general class with which the learner is to become familiar – a particular case of a generality. (Watson and Mason 2005, 4)

The data collected was also scrutinized using the framework of the 'Knowledge Quartet' developed by Rowland et al. to see the extent to which final year primary trainees use elements of the Quartet to plan lessons and choose examples. The analysis also gave scope for using this framework to support future cohorts of trainees. The Knowledge Quartet sets out to focus on the "classification of the situations in which mathematical knowledge for teaching surface in the classroom" (Rowland 2008).

The Study: Context and Methods

The study reported here began during the 2007/8 academic year in one ITT institution. Data was collected from two final year (3rd Year) cohorts of the B.Ed programme and included the following range:

- School placement data in terms of year groups taught
- GCSE and A-level grades in mathematics prior to starting the course
- Mathematics interview test data – item scores and totals
- Mathematics module assessments from each year on the course
- Diagnostic Numeracy Test scores from early in the 1st Year
- Results from 'Confidence Counts', an additional mathematics support module
- Trainees' self-audit of subject knowledge for mathematics

In Phase I (2007-08), 22 trainees brought a collection of plans to be used as data. This was around 400 separate lessons, covering a range of pupil year groups and mathematics topics. In Phase II (2008-09), 18 trainees brought around 300 separate lessons to be used as research data, covering a range of pupil year groups and mathematics topics. By separating the year groups and topics, it was possible to focus the analysis of examples to those year groups and topics which offered most data, by selecting as cases those trainees who had taught those topics and in those year groups. The sorting demonstrated that Year 3 and Year 4 lessons were most commonly represented in the primary range, followed by those from the Reception year. Trainees tended not to have placements in Year 6 classes so that school preparation for Standard Assessment Tasks (SATs) at age 11 is not interrupted. The most common topics were addition and subtraction, which accounted for 66 plans, followed by 52 on multiplication and 42 on 2D and 3D shape.

As well as lesson plans, resource materials such as worksheets were collected, both published and 'home-made' by either the trainees or their placement class teachers. The published resources tended to come from a limited range of materials, with only a small number of educational publishing companies being used. Amongst the material from publishers are mostly pupil textbooks, with pages allocated to different topics, demonstrating particular concepts by way of a range of examples. These examples form part of the analysis. Self-produced worksheets are generally variations of those found in published materials, and modified to suit the particular needs of a teacher and their pupils. The modifications are most often based on the notion of differentiation of tasks for the attainment range of the group or class for which the worksheet is designed.

By considering the range of data for each trainee, it was decided to give each trainee an overall grade in the range A, B, C to indicate whether they were likely to be of higher attainment, middle attainment or lower attainment relative to the cohort. This grading was largely the researcher's subjective decision and was not arrived at by trying to calculate an overall result by any formulaic process, but sought to allow the selection of the case study students to form a purposive sample which, as fairly as possible, represented the range of students from two cohorts in terms of their past achievements, which informed my assessment of their potential for teaching mathematics.

The decision to choose the trainees to be the seven case studies was therefore then taken based on the following criteria:

- Year 3 trainee in either of the 2005-08 or 2006-09 cohorts
- Completing final school placement in the spring term of Year 3
- School placement was in Key Stage 2 and one of the most common school year groups
- Willing to submit mathematics lesson plans from final placement
- Mathematics topics taught were amongst the most common represented in the collection of lesson plans
- Willing to be interviewed about their planning and examples
- A selection of trainees from each of the A-C overall grading
- Interviews produced good quality data in sufficient depth for analysis

From the data and the criteria, seven trainees were selected for analysis of interview responses and lesson plans, against the research questions and literature themes.

Ref. No.	Pseud.	School Year Group	Pre-course data (GCSE, A-level)	Interview test score	Y1	Y2	Y3	No. of Lesson plans given for use	Grade for case choices
ED06	Suzy	Y4/5	A,B	70	62	68	78	25	A
ED13	Dawn	Y4	B	50	65	57	80	22	B
ED18	Sharon	Y4	A*,A	90	71	67	68	33	A
ED21	Victor	Y3/4	C	15	53	55	48	8	C
ED24	Naomi	Y4	C	n/a	40	45	40	21	C
ED26	Rachael	Y3	B	71	60	58	65	19	B
ED37	Andy	Y5	B	42	48	57	62	20	B

Results and Discussion

This paper reports analysis of the data collected from Phases I and II in terms of obtaining an overview of the range and scope of data within the lesson plans and how the interview outcomes provide insight into the approaches trainees use when planning mathematics lessons and selecting examples. The findings from the study are given briefly here in relation to the research questions. With regard to the first research question ‘What pedagogic considerations do a cohort of trainee primary teachers use when choosing mathematical examples in the classroom?’, the findings suggest that trainees use a variety of approaches, these being broadly summed up as ‘reliant on the Primary Strategy’, ‘reliant on other sources’ and ‘use of their own knowledge’.

The second research question was ‘How do these pedagogic considerations fit within current theoretical frameworks in primary mathematics pedagogy?’ This resulted in finding generally that primary trainees from the study are mostly able to recall aspects of theory from various module assignments during their course, but

were collectively rather inconsistent in considering any theoretical frameworks specifically when planning to teach mathematics. The third question asked 'Is there a relationship between the cohort of primary trainees' level of mathematical subject knowledge and the types of examples they select?' In response to this question, each of the trainees identified with the idea that subject knowledge is related to choice of examples. However, their views on the range and scope of subject knowledge and their understanding of mathematical 'examples' led to a blurred interpretation of the relationship between subject knowledge and examples.

The higher attainers demonstrated greater understanding of the 'knowledge – examples' relationship and believed in each case that they chose better examples but also pitched their lessons at a level too difficult for pupils. The middle attainers had varying mathematical competence but firmly believed that better subject knowledge led to better examples being chosen. The two lower attainers had different views; one lacked confidence and needed more help with subject knowledge and choosing examples, which he did not regard as being related, whilst the other was confident but recognized she was still learning and felt that better knowledge of the pupils helped her choose better examples.

Amongst all the trainees, there was ample evidence in both interview discussions and from examples on lesson plans that all the case study trainees, regardless of attainment, used differentiation as a key feature of their examples. There were many instances of trainees talking about starting off with easier examples, so that every pupil could do them, and then making the examples progressively harder in order to challenge pupils of middle and higher attainment. This finding was not anticipated from the research questions but was drawn directly from the collected evidence and emerged during the analysis phase. Looking back through the interview data, it is also apparent that none of the trainees who were in the case study group mentioned the importance of assessment in choosing examples, even though assessment can be regarded as a theoretical perspective. It may have been interesting to explore this aspect, relating trainees' choices to their assessments of children's prior learning.

Summary

The data collected in this study has provided an insight into the subject knowledge and choice of examples by two groups of primary trainees. From a small, self-selected sample of final year B.Ed trainees, there is some evidence that awareness of theoretical influences is weak, subject knowledge continues to be a cause for anxiety and the process of selecting examples for teaching and learning mathematics is rather more random than pedagogically planned. In order to extend this study, one of the most beneficial approaches would be to combine data collection of lesson plans and interviews with other data such as video-taping of lessons, interviews before and after the lessons with the trainees, and interviews with other participants in the lessons, such as teaching assistants and the children. Video tapes from lessons can be analysed in their own right, but could also be used in video-stimulated reflection with the trainees to enable them to focus on aspects of their practice which might improve when they see their teaching from the perspective of observer.

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