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Title: Changes in the 'beliefs' of pre-ITE maths students on a 24-week Subject Knowledge Enhancement Course
Year of publication: 2011
Citation: Clarke, J. (2011) 'Changes in the 'beliefs' of pre-ITE maths students on a 24-week Subject Knowledge Enhancement Course', *Research in Secondary Teacher Education*, 1(1) pp.3-8.

RESEARCH IN SECONDARY TEACHER EDUCATION
Vol.1, No.1. April 2011. pp. 3–8.

Changes in the 'beliefs' of pre-ITE maths students on a 24-week Subject Knowledge Enhancement Course

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In this paper I present the work from a small-scale mixed methods research project undertaken with participants from a pre-Initial Teacher Education (ITE) Mathematics Enhancement Course (MEC) at the University of East London (UEL) between January 2008 and July 2009. The study was part-funded by a Learning Enhancement Opportunities (LEO) grant and is being used as the pilot stage for a continuing long-term project. Data analysis is in the early stages; however, evidence indicates that there are complex relationships between how students understand mathematics as a subject, their own experiences of learning the subject at school and in higher education, their constructions of what kind of mathematics teacher they wish to be and their experiences of learning on the MEC. Findings indicated that the 'apprenticeship of observation' (Lortie 1975: 63) that students have undergone through their own learning in schools may be a key factor.

Keywords: Mathematics; Teacher Education; Subject Knowledge; Beliefs.

Introduction

Recruitment and retention of secondary school mathematics teachers, the provision made for student teacher learning on pre-service, or Initial Teacher Education (ITE), courses, the quality of mathematics teaching in schools and the subject knowledge of beginning teachers are issues of concern which date back to at least the Cockcroft Report (Cockcroft 1982). The Training and Development Agency (TDA), which regulates pre-service courses in the UK, their numbers and training quality, initiated Mathematics Enhancement Courses (MECs) in 2004, to help address some of these issues. A MEC is a six-month mathematics subject knowledge for teaching course undertaken by graduates who do not possess a mathematics degree, but who wish to teach mathematics at secondary level (age 11 and over). A MEC is a step on the road to mathematics subject knowledge, understanding and performance, which is completed before commencing a course in ITE. The philosophy behind MEC is heavily influenced by Ma (1999). Using Shulman's (1986) terms, the aim of a MEC is to develop Pedagogical Content Knowledge (PCK) through a focus on Subject Matter Knowledge (SMK). As the programme leader of a pre-ITE MEC, I have seen students exposed to a wide variety of teaching pedagogies which they had not previously experienced as learners, and from discussion with the MEC 2007 cohort of students I was provided with anecdotal evidence that this exposure had impacted on their 'beliefs' concerning how they thought mathematics should be taught. I presented papers to the British Educational Research Association (BERA) in September 2008 (Clarke 2008a) and the British Society for Research into Learning Mathematics (BSRLM) in November 2008 (Clarke 2008b) in an attempt to place my early anecdotal ideas in a more evidence-based, critical framework. I felt, and still feel, that changing these 'beliefs' of mathematics teachers will eventually impact on the 'quality' of mathematics teaching in the classroom.

The research question to be answered here is: does participation in a pre-Initial Teacher Education MEC change the 'beliefs' of pre-ITE students concerning how they think mathematics should be taught?

My evidence leads me to tentatively say yes. The emerging results are providing insights into the relationship for a trainee mathematics teacher between prior experience of pedagogy as a learner, current experience of pre-ITE pedagogy in a transition phase from learner to teacher and future beliefs about their pedagogy as a teacher.

Methodology, methods and research instruments

The research draws on a mixed research design consisting of a mixed methods study of MEC students. The research method had two distinct parts:

1. Quantitative data from a sample of 20 MEC students collected via two identical questionnaires during the 2008 MEC course, one at the start and one at the end of the course; the resulting analysis looked at the difference in responses. The sample was almost a census of the 2008 MEC cohort, and the questionnaire included information on the biographies, schooling and education of the participants.

2. Qualitative data from a purposive sample of four MEC students from the 2009 MEC cohort, using guided/semi-structured interviews and performed towards the end of the course. The interviews aimed to explore whether, how and why the participants' beliefs changed during the MEC.

The 2008 quantitative study

In 2008 I collected 20 paired data responses to two questionnaires from the 2008 MEC cohort. The questionnaire consisted of 25 statements concerning teaching practices on which the participants had to express a 'belief' (scored 1 to 5 on a Likert scale). The 'belief statements' used to form the questions in the questionnaire were based on statements previously used by Swann (2005) and the Standards Unit (2005) and are listed elsewhere (Clarke 2008a: 3–4). The participants first filled in the questionnaire on day one of the MEC, and a second time on the last day of the MEC. I did not discuss the research with any of the participants between these occasions. In addition, I collected data on the group concerning gender, age range, the highest qualification they had obtained in mathematics, and their 'place of origin'. As their place of origin I asked for the country and continent where they received most of their secondary school teaching aged 11–16.

There were 500 possible changes in belief (20 students × 25 statements). A total of 260 responses (52%) showed a change in belief. This change was not very strong and is not consistent throughout the statements. I analysed the 2008 data by age, sex, geographical origin and highest qualification in mathematics. It was not possible to identify a strong correlation of age with belief change. However, in this particular group the older participants did exhibit more of a change away from didactic teaching. There does appear to be some gender difference in belief change and in belief change correlated with geographical origin. European respondents appeared to make a much stronger move away from didactic beliefs than those of African origin; however, females constituted 29% of the African group and 55% of the European group, so this variation in belief change may be due to a gender effect rather than a 'place of origin' effect. A very interesting feature of the data was that the lower the highest qualification in mathematics attained by the participant prior to the MEC, the stronger the move away from didactic beliefs. In terms of the analysis by descriptive statistics, the beliefs of the 2008 MEC participants appear to have changed.

The 2009 qualitative study

The interviews took place towards the end of the course and were analysed using ideas informed by a grounded theory approach (Goulding 2002). The transcripts of the interview texts were initially open-coded (Strauss & Corbin 1990: 61) before analytic decisions concerning the data were made. A more focused approach followed after highlighting the more frequently appearing codes.

I will call the four participants Alan, Betty, Chris and David. Alan and David were both male and had received their secondary education in the UK. Betty and Chris were both female and had received their secondary education outside the UK; Betty had

the UK; Betty had received her secondary education in India and Chris had received her secondary education in the Caribbean.

Alan was very articulate and had been educated in the independent sector. He had not done well in mathematics examinations (in his opinion) at age 18 and had completed an engineering degree before undertaking an engineering-based career. At the start of the MEC he had firm ideas on what he thought 'good' mathematics teaching was, and considered one of his own secondary mathematics teachers inspirational in his choice of teaching as a career later in life. He had thought deeply about the philosophy of his new career and saw mathematics teaching as a fine balance between keeping the Government or management happy with examination results and delivering creative teaching. He saw these two as mutually exclusive issues and activities:

> *'There is a real tension for me here, we are trying to say you need a sort of driving licence in mathematics that everyone can do but you also want brilliant mathematicians of the future, all from one teacher, all from the same lesson. Can I steer a line through this in my teaching? I don't know.'* (Alan)

Before joining the MEC, Betty had had a career in sales and marketing. Chris had previously worked as a team leader for a mobile phone network but since arriving in the UK she had been a supermarket sales assistant. Both Betty and Chris were currently non-working mothers and both stated that their children reaching school age had stimulated their interest in mathematics teaching. In addition, both described their own secondary education mathematics teaching as having been didactic; neither saw this as a good model of teaching, but they were convinced that it had worked well within the examination-driven cultures in which their secondary schools appeared to be immersed:

> *'They basically taught us stuff about formulae and plugging things in. You were taught you had to pass the exam, but never told anything about why.'* (Chris)

> *'I viewed my maths lessons as number-crunching, sort of accounting, tedious, laborious…'* (Betty)

David had been educated in the state sector (a London, inner-city comprehensive school) and felt let down by the system; he considered that any mathematics he knew had been learnt without the help of his teachers. He did have one teacher who inspired him to enjoy mathematics, but he was with that teacher for only a short time. He had undertaken an engineering-based career, and he related stories of gradually growing to enjoy mathematics through personal challenge while studying in higher education. He seemed very concerned with using the right textbook and the right examples in his future lessons as a teacher. He had a firm idea of what secondary school mathematics teaching should look like, which tended not to reflect his own experiences but did nevertheless reflect a rather didactic view.

It was based on fixing the mathematics material within 'concrete examples':

> *'Practical things like dropping objects off buildings in Mechanics, practical hands-on things. Like a bit of string, a can of beans and you can see the pi thing; actually see it… Something you see and do; that's the way.'* (David)

I identified three themes that appeared to run through all four interviews (there were other themes present but most were not related to my field of focus).

The first theme, as revealed by the qualitative data, concerned what may be termed subject knowledge issues. The participants all acknowledged that they did not see themselves as mathematics experts and tended to be concerned about what they described as 'confidence' in their own mathematical ability. They all acknowledged that the MEC course had helped them 'build' their mathematical confidence. They failed to expand on what mathematical confidence was but did give examples of places where they believed their mathematical grasp had moved on and where their confidence had been built:

> *'It has opened up my horizons about what maths is. I'd only really done engineering maths before, and suddenly there is like lots of other maths.'* (David)

Certainly the participants had all acquired a wider mathematical vocabulary and seemed fluent in expressing themselves in mathematical ways; however, I found it hard to separate out implied references to SMK and PCK. In practice, SMK and PCK did not appear implicitly or explicitly in the interviews; they both merged into a sort of generic 'teaching' or 'subject knowledge' vocabulary. Only one of the participants described themselves as a 'mathematician' following the MEC. Here I could see sociological ideas of 'identity' coming in; however, I had deliberately put this beyond the focus of the project.

The second theme, as revealed by the qualitative data, concerned issues of transition from a learner of mathematics to a teacher of mathematics. On one level this theme was explicitly acknowledged and addressed by all the subjects at some stage of the interview. Only one (Alan) had explicitly approached the course from a metacognitive perspective, realising that he was learning to know about knowing. The theme appeared implicitly in many areas, particularly when the subjects spoke of what they thought mathematics was:

> *'It has rekindled a passion for maths in me and I haven't had as much fun with learning for 20 years. But there is much more here than just learning maths… There are ethical issues concerning how you teach… There are opportunity costs associated with teaching styles… There are…'* (Alan)

Three of the four participants realised that their relationship with the mathematical subject matter had changed, but had not begun to engage with this idea of change in a sophisticated way.

The third theme, as revealed by the qualitative data, concerned issues of teaching based on the participants' own experiences as a learner during their own secondary school career. All participants stated that they had started the MEC with the idea of planning to teach as they themselves had been taught at secondary level; after all, such instructional practices had worked for them! It was while reflecting on the question 'What impact do you think the MEC has had on you?' that three of the four claimed to have assimilated the idea of less didactic means of teaching into their own ideas of how to teach. The fourth participant stated that he wanted to inspire young learners, and already had ideas of teaching in less didactic ways based upon an idealised teacher from his own school days. The examples of less-didactic teaching given by the participants included group work, interactive teaching, collaborative work and discussions of common misconceptions:

> *'My view of mathematics has changed a lot since the start of the course… I think my way of thinking has as well.'* (Betty)

> *'I think I have a better view of applying my own maths… apply it rather than just getting marks in an exam.'* (Chris)

All four still clung to the idea of textbook-driven examination courses as a necessary experience for their future teaching, even though all of them criticised it at some stage during their interview. Worryingly, I felt they saw this as some form of status quo that they would have to adapt to.

Taking an overview of the three themes and four interviews, I can see my findings support the 'apprenticeship of observation' (Lortie 1975: 61) which students have undergone through their own learning in schools. This is a phenomenon whereby student teachers arrive at teaching having spent thousands of hours as schoolchildren observing and evaluating teachers in action. Lortie (1975) argues that this is a very different apprenticeship from that of other professionals, such as doctors or lawyers, and is largely responsible for many of the preconceptions that pre-service teachers hold about teaching.

Lortie (1975) wrote that a student 'sees the teacher frontstage and centre like an audience viewing a play'. He added that, while students can view the 'frontstage' behaviours (teaching, marking, etc), they do not see the 'backstage' behaviours which are central to a teacher's performance:

> *'Students do not receive invitations to watch the teacher's performance from the wings; they are not privy to the teacher's private intentions and personal reflections on classroom events. Students rarely participate in selecting goals, making preparations, or post-mortem analyses. Thus they are not pressed to place the teacher's actions in a pedagogically oriented framework.'* (Lortie 1975: 62)

The participants in my interviews appear to be entering their teaching career with *some* reflections on their own experiences as a learner. This is acknowledged through an explicit desire to change their 'style' of teaching to a less didactic one; it is here that the MEC appears to make an impact on the participants' 'beliefs'. One could debate on degrees of reflection; however, they are still relying heavily on their early experiences of early secondary school teaching as an indication of what they want to do in their own classroom, themselves. At most, their MEC learning experiences have been assimilated into their overall sum of teaching and learning experiences which appear to be driving their own current 'apprenticeship of observation'. The MEC appears to be instigating a change in beliefs, but not a great change.

Conclusions

The research in this project is limited by the size of the participation group. Small numbers are impossible to generalise from, so any conclusions I arrive at can only really be applied within the context of this small group of individuals.

The belief changes observed in my study need not be a function of the teaching on the MEC course and I am fully aware that the students may have been giving me answers they felt I wanted. Even if the belief changes observed in my study turn out to be a function of the teaching on the MEC course, I am aware that the students may not eventually be turning their beliefs into action when they arrive in schools. In fact, recent work (Clarke 2009) tends to support the hypothesis that they are not doing so.

We know there is evidence that many teachers begin their careers with previously constructed, often naive, theories about teaching (Powell 1992). In fact, Harel (1994: 115) notes, reflecting comments made by Thompson (1992), that 'teachers' beliefs of what mathematics is and, in particular, how it should be taught are tacitly formed by the way they are taught mathematics in their precollege and college mathematics education'.

It needs to be noted that this piece of research was a pilot study and that data analysis is still in its early stages, with further work being undertaken with the 2010 MEC cohort. That said, triangulating between the two parts of this study does appear to give evidence that participation in a pre-Initial Teacher Education MEC does change the 'beliefs' of pre-ITE students concerning how they think mathematics should be taught. This change is not large and, in addition, appears to be a change away from didactic towards less didactic forms of teaching. The initial evidence, particularly from the qualitative aspects of this study, does indicate that there are complex relationships between how students understand mathematics as a subject, their own experiences of learning the subject at school and in higher education, their constructions of what kind of mathematics teacher they wish to be and their experiences of mathematics learning on the MEC. These relationships are still being explored.

Enhancement Courses are very important in today's ITE landscape. These courses and the ITE pre-learning which takes place on them, as part of becoming a teacher, are an under-researched area. The whole area of subject knowledge has recently attracted political interest and it is important that the mathematics education community take the lead in figuring out which professional knowledge and, just as importantly, which pedagogy matters most for the effective teaching of mathematics. The following quote embodies an emerging consensus:

> *'A new discourse is emerging, attempting to distinguish and mark out Mathematics for Teaching as a distinctive form of mathematical knowledge, produced in, and used for, the practice of teaching. And this discourse is fledgling.'* (Adler & Davis 2006: 272)

Practitioners in ITE and pre-ITE may find it difficult to influence the way in which mathematics is taught to students prior to their arrival on an ITE course. However, they do have an influence over the way

that mathematics and particularly mathematics subject knowledge is taught during the ITE and pre-ITE courses. Potentially, this is where the 'quality' of the mathematics teaching could start to change.

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