Research into pedagogical 'belief statements' held by pre-ITE students on a Mathematics Enhancement Course.

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In this paper I will present the results from a small-scale research project undertaken with a group of pre-Initial Teacher Education (ITE) Mathematics Enhancement Course (MEC) students at the University of East London between January and July 2008. The emerging results are in their early stages of development and are a continuation of the results addressed in a paper presented to the British Educational Research Association (BERA) Conference in September 2008 (Clarke 2008). They appear to show some evidence that participation in a MEC, and hence exposure to a variety of teaching approaches, does change "beliefs" concerning the way in which participants think mathematics should be taught.

Keywords: Mathematics; Beliefs; Teaching; Enhancement; Pre-Initial Teacher Education; Subject Knowledge.

Introduction

In recent years, the *quality* of mathematics teaching has been a focus of concern. A recent Ofsted report 'confirmed the narrow nature of much of the teaching' (Ofsted 2008, 5) of mathematics in schools, while an earlier report had, as one of its main conclusions that the 'quality of teaching was the key factor influencing students' achievement' (Ofsted 2006, 1). How can the 'quality' of our mathematics teaching in this country change?

As the programme leader of a pre-Initial Teacher Education (ITE) MEC, I have seen students exposed to a wide variety of teaching pedagogies which they had not previously experienced as learners. 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 think mathematics should be taught. This paper is an attempt to place my anecdotal ideas in a more evidence based, critical framework as I feel changing the beliefs of mathematics teachers will eventually impact on the 'quality' of our mathematics teaching.

It appears obvious that if you want teachers to teach in a less didactic way then their own learning of mathematics should be facilitated in a less didactic way. However, if it really was that easy there would be less didactic teaching of mathematics taking place in schools and less need for critical Ofsted reports.

Schoenfeld (1992) tells us that beliefs underpin personal thought and behaviour. Beliefs underlie reasons why we engage in certain practices and not others. However, beliefs can also become too comfortable and resistant to change (Green, 1971; Rokeach, 1960). Swan (2006) pulled much of this work together and has indicated that any attempt to develop mathematical teaching practices must attend to the beliefs of mathematics teachers and to changes in those beliefs.

The essential question to be answered in this paper is: Does participation in a pre-ITE MEC, and hence exposure to a variety of teaching approaches, change the 'beliefs' of pre-ITE students concerning the way in which they think mathematics should be taught? My evidence leads me to tentatively say 'yes', but with various qualifying statements.

The Study

My research method was to collect quantitative data from MEC students via two identical questionnaires. Then analyse the differences.

As Thompson (1992) notes, most research into beliefs is interpretative and uses qualitative methods. Here I tried to follow some of the work of Swan (2006) and have attempted to use quantitative data. It is hoped that the emerging results will eventually provide some insight 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.

The 2008 MEC cohort consisted of 25 students (13 male, 12 female) from very diverse backgrounds. The original idea for the study was to involve a census rather than a sample questionnaire, however due to reasons beyond my control I collected only 20 of the potential 25 paired data responses to the two questionnaires.

The questionnaire consisted of 25 statements on teaching practices which the participants had to express a 'belief' in (scored 1 to 5 on a Likert scale). The 'belief statements' used to form the questions in the questionnaire were based upon statements previously used by Swann (2005) and the Standards Unit (2005) and are listed elsewhere (Clarke 2008, 3-4). The first time the participants filled in the questionnaire was on day-1 of the MEC and the second time was on the very 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 obtained in mathematics and their 'place of origin'. For the 'place of origin' I asked for the country and continent where they received the majority of their secondary school teaching aged 11-16.

Findings

I am aware of the disadvantages of using Likert scales (Forrester 2008, 27) and the problems of effectively treating ordinal scaled data as a continuous ratio scale for the purposes of my statistical analysis. However, to paraphrase Rorty (1994, 59) I am attempting to obey 'the normal conventions of (my) discipline', while 'not fudging the data too much' but also 'not blocking the road to enquiry.' In other words, I know that my statistical work is not too robust, but I will continue to analyse it pragmatically.

There were 500 possible changes in belief (20 students x 25 statements) involved in this study. 240 responses (48%) showed no change in beliefs. Of those responses which represented a change in belief 160 (32%) were positive changes representing a change towards a less didactic approach to teaching and 100 (20%) were negative changes representing a change towards a more didactic approach to teaching. At this basic level the evidence leads me to tentatively state that participation in this pre-ITE MEC, and hence exposure to a variety of teaching approaches, has changed the 'beliefs' concerning the way students think mathematics

should be taught. In addition the beliefs of the participants appear to have changed away from didactic teaching towards less didactic teaching.

This change is not a *strong* change and it is not consistent throughout the statements. Some statements have much more change than others and some statements even have relatively strong negative changes. For example statement 10 (I believe I need to teach each maths topic separately), statement 18 (I believe I should jump between topics as the need arises) and statement 19 (I believe I should find out which parts learners already understand and don't teach those parts) exhibited strong positive change for half the group. These may be 'beliefs' which are easily changed in the context of the students themselves being learners. While statement 1 (I believe Learners should start with easy questions and work up to harder questions), statement 5 (I believe Learners learn maths through doing maths exercises) and statement 22 (Even though I'll plan my lessons thoroughly, I believe I'll be constantly surprised by the ideas that come up during my lessons) exhibited very little change. Many of these beliefs were already at the top end of my scale and therefore difficult to exhibit more positive change. It was interesting that statement 6 (I believe I should try to cover *everything* in a topic) exhibited a negative change in 50% of the group. This is causing me to return to my interpretations of which statements display belief bias towards didactic or non-didactic type teaching.

I analysed the data by age, splitting the group up into two subgroups (under 30 and over 30). The 13 participants in the under 30 group had a mean positive total change of 2.9, on the 1 to 5 scale and a standard deviation of 8.64. The 7 participants in the over 30 group had a mean positive total change of 4.4 and a standard deviation of 5.59. It was not possible to identify a strong correlation of age to belief change. However, in this particular group the older participants did exhibit more positive change with less variation within that change.

Males in the group had a mean positive total change of 5.6, on the 1 to 5 scale which was much higher than the females in the group who had a mean positive total change of only 1.3. In addition the males in the group had a much higher standard deviation concerning this change than the females 9.07 as opposed to 5.38. The males demonstrated a higher level of positive change in beliefs away from didactic teaching but at the same time also had more variation within that change. Four statements show wide variation in belief change between males and females in the group. Statement 2 (I believe I should tell learners which questions to tackle) had a mean +0.8 change for males but -0.3 for females while statement 24 (I believe Learners themselves should choose which questions they are to tackle) had a mean +0.9 change for males but -0.1 for females. Here males showed a much stronger move away from didactic beliefs for statements 2 and 24 than females. Statement 12 (I believe I should draw links between topics and move back and forth between several topics) had a mean -0.4 change for males but +0.7 for females while statement 23 (I believe I should encourage learners to work more slowly) had a mean 0.0 change for males but +1.0 for females. Here females have shown a much stronger move away from didactic beliefs for statements 12 and 23 than males. There does appear to be *some* gender difference in belief change but this requires more investigation before passing general comments.

There were 7 participants of African origin in the group, 2 participants of Asian origin in the group and 11 participants of European origin in the group. Ignoring the 2 participants of Asian origin as I considered their sub-group too small, I compared the African sub-group with the European sub-group. Their means were very similar +3.1 and +3.5 and it was not possible to identify a strong correlation of 'place of origin' to belief change. Hidden within this 'place of origin' analysis I found

two statements which showed a wide variation in belief change between Africans and Europeans in the group. Statement 2 (I believe I should tell learners which questions to tackle) had a mean -0.6 change for Africans but +0.5 for Europeans. Here Europeans have shown a much stronger move away from didactic beliefs for statements statement 2 than Africans. Statement 23 (I believe I should encourage learners to work more slowly) had a mean +1.3 change for Africans but +0.1 for Europeans. Here Africans have shown a much stronger move away from didactic beliefs for statement 23 than Europeans. Females made up 29% of the African group but 55% of the European group; so this variation in belief changes for these statements may be due to a gender effect rather than a 'place of origin' effect.

The participants can be split into two groups by their highest qualification in mathematics. Seven participants had a level 2 qualification (GCSE, 'O' level or equivalent) as their highest qualification in mathematics before embarking on the MEC; they displayed a mean total change in beliefs of +5.3. Thirteen participants had a level 3 qualification (AS, 'A' level or equivalent) as their highest qualification in mathematics before embarking on the MEC; they displayed a mean total change in beliefs of +2.5. There does appear to be some variation in belief change between these two groups but this requires more investigation before passing comments. Interestingly only one statement (I believe I should try to cover *everything* in a topic) exhibited large differences between the two groups. The level 2 students had a mean change of +0.3 whilst the level 3 students had a mean change of -0.9. Here level 2 participants have shown a much stronger move away from didactic beliefs for statement Q6 than level 3 participants.

Conclusions

Enhancement Courses are very important in today's ITE landscape. These courses and the ITE pre-learning which take 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 as a profession we take the lead in figuring out which professional knowledge, and just as importantly which pedagogy, matters most for the effective teaching of mathematics. It is hoped that if this paper does nothing else it will stimulate dialogue in this area.

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". I am still in the process of confirming these ideas with my research and measuring if these beliefs and hence future teaching pedagogies change during pre-ITE or ITE, but I have seen measurable change.

This research is limited by the size of the participation group. Twenty is a very small number to generalise from and therefore 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 fully aware that the students may not turn these beliefs into action in schools. Having discussed these

issues with ex-MEC students from the 2007 cohort who have recently completed their PGCE in 2008 I feel there is anecdotal evidence that this is happening.

Despite the qualifying statements above, this paper demonstrates that I do appear to have some evidence to indicate that participation in a pre-ITE MEC, and hence exposure to a variety of teaching approaches, does change the 'beliefs' of pre-ITE students concerning the way in which they think mathematics should be taught.

As practitioners in ITE and pre-ITE it is difficult to influence the way in which mathematics is taught to our students prior to their arrival on our Teacher Education courses. However, we do have an influence over the way that mathematics and particularly mathematics subject knowledge is taught on our ITE and pre-ITE courses. Maybe this is where the 'quality' of the mathematics teaching in this country could start to change.

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