

PRIMARY TEACHER TRAINEES' MATHEMATICAL SUBJECT KNOWLEDGE: THE EFFECTIVENESS OF PEER TUTORING

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As a matter of course, primary teacher trainees are introduced to theories of learning and to a range of pedagogical approaches as part of their training for teaching. From the outset they are encouraged to become aware of their own learning processes - a focus on meta-cognition - and share insights with their peers, and to do so in a way that might inform their teaching of children.

The role of social interaction and collaboration in learning is explored. In their classrooms, trainees are encouraged to try a range of pedagogical approaches as they learn their craft, including setting up situations in which their pupils are encouraged to think about their own learning, can collaborate and help each other to learn.

It is a basic premise that in our own approaches as teacher educators within initial teacher training that we should aim to demonstrate these processes in our own teaching. At the Institute of Education we have been trying to encouraging collaborative learning amongst our trainees and trying to judge where collaborative approaches might be most effective.

In recent years we have been developing a place for peer tutoring within the learning experiences for trainee teachers within the PGCE course, and it is in relation to the development of curriculum subject knowledge that peer tutoring is now most formalised. In each of the curriculum subject areas where, until recently, there has been a requirement to audit the subject knowledge of trainees and take steps to remedy any deficiencies (DfEE 1998) we have developed course structures that include a role for peer tutoring. This paper describes our approaches to subject knowledge development in Mathematics and the role of peer tutoring within it.

The research reported arose out of a collaboration of researchers from Cambridge, London, York and Durham universities in the UK who have been exploring primary trainee teacher's subject knowledge in mathematics. Our findings are based on the feedback we received from trainees following peer tutoring to enhance subject knowledge. The sample cohort consisted of 210 postgraduate primary teacher trainees, all of whom have passed a qualification in mathematics at GCSE.

The importance of mathematical subject knowledge in primary teaching has been established (Ball 1990, Shulman 1986, and Aubrey 1997) along with the negative effects of weaknesses on teaching in the classroom (Goulding et al 2002). Deficiencies in subject knowledge are linked to less effective teaching and also to an over reliance on commercial schemes (Millet and Johnson, 1996).

To enhance the trainees' understanding of mathematical subject knowledge we chose to use an approach involving peer tutoring for several different reasons. The literature has indicated benefits from studies in Higher Education (Topping in

Goodlad, 1998). In his review of the literature about peer tutoring within Higher Education contexts, Topping points out that there is a great deal more research into teaching and learning in schools than in Higher Education settings (Topping in Goodlad 1998). Similarly much of the work on the contribution of peer tutoring processes to learning has taken place in school settings.

Much less is known about adult learning - yet there is increasing scrutiny of the effectiveness of teaching and learning in tertiary settings. Topping suggests, with a certain irony, that the upsurge in interest in peer tutoring in Higher Education may be a pragmatic response to the double bind in which these institutions find themselves. Shrinking resources push them back towards traditional instructional methods, yet these are consistently criticised as ineffective. Including elements of peer tutoring may offer a way out of this difficulty.

More optimistically, it seems that the majority of research studies that attempt to evaluate peer tutoring initiatives do suggest that peer tutoring has a positive effect. Some of these involve control groups and the independent measure of learning gains in different conditions, and some rely only on outcomes reported by participants. 'Studies of achievement gains almost all indicate outcomes as good or better than group tutoring by faculty, and student subjective feedback is generally very positive.' (Topping in Goodlad, 1998, p. 67)

We also wondered if the specific nature of mathematics and the emotions it tends to engender (Brown et al., 1999; Green and Ollerton, 1999) would mean that this approach would be particularly helpful in this context as indicated in the successful mathematical learning in New Zealand (Peters 1998) of children in one to one pairings and supported by Sylva et al (1980) which found that the highest proportion of challenging play occurred when the children were in a pair.

The sources of data we used were from an initial self audit of the trainees understanding of mathematical knowledge, written feedback from trainees about the initial audit, data collection and rank order of the results of the initial self audit, and a formal audit of mathematical subject knowledge marked by lecturers and, finally, written feedback after a peer tutoring session from peer tutors and peer tutees where the highest scoring trainees were paired for peer tutoring with the lowest scoring trainees.

The analysis of the comments made by these low scoring peer tutees (N=20) before peer tutoring shows that the general level of confidence was low with many reporting panic.

'I tend to freeze when I am required to do maths'.

They also perceived their levels of knowledge as low and many said they had forgotten the mathematics they had previously learned.

'My maths seems very rusty and I need a lot of time to recall back to different methods of calculating things.'

They generally found the process of the audit very difficult. Only one of these trainees reported feeling fairly happy and one other said that she was aware of some of the required procedures. Some of these trainees suggested that the remedy for the poor state of their subject knowledge was self study and lots of revision of the forgotten topics. They felt they needed lots of practice.

We provided training for the peer tutors with Amy who concentrated on the audit items that had caused the most difficulties for the peer tutees. Taking each item in turn, Amy asked the peer tutors to work in small groups going over it again, listening to each other's explanations, then finally giving one person the opportunity to 'teach' the whole group. The peer tutors reported how enlightening it was to hear so many alternative ways of approaching each problem and how instructive to realise that their own perspective on the problem was not the only one.

During the preparatory session and during informal discussions with the peer tutors after the tutoring session it was clear that the peer tutors treated the responsibility with great seriousness. Generally they confirmed the impression gained from previous cohorts that they felt that not only their own subject knowledge but their pedagogic content knowledge were on the line. Many expressed apprehension at the prospect of the tutoring session and expressed doubts about what they had to offer.

The feedback from the peer tutoring sessions pointed to the mediating influence of emotional factors in responses. Tutees expressed their own panic about mathematics and the associated lack of confidence at the beginning of the course. All of the tutees (n=20) found working with a peer tutor a positive experience and an aid to their understanding and confidence. There are comments in the written feedback to qualify the evidence.

'I found working with a peer tutor extremely helpful. A lot of problems I had were clarified'.

Their feelings were comfortable and relaxed, preferring the one to one situation.

'It was good to talk to someone else about difficulties and get advice from them.'

Confidence was much improved, too.

'I found working with my peer tutor I felt less self conscious about where the gaps in my knowledge lie. Being able to work at a pace that was suitable for me to internalise the knowledge was very helpful.'

The peer tutors also all found their sessions beneficial and highlighted it in their written feedback, too.

The study largely dealt with students' perceptions but it does highlight questions for the future. It does suggest that peer tutoring is beneficial for this group of trainees who tend to be lacking in confidence.

Our aim, in reflecting on our experience and in undertaking this analysis of the perceptions of peer tutoring has been to seek to improve the effectiveness of our

strategies for supporting our trainees. A number of issues have arisen as a result of this work.

If we are to support the trainees with weaker subject knowledge more effectively we need to provide ongoing support earlier in the course. This was highlighted in the self audit feedback with many peer tutees reporting that they knew their levels of knowledge were poor. We need to pick up those who are finding difficulty and put in place more one to one and taught group sessions. However, early identification using the self audit only would fail to pick up some of the group, as only 50% of the eventual peer tutees were among the lowest scorers on the self audit, and some of those who were not, marked themselves as reasonably secure. They did, however, indicate their difficulties on the 'confidence' section of the self audit. Falchikov (2001) discusses the challenge of ensuring that peer tutoring is embedded firmly in the culture of the course. This is a challenge for us too. Although at present the peer tutoring occasion is organised and orchestrated by staff and is part of the timetable of the course, it is only on a single occasion. Given the positive feedback, we are actively considering the way we support peer tutoring at earlier stages.

Many commentators suggest that appropriate training for peer tutors is a key issue in improving effectiveness (Falchikov, 2001). Although great appreciation was expressed for the preparatory sessions that were provided, we might consider whether, and in what ways, these might usefully be extended. If the use of peer tutoring were to be more formalised earlier in the course then perhaps a different approach to training would have to be devised.

'Quality control' in peer tutoring sessions would also be an issue - and it is hard to see how this could be secured. It is a considerable challenge for staff to monitor peer tutoring processes. Some studies suggest that peer tutoring is most successful where the 'gap' between peer tutor and peer tutee is fairly narrow. This suggests that a different approach to organising pairings in our context might usefully be explored. Also pairings in which tutor and tutee change roles (rather than 'fixed' role pairings) are sometimes recommended. It is interesting to note that, although our research has not explored to any great extent the experiences of the 'middle' band of our trainees, we know that they were less enthusiastic about their experience of peer tutoring in more homogenous groups. There may be many reasons for this. Certainly the occasion was orchestrated very differently, and it may be that with different 'preparation', these trainees could gain more from the experience. We continue to think about this.

At any rate, self study as an approach to remedying deficiencies in mathematics subject knowledge does not seem to be sufficient. Many of the tutees, realising their low levels of subject knowledge early in the course, indicate that they will revise and use self study guides. However, the effectiveness of this may be limited. Half of those who identified themselves as having poor subject knowledge at the beginning of the course achieved the lowest scores in the formal audit. It may be that to develop knowledge and understanding in Mathematics requires more one to one support and

guided teaching? We need to understand more about the potential role of peer tutoring in mathematics specifically.

The range of strategies employed by the peer tutors were welcomed by the tutees except for the trainee who found visualisation difficult and another where the tutor's explanation of algebra was not helpful. These issues might be addressed by making sure that we place more emphasis on the sharing of strategies in the taught sessions and in the preparation for peer tutoring. The tutors commented on their own opportunities to sharpen their thinking through *explaining* to the tutee. The tutees apparently found *explaining* to the tutor helpful. So *explaining* seems to be valued by everyone. But intriguingly, there was no mention of *listening* - it raises the link with pedagogical content knowledge and the kinds of issues we might want to raise in early briefing sessions.

CONCLUSION

And for the future?

How can we be sure what happened in individual peer tutoring sessions? How can we handle quality assurance ?

Should there be more specific training for peer tutors?

Is the self audit the best way of highlighting the gaps initially as others emerged after the formal audit?

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