

## **TEACHER-RESEARCHERS: CAN THEY CHANGE SCHOOLS?**

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*Following a year-long research project to identify ways of improving numeracy levels in year 8 students I reflect on how the results have changed the way mathematics is taught in my school. I conclude that the process of research changes the researcher and students with consequent changes in the classroom culture which affects outcomes. The results suggest that the changes improved levels of numeracy and helped maintain good levels of interest and motivation without a drop in standards in the general curriculum. However, it was found that there was not an automatic adopting of my recommendations. The Head of Department was supportive of the research but unless senior managers co-own the research and are continually consulted and up-dated they are unlikely to implement change. Resistance to change exists despite positive evidence that benefits would follow.*

### **INTRODUCTION**

By September 2001 work had already been in progress for several years in the Notre Dame High School Mathematics Department to improve numeracy levels through an intervention we called the Rainbow Scheme. Pupils were working through a series of worksheets appropriate to their level and designed by the Head of Department to lead them through basic numeracy skills which could be described as mainly arithmetic-based. This was spread out over the year and ran parallel with the broader curriculum with two or three worksheets completed each half term in the context of appropriate lessons. We wanted to prepare for the introduction of the new secondary numeracy strategy by starting a year early and trying out a new Rainbow Scheme. I had begun a Master's Degree in Mathematics Education and was reading about issues to do with the teaching and learning of Mathematics and became particularly interested in teaching and learning styles. In particular my reading and thinking stimulated an interest in a number of issues:

- Issues around the motivation, enjoyment and confidence of pupils in relation to their achievement
- The effective use of computers and white boards with fibre pen to enhance learning
- The effects of different teaching styles on the ability of pupils to learn and the way this interacts with their own learning styles
- The effect of different learning contexts on understanding

An underlying issue for me was whether there was a 'best way' to teach mathematics. The three-part lesson with the teacher engaged in a large proportion of direct teaching was being proposed by government as the best way forward and would lead to improved standards but my reading was suggesting that this assertion was not necessarily based on substantial research evidence.

## THE RESEARCH METHODS

Essentially I taught two year 8 Mathematics groups of similar (average and just below average) ability for one academic year. They were tested in numeracy before and after the period of treatment, and also were similarly assessed in terms of their attitudes and perceptions of the subject. The termly exam results also gave an indication of the effect of the treatment on the understanding of the wider Mathematics curriculum for both groups.

I continued the Rainbow scheme with one group (which would be a control group) but tried a different approach with the other (the treatment group). The treatment group would have a whole lesson (one hour) each week devoted to numeracy, and in particular arithmetic. There would still be the regular use of a lesson on some aspect of numeracy followed by a worksheet for homework which would be handed in and marked for the next week. There would then be a follow-up lesson, going through the worksheet, discussing difficulties, repeating questions, doing various tasks to strengthen concepts and understanding. Within the next week or two, the cycle would begin again; activities on numeracy, the introduction of the next worksheet, teaching and practice in the lesson then homework focussing on the new sheet.

All of this was set in the context of a variety of lesson types focusing on numeracy but using different approaches and giving the pupils a varied experience of working with number. For example, one week the pupils would be gathered around desks in small groups solving a problem as a team. One week they considered the best way to buy a 3-piece suite and not only had to calculate the final costs for different methods but had to discuss other factors of payment. There was a lot of discussion, debate, swapping of methods and opinions until they arrived at a group conclusion. On another occasion the pupils worked outside and stood on the school drive to work out how much ready-made concrete needed to be ordered to re-lay it. In a non-classroom context and with basic tools of tape measure, pen, pencil, paper and calculator they had to discuss what was needed to arrive at a reasonable estimate. Charts were also given from a DIY book for them to interpret if they so wished.

Other activities for the Rainbow numeracy lessons included an activities circus in the yard where pupils measured and calculated various things such as speed of running, time for a hundred knock-ups with a racket and ball, badminton hits etc.. The pupils worked on the statistics and calculated means in order to come to some conclusions about their own performance. Work on ratios included the use of a real recipe, altered to make a different sized cake which they actually went on to bake. Groups working on this were again encouraged to discuss method and share ideas. The Rainbow lesson was, and felt like, a completely different entity from the normal lesson with the text-book context.

This cycle of teaching and learning, practice then feedback interspersed with a variety of lesson types would spiral throughout the year with the hope that there would be a positive effect, not just in the pupils' level of numeracy, but also in their general Mathematics work. Also, the treatment group would receive 5-10 minutes of mental Mathematics work each lesson, following a structured course derived from the DfES numeracy documents, often with the use of the white board and pen by each pupil.

The Notre Dame High School Mathematics department is using the Key Maths scheme for its year 7-9 groups and this work would continue parallel to the numeracy work, obviously with significantly less time for the treatment group in which to do the general syllabus work. One part of the research was to evaluate the effect of this reduced time on the general performance of the pupils in the termly examinations: would the treatment affect the results adversely or feed positively into the general understanding of other topics? An important research question revolves around the experience of the pupils as they study in this new format: would they receive the new structure positively or would their perception and enjoyment of learning mathematics change for the worse?

### **The Data Gathering**

#### **Testing numeracy**

Mike Askew et al in 'Effective Teachers of Numeracy: Final Report' (1995-96) define numeracy broadly as '... the ability to process, communicate and interpret numerical information in a variety of means.' (page 4). I take this to be a good working definition but at the same time must point out that the emphasis of this work is on those skills which might usefully be labelled as arithmetic. There was some emphasis on real-life contexts in the control group but it was in the treatment group that more time was allowed for discussion and exploration of different approaches to problem solving in different contexts. The changes in ability in numeracy were judged through the initial and final results of the Rainbow Level Tests; both groups of pupils took exactly the same Rainbow tests before and after treatment and the results analysed statistically.

#### **Testing the effect on the wider syllabus**

During the Year at Christmas, Easter and at the end of the summer term all pupils routinely take a test on material from the wider curriculum covered in year 8. The two groups of pupils took these same tests and the results were analysed to see if there was any appreciable difference in performance.

#### **Gauging effects on pupil perception of and attitude towards Mathematics**

As the research got under way, both sets of pupils filled in a questionnaire, which was first piloted. This was a combination of structured and more open-ended questions. There was also, early in the proceedings, a focus group interview with volunteers from each group, which was more open-ended and this was tape-recorded for future analysis. Another focus group interview with the same pupils followed on at the end of the year to see if there had been any shift in agendas, issues, perceptions or feelings regarding their mathematics course.

### **RESULTS**

#### **The Core Syllabus Tests**

Statistical testing showed that doing the extra hour per week on numeracy did not disadvantage the group treatment pupils in the core tests and there was no measurable difference in the performance of the two groups.

## **The Rainbow Tests**

It is worth emphasising that there was still *some* intervention with the control group which followed the old Rainbow Scheme, with extra numeracy work given every few weeks. I felt it would have been morally unjustifiable to have withdrawn this extra help for the control group. Overall, though, the treatment group has significantly out-performed the control group in the numeracy tests (significance level of 0.005 in independent T-test, one-tailed hypothesis.)

## **Perception of and Attitude towards mathematics**

### **The Questionnaire Results**

Analysis of the responses can be summarised as follows:

- There was a suggestion of a drop in the level of enjoyment of mathematics in the pupils of the control group, but not in the treatment group.
- Pupils in the treatment group, in general, reported increased ease of working with numbers (basic arithmetic) whereas the control group reported a slight drop.
- The treatment group rated their progress in mental maths higher than the control group.
- There was the suggestion of a drop in perception of progress made by some students in the treatment group

### **The Focus Group Interviews**

The Treatment Group interviewees confirmed the questionnaire finding that they felt they had improved in their ability to work with number in calculations. All four pupils felt they had improved their mental maths (which agrees with the questionnaire findings) Also confirmed in the interviews was the positive attitude towards learning Mathematics and the importance assigned to it which was a feature of the questionnaire.

The Control Group interviewees came across as just as keen to do well and had many positive things to say about learning Mathematics. For me, there was a notable difference in the way they talked about their year 8 experience, in keeping with the questionnaire finding, that they perceived their improvement to be greater than the pupils from the treatment group. By comparison there was a certain downbeat feeling around from two of the treatment group pupils: the tests had not gone well, they thought, and although not articulated fully, there was a sense in which after a promising start things had turned out more complicated and difficult. Was there evidence here to support the notion that all the extra activities had complicated their progress through mathematical understanding and that a more limited, contained curriculum would have appeared more manageable and safe and would have led to a greater sense of success?

### **So can Teacher-Researchers Change Schools?**

In a nut-shell, my experience leads to the answer 'yes' and 'no'. Although only small-scale there was enough learned from this research for me to be excited about the prospect of changes which would improve the quality of mathematics education in my school. My reflecting led me to the following conclusions.

### **Research Changes the Researcher**

My understanding grew as the research progressed and my reading and practice interacted to produce better insights into theories of learning and in to what was practical and workable for my situation. I was opened up to new possibilities and ways of doing things with the pupils but also discovered limitations only practice could highlight. My confidence increased as a result: confidence to try things out, to question, reject and adapt. I also found my attitude to students became more understanding as I began to interact more with them and to discover more clearly their perspective as learners.

### **Research Changes the Classroom Culture**

My classroom became more a place of cooperation, communication and openness. The students were fully informed of the research aims right from the beginning and a big proportion were drawn in to the process and became interested and inquisitive-almost co-researchers and certainly co-learners with me. There was so much more social interaction and mathematical discussion and debate. My own view is that this certainly aided the growth of learning and depths of understanding and strengthened my growing sense that a social constructionist approach to learning was where I was moving. The theory and practice did seem to be supporting each other and as my own enjoyment of teaching was increasing in this new framework, so this enthusiasm would positively affect the students, I concluded. The results would support the claim that student enjoyment and motivation was positively affected.

### **Research Changes Pupils**

What I have said so far, I think, helps justify this claim. The treatment group showed sustained interest and motivation and took on part ownership of the project to a remarkable extent, constantly asking what the results were showing and even making suggestions of their own. Consequently I feel justified in claiming a healthy level of self-esteem as they began to see how valued their participation and comments were. The whole process seemed to bind us together more in this common exploration and just as I felt I had begun to understand the students more, so I feel they got to know more about the challenges of teaching and could better understand what I was trying to do.

### **Research Changes Outcomes**

The outcomes so far described, I feel, build up a strong case for the conclusion that research changes outcomes. I am a more motivated and enthused teacher, the pupils are learning effectively and the intervention has brought about an increase in numeracy levels and engaged the pupils with interesting and often enjoyable work. Over the year the levels of enjoyment and motivation certainly did not fall in the treatment group, as they did with the control group. So the scene is set, then, surely, for some changes in the mathematics department?

### **YES, BUT...**

The reliability of this small-scale research cannot be judged at the present time: more teacher-researchers need to do similar projects and the results compared. Even so, I feel reasonably confident that if this approach were to be applied across the lower school

curriculum there would be noticeable gains made in levels of numeracy. The Head of Department was supportive of the research and interested in the findings but it is the case that the pattern and approach taken with the treatment group has not been taken on board. There was no detailed de-briefing, no departmental discussion and no new recommendations to take to senior managers for comment or approval. This was disappointing and led me to wonder why this had been the case. I have experienced first hand the resistance to change so often spoken of. I believe teacher-researchers can change schools but only if senior managers are pulled into the process from early on and encouraged to part-own the project. Had I reported to them, asked opinion and advice, and invited them to observe some of the innovations I feel change might have been easier to come by. It takes more than a passing interest and a distant acknowledgement to the work being done to bring through the changes research can suggest. Of course there could be other factors to be aware of: mistrust of research methods, findings and reliability and the very significant power invested into Heads of Department who can often be so single-minded and focussed on their own ideas that it is hard to influence them. It has been said to me that in the face of all the evidence from this research it seems a great pity there has not been associated change in the way we teach mathematics at my school. I genuinely feel I have been a member of a well-led and strong department this last four years or so who have achieved much with our pupils. It is, however, at another school that I now have a chance to put into practice all that I have learned, if I am given the chance that was indicated on interview. I have a feeling that teacher-researchers can indeed change schools, but only if managers are more open to change, and therefore open to its oft un-welcomed partner, risk.

### Biographical Details

Kevin Thompson was a Mathematics teacher at Notre Dame High School, Sheffield, at the time of the research and is now helping to lead the Mathematics Department at Fir Vale School, Sheffield. The research was done through a Best Practice Research Scholarship and as part of a Master of Science (Mathematics Education) degree at Sheffield Hallam University. He is a Leading Mathematics Teacher for Sheffield authority and his current research interests are factors affecting confidence and motivation in Mathematics.