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A SYSTEMATIC REVIEW OF RAISING PUPIL MOTIVATION IN KS4 MATHEMATICS

Chris Kyriacou and Maria Goulding

University of York, Department of Educational Studies

This paper reports the emerging findings of a systematic review of the literature looking at the following question: What strategies can raise motivational effort in Key Stage 4 mathematics amongst pupils in the mid-below-average to average range of mathematical attainment in England? The review has identified four key areas: (i) grouping; (ii) pupil identity; (iii) teaching for engagement; and (iv) innovative methods.

INTRODUCTION

A Systematic Review Group for Mathematics Education was established in October 2003 with funds from the DfES to be coordinated by Maria Goulding and Chris Kyriacou at the University of York Department of Educational Studies. The purpose of such review groups is to carry out a systematic review of the literature on questions of importance for policy and practice. The review group includes teachers, teacher educators, researchers and policy makers. The current review question being undertaken by the group is "What strategies can raise motivational effort in Key Stage 4 mathematics amongst pupils in the mid-below-average to average range of mathematical attainment in England?".

In the U.K. an Evidence for Policy and Practice Information (EPPI) Centre was established in 2000, based at the University of London Institute of Education, to undertake a programme of work to guide, oversee and moderate the work of 'review groups' commissioned by government agencies to undertake a systematic review of the literature in areas of importance for policy and practice in Education.

The report of the Mathematics Education Review Group on this review question is expected to be published in early 2006 on the EPPI Centre's website (http://eppi.ioe.ac.uk) alongside the reports of review groups

WHY THIS REVIEW QUESTION?

The aim of this review is to consider the research evidence regarding strategies that can raise motivation in Key Stage 4 mathematics amongst pupils in the mid-below-average to average range of mathematical attainment.

This review arises from a discussion held at the DfES in March 2005. It was felt at the meeting that a systematic review with a focus within mathematics education on Key Stage 4 would be particularly useful in the light of: (i) the Smith Report on post-14 mathematics education; (ii) the carrying forward of the principles underlying the numeracy strategy through Key Stages 1, 2 and 3 into Key Stage 4; and (iii) the standards agenda for mathematics attainment at the end of Key Stage 4.

It was felt at the meeting that pupils whose attainment level in mathematics at the

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start of Key Stage 4 ranges between the 20th and 50th percentile could achieve significantly higher grades in GCSE mathematics through the use of more effective strategies to raise their motivation, and that a systematic review could usefully focus on the research evidence on the effectiveness of strategies to raise such pupils' motivation.

The findings of this review will have important implications for policy and practice, particularly in terms of considering how well any successful strategies identified are in line with strategies being advocated to raise standards and with strategies underpinning reforms in the 14-19 curriculum. The review will also have important implications for the implementation of 'personalised learning' in schools.

METHODS USED IN THE REVIEW

Identifying relevant studies involved carrying out an electronic search using keywords with bibliographic data bases, hand searching through key journals and conference proceedings, citations, and publications recommended by contacts. This resulted in 25 key papers being identified for the in-depth analysis (Andrews and Hatch, 2000, 2002; Bartholomew, 2000; Bills and Husbands, 2005; Boaler *et al.*, 2000; Cramp and Nardi, 2000; Crisan, 2004; Dorman and Adams, 2004; Edmiston, 2003; Gage, 1999, 2003; Gage *et al.*, 2002; Gkolia and Jervis, 2001; Goulding, 2002; Hallam and Deathe, 2002; Hallam and Ireson, 2005; Hyde, 2004; Ireson *et al.*, 2001; Jackson, 2002; Jones and Tanner, 2002; Miller *et al.*, 2005; Nardi and Steward, 2003; Smith and Gorard, 2005; Tanner and Jones, 2003; Watson and De Geest, 2005).

EMERGING FINDINGS

The in-depth analysis of the 25 included studies led to the identification of four key areas: (i) Grouping; (ii) Pupil identity; (iii) Teaching for engagement; and (iv) Innovative methods**.**

Grouping

This area looked at the use of grouping by ability (i.e. setting) and the use of single sex classes in co-educational schools. A number of issues were identified concerning the impact on motivational effort of school practices in terms of how pupils are grouped to form classes; two issues in particular were: (i) that if the whole class knows that being in a lower set will deny them access to higher GCSE grades, this can make it very difficult to sustain their motivational effort; and (ii) that the use of boys only classes in co-educational schools can sometimes enhance rather than undermine the 'laddish' culture that it is in large measure designed to combat.

Pupil identity

This area looked at the extent to which pupils have a positive pupil identity of themselves as 'mathematicians': i.e. as people who can understand and can do mathematics. Studies here indicated that raising motivational effort through developing a more positive pupil identity involves the use of strategies characterised by: (i) providing a caring and supportive classroom climate; (ii) providing activities

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which pupils find challenging and enjoyable; (iii) enabling pupils to gain a deeper understanding of the mathematics; (iv) providing opportunities for pupils to collaborate; and (v) enabling the pupils to feel equally valued.

Teaching for engagement

This area looked how teachers' choice of teaching and learning activities, the way they interact with pupils, and the type of classroom climate they establish, are intended to enhance pupils' engagement**.** The ideas identified here echoed the five elements in the picture emerging in the previous section. However, in this section (teaching for engagement) the emphasis was more on the importance of the teacher being caring and supportive and making the maths enjoyable, whilst in the previous section on pupil identity, there was more emphasis on the importance of pupils gaining a deeper understanding of the mathematics they were doing as being crucial to the development of a more positive pupil identity.

Innovative methods

This area was sub-divided into ICT-based innovative teaching methods and other innovative teaching methods. Strategies making use of ICT (ranging across methods involving the use of interactive whiteboards, videoconferencing, supportive software packages for pupils, and graphical calculators) appeared to be capable of having a powerful effect on raising motivational effort. However, in using ICT an important distinction needs to be made between two stages: (i) the motivating effect of using ICT based on its novelty, stimulating visual appearance, and the opportunity it affords to work in different ways, including working in groups; and (ii) the motivating effect of using ICT in a way that enhances deeper understanding of the mathematics.

Other innovative methods included the use of Cognitive Acceleration in Mathematics Education (CAME) or CAME-type lessons and the teaching of self-regulation strategies, teaching based on extending features of the NNS in primary schools into secondary schools, such as the use of mental/oral starters and whole class interactive teaching, and the use of formative assessment. The studies here indicated that such innovative methods can play a part in raising motivational effort.

However, for both ICT-based and other innovative methods of teaching to foster a deeper understanding of the mathematics as a means of raising motivational effort, teachers need to have a good understanding of the theoretical basis concerning why and how the innovation can be effective and to develop the skills and techniques required for its effective practical implementation.

CONCLUSION

There is also little doubt that there is a vast array of initiatives that are current taking place in schools, many of which are already indicating ways in which raising pupils' motivational effort can be achieved. What is clearly needed is for more teachers to adopt what is emerging to be effective practice. This requires in-service support and

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training. The strategies considered in this review, ranging across the use of interactive whiteboards, videoconferencing, opportunities for peer collaboration, and providing a supportive classroom climate, all require a high level of skill and expertise. These are not strategies that teachers can simply implement without on-going support and training. The evidence here indicates that enabling teachers to work together in collaborative groups to explore and evaluate together innovations in their practice can make a major contribution to enable changes in practice to be effective in raising pupils' motivational effort.

MEMBERSHIP OF THE REVIEW GROUP

Patti Barber (Department of Primary Education, Institute of Education, University of London); *Peter Bland* (Bootham Secondary School, York); *Lynne Carruthers* (Fulford Secondary School, York); *Robert Coe* (Curriculum Evaluation and Management Centre, University of Durham); *Ann Dowker* (Department of Experimental Psychology, University of Oxford); *Ann Gannon* (Department of Educational Studies, University of York); *Maria Goulding* (Department of Educational Studies, University of York); *Gill Hatch* (Institute of Education, Manchester Metropolitan University); *Charles Hulme* (Department of Psychology, University of York); *Qaimah Ismail* (Department of Educational Studies, University of York); *Barbara Jaworski* (Department of Mathematics, Agder University College, Norway); *Chris Kyriacou* (Department of Educational Studies, University of York); *Ann MacNamara* (National Numeracy Strategy, London); *Anne O'Connor* (Wilberfoss Primary School, Wilberfoss, York); *Alison Robinson* (Department of Educational Studies, University of York); *Tim Rowland* (Department of Education, University of Cambridge); *Sue Sanders* (Department of Education, University of Swansea); *John Sharpe* (City of York Local Education Authority Advisory Service); *Peter Tymms* (Curriculum Evaluation and Management Centre, University of Durham).

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