Research methods

The research adopted three phases: literature review, informal semi-structured interviews with all the teachers in the mathematics department, and action-research based on the written findings of the earlier work.

Conclusion

Research evidence frequently confirms, and occasionally contradicts, the intuitive judgements of experienced practitioners. This can be used, across many fields of educational research, as a vehicle to promote professional dialogue about classroom practice. Such dialogue is seen as a pre-requisite of effective change across a group of staff, and in this instance led to significant changes in teaching practice.

Suggestions for further reading

Three recommended titles for information on gender differences in learning:

Arnot, M. Gray, J. James, M. Rudduck, J. and Duveen, G. (1998)
Recent Research on Gender and Educational Performance
OFSTED Reviews of Research.
London: The Stationery Office.

Boaler, J. (1997)
Experiencing School Mathematics: Teaching Styles, Sex and Setting.
Buckingham: Open University Press.

Head, J. (1995)
Gender Identity and Cognitive Style.
Paper presented at UNESCO/ULIE colloquium 'Is there a pedagogy for girls?'
London: UNESCO.

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National Teacher Research Panel
engaging teacher expertise

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Gender and mathematics: what can research tell us about how we teach mathematics to boys and girls?

Aims of the project

The project had three quite distinct aims:

(1) to identify from existing research literature what is known about gender differences in learning mathematics at secondary school - no attempt was made to establish any new insights;

(2) to elicit, through interviews, the perceptions that a group of mathematics teachers had concerning the impact of gender on learning mathematics; and

(3) to use the contrasts and similarities between the findings of the research and the outcomes of the interviews, as a stimulus for the development of classroom teaching.

Context

The study was conducted in one secondary school (850 pupils) by the Head of Mathematics, and involved interviews with seven colleagues all of whom were actively involved in teaching Mathematics from Years 7-13. The study took place over a period of two school terms, and gave rise to a subsequent programme of practical modifications to the department's teaching strategies.

Summary of main findings

(1) The findings from the review of existing research included:

- evidence that girls outperform boys in mathematics up to the beginning of A-Level, but that differences are small, and are not consistent across all components of the subject;
- evidence regarding details of how attitudes to mathematics vary by gender;
- evidence that there are significant differences in the expectations of boys and girls regarding their own performance in mathematics;
- evidence that boys and girls differ in their typical learning styles; and
- evidence that ability grouping impacts differently on boys and girls.

(2) The interviews revealed that teachers with very limited exposure to formal research were able to articulate judgements about gender differences in learning mathematics based solely on classroom experience; and that their intuitive judgements were often broadly correct, but tended to exaggerate the extent of any real differences.

(3) The process of comparing the research findings with the interviews did act as a stimulus for developing classroom teaching. For example, it led directly to an enhanced professional dialogue; and, in turn, gave rise to specific modifications in lesson preparation and delivery including:

- a recognition that grouping pupils by ability (measured in examination performance) did not create sets with uniform learning needs. For example, whilst some 'top set' students thrive with a full theoretical approach to new topics, others need 'step by step' practical examples;
- an understanding that, since boys typically over-estimate their understanding of and performance with mathematical topics, teachers need to be appropriately cautious about advancing to a new subject, based solely on pupils self-reporting their own satisfaction with their learning;
- an awareness of how to manage introductions to lessons, given that some pupils (typically boys) need the 'big picture' provided by lesson objectives, whereas other pupils (typically girls) want sequenced instructions one at a time.

Background

The project was conducted in an established mathematics department of an Essex boys' secondary school. It is an over-subscribed selective school, where pupils are required to pass an entrance examination to secure a place. Informal estimates suggest that the school caters for the most-able 20-25% of the local population. The school is situated in an urban area with relatively high measures of socio-economic deprivation, but draws upon a wide catchment area and has relatively low numbers of pupils on free school meals.

Although external indicators, such as examination results, demonstrated a very successful department, teaching tended to be according to 'personal style', and departmental development focussed on administrative and managerial changes. The desire to develop a greater focus on how to teach better appeared to be hampered by a lack of dialogue about varying teaching approaches. Since discussions about best practice tended to focus on teachers' personal preferences, it made sense to attempt to introduce relevant research literature, so that lesson planning could become evidence informed. The natural question to ask was whether there were particular classroom approaches that had been shown to be more effective with boys. The gender focus of the research reflected this aspect of the school's context, and was particularly suitable as a substantial literature existed in this area. The intention was to use the 'gender debate' as a vehicle to promote professional dialogue, and to facilitate subsequent change in classroom approaches.

Findings

The first stage of the research was to conduct a thorough review of the existing research literature regarding boys and girls learning mathematics. This was made possible through access to the library at the University of Cambridge, helpful cross-referencing in the Ofsted review of research (see 'suggestions for further reading'), and a range of government statistical publications.

Amongst the findings supported by the research literature were that:

- although girls outperform boys in mathematics up to the beginning of A-Level, an analysis of 98 studies of the differences in mathematics achievement between males and females shows that the average difference is very small and has been decreasing steadily (Friedman: 1989). These differences vary by topic within mathematics, with some studies reporting that boys are best, relative to girls, in the applied and practical areas - measures and rate and ratio - while girls do best relative to boys in computation with whole numbers and decimals and some aspects of algebra (Joffe and Foxman: 1984).
- attitudes towards mathematics vary by gender, with school subjects such as science and mathematics being rated as 'masculine' by pupils and preferred by boys; whilst English and the humanities were rated as 'feminine' and preferred by girls." (Arnot et al.: 1998).
- pupils' expectations of their performance in mathematics vary by gender. Boys showed a significantly greater tendency to judge topics as easy or very easy; and as a general rule, boys perceived the topics to be less difficult than their success rate would warrant. This is echoed further in reports that show significantly more girls than boys believed that they had difficulty in remembering formulae, in understanding mathematical topics, and in applying the work that had been studied in class. Almost 20 per cent more girls than boys considered themselves lucky if they did well on a maths test (APU: 1981).
- boys and girls vary in their approach towards aspects of learning. One of these distinctions concerns the difference between learners who are 'serialist' and those who are 'holist'. Serialists prefer to accumulate new knowledge in sequenced chunks, and with set procedures and methods for problem solving. Holists tend to assimilate new knowledge within existing understanding, looking for connections and similarities within the overall 'big picture' context of their learning. The studies report that a disproportionate number of boys exhibit holistic tendencies, and that it has been established that the level of uncertainty at which individuals are happy to work is a distinguishing characteristic between serialists and holists (Scott-Hodgetts: 1986).
- variations between boys and girls impact on their experiences of ability grouping, with research evidence suggesting that the nature of high set classes contributes to the disparity in attainment of girls and boys at the highest levels. This is explained in part by the requirement to work at an inappropriate pace as a source of real anxiety for many students, particularly girls (Boaler et al.: 1998).

Teaching processes and strategies

In the second stage of the research, seven teaching colleagues in the mathematics department were interviewed (without knowledge of the research findings) and asked what they would expect to find if boys and girls approaches to learning mathematics were compared. They were asked to comment on relative attainment, on pupil attitudes and expectations, on different approaches to learning by gender, and on how pupil grouping might impact differently on boys and girls.

Commentary from the interviews was then combined into a report with the principal findings from the review of research literature. Although none of the other teachers had direct experience of the research findings, their informal observations (from many years in the classroom) provided a surprisingly close match to the empirical evidence from the published studies.

This written report became the focus of discussion in the department. Teachers were invited to discuss the implications of the gender differences for their own teaching, and to comment on how these variations displayed themselves in their classrooms full of boys.

The findings which proved most helpful were those in relation to the relative proportions of boys and girls who are either 'serialist' or 'holist' learners. This contrast helped to explain the differing behaviour of students according to the extent to which lessons were either acts of sequential instruction, or provided the big picture. The differing needs of extreme holists and extreme serialists require contrasting classroom strategies. This led to a new awareness of how to manage introductions to lessons, given that some pupils (typically boys) need the 'big picture' provided by lesson objectives, whereas other pupils (typically girls) want sequenced instructions one at a time.

The same evidence-informed perspective also helped to develop a recognition that grouping pupils by ability (measured in examination performance), did not create sets with uniform learning needs. For example: whilst some 'top set' students thrive with a full theoretical approach to new topics (typically boys), others need 'step by step' practical examples (typically girls). The case for careful differentiation of approach, both within and between lessons, became more apparent and explicitly identified. The teachers involved were also acutely aware that 'typical' boys and girls do not exist: it was necessary to remain attuned to the differences between the actual individuals in the classroom.

This stage of the research also led to a new understanding that, since boys typically over-estimate their understanding of, and performance with, mathematical topics: teachers need to be appropriately cautious about advancing to a new subject, based solely on pupils self-reporting their own satisfaction with their learning. The careful use of diagnostic question and answer activities was clearly a more suitable strategy.