"

TEACHING MATHEMATICALLY ABLE CHILDREN

WORKING GROUP REPORT

Roy Kennard

University of Sunderland

Abstract

A succession of HMI/OFSTED reports over recent decades indicates that able children are often insufficiently challenged by the work that they are set. Why is this? Is it a problem of provision or a problem of identification or both? How discerning are we when it comes to recognising the mathematical characteristics of able children? The working group pursued a discussion and activity framework which was designed to explore these questions. Particular attention was given to problems of identification.

Introduction

There is a long history of concern about provision for able children (DES, 1992, p.2). In general terms schools need to consider:

if the teaching provides sufficient challenge to pupils of all abilities, particularly in Key Stages 2 and 3 *(DFE, 1995a, p. 5).*

This is illustrated with respect to mathematics in a comment about year 7 pupils:

40% of work in mathematics is too easy, especially for more able pupils; there is too much repetitionfor able pupils (DFE, 1994, *p. 23).*

Why is this such a persistent problem?

Identification

We decided to focus first on problems associated with the identification of mathematically able pupils. Is it the case that able pupils must be correctly identified *before* challenging materials can be presented to them? How can this be done? We responded to this question in four ways.

(i) *Attainment.* This is likely to be the most typical way that teachers identify their most able pupils. But what proportion of children should be regarded as 'able'. What will they have achieved in order to earn this label? Referring to Key Stage 3 the National Curriculum for Mathematics says:

Level 8 is available for very able pupils (DFE, 1995b, p. 22)

The Ofsted report 'A review of inspection findings 1993/94' reveals that approximately 2 to 3.5 % of pupils achieved level 8 in the 1994 end of Key Stage 3 assessments (DFE, 1995a, p.36). A further 10 % of pupils achieved a level 7 in the formal tests. Should this latter group not also be regarded as 'very able'? Where should the line be drawn? As soon as a line is drawn however, some pupils will be overlooked. This is for the simple reason that whilst high achievement may be taken as an indicator of high ability low achievement does not always indicate low ability.

(ii) *Testing* Can tests of general ability or intelligence help with the identification of mathematically able pupils? What is the predictive power for example, of IQ scores? According to Renzulli;

Because IQ scores correlate only from 0.4 to 0.6 with school grades, they account for only 16-36 % *of the variance in these indicators of potential (Renzulli,* 1986*, p. 58).*

In other words school performance depends on a range of other factors apart from general ability as measured by an intelligence test. These other factors include such things as pupil perseverance and teaching quality. Whatever else is said about the use of tests of general ability it must be remembered that they are *not* tests of mathematical ability .

(iii) *Checklists* There have been various attempts to draw up general checklists to facilitate the identification of able children. We considered an illustration of this given in the HMI report of 1992 which was drawn from guidelines drawn up by Solihull LEA. The following is a selection from this list and represents the likely characteristics of able primary school pupils.

Learns easily
Musical
Has an excellent sense of humour
Good judgement, logical.
Persistent, resourceful, self directed
(DFE, 1992*, p.3)*

Whilst such a list *might* prove helpful it is clearly not specifically targeted at identifying mathematical ability. A subject specific checklist for mathematics has been designed by Denton and Postlethwaite (1985). The list contains 22 items and is largely derived from Krutetskii's work (1976). It was concluded however, that:

checklists, used over a short period in the way that is widely recommended, had done nothing to add to what teachers could achieve without them (Denton and Postlethwaite, 1985. *p. 99)*

Perhaps such a long list is too unwieldy and difficult to interpret.

(iv) *Challenge in order to identify* Our fourth approach was to answer the question in the negative and to reverse the proposition that identification must precede provision. From this standpoint, the characteristics we seek to observe depend on pupils being challenged in the first place. In other words, it is not possible to recognise what is not there! This is to see identification as a problem of provision. On a regular basis we need to provide *all* pupils with challenging and demanding tasks and to interpret their responses accordingly (Kennard, 1994, p.Sl).

In this context can we describe the characteristic abilities of mathematically able children?

What characteristic mathematical abilities are we looking for?
We tackled this question from four different perspectives and without reference to previous work. These were:

(i) Reflect on your own ability to do mathematics. Ignore your own excellent attitude and diligence! Instead try to identify the specific mathematical abilities which have enabled you to learn mathematics.

(ii) Imagine you are back in school. Think of the able pupils that you taught. What mathematical abilities did they display?

(iii) Can this question be approached by considering the nature of mathematical thinking? Are there essential features to mathematical thinking which point to specific abilities? Consider for example, the mathematical features involved in problem solving or mathematical enquiry. Can you infer specific abilities from such a standpoint?

(iv) Can this question be approached by considering the content of the National Curriculum for Mathematics? For example, what specific abilities can be inferredfrom a study of ATJ?

The following is a summary of the key mathematical characteristics to emerge:

- Can quickly and easily see solutions to standard problems.
- Can quickly and easily see several routes or methods to solve problems.
- Can discriminate between relevant and irrelevant information when solving problems.
- Can sense how individual components of working in a problem contribute to the whole.

- Can make connections, determine relationships and generalise when studying mathematical material.
- Can recognise similarities between mathematical structures.
- Can reason logically.
- Can transform relationships.
- Can easily recognise inverse relationships.
- Can think relationally.

•Can use symbols to represent mathematical ideas and to solve mathematical problems. • Can apply knowledge to different situations and in unfamiliar cicumstances.

Computational ability was not seen as a necessary characteristic of mathematically able pupils. Other related characteristics included:

- Has a fascination and curiosity for mathematics.
- Has a questioning attitude and probes for meaning.
- Appreciates structure and the elegance of ideas or solutions.

These assumptions about the characteristic abilities of mathematically able children were found to overlap with the assumptions which formed the basis ofKrutetskii's structure of abilities. Although there are problems of interpretation to resolve it seems that the working group did not identify Krutetskii's category associated with memory. For Krutetskii, able children have the ability to remember generalised ways of approaching problems and patterns of reasoning. The purpose of Krutetskii's work was to identify aspects of mathematical ability:

in which differences between pupils capable of learning mathematics and pupils less capable would be the most striking (Krutetskii, 1976, *p. 78)*

Future work

There is scope for further discussion of the points raised above. Is there a place, for example, for self-identification by pupils? Matters associated with provision including materials, grouping, teaching approaches and teacher training are all potential areas of debate and research. **References**

Denton, C. and Postlethwaite, K. (1985) *Able Children* NFER-NELSON

DES (1992) *The Education of Very Able Children in Maintained Schools* HMSO

DFE (1994) *Science and Mathematics in Schools -A Review* HMSO

DFE (1995a) *Mathematics A review of inspection findings1993/94* HMSO

DFE (l995b) *Mathematics in the National Curriculum* HMSO

Kennard, R. (1994) *Researchfor the Education of Able Children* Proceedings of Day Conference of British Society for Research into Learning Mathematics, Northampton.BSRLM

Krutetskii, V,A. (1976) *The Psychology of Mathematical Abilities in Schoolchildren* University of Chicago Press

Renzulli, *1,S.* (1986) The Three Ring Conception of Giftedness, in Sternberg,R,J. and Davidson,J,E.(Eds) *Conceptions of Giftedness* (New York, CUP)