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BOYLAN, Mark and POVEY, Hilary

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ABILITY THINKING

Mark Boylan and Hilary Povey

INTRODUCTION

Discussion 1

There are many words and phrases used in schools by teachers and students that refer to or describe mathematical 'ability'.

Make a list of words that you have used or heard others use. If you are working or placed in a school you might keep a record of the different ways teachers and students use ability and other labels.

Which of the words on your list are useful and helpful for teachers and learners and which do you think are unhelpful and damaging?

This chapter is about an important aspect of how people in the UK and in some other countries think about how mathematics is taught and learnt. We call this 'ability thinking'. The central belief in this mindset is that each person has a particular level of mathematical ability that is relatively stable. Mathematical ability, on this view, is an entity that helps to determine how much mathematics and how fast an individual can learn. It is seen as determining and so predicting future attainment. It is also claimed that learners with similar levels of attainment and so, it is assumed, ability are best taught together. This idea is the basis for either setting or banding of pupils in secondary schools in the UK and in primary schools either the use of within class ability grouping or setting with the latter becoming increasingly common. These grouping practices are outcomes of ability thinking and also help to produce it because they shape how we think about our own and others' capacity to learn mathematics.

Much of our discussion in this chapter is about setting and grouping as these are the clearest manifestations of ideas of ability and symbolise this way of thinking. However, the lens of ability influences everyday interactions between teachers and learners and the way learners relate to each other. . It is the dominant way that teachers, children, parents and policy makers think about attainment in mathematics. It is so dominant that it is often take for granted as obviously true. Because of this it is rarely debated. We think it should be. A recent international study by the Organisation for Economic Cooperation and Development concluded that setting students should be avoided at least until upper secondary education as it has negative effects on overall attainment and is unfair (OECD, 2012).

In the chapter we look at four areas. We begin by questioning the idea of mathematical ability as it is used in everyday classroom talk, we then go onto examine setting practices, including the impact of setting on attainment, issues of fairness and the longer term consequences of ability thinking. We conclude by considering alternatives to ability thinking.

ABILITY THINKING

Discussion 2

Consider this statement

Your mathematical ability is something about you that you cannot change very much.

How far do you agree?

If you broadly agree with the above statement it is likely that you have an entity or fixed view of mathematical ability. You are likely to think that whilst people can learn more mathematics each person has an underlying level of mathematical ability which is the main factor in determining, and so is predictive of, future attainment. It is not surprising if you hold this view. It is probably shared by the majority of mathematics teachers in the UK. If educated here, your own experience of being taught in mathematical sets and being labelled by ability is likely to have shaped your beliefs. Further, evidence from schools appears to support this view. After all, some students do know more mathematics than peers of the same age and do seem to understand new mathematical ideas more quickly.

The fixed view of mathematics ability is linked to a more general view of 'inborn intelligence'. In the space we have here we can only summarise some key reasons why this innate view of ability is wrong. The statistical basis for this theory is fundamentally flawed (Gould, 1981). Success in tests that purport to measure innate mathematical ability is not independent of cultural knowledge or formal and informal education. With practice it is possible for people to increase their test scores which should not happen if the tests were measuring something fixed. Recent studies have also shown a link between intelligence test outcomes and motivation. If you believe that success in a test will lead to a reward you tend to do better (BBC, 2011).

Further, the capability to carry out even relatively simple calculations is situated by context. What people can do in informal situations in their daily lives is very different to the knowledge they display in formal school environments or in tests. Attainment on mathematics tests is not only determined by how much mathematics is known but also by a host of other factors including: physical well being on the day, level of motivation, general test taking skills ; emotional issues such as test anxiety, and the amount of revision an individual might have done. These are only some of the reasons why tests are unreliable and different tests produce different results. Teachers are also used to the experience of finding that students with very similar tests scores have quite different capacities to engage in classroom activities. Even those who believe that cognitive ability can be measured estimate that differences in scores on cognitive ability tests only explain 36% of the variance in attainment outcomes (Ireson & Hallam, 2001).

Ability thinking also supposes that mathematical ability is a single entity that is generally disconnected from other human capacities. However, mathematics is much more diverse than the content that is included on tests of mathematical ability. For example, research shows that the depth of imaginative play young children engage in and their creativity is a good indicator of later mathematical attainment (Hanline, Milton, & Phelps, 2008). The current curriculum has tended to be shaped by what can be easily tested rather than reflecting the diverse ways that mathematics is used in society or important aspects of mathematical activity. Ability thinking entails and is supported by a narrow view of what mathematics is that can exclude these other aspects of thinking mathematically including problem solving, communicating about mathematics and collaborating with others.

Mathematical labels such as high or low ability are used to predict future attainment outcomes. However, it has long been established that students will tend to fulfil the expectations that teachers and the education system place on them (Rosenthal & Jacobsen, 1968/2003). Ability labels tend to lead to a series of self fulfilling prophecies, lowering expectations of teachers and students as to what is possible. They tend to narrow and restrict learning objectives. By questioning the idea of mathematical ability we are not suggesting that there are not differences in people's capacity to do mathematics, or to learn mathematics. Clearly, learners are not the same and it is important that teachers understand these differences to inform their teaching. However, we do not believe that these differences are fixed, unchanging and context free. Further, ability thinking can get in the way of understanding and appreciating these differences as it can lead to 'seeing and teaching the label' rather than the student.

SETTING AND ATTAINMENT

Discussion 3

Consider the following possible purposes a mathematics teacher might have:

- *to enable students to have mathematical skills to be active citizens*
- *to maximise the highest attainment possible for the highest attaining individuals*
- *to maximise the number of passes in the school leaving assessment*
- *to promote enjoyment of mathematics*
- *to develop problem solving skills*
- *to ensure all students have skills needed for daily life*
- *to maximise the highest possible attainment for the lowest attaining individuals*
- *to promote the social cohesion of the classroom.*

Which of these purposes do you think are the most important and which the least important and why?
What tensions might exist between these different purposes?
How might setting in mathematics influence or impact on achieving these purposes?

The most visible outcome of ability thinking in secondary schools is teaching students in sets. Setting has been the dominant form of organisation for mathematics lessons in most secondary schools in the UK for a long time. In primary schools it is more common to place students in small groups that are seen as having the same ability for mathematics lessons. In response to the pressure to 'raise standards' and official government encouragement for these approaches, since the start of the century these practices have become even more embedded and accepted in England (Ofsted, 2008). Indeed, in one recent extreme example students were required to wear different coloured ties to indicate their different perceived levels of attainment (David, 2011).

Although ability grouping and thinking is the norm in England there are other countries that do not organise mathematics learning in this way. Attainment in England is lower than in those countries that do not segregate learners. Over the last twenty years, comparing mathematics education internationally has become a 'hot topic' for politicians and journalists, as well as mathematics educators and it is important to be

cautious about drawing conclusions. Politicians' declarations that England has gone down the international league tables do not entirely stand up when these studies are critically examined. The actual differences in attainment between all prosperous and relatively industrialised countries in mathematics as measured by international comparison surveys TIMSS (Trends in International Mathematics and Science Studyand PISA (Programme for International Student Assessment) are relatively small (Askew, Hodgen, Hossain & Bretscher, 2010). Most learners in most of these countries have quite similar levels of attainment. The reasons for the differences that do exist between them are complex and multiple and so it is possible to find evidence from international comparisons to support a variety of views on setting. However, no high performing country groups students by ability in mathematics in the rigid and fine ranked way we often do in England. The countries that are most successful, such as Finland, generally teach mathematics in all-attainment groups and this is generally true of highly ranked European countries. Thus, it is ironic that the drive to increase setting, that has come in part from politicians' desire to compete with other countries in international comparisons, does not take into account the lessons we can potentially learn from such countries.

Teachers in these other countries are experienced in teaching all attainment groups. Further, they will generally have experienced this way of learning in their own education, and importantly their beliefs about learning mathematics are not constricted by ability thinking. In the UK all attainment grouping in mathematics has often been put into practice in a hostile policy context, by teachers with little support from initial teacher education or continuing professional development, and where the assessment regime is based on and backs up ability thinking.

Given this we might expect that in the UK we would find that setting leads to higher outcomes than all-attainment teaching. However, comparisons of different forms of grouping within the UK also show that grouping by perceived ability does not generally raise attainment when compared with alternatives. The evidence from various studies is somewhat contradictory due, perhaps, to the effects of other features associated with setting such as different curricula and teaching practices). Some studies have shown that no groups of students benefit from setting or tracking in terms of attainment (for example, Boaler, 1997). Other studies have shown that those who are highest attainment on entry to secondary school may get some limited benefit in terms of attainment outcomes but that lowest attaining students suffer and do less well when segregated (Ireson & Hallam, 2001). Once placed in a lower set, students usually suffer from lower expectations and a restricted curriculum and may be given less qualified or experienced teachers. Students with very similar levels of attainment when placed in different sets have very different outcomes and in mathematics this can be as much as a GCSE grade (Wiliam & Bartholomew, 2004)

SETTING PRACTICES

Discussion 4

Investigate how individuals are allocated to particular sets or groups in mathematics and their educational experience in those sets.

You might reflect on your own experience as well as talk to other people about theirs. If you always were in one type of set then it is valuable to talk to people who were in different types of grouping.

If you're currently working or placed in a school enquire into the process by which students are placed in sets. What influences those decisions?

Setting practices are deeply inequitable. Some gain at the expense of others and often the ones who appear to do well out of setting tend to be students who are already advantaged. Teacher beliefs about students rather than attainment evidence can be significant in deciding on sets. Such perceptions can be influenced by cultural stereotypes. This may explain why, for example, a lower proportion of Afro-Caribbean students are entered for the higher mathematics tier than would be expected on the basis of their prior attainment (Strand, 2011). Because movement between sets is rare (Hart et al., 2004) once allocated to a particular set educational opportunities may be curtailed for the rest of the student's schooling. Students from groups who experience social and economic disadvantage are more likely to be found in the lower sets (William & Bartholomew, 2004) as are girls (Brown, Brown, & Bibby, 2008). Our view, and one we hope you would share, is that mathematics teachers have a responsibility to support all students to achieve mathematically and to develop a positive relationship with the subject.

When students are taught in sets few students receive an appropriate level of challenge. It is all too easy to teach a class in which the range of attainment is narrowed as if the attainment, motivation, and disposition of all students in the class is the same. In top sets the usual assumption is that learners benefit from or need a fast pace and instrumental proficiency even though evidence suggests that many learners, and in particular girls are alienated in this environment (Boaler, Wiliam & Brown, 2000). Further, such practices appear to put learners off studying mathematics once the subject becomes optional (Brown et al., 2008). Offering those with the highest previous attainment or with a particular interest or disposition for mathematics a diet of mathematics in pre digested bit size pieces 'delivered' at pace may also leave them unchallenged.

Those in lower sets in secondary schools will often only be offered material that they have previously encountered and so meet a narrow and restricted curriculum (Watson & De Geest, 2005). Through adherence by teachers and schools to a simplistic theory of learning styles they may be labelled kinaesthetic and so be required to use practical equipment even when it does not support mathematical learning (Marks, 2011). At the same time students in high sets may not be offered the opportunity to develop their thinking through engaging with manipulatives, physical models or embodied learning that can stretch understanding and provoke debate about the meaning of mathematical concepts. There appears to be a link to the type of curriculum and learning experiences that are offered and the patterns of social class background found in different types of set. Groups in which working class students are more likely to be found are offered a more 'manual' curriculum.

ABILITY MINDSETS

Setting and the ability thinking that supports it is unjust and damaging in other ways. It not only creates barriers to attainment - it also can have profound impacts on learners' beliefs about themselves and their relationship to mathematics. There is now extensive evidence of the ways in which children, including from young ages, are highly aware of their relative position in the class or year group (for example, Hodgen & Marks, 2009). The process of 'measuring and being measured' (Boylan, 2004) effects how children see themselves and others. For some, including those who appear to gain by being labelled clever or 'top set', it can lead to profound anxiety (Boaler, Wiliam & Brown, 2000). Mathematics comes to be seen as an elitist activity that only some can do

(Nardi & Steward, 2003). One understandable response by teachers of previously low attaining students is to try to further simplify or reduce the challenge in mathematics - to try to make mathematics easy. Unfortunately, this is counter productive as it makes learners over reliant on teachers doing the mathematical thinking on their behalf, robs the mathematics studied of meaning and purpose thus making it harder to learn, and makes students unwilling to tackle questions or topics that appear difficult when first encountered, to engage in problem solving or to apply mathematics in unfamiliar context.

The effect on identities lasts beyond compulsory mathematics education. Mathematical anxiety and shame experienced at school can still be felt in adulthood (Bibby, 2002). Jo Boaler (1997) did a celebrated study in the 1990s of the experience of school mathematics in two schools similar in terms of attainment and socio-economic profiles but which had different approaches to teaching mathematics. In one, mathematics teaching focused on a problem solving curriculum and students worked in all-attainment groupings. Hilary discusses this approach in more detail in a later chapter. In the other school students learnt through a more traditional approach and learning took place in sets. When she later interviewed participants from her original study as adults, she found that those who had learnt mathematics in all attainment classrooms were more likely to be working in higher paid and more highly skilled occupations. She concludes that setting can limit the aspirations of those who are placed in lower sets. One of her interviewees who had experienced setting reflected on the effects on his peers:

> You're putting this psychological prison around them …It kind of just breaks all their ambition … It's quite sad that there's kids there that could potentially be very, very smart and benefit us in so many ways, but it's just kind of broken down from a young age. So that's why I dislike the set system so much - because I think it almost formally labels kids as stupid. (Boaler, 2005:142)

We believe it is not only those who find themselves in lower sets who may experience psychological prisons. There is evidence that not just setting but ability thinking itself damages all learners.

Carol Dweck (1999; 2006) and colleagues have done extensive research into the way peoples' self theories or 'mindsets' about ability influence their achievements. She identifies two contrasting theories or beliefs. One is to see intelligence as 'malleable' or changeable. Learners with this incremental view tend to stick at challenges. They see effort as the key to success. The other theory is at the heart of what we call ability thinking. Here intelligence or ability is seen as an entity and is fixed. The consequence of this mindset when met with challenge or difficulty is often to give up due to a belief that ability equates to being able to do a task straightaway. If the task is challenging then this, it is supposed, means that the task is beyond their ability. Success for the entity theorists should be effortless and there is little point trying. Carol Dweck has found that learners with the same level of initial attainment given the same learning opportunities but with different mindsets have different outcomes. Those with a fixed view of ability tend to do worse.

Dweck's research is able to explain why, for example, even those who go on to achieve highly in mathematics may still feel insecure about their competence or mathematical identity (Black et al, 2009). We have a culture in school mathematics where if someone is placed in the top set through their effort they are not seen as being as 'bright' as others; achievement in mathematics is supposed to be effortless,

thus reinforcing entity theories. Most teachers, of course, encourage their students to try hard and not to give up when meeting challenges. However, this encouragement cannot, on its own, develop or sustain an incremental view if the language of the classroom, the emphasis on measurement, the pedagogy, curriculum and the experience of setting all assert a fixed view of ability. Whatever the form of classroom organisation, often the most significant lesson learnt by students is that in mathematics what counts and is valued is speed, competition and the amount "covered".

Discussion 5

How far does Carole Dweck's research reflect your own experience or that of people you know?

What are the implications of Dweck's research for how mathematics should be taught and organised in schools?

ALTERNATIVE MINDSETS

In this chapter we have discussed the negative effects of the setting practices that flow from ability thinking. However, adopting all-attainment groupings will not by itself creative inclusive classrooms where the attainment of all can be fostered. The negative consequences of ability thinking can and do happen in mixed ability classes as well, if the ability mindset is the way teachers and learners are thinking about learning mathematics.

Fortunately, there are other ways to think about mathematical capacity and learning than 'ability thinking'. We have discussed Carol Dweck's concept of malleability emphasising that human cognitive and social capacities are not fixed. Susan Hart and colleagues propose a similar concept of 'transformability' that focuses on the potential for change (Hart et al., 2004). There are many ways in which classroom mathematics can be taught based on the principle of transformability and Hilary discusses a number of these in a later chapter in this volume *'A pedagogy of attainment for all'*.

However it may not be the teaching practices, classroom organisation or curriculum that are most important in supporting success for all learners, but rather the beliefs of teachers and so of learners themselves. We noted above that there are many countries which do not think about mathematical capacities and learning in terms of ability and who successfully support high attainment for the majority. These countries differ in their approaches to teaching mathematics but what they have in common are:

- high expectations of all students
- allowing all to access a challenging curriculum
- valuing current effort rather than previous attainment
- and striving for the achievement of all rather than of a few.

These countries demonstrate what is possible on a national scale. Obviously, individual teachers cannot reproduce their pedagogical approaches or the culture that supports them. However, we can, as teachers, change our own mindsets and strive to teach our students rather than teaching to labels. When we do this remarkable and surprising outcomes are possible. Brent Davis, Dennis Sumara and Rebecca Luce-Kapler (2008), for example, offer the story of Krista, who is labelled as having a learning disability in mathematics but goes on to achieve highly when her learning needs are addressed.

Anne Watson and Els De Geest (2005) point to what is possible for whole classes of what they describe as previously low attaining students. They identify the principles that underlay the practice of teachers who were particularly successful with such students in spite of the restriction of rigid curricula or prescribed types of lessons. These principles include: access to a broad mathematics curriculum; supporting students to develop reasoning and thinking and to become mathematical learners; supporting students' self-esteem through mathematics; giving students freedom to exercise rights and responsibility; taking into account the power of external measures but not being driven by them; and providing extended thinking time and extended tasks. It is principles rather than practices, they argue, that are key. These principles also provide their own challenge to the restrictions generated by ability thinking. When low attaining, demoralised students are given 'more choice, freedom, challenge, responsibility and time' (Watson & De Geest, 2005: 230) they are enabled to succeed.

In the UK there is general agreement on the need to support more learners to be successful in mathematics and to address the disengagement of many from the subject. In recent times this has been addressed, in the main, by focusing on differences between learners. National Curriculum levels, and more recently the fictitious idea of sub levels, are used as tools to identify ever more narrow diets of mathematical content for specific groups of learners. The increased use of setting has tended to predetermine the range of possible outcomes for students. Resources and attention has tended to flow to whichever groups of students are designated as being of most concern by whatever measure is used, at any particular point in time, to judge school success. The alternative we propose is one which

> emphasises *universal entitlement* rather than differences: *everybody* counts, *everybody's* learning is equally important, *everybody* contributes to the learning environment. And so it follows that teachers work constantly to create - and if necessary invent - approaches that allow everybody without exception, to engage in the activities provided, to have the experience of being excited by learning, to gain something worthwhile, and to feel a sense of safety and belonging. (Dixon et al., 2002: 9, original emphasis)

Challenging our own and others ability thinking offers the possibility of honouring this entitlement.

Readings

Dweck C (1999) *Self-theories: Their Role in Motivation, Personality, and Development*, Philadelphia: Psychology Press.

> This is an engaging digest of a body of research that demonstrates that ability thinking is damaging for learners. Dweck also challenges 'commonsense' ideas about praise and feedback, emphasising the importance of valuing effort, challenge and the development of strategies rather than ability.

Hart, S., Dixon, A. Drummond, M J. & McIntyre, D. (2004). *Learning without limits.* Maidenhead: Open University Press

This book is based on a research project which studies the practices of a group of teachers who teach all-attainment or widely attaining classes. They propose the concept of transformability as an alternative to ability. Chapter 2 - 'What's wrong with ability labelling' is particularly relevant to the ideas we have presented in this chapter.

Wiliam, D., & Bartholomew, H. (2004). It's not which school but which set you're in that matters: The influence of ability grouping practices on students progress in mathematics. *British Educational Research Journal*, *30*(3), 279-293.

This article provides a summary of key research on setting in mathematics as well as evidence from a study that tracked the progress of 950 students. The study showed how setting can affect attainment and teaching practices.

Watson, A. & De Geest, E. (2005) 'Principled teaching for deep progress: improving mathematical learning beyond methods and materials', *Educational Studies in Mathematics*, *58* (2) 209–234.

This article reports on a two year action research project with 10 teachers to improve the achievement of previously low attaining secondary students. A key finding was that effective practices were based on common principles. These principles represent, in our view, an alternative to ability thinking.

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