

# AN INVESTIGATION OF MATHEMATICS TEXTBOOKS AND THEIR USE IN ENGLISH, FRENCH AND GERMAN CLASSROOMS: WHO GETS AN OPPORTUNITY TO LEARN WHAT?

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***Abstract:** This paper reports on an examination of mathematics textbooks and their use in lower secondary classrooms in England, France and Germany. An analysis of the data suggests that learners in the different countries are offered different mathematics and given different opportunities to learn that mathematics. It also identifies pupil access to textbooks in England as a cause for concern.*

## **Introduction**

Students spend much of their time in classrooms exposed to and working with prepared materials, such as textbooks, worksheets and computer programmes. It is reasonable to argue, therefore, that such materials are an important part of the context in which pupils and teachers work. It is also commonly assumed that textbooks (with accompanying teacher guides) are one of the main sources for the content covered and the pedagogical styles used in classrooms. It is not surprising, then, that considerable attention has focussed on textbooks, including the economic and political circumstances of their production (Apple, 1986 and 1992), their linguistic features (Castell et al, 1989) and their sociological features (Dowling, 1996).

The focus of this paper is with the mathematics made available to pupils through textbooks, and the ways in which teachers use the textbooks, in order to reflect on the learning opportunities offered to pupils in mathematics in each of the three countries. Three best-selling mathematics textbooks in each of the countries were analysed in relation to the teaching of angle and directed numbers. In addition, ten teachers in each country were observed for a day and also interviewed to help understand how they used textbooks in their classrooms.

## **Mathematics textbooks and their use in France**

In lower secondary years in a mathematics classroom in France, there is no grouping of pupils by perceived ability. Rather, all pupils in a class are given opportunities to learn the same mathematics, with each topic studied for the same amount of time by all pupils, from the same textbook supplied by the school. The textbook 'belongs' to the pupil for the academic year and is therefore available for their use at home and in school. All teachers we interviewed in France told us they used the textbook most if not all of the time in their lessons, and as their main resource for lesson preparation.

Textbooks are mainly written by mathematics inspectors in France (who regularly inspect mathematics teachers and, partly on the basis of this inspection, determine the speed at which each teacher moves up the salary scale) and therefore reflect the pedagogical concerns and emphases of those inspectors. The traditional 'cours magistral' (lecture) has almost entirely been replaced by lessons organised in three parts: the activity (cognitive activities to prepare for learning); the cours (the 'meat' of the lesson); and the exercises. Questions in the exercises are characterised by their interest, challenge, the range of contexts used and connections made within mathematics. It could be argued that it was in teachers' interests to follow the advice offered by inspectors, and certainly teachers' interviewed all had the perception that this was how lessons should be structured. Thus, textbooks represented best pedagogical practice amongst a significant group of mathematics educators, and teachers based most if not all of their teaching on them.

Most mathematics teachers in France saw it as their responsibility to prepare the 'cours' of the lesson, and drew on a number of textbooks and other sources for its preparation. Pupils kept a copy of the 'cours' presented to them in their *cahier de cours* and many teachers said they encouraged pupils to compare their 'cours' with that of the textbook. Many also said that at the beginning of the year they explained the outline and structure of the textbook, the different kinds of exercises, the dictionary at the end of the book, the relevant statements from the National Curriculum for the particular year (often included in textbooks), and they initiated

tasks where pupils had to search through the books for information. Their longer-term aim here was that it should become a resource for them in their learning.

Given that all pupils in a class are engaged in the preliminary activities and the course – where it is expected that all pupils should be given the opportunity to learn and understand it – they are therefore exposed to the same cognitive and language demands as each other at these stages. Differentiation took place during the exercise phase of the lesson, when teachers interviewed seemed genuinely concerned with identifying and providing pupils with appropriately challenging exercises, and in such a way that every pupil had the opportunity to understand. Observations showed that in general all pupils were given the same questions to do, and teachers would talk to individuals if they thought that they needed either stretching with some more difficult questions, or changing the kinds of questions to easier ones. It was assumed that some pupils might not be able to complete all the parts of the particular questions set. Outside whole class time, support classes were set up to help those pupils with difficulties.

### **Mathematics textbooks and their use in Germany**

At age 10 in Germany, pupils are allocated, according to parents' wishes and school recommendations, to the *Hauptschule*, the *Realschule*, or the *Gymnasium*. Whilst the first two have a vocational orientation towards education, the last has a much more academic tradition. Although the core curriculum for mathematics in Germany is similar for all pupils, the mathematics is treated in different ways, with proof and cognitive challenge being important in the *Gymnasium* and the use of algorithms to apply mathematical ideas being emphasised in the *Hauptschule* and *Realschule*. There are different textbooks for each school type and in this research we predominately looked at teachers and the textbooks used in the *Gymnasium* and the *Hauptschule*.

Textbooks are not supplied by the school and it is expected that parents will buy them, unless they have financial difficulties. This means that pupils then have access

to the textbook both at school and at home since it literally belongs to them. The school itself decides on the textbooks to be purchased by parents from a list of approved books supplied by the ministry of the *Land*.

Traditionally, textbooks have been used differently in mathematics in the different school forms. Thus although all German teachers said that they used the approved textbooks to prepare their lessons, their use of them in the lessons varied.

Those who used it very little in lessons were exclusively *Gymnasium* teachers. It appeared that for the pupils in the *Gymnasium*, who were usually the high achievers, an exclusive use of the textbook was not seen as appropriate. German teachers saw the books as a ‘collection of exercises’ and these (as in the *Hauptschule* textbooks) could be characterised as extensive and relatively closed, in that pupils were rarely encouraged to explore ideas further. However, it was also expected in the *Gymnasium* that teachers should talk about the mathematics in a more or less conversational style in lessons. Indeed, the discussion and exploration of mathematics in this way – and without reference to the textbook – was a strong feature of mathematics teaching in this school type. Little differentiation was practised in the *Gymnasium*: it was expected that all pupils of a class would follow the same curriculum, otherwise they repeated the year, or left the school.

The *Hauptschul* teachers in general followed their textbook more closely than their *Gymnasium* colleagues. They felt that this was necessary because pupils were perceived as not being able to cope with too many deviations from the straightforward mathematical algorithms. For example, questions in context were regarded by the teachers as generally ‘too hard’ for the *Hauptschul* children. It was further claimed that ‘their’ children could either read or understand, but not both at the same time.

A particular feature of German *Hauptschul* teachers was that they changed their lesson style and the use of textbooks according to the perceived ability of the children: the lower the perceived ability of pupils, the more textbooks were used. Furthermore, and this was consistent with observations, teachers spent relatively little

time explaining and developing mathematical ideas, but rather more on the teaching of algorithms followed by exercises. On the other hand, with the higher achieving pupils in the *Hauptschule* teachers' style resembled that of the *Gymnasium* with its emphasis on the whole class development of ideas.

In general, German teachers valued their textbooks, but in particular in the *Gymnasium* they had reservations about them in terms of their value as a teaching aid in lessons, and they did not use them exclusively. As far as pupils were concerned, they had different access to mathematical ideas depending on the school form they attended: once this was decided, everything else followed. The focus for the teacher in a *Gymnasium* was to offer appropriately challenging mathematics given the school form, and not necessarily be too concerned with attempting to meet the needs of an individual pupils within that school form. On the other hand, a pupil in a *Hauptschule*, even though it is possible to transfer to the *Gymnasium* at the end of school form, would have been given an experience closer to that offered in the textbook they had available, and with an emphasis on the practice of routine algorithms rather than an exploration of overarching and challenging ideas in mathematics.

### **Mathematics textbooks and their use in England**

Pupils in England in this study were put in sets for mathematics during their first year in secondary school according to their results in National Curriculum tests. Once in those sets, they followed the same National Curriculum but from different starting points and with different end points in mind. Textbooks reflected this way of organising pupils so that in any year group, a particular textbook scheme might have different textbooks aimed at different sets of pupils.

Teachers in England in this study all said that they used textbooks regularly, and almost all that use in lesson times was for pupils to practice exercises selected by the teacher following on from teacher explanation of a particular skill or technique. Outside lessons, teachers used the textbook differently. Heavy users of the textbook

in class relied on the textbook to provide them with most of the materials and ideas they would use in their lessons. Other teachers talked about referring to a range of textbooks or worksheets or previous ideas and experiences to help guide their thinking and planning. However, an increasing lack of time was frequently mentioned as an inhibitor to lesson planning so that many reported an increasing reliance on their textbook. Thus, whilst more experienced teachers talked about drawing on a bank of ideas to plan their lessons, they said that less experienced teachers were more likely to have to rely solely on the textbook given the range and complexity of demands made on them. Unfortunately we were unable to explore this further.

Pupils in the lower secondary years rarely had access to a textbook outside lessons and the reason given for this were because of imposed financial constraints on schools. None of the teachers suggested that pupils themselves might buy their textbooks, unless they were preparing for external examinations. It seems, therefore, that very many pupils in these schools had no access to the school textbook to help their learning and consequently they had to rely entirely on teacher guided input in lessons. This was particularly true of lower attaining pupils: there seemed to be a problem in finding a suitable book for them; and such pupils were almost always perceived as unreliable in the sense that they would be unlikely to remember to bring the books to lessons anyway. Given that this was exacerbated by shortage of funds to buy books, it seems that such pupils might well go through 5 years of compulsory secondary schooling without any support for their learning in mathematics apart from their teacher in lesson time.

All teachers considered that it would be impossible to use the same textbook with all pupils in a year group. Instead, they talked about the need for different textbooks for high, for intermediate and for low ability pupils. High ability pupils were said to need exercises with interesting and challenging questions and, perhaps, some explanation. Intermediate pupils were said to need plenty of straightforward questions practising particular skills or techniques. The perceived needs of low ability pupils were heavily influenced by concerns about context, layout and language demands. In fact,

exercises in all textbooks were characterised as containing mostly routine questions very similar to worked examples included in the text.

Language demands were often mentioned in relation to all textbooks, regardless of pupil ability. However in general, the concern was about the perceived inability of pupils to read and understand any text, and mathematical text and instructions in particular. As a result of this concern, teachers rarely asked or expected pupils to use textbooks for anything other than exercises, and questions in context were read and often personalised by the teacher so that pupils needed to carry out no reading for understanding whatsoever. This was confirmed in lesson observations. Given that access to textbooks was limited to use in lessons for many pupils, that their use was restricted in those lessons to exercises, and that teachers mediated the language used in the exercises, pupils in this study had almost no opportunity to develop their reading and comprehension skills in mathematics. It is perhaps unsurprising that some teachers commented that when pupils did have access to textbooks, many seemed unable to use them to support their learning.

A lower secondary pupil learning mathematics in England seems to have to face some significant problems. Textbooks offer mathematics which is lacking in variety, cognitive challenge and linguistic complexity. Teachers say they increasingly have little time to go beyond the textbook in preparing their lessons and therefore there is a danger that they rely on what is offered in them as a framework for what is possible in their lessons. Because of a shortage of funds and a tradition in which schools have supplied textbooks in the past, pupils have almost no access to the textbooks: textbooks which are actually designed for them are used mostly by their teachers. And when textbooks are made available to pupils, teachers may further limit learning opportunities by selecting only those questions judged to be appropriate for the perceived ability level of the set.

Indeed from the researchers' perspective, looking across the three countries, whereas the concern for pupils in France relates to how low attainers might cope with the mathematical demands made on them, and whereas the concern in Germany is how

differentiation is achieved within the school types, the concern in England is how to increase rather than limit the learning opportunities currently offered to pupils in mathematics.

## **Reflections**

What has interested us about the research reported here is that pupils across the three countries and within two of them get such different opportunities to learn mathematics. Putting to one side the extent to which pupils learnt what they were offered, there was no doubt that pupils in France and in the *Gymnasium* in Germany were stimulated by challenging mathematics both in their textbooks and, during lessons, by their teachers. Both appeared to work in relative harmony to ensure that mathematics was offered which was stimulating and challenging. This was less clear in the *Hauptschule* where teachers restricted opportunities for learning because of their perceptions of what pupils could actually achieve if they were in that system. Their textbooks, however, remained relatively challenging. However, of most concern was the situation in England where textbooks were rarely available for pupils in lower secondary years; where the mathematics in the textbooks, even for the most able, was not as cognitively challenging as that offered in the other countries; where textbooks and teachers appeared to be in agreement that all but the most able pupils needed routine and relatively low level demands made of them. Challenge might have been met to some extent by enriching the language used in the texts, but this tended to be avoided both by textbooks and teachers so that pupils got few opportunities to improve their literacy skills, never mind getting fewer opportunities to engage in mathematics which was in complex or unfamiliar contexts. Given that teachers in England (but not Germany or France) talked about the increasing difficulty they had in finding time to prepare their lessons, it might be speculated that the textbook will increasingly define the boundaries of what is possible in mathematics classrooms in England. If that is the case then textbooks need to be available to pupils and need to

offer much richer mathematics if pupils are to receive the same kind of mathematical offering as their French and German counterparts.

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