Mathematics textbooks and their use in English, French and German classrooms:
a way to understand teaching and learning cultures

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Abstract: After a thorough review of the relevant literature in terms of textbook analysis and mathematics teachers' use of textbooks in school contexts, this paper reports on selected and early findings from a study of mathematics textbooks and their use in English, French and German mathematics classrooms at lower secondary level. The research reviewed in the literature section raises important questions about textbooks as representations of the curriculum and about their role as a link between curriculum and pedagogy. Teachers, in turn, appear to exercise control over the curriculum as it is enacted by using texts in the service of their own perceptions of teaching and learning. The second and main part of the paper analyses the ways in which textbooks vary and are used by teachers in classroom contexts and how this influences the culture of the mathematics classroom. The findings of the research demonstrate that classroom cultures are shaped by at least two factors: teachers' pedagogic principles in their immediate school and classroom context; and a system's educational and cultural traditions as they develop over time. It is argued that mathematics classroom cultures need to be understood in terms of a wider cultural and systemic context, in order for shared understandings, principles and meanings to be established, whether for promotion of classroom reform or simply for developing a better understanding of this vital component of the mathematics education process.

Kurzreferat: Nach einer gründlichen Literaturübersicht berichtet dieser Artikel über die Ergebnisse einer Studie, die Mathematikschulbücher und ihren Gebrauch im Unterricht in England, Deutschland und Frankreich untersuchte. Die im ersten Teil des Artikels betrachtete Literatur wirft wichtige Fragen im Zusammenhang mit der Annahme auf, dass Schulbücher als Repräsentanten des Lehrplans angesehen werden können und angeblich eine Mittlerrolle zwischen Lehrplan und Unterrichtspraxis übernehmen. Im zweiten und Hauptteil wird untersucht, wie und in welcher Weise sich Schulbücher in den drei Ländern unterscheiden, wie sie von Lehrern im Unterricht benutzt werden und wie dies die 'Kultur' des Mathematikunterrichts beeinflusst. Die Ergebnisse zeigen, dass 'Unterrichtskulturen' von mindestens zwei Faktoren beeinflusst werden: von den pädagogischen Prinzipien und Überzeugungen der Mathematiklehrer in ihrer 'hautnahen' Schul- und Klassenzimmerumgebung; und von den 'Traditionen' der jeweiligen Bildungssysteme und deren historischen Entwicklungen. Es wird argumentiert, dass die 'Kulturen' des Mathematikunterrichts im weiteren kulturellen und systemischen Rahmen verstanden werden müssen, sodass gemeinsames Verständnis, Prinzipien und Bedeutungen erarbeitet werden können, sei es für Reformen oder einfach um diesen wichtigen Prozess des Unterrichts besser zu verstehen.

ZDM-Classification: U20, D40

Introduction

"The cultural perspective requires us to culturalise the curriculum at each of the levels, and demonstrate that no aspect of mathematics teaching can be culturally neutral. The cultural 'messages' in the educational enterprise are created and manifested by people. People create the national and local curriculum statements, people write the books and computer programs, people bring their cultural histories into the classroom, and people interpret and reconstruct the various messages." (Bishop 1992, p.185)

In order to refine our understandings of the teaching and learning cultures of the mathematics classroom in different countries, we need to refine our understandings of the teachers, the learners, the materials used for learning and the interactions between them. However, each of these is influenced, and in some cases determined, by the educational and cultural traditions of the particular country in which the teaching and learning takes place. Until we have a richer, more clearly articulated, and more detailed understanding of the ways each of these factors interrelate, educationists are likely to be pulled in inappropriate and ill-judged directions by policy makers intent on short-term, measurable outcomes of performance improvements in a narrow range of areas which are not only opposed to the values held by their own society, but also unworkable within the cultural traditions shaping it.

The choice of a comparative enquiry is an important one to explore. The perceived aim of a comparative analysis is a better understanding of the cultures under study by comparing them. It allows researchers to be able to examine the taken-for-granted assumptions of the known culture, which in turn can lead to a deeper understanding of issues that are of central concern in different countries. Cross-national comparisons may also point to possible directions that could be followed and about which the researcher may not previously have been aware, or they may help to sharpen the focus of analysis of the subject under study by suggesting new perspectives. Thus, cross-national comparativists are forced to adopt a different cultural perspective, to learn to understand the thought processes of another culture and to see it from the native's viewpoint, while also reconsidering their own country from the perspective of a skilled observer from outside (Hantrais and Mangen 1996).

From previous research (e.g. Pepin 1997), we have been able to identify the extent to which educational traditions influence both what teachers do and why in their classrooms. For example, we can locate French teachers concern with the 'connectedness', coherence and wholeness of mathematics within their educational tradition of rationality, one of the signposts of French *encyclopaedism*. As another example, 'setting' in England, a common way of grouping pupils in secondary mathematics classrooms, is said to lead to different learning experiences and outcomes for pupils. This contrasts with the French belief in entitlement for all pupils to the same curriculum. Each of these can be

located within educational traditions: individualism which is part of the English humanistic philosophy; and egalitarian views connected with French *encyclopaedism*. Similarly, the intensification and extent of the teachers' role in England contrasts with those of France and helps us to understand why teachers spend their time both inside and outside the classroom doing different kinds of things. Again, this can be understood within traditions of the 'whole-child' approach in England (as part of the principle of morality in English humanism), compared with the principle of *laïcité* which appears to free French teachers from pastoral care duties, and the principle of rationality (as part of encyclopaedic views) seems to encourage French mathematics teachers to focus on the preparation, the teaching and the assessment of their lesson. In Germany, Humboldt's humanistic concept of *Bildung* basically promotes the unity of academic knowledge and moral education. German mathematics teachers have traditionally held the two functions, that of academic specialist and, possibly to a lesser extent, that of moral educator. Depending on the school type of the tri-partite system teachers are working, their responsibilities in terms of pastoral care are greater (*Hauptschule*) or lesser (*Gymnasium*).

Students spend much of their time in classrooms exposed to and working with prepared materials, such as textbooks, worksheets and computer programmes, to name but a few. It is reasonable to argue, therefore, that such materials are an important part of the context in which pupils and teachers work. Some researchers (e.g. Cherryholmes, 1988, in Doyle, 1992) argue that these materials are the means by which the curriculum is made manifest in teaching episodes.

Not all texts used in classrooms are textbooks. Nevertheless, textbooks are an important way to connect knowledge domains to school subjects. Moreover, it is 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 (Castell et al, 1989) or sociological features (Dowling, 1996), amongst other features.

The aim of the proposed study is to refine our understandings of both the materials teachers use in their classrooms, and the ways in which they use them, locating our understandings insofar as it is possible within the educational traditions of England, France and Germany.

Rationale for textbook research

The framework for the Third International Mathematics and Science Study (TIMSS) differentiates among the intended curriculum, the implemented curriculum, and the attained curriculum, which raises questions about the role and function of mathematics textbooks. They assert that in most countries the textbook is 'almost certainly not the embodiment of the intended curriculum', and similarly that 'the textbook is not identical to the implemented curriculum, as teachers make their own decisions about which topics to include or not to include in their course, and about which approach … to take in the teaching of particular topics' (Howson 1995, p.6). We now attend to questions connected to the intended, implemented and attained curriculum. The following paragraphs are concerned with questions of *why textbooks are used* (and not other text material); *how textbooks and other text material (for example, curricular material) relate*; and *what differences there are between textbooks and other text material*.

In order to explore teaching and learning cultures in England, France and Germany, it is important to see what there is in common. All situations concerning teaching and learning involve teachers, pupils, mathematics, and curriculum materials. The latter help, to a greater or lesser extent, determine teachers' practices, and, either directly or indirectly, pupil learning. Many other factors shape these situations, such as perceptions and beliefs about the nature of mathematics, or about the teaching and learning of mathematics, but nevertheless they all flow from the visions and intentions of particular systems. Thus, the values and educational and cultural traditions which underpin such systems make their way not only through teachers' perceptions of the teaching and learning of mathematics, or through their classroom practices, amongst other factors, but also through official texts that are provided and, in some cases, authorised by the respective countries.

The main texts are the curriculum documents, which consist of curricula and textbooks. In recognition of the central importance of such documents, TIMSS included large-scale cross-national analyses of mathematics curricula and textbooks as part of its examination of mathematics education and attainment in almost 50 nations. In their analysis of textbooks, Schmidt et al (ibid) provide as a rationale that textbooks are likely to reflect, at least in part, official intentions of the national curriculum since they would be commercial unviable if they did not. They assert that textbooks served 'at times almost as de facto mathematics curricula, with curriculum guides helping to shape omissions, time allocations, and instructional goals' (Schmidt et al 1997). At another stage they comment that it was possible to compare what was commonly intended in curriculum guides with what was commonly intended in textbooks:

"Often the same topics were widely present in both. Some topics- usually the more advanced or those related to recent reforms- were present in curriculum guides but not in textbooks. This suggested that more conservative approaches were taken in textbooks, or that there was a lag between when topics began to be emphasised and when they found their way into textbooks. Conversely, some topics- usually those already considered in previous grades- persisted in textbooks even when not widely present in curriculum guides. This further suggests more conservative visions of mathematics curricula implicit in textbooks." (p. 19)

Indeed, in a study of textbooks and the English National Curriculum MacLure and Elliott (1991) assert that

'the impact of the NC upon textbooks is pervasive: all of the commercial schemes have made additions to their subject

coverage to bring it in line with new requirements. More strikingly, all of the schemes recognise and use the new vocabulary of the National Curriculum' (p.97).

Lourenco (1998), using Bernstein's pedagogical discourse model (Bernstein 1990 and 1996), compared the sociological message underlying the pedagogical discourse in distinct science textbooks in Portugal and considered the extent to which this discourse represented a recontextualisation of the official pedagogic discourse present in the syllabus. She found that textbooks showed differential degrees of recontextualisation of the syllabus, and that all of them talked in the teachers' voice.

Starting from the premise that teachers declared that their main tool in the classroom was the textbook (and not curricular guidelines), and considering the above outlined findings of TIMSS that in general textbooks cover the same topics and seem to reflect, with a time lag, the visions of curricula (Schmidt et al 1997), it is reasonable to investigate textbooks as important classroom materials.

There is still one main question remaining: how to investigate textbooks, in particular mathematics textbooks at lower secondary level? Gilbert (1989) gives a brief review of 'traditional approaches' and criticises the reliance of research on text analysis removed from their context of use. He argues that 'the analysis of text can point to potential, even likely, outcomes in classroom use of texts, but it can never conclude with confidence that the ideological import of a text as interpreted by the researcher will be similarly realised in the discourse of the classroom' (p.68). In previous work (Gilbert 1987) he commented on the homology between interviews and classroom interaction for the purpose of analysing texts in use. In addition, textbooks are likely to be an important factor influencing the questions, issues and topics covered and discussed in classrooms. Thus, textbooks should be analysed both in terms of their content and structure, as well as in terms of the process component, i.e. their use in classrooms by pupils and teachers.

Content and structure of textbooks

There appear to be four main areas according to which textbooks have been analysed in terms of their content and structure: the mathematical intentions of textbooks; pedagogical intentions of textbooks; sociological contexts of textbooks; and the cultural traditions represented in textbooks.

1. Mathematical intentions of textbooks

Mathematical intentions of textbooks can be seen to divide into three areas: what mathematics is represented in textbooks; beliefs about the nature of mathematics that are implicit in textbooks; and the presentation of mathematical knowledge. Mathematics represented in textbooks

The literature, in particular the French literature on pedagogy and *didactiques*, makes a distinction between the scientific knowledge (*savoir savant*- knowledge which is accessible through books and magazines and generally accepted as knowledge by the research community) and the taught knowledge or school knowledge (*savoir enseigné* - knowledge proposed to pupils in the form of textbooks, for example). Chevellard's (1985) famous notion *of transposition didactique* is explained as the process from the *savoir savant* to the *savoir enseigné*, and which attempts to formalise the conception of relation and one-way dependence between 'educational' and 'scholastic' mathematical knowledge. However, Freudenthal (1986) is highly critical of Chevellard's notion, and he points out the complexity of relation and the difficulty of indicating from which 'scholarly' mathematics particular 'school mathematics' is supposedly transposed. Furthermore, he argues that the notion of *transposition didactiques* is a false one and that it is a naive claim that school text material is a special version of mathematics.

"La fausse perspective est celle d'en haut vers en bas au lieu de l'ordre inverse. Les mathématiques que la grande majorité de nos citoyens futurs doit apprendre, ne correspondent à aucun savoir savant dont elles seraient la transposée (didactique ou non), sinon au savoir savant d'un passé de nombreux siècles." (p.326)

Love and Pimm (1996) add that it is 'a trap, for it privileges the other mathematics as being the 'real' mathematics, rather than seeing both as versions of mathematics for particular purposes' (p.375). In the American literature McEwan and Bull (1991) argue on a similar line by opposing Shulman's familiar notion of pedagogic content knowledge. In their view, the teachers' knowledge of subject matter is not different in kind from that of scholars. This points to the importance of considering the authors' views of mathematics when analysing textbooks.

Beliefs about the nature of mathematics implicit in textbooks

Van Dormolen (1986) points out that there is a wide range of opinions about the nature of mathematics, ranging from the goal of acquisition of knowledge with activities provided as a means to that end; to, essentially, the goal of acquisition of process skills (e.g. problem solving, exploring and investigating) with content knowledge growth as a means to that end. This resembles two of the categories defined in Ernest's (1991) classification of ideologies in mathematics education and leads to the notion of textbooks reflecting a particular view of the mathematics. One might, for example, have textbooks in which exercises predominate, with few connections made between the concepts practised in each. On the other hand, one might find texts which encourage pupil exploration, questioning and autonomy, and with the posing of problems providing the motivation for the acquisition of new knowledge. Since we already know that teachers' views of the nature of mathematics are, to some extent, culturally dependent, it seems important that the textbook analysis includes the investigation of intended views of the nature of mathematics projected in textbooks.

Presentation of the mathematical knowledge

Suggestions for analyses of the mathematical knowledge in textbooks are provide by Van Dormolen (ibid) and by Schmidt et al (1996,1997). Van Dormolen

suggests, for example, that in analysing a text one might look for the extent to which it has each of the following: a theoretical aspect (theorems, definitions, axioms); an algorithmical aspect (explicit 'how to do…'); a logical aspect (rules about how we are and are not allowed to handle theory); a methodological aspect ('how to do…' more heuristically, for example how to use mathematical induction); a communicative aspect (conventions, or how to write down an argument, for example). Schmidt et al, on the other hand, classify an understanding of the content in terms of its: topic complexity (which topics; when; which emphasised; with what conceptual demands); developmental complexity (ways of sequencing and developing topics across lessons and across the whole curriculum (for example, focused and concentrated or a spiral of revisiting topics)); cognitive complexity (the pedagogical intention for the topic i.e. what you want the students to do as a result of having learnt the topic).

It appears that the ideas from Van Dormolen can be subsumed into the analysis of the nature of mathematics. Indeed, there seems to be a belief about the nature of mathematics implicit in his classification: that of mathematics as rule-bound and convention-bound; with knowledge which is certain; and with official methods and techniques to be acquired. The classification by Schmidt, on the other hand, appears more promising since it seems to offer insights not necessarily elicited in any other way. Indeed, they develop their idea of cognitive complexity and introduce the notion of commonly intended performance expectations such as representing; recognising equivalents; recalling maths objects and properties; using equipment; performing routine procedures; formulating and clarifying problems and situations; developing strategy; solving; developing algorithms; conjecturing; using vocabulary and notation; relating representations. They comment that they found diversity in terms of all three aspects of topic complexity, developmental complexity and cognitive complexity the analysis of content in their cross-national comparisons. It therefore seems important to explore any diversity in textbooks in England, France and Germany and, in order to understand this diversity, identify the educational traditions, which may account for them.

Pedagogical intentions of textbooks

Pedagogical intentions of textbooks have been addressed in the literature in terms of three themes: (1) ways in which the learner is helped (or not) within the content of the text to learn the materials; (2) ways in which the learner is helped (or not) within the methods included in the text; and (3) ways in which the learner is helped (or not) by the rhetorical voice of the text.

As an example of the first (1), Van Dormolen (1986) suggests that in terms of a long term 'global perspective', we should consider the extent to which a text provides: cursory preparation (e.g. is everything already introduced which needs to be introduced, and in the right order?); conceptual preparation (e.g. is the learner blocked from new learning because of what is already learnt, perhaps because pupils are not persuaded of the value of new methods over previously learnt ones); adaptation to students' abilities (with a build up of the learning process, appropriate use of language, and the possibility of handling text without help).

As an example of the second (2), Johnsen (1993) quotes Gustafsson's (p. 163) research in which she suggested that textbooks could exercise a negative (as well as positive) control on learners in relation to: material selection and sequencing (when the teaching medium was not based on the logical structure of the subject); language (when the pupils do not need to understand the language of the teaching medium); learning (when pupils did well merely by memorising the words in the textbook and when basic skills like speaking and writing were not called for); ideology (when there was no discussion about the values expressed in the teaching medium); methods (when the teaching medium "forced" users into certain routines).

The usefulness of this is that it extends and enriches Van Dormolen's ideas as well as addressing some of the analytical demands of Schmidt et al, and emphasises of the potential power of the text as it either helps or hinders pupil learning. Nevertheless, Van Dormolen's ideas are likely to need further refinement, not least because of their lack of detail and clarity but also because of the use of a generalised descriptor of student 'ability'.

As an example of the third (3), Crismore (1989) suggests that a learner can be helped to achieve cognition by the author providing a metadiscourse to the text, reflecting the author's presence in the text (e.g. "The important thing here is…"). He argues that a rhetorical text presents a complete communication plan of the text with elaborate pre- and post-summaries and briefer updates of content, as well as the author's intentions and evaluations of the content, so that readers can recognise the author's plan and use it for constructing meaning.

Clearly, the teacher can decide either to teach the learners such metacognitive strategies, or to provide a metadiscourse him/herself. Either way, these represent ways in which teachers might mediate the text (explored below). It is important to note here, though, that any metacognitive strategy not already available to the learner can be introduced (or not) either by the text or the teacher and therefore puts both in positions of power in relation to learner cognition.

The sociological contexts of textbooks

Dowling (1998, 1996) carried out a sociological analysis of texts in common use in Britain. He chose textbooks from the SMP 11-16 scheme, and in addition, because textbooks in the scheme were targeted at pupils of perceived ability levels, he chose to analyse one designed for relatively high achievers (the Y series) and another designed for relatively low achieving pupils (the G series). The results of his analysis suggest that there are differences, for example, in content, levels of abstraction, in treatment of topics, in expectations and in aspirations of its target audience. Since these differences match, to a large extent, stereotypes within the culture, his work is particularly relevant for this study since there is differentiation in Germany in relation to school form, differentiation in England, frequently in relation to setting policies in schools, but no differentiation in France.

In terms of differences in content, for example, he first defines an 'esoteric' domain in his classification, which appears to relate to a level of abstraction in the text. From his analysis he concludes that in terms of both the topics covered, and the content of the texts, Y scheme users become apprentices of esoteric mathematics, G scheme users remain dependent on the text. Indeed, he develops this further by suggesting that whilst Y scheme users are helped to abstract the essence of the mathematics from the text, G scheme users are given settings which obscure the mathematics. Thus, Y books' features 'serve to minimise the local importance of the setting and to accentuate the mathematical grammar' while for G books, 'there is no pedagogizing of methods, methods are constructed as residing within the reader or within the setting' and 'the context is precisely the pedagogic programme itself'.

The contexts of the mathematics, argues Dowling, also reinforce stereotypical views about likely career destinations, with the Y reader voice associated with a high salary earner, 'a potential professional and a describer of manual workers', the G reader voice associated with a low salary earner, 'a potential manual worker and an occasional watcher of professionals'. Of particular interest here is that in Planel's research (1997), she argues that the educational goals for French and English (primary school) pupils are different, with French pupils having a clearer perception than the English pupils of a final career and with school as a precursor to that. English (primary school) pupils, on the other hand, are more concerned with school as a place for enjoyment . Clearly, whether or not pupils in English secondary schools see school as a precursor to a career they are, according to Dowling, being prepared for their likely future career even in their mathematics textbooks.

Dowling is able to add to his analysis of the written textual contexts with an analysis of the proportions of iconic representations (cartoons, drawings, photographs); mathematical representations (tables, graphs); and symbolic representations with the textual frame. He notes from this, for example, that in the G series, the move from cartoons to photographs through the series 'connotes a trajectory from the playful and fictional world of childhood to the real world of adulthood'.

Dowling's sociological analysis of textbooks adds important information to any analysis of texts. It prompted us to ask about the extent to which cultural traditions, stereotypes and expectations influence the authors of textbooks and the ways in which they are made apparent in the texts in each country.

Cultural traditions represented in textbooks

The idea that a textbook reflects national curricular goals and, further, reflects and legitimises national cultural traditions are well documented in the literature. Apple (1986), for example, argues that the textbook 'often defines what is elite and legitimate culture to pass on' (P. 81) and, in addition, that their widespread usage in classrooms has the potential to exert a powerful influence on pupils:

"Whether we like it or not, the curriculum in most American schools is not defined by courses of study or suggested programs, but by one specific artefact, the standardized, grade-level-specific text in mathematics." (p. 85)

In another article Apple (1992) asserts that:

"texts are not simply "delivery systems" of "facts". They are the simultaneous results of political, economic, and cultural activities, battles, and compromises." (p.4)

In the same article he also quotes A. Graham Down of the Council for Basic Education:

"Textbooks, for better or worse, dominate what students learn. They set the curriculum, and often the facts learnt, in most subjects. For many students, textbooks are their first and sometimes only early exposure to books and to reading. The public regards textbooks as authoritative, accurate, and necessary. And teachers rely on them to organise lessons and structure subject matter. But the current system of textbook adoption has filled our schools with Trojan horses- glossily covered blocks of paper whose words emerge to deaden the minds of our nation's youth, and make them enemies of learning." (p.6)

Similar views are expressed by Castell, Luke and Luke (1989) who argue that:

"Of the many kinds of texts available to the modern reader, the school textbook holds a unique and significant social function: to represent to each generation of students an officially sanctioned, authorised version of human knowledge and culture. Within the context of compulsory public schooling in industrial and post-industrial cultures, textbooks form shared cultural experiences, at times memorable and edifying, while at others eminently forgettable and uneducational." (p. vii)

Stray (1994), in an article about school texts, claims that 'textbooks can be conceived as a focal element in processes of cultural transmission' (p.1) and asserts:

"Text' is of course a contested category. … Textbooks are the bearers of messages, which are multiply coded. In them, the coded meanings of a field of knowledge (what is to be taught …) are combined with those of pedagogy (how anything is to be taught and learnt). With the development of a capitalist system of production, these messages are conveyed through production, distribution and consumption of commodities" (p.2).

Thus, it appears that textbooks reflect a nation's cultural values and that textbooks in this study will have embedded in them, and will legitimise, the different cultural educational values of England, France and Germany. But what is decisive is not only the system of ideas and beliefs that textbooks reflect, but the whole process -as practically organised by particular and significant meanings and values- that is lived in the classroom. This is the subject of the next section.

The use of textbooks in classrooms

With respect to the use of textbooks by teachers and pupils, there appear to be six main areas under which the emerging themes from the literature can be usefully organised: (1) *whether textbooks are used or not for teaching and learning*; (2) *the authority of textbooks*; (3) *who uses the textbooks (pupil/teacher) and who makes the decisions on who uses textbooks*; (4) *how textbooks are used, who makes decisions on how they are used and what teachers value about textbooks*; (5) *the teacher as the mediator of the text*; and, finally, (6) *educational*

traditions as a potential influence of what happens in classrooms.

1. Textbooks are used or not

Apple (1986) makes the claim that textbooks are used extensively in American schools, and Millett and Johnson (1966) make similar claims about their use in English classrooms. Their source is HMI who claim in 1992 that 67% of schools used commercial schemes in years 7 and 8, with 41% of pupils working from them for 51-80% of the time and 38% using it for more 80% of the time.

The German as well as the Anglo-Saxon literature is clear about the fact that textbooks are used extensively in the classroom. Keitel et al (1980) claim that amongst the tools for teaching and learning the textbook is one of the 'oldest and also the most controversial' (p.15, free translation). They claim that 'in any case' the textbook is 'one of the most important orientations [for the teacher] and the factor which influences the teacher's work in its entirety' (free translation). In England Her Majesty's Inspectorate estimated that two-thirds of middle and secondary schools used a commercial mathematics scheme for Year 7 and Year 8 pupil (HMI 1992). However, they do not say how they were used within the schools and whether they formed the major part of pupils' mathematical diet. Millett and Johnson (1966) argue that mathematics has long been regarded by many teachers in Britain as a subject for which the textbook, or commercial scheme, is the main resource. Evidence from the IEA Second International Mathematics Study (Robitaille and Garden 1989) and the more recent Third International Mathematics and Science Study (TIMSS, in Schmidt et al 1996) indicate that this is a world-wide phenomenon.

Interestingly, in the Handbook of Research on Mathematics Teaching (Grouws 1992) there is no chapter on textbooks and equally no entry in the subject index under 'textbooks'. Howson (1995) argues that one reason for this situation might be 'the paucity of research papers on this aspect of mathematics education'. However, in the International Handbook of Mathematics Education (Bishop et al 1996), Love and Pimm (1996) raise issues of texts, both text materials themselves as well as their function in the classroom.

Many people work directly with school texts –teachers, pupils, educators, administrators, researchers, and sometimes parents. However, teachers and pupils are rarely given the opportunity to reflect on the unique status of the textbook as 'the primary medium of formal education' (Castell et al 1989), nor to consider the varied theoretical and practical questions to which the status gives rise. Questions arise concerning what can be transmitted by text, the relationship between knowledge and textual representation (and how these vary), and whose knowledge is represented (see earlier 'which knowledge').

2. The authority of the textbook

The idea of the authority of school textbooks is explored by many authors, although the extent of that authority today is in some dispute. The underlying question is what content should be granted the status of knowledge and then be communicated by textbooks. Bernstein (1990) considers the 'cultural capital' of dominant classes and class segments as the most legitimate knowledge. This 'legitimate' knowledge is made available in schools through the textbook. Apple (1986) asserts that the curriculum in most American schools is not defined by programmes of study, but by the grade-level-specific text.

"It is estimated, for example, that 75 per cent of the time elementary and secondary students are in classrooms and 90 per cent of their time on homework is spent with text materials." (p. 85)

Keitel et al (1980) give a detailed analysis of how historically text became 'autonomous' with the invention of printing and how this influenced teaching and learning. They also outline the historical development of school textbooks in Germany, and assert that since the 1968 reforms the school textbooks were 'the real instruments for innovation' (p.73) in the sense that they communicated the then newly developed curricula. In Germany the textbook became the basis for lesson planning and a reflection of the 'new' lesson.

Similarly, Olson (1989) talks of the school text as the 'authorised version of society's valid knowledge'. Assuming that schooling aims to transmit to each new generation 'culturally significant knowledge', school textbooks seem to be an ideal format. Yet there is a distinction to be made between the reader and the author. Olson views textual language as 'a device for managing authority', in the sense that, by separating the speaker from the author, the text is made 'impersonal, objective and above criticism'.

"The centrality of textbooks to schooling, then, derives from the authority of texts, and, for Olson, text authority has two main sources. First, particular linguistic structures make texts explicit, albeit inaccessible, until those structures have been mastered by the student. Second, texts appear 'above criticism' because of the separation of the speaker from the speech, and the corresponding dissociation of the speaker from the reader, so providing an impression of textual objectivity and neutral validity." (Luke et al 1989, p.247)

This is interesting in itself, but even more so if one assumes that teachers mediate the knowledge in the text and that the student is in a subordinate status to the teacher. Authorised information becomes associated with teachers' explanations. As students are not within the appropriate and sanctioned group to be entitled to criticise the school text, teachers' mediation becomes authoritative.

"Thus, teachers are in fact, and by status, in command of textual knowledge. As such, text and teacher can be seen to co-constitute a domain of knowledge, and to co-constitute one authoritative identity." (Luke et al 1989, p.258)

Furthermore, Luke et al. (1989) argue that because in the classroom teachers refer to textbooks as 'the blue book', or 'get your textbook out', for example, teachers detach authorship - therefore fallibility - from the text, and therefore giving the text even more authority. Since the teacher mediates the knowledge in the text, 'text and teacher can be seen to co-constitute a domain of knowledge, and to co-constitute one authoritative

identity'.

What is interesting from these ideas is that there may be two kinds of authority in relation to mathematics textbooks: authority associated with the mathematics; and authority over negotiation of the text . Thus, appropriate questions to ask include: is the mathematics itself open to negotiation, or is it being presented as incontestable knowledge which may be open to revision and interpretation; is the textbook open to challenge in terms of methods and sequencing?

While these can be addressed in terms of the mathematical analysis of the text, they are also open to mediation by the teacher. Nevertheless, the student is in danger of assuming an acquiescent, non-authoritative status in relation to both of them (Castell et al, ibid.). The extent of the acquiescence is, according to Planel (1997), also likely to be culturally determined and in her work in primary schools in England and France she found that the French teachers had relatively greater control over pupil related behaviour, pace of work, task time, and content, with 'authoritarianism … [being] part of the French cultural and educational tradition'. She found that whilst English pupils saw that there were a number of sources of learning, French pupils assumed lessons must be teacher led, with the acquisition of facts and concepts.

Thus, both the extent of the authoritative voice chosen by the author in relation to the portrayal of mathematics, and the authoritative voice chosen by the author (and mediated by the teacher) about ways of negotiating the text may well be culturally determined and therefore different in the three countries.

3. Who uses textbooks (pupil/teacher) and who makes the decision on who uses them

Although the German literature claims that educational reforms aimed to put the pupil in the centre of the mediation between knowledge and textbook (‘pupil books’), in reality, even after the 1968 reforms, the ‘pupil books’ were written for teachers and the educational theories were addressed to the teacher (Keitel et al 1980). Empirical studies (Hopf 1977, in Keitel et al 1980) showed that only about 52 per cent of teachers used any other literature for lesson planning in addition to the textbook. In other words, 48 per cent used only the school textbook for their lesson preparation. Hopf also asserted that the textbook was used mainly by the teachers as a guideline, very little by pupils, and that teachers stayed closer to the textbook the longer they were in service and the less complete they saw their education. The American literature (for example, Kuhs and Freeman 1979), in a similar vein, explains that about 50 per cent of teachers teach ‘textbook bound’. Therefore, although the textbook seems to influence the lesson to a large extent, it appears that it is rarely used as a ‘pupil book’.

The Anglo-Saxon/American literature also claims that historically, teaching of the text has always been the teacher’s primary function, with the teacher as mediator (for example, Luke 1989). It appears that teachers, in consultation with their colleagues, decide which textbook or textbooks to use, and where and when to use it in the classroom. They initiate children not only into the prescribed knowledge, but moreover to the ways the knowledge should be acquired, and in which ways pupils and teacher interact with the text. Luke et al (1989) argue that school textbooks are always the object of teacher mediation in which ‘the student assumes an acquiescent, non-authoritative status in relation to both the text and the teacher’.

Interestingly, Luke et al (1989) also point to the fact that teachers control the text by virtue of the institutionally defined authority of their role, and that students have little or no say in the selection of texts. For example, Dowling (1998) analyses the different sociological messages in different texts for different achievement groups, and these different texts are allocated to students at the beginning of every year. This ‘differential distribution of classroom knowledge’ (Apple 1979) is mostly decided by the teachers in any particular school, sometimes without clear or moderated criteria amongst schools, departments or education authorities.

4. How textbooks are used (how do teachers/pupils use textbooks), who makes the decision on how they are used, and what do teachers value about textbooks

Concerning what teachers value about textbooks, Keitel et al (1980) report on a series of interviews they conducted with teachers about textbooks and their use. Their teachers made some interesting points: they felt that a short and precise ‘knowledge storage’ part was important for them, but most important, in their view, was the quality and differentiation of exercises. Unfortunately, they said, textbooks were not suitable for pupils for revision purposes. The main point on exercises and problems for lessons was also highlighted by teachers in another study on English, French and German teachers (Pepin 1997).

Johnson and Rising (1972) assert that the textbook was a major factor not only in determining what mathematical topics were taught (and how they were taught), but also in terms of the introduction of new topics into the curriculum. They highlighted one of the dangers of ‘textbook bound’ teaching where the focus can potentially turn from the learner to the text. The Cockcroft Report (1982) also warned that:

> “…it is always necessary to use any textbook with discrimination, and selections should be made to suit the varying needs of different children. It may be better too, to tackle some parts of the work in an order which is different from that of the book, or to omit certain sections for some or all children. It should not be expected that any textbook, however good, can provide a complete course to meet the needs of all children; additional activities of various kinds need to be provided.” (p.91-92)

Millett and Johnson (1966) point out that some teachers, lacking confidence in their own mathematical competence, regard those who write commercial mathematics schemes as ‘experts’ and uncritically adopt such schemes. The Cockcroft Report addresses that point:

> “In our view there are some major problems which need to be resolved when using such schemes. One is that of providing sufficient opportunities for oral work and discussion. Another is the difficulty of devising materials from which all pupils can learn satisfactorily and of ensuring that the necessary interconnections are established between topics which are being

studied and other pieces of mathematics." (p.152)

It is clear, as Elbaz (1983) points out, that teachers are not 'passive transmitters of knowledge. They introduce, they explain and discuss texts. Intentionally or unintentionally, they emphasise or de-emphasise, they select and exclude.

As argued before, it seems that textbooks, for commercial viability, are likely to be in line with national curricula and therefore reflect any intended national curriculum. Thus the mathematics in them is likely to reflect and legitimise the intentions of those national curricula.

However, whilst textbooks may reflect an intended curriculum, their use is likely to be moderated by teachers in the three countries. Thus, whilst they provide a way of developing an understanding of national intentions, they may provide only a partial picture of the curriculum actually implemented by teachers in their classrooms. Indeed, Gilbert (1989) writes that 'analysis of text can point to potential, even likely, outcomes in classroom use of texts, but it can never conclude with confidence that the ideological import of a text as interpreted by the researcher will be similarly realised in the discourse of the classroom' (p. 68).

These practices result in another phenomenon: the identification of textbooks with courses or teachers. Since students, by and large, do not identify textbooks with authors (or groups of authors), but rather with teacher explanations, the teacher becomes the quasi-author of what was taught from the textbook. The textbook thus becomes more closely associated with the teacher and the subject content, which is authoritatively prescribed, and teachers embody and reconstitute the textbook in use (Luke et at 1989).

5. Teacher as mediator of the text

It is clear from the literature that many researchers have recognised that whilst an analysis of textbooks provides information relating to curricula intentions and accepted cultural traditions, they provide only a partial picture in relation to what is implemented in the classroom, even when textbook usage is as widespread as studies mentioned earlier have claimed.

The reason for this is clear: teachers act as mediators of the text. Teachers decide which textbooks to use; when and where the textbook is to be used; which sections of the textbook to use; the sequencing of topics in the textbook; the ways in which pupils engage with the text; the level and type of teacher intervention between pupil and text; and so on.

The literature is clear about the potential power and authority of textbooks, and the ways in which cultural traditions are either implicit or explicit within textbooks. What is not known is the extent to which cultural traditions influence teachers' mediation of the text and, indeed, whether teacher mediation serves to reinforce or reduce any cultural differences between them.

Teachers as mediators of the text is an idea which is explored in the literature. Both Johnsen (1993) and Van Dormolen (1986), for example, refer to studies which suggest that teachers use all kinds of textbooks in all kinds of ways, and comment that whilst textbooks control what happens in the classroom to a large extent, they do not do so in ways envisioned by the authors of the texts. Johnsen (ibid) classifies teachers as either faithful followers of the textbook lesson by lesson with little or no time on supplementary material; followers of the plan and progression of the textbook but selective in its use; those who break from content and structure and add supplementary material.

He also quotes research by Stodolsky who concludes:

"In sum, our cases suggest that teachers are very autonomous in their textbook use and that it is very likely that only a minority of teachers really follow the text in the page-by-page manner suggested in the literature. Use is much more varied than usually suggested, particularly when one considers more than just the topics contained in the books. Even with regard to topics, we found…that what teachers teach is in the book, but they do not teach everything that is in the books. Thus, math textbook content tends to place something like a cap on content coverage in classrooms, although putting something in a book does not guarantee instruction will be devoted to it." (Stodolsky 1989, in Johnson 1993)

The mediatory role of teachers extends beyond that of content selection and includes decisions about wider pedagogical issues. As we have already argued, the teacher may act as mediator of the authority of the text; mediator or provider of the metadiscourse of the text; mediator of the language and explanations of the text. In addition, the teacher might offer additional explanations, materials or examples.

The level of mediation of textbooks in England, France and Germany has not been studied systematically. However, Schmidt et al (1996) report that as part of the TIMSS study they observed lessons in where there was heavy reliance on the textbook in Norway, Spain and USA: 'In all these cases, the mathematics presented in the class appears as an authoritative body of knowledge to which students and teachers must hold'. In France on the other hand, 'the frequency with which teachers departed from a strict reliance on the textbook was evidence of classrooms centred on teacher expertise' (pp. 91).

Teacher expertise does not seem to be a factor in available literature in England, and although the working conditions for teachers in England (Pepin 1997) as well as the use of individualised schemes (Millett and Johnson 1966) may signal little mediation, comments by Bierhoff (1996) suggest a heavy use of additional materials by teachers - and therefore of significant mediation by them.

In her recent study Boaler (1997) conducted a detailed study of two secondary schools in England where teachers taught mathematics in 'traditional' and 'progressive' ways respectively. She asserts, and this is supported by Jaworski (1994), that in England the 'exposition and practice' approach is relatively typical for mathematics at secondary level, where 'textbook teaching is employed by the vast majority of mathematics teachers' (Boaler 1997, p.39). She also refers to Schoenfeld (1988) who asserts that textbook teaching generally entails the teaching of different content areas 'that have been chopped into small pieces which focus on the mastery of algorithmic procedures as isolated skills' (Schoenfeld 1988, in Boaler 1997). Interestingly, Beaton et al. (1996) claim that, according to TIMSS, nearly half

of the English students asked regarded success in mathematics as involving memorising the textbook.

It seems, then, that the ways in which the teacher mediates the text are largely unknown, particularly in England and Germany and, in addition, there are no theorised understandings about the ways in which such mediation is influenced by cultural traditions in the three countries.

6. National culture as an influence of what happens in classrooms

When preparing to develop research instruments to explain and understand cross-national differences in student achievement in TIMSS, Schmidt et al (1996) describe how they and colleagues from countries involved in the study found that early in the development stage, it became clear that the assumptions brought to investigations of classrooms and what occurs in them were not always the same. Quite simply, the questions, which seemed relevant for researchers working in one country to ask seemed irrelevant to those in another. They concluded that it was necessary to develop a common language and understanding of classrooms in the various countries. Indeed, they further argued that whilst developing an understanding of classrooms is important, what happens there is influenced by each system's decisions about specific visions, aims and goals which are expressed in National Curricular materials and resources.

The influence of cultural traditions on educational practice has long been recognised. Indeed, Alexander (1996) writes that it has become almost obligatory for comparativists to quote Sadler who, in 1902, wrote that 'in studying foreign systems of education we should not forget that the things outside the schools matter even more than the things inside the schools, and govern and interpret the things inside … all good and true education is an expression of national life and character'. However, Sadler also raised the issue of the extent to which comparative studies should be used to change practice ('It must be taken in all, or left unimitated') or to understand practice ('it will result in our being better fitted to study and understand our own').

Alexander (ibid.) is clear about his own stance in the debate:

> "Simple 'off the peg' borrowing of educational practices, of the kind that is currently being commended for primary schools, may not work, because it treats such practices as value-neutral and fails to explore the way they relate to the wider culture of which classroom life is a part." (p. 29)

On the other hand, Bierhoff's (1996) study of the 'main' textbooks used in primary classrooms in each of Britain, Germany and Switzerland had as the stated aim the discovery of 'whether there are important differences between Britain and the continent in approaches to teaching the foundations of mathematics which British teachers *would do well to consider*' [our italics]. This seems to be an example of a comparativist whose concern is with change rather then understanding. Our own stance is that of developing an understanding of differences (and similarities) rather than an identification of differences in order to engage in 'off the peg' borrowing of practices.

Harris and Sutherland (1998) have also studied primary textbooks with the particular focus on the treatment of number in five countries (England, France, Hungary, Singapore, USA). Research associated with TIMSS, and in particular that related to textbooks in secondary mathematics classrooms (Schmidt, et al, 1997 and 1996) did not include England or Germany. Unfortunately, they limited themselves to analysis of the semiotics of the mathematical content and did not include the wider intended and unintended messages in the texts. In connection with TIMSS, Howson (1995) presented his analysis of mathematics textbooks for 13-year-old students from eight of the countries participating in the study (and including England this time). He selected one text for each country, which he does not regard as representative of those found in a particular country. Thus, he claims that the texts studied 'provide indications' and 'messages', but 'are not determinants of national characteristics or necessarily of classroom practice' (p.13). More recently, Foxman (1999) reviewed some findings from TIMSS relating to mathematics textbooks and their use in 16 countries, excluding Germany and for some parts also England. He believes that the TIMSS, Howson and Harries/Sutherland studies would need to be supplemented by studies 'of [textbooks'] actual usage in a range of classrooms', in order to provide a representative picture of a country.

The study

The research builds on the authors' previous work which developed an understanding of mathematics teachers' work in England, France and Germany in the light of the countries' educational traditions (Pepin, 1999 a,b,c). The present study, firstly, investigates the similarities and differences of mathematics textbooks at lower secondary level in the three countries. The aim is to understand the range of ways in which commonly taught topics in secondary mathematics are addressed in textbooks, in order to widen our understanding of how mathematics is perceived in the different contexts, and of the pedagogical 'intentions' of mathematics textbooks. Secondly, the research explores the ways mathematics teachers use textbooks in English, French and German secondary classrooms. The aim is to develop an understanding of the relationships between the mathematical and pedagogical 'intentions' reflected in textbooks, teachers' use of those textbooks, teacher pedagogies and the different facets of educational traditions in the three countries.

There are a number of important underlying issues. Firstly, it is suggested that within a particular country mathematics textbooks reflect the significant views of what mathematics is, the mathematics that students need to know, and the ways that mathematics can be taught and learnt. Thus, what appears in mathematics textbooks is influenced by the multi-faceted aspects of an educational culture, and can therefore provide a window onto the mathematics education world of a particular country. Secondly, it is suggested that mathematics teachers mediate textbooks in their lessons. The mediatory role of teachers extends beyond that of content selection and

includes decisions about wider pedagogical issues (Johnson 1993, Van Dormolen 1986, Boaler 1997). Previous research indicates that in France and Germany the textbook is regarded as the key element of teaching and learning, whereas in England textbooks are viewed as one of many resources that teachers use in their classrooms. Thus, it is suggested that teachers' use of textbooks is also underpinned by educational trends, developments and traditions (Alexander 1996, Pepin 1999b) that flow from the visions and intentions of particular systems. Furthermore, whilst it is acknowledged that there are diverse educational trends, developments and traditions within every country, it is argued here that there are common properties of educational developments and 'cultural' traditions, and that these underpin the particular systems. Thus, these educational currents and 'cultural' traditions are likely to make their way not only through teachers' perceptions of teaching and learning of mathematics, reflected in their classroom practice, but also through official texts.

Research design

In line with the two main aims of this study, namely to explore mathematics textbooks and mathematics teachers' use of textbooks in the classroom, the methodology of this study has two strands. Firstly, the textbook analysis strand uses a schedule, which draws on the range of ideas in the literature, and which has been newly devised to examine mathematics textbooks in the three countries. What has been attempted in this analysis schedule for textbooks of the three countries is -by drawing on ideas from the literature- to arrive at a comprehensive set of questions for the analysis of texts in terms of the wider intentions and characteristics than those explicitly stated in the textbooks. Secondly, the semi-structured interview strand provides an opportunity to explore teachers' views underpinning their use of textbooks in the classroom, in combination with classroom observation, in order to be able to triangulate the data gained through interviews.

For the **analysis** of the responses to the questions, in particular to the more open-ended questions, as well as the data gathered from the textbook analysis, a procedure involving the analysis of themes similar to that described by Woods (1986) and by Burgess (1984) will be adopted, which has already proved useful in other cross-national studies (for example, Broadfoot and Osborn 1993). However, there will be the additional cross-cultural dimension making it essential for the researchers (who have different educational and cultural backgrounds) to work together in sifting and sorting the data and identifying the issues of importance. In this respect it is important to address the potential difficulties with cross-cultural research projects, in particular the issues involved with conceptual equivalence, equivalence of measurement, and linguistic equivalence (see Warwick and Osherson 1973, in Pepin 1997).

In order to locate and understand the textbook 'intentions' and teachers' use of textbooks in the light of educational currents and traditions of England, France and Germany, it is useful to draw on knowledge gained from recently completed comparative research (Pepin 1997) which developed an understanding of mathematics teachers' work in the light of complex influences such as educational developments and traditions in the three countries.

Findings

It is important to note that the findings that are presented in this paper are preliminary findings. They cannot be regarded as being complete or refined. For example, in terms of textbooks, one of the best-selling series in each of the countries was analysed. Equally, in terms of teacher interviews, not all interviews have been included in the analysis. The findings presented here can be regarded as a first attempt to describe and develop an understanding of selected issues that emerge from the analysis of the data. The three issues examined here, which emerged as general themes and which characterised cultures of mathematics classrooms in England, France and Germany were: the nature of mathematics textbooks; pupil access to mathematics textbooks; and the use of textbooks.

1. Nature of textbooks

Structures of mathematics textbooks in England, France and Germany are quite different. For example, French mathematics textbooks are structured in a very particular way. Firstly, they are usually divided into three sections according to the structure of the *programmes* (the curriculum): numbers and algebra; statistics; and geometry. Every chapter is then divided into three parts: *activités; l'essentiel; exercices* (activities- essential- exercises). The activities are small investigations, practical or cognitive activities (sometimes bordering on exercises) which are intended to introduce pupils to a notion. *L'essentiel* corresponds to the essential part that needs to be taught and understood, in words and in worked examples. This is often referred to as the *cours*. The third part accommodates exercises, sometimes graduated in order of difficulty.

The part that distinguishes French from English and German textbooks is, amongst other factors, the *activités* (small investigations) part. In German textbooks, after a short section with selected introductory exercises and the main 'message' or formula followed by worked examples, the majority of the sections consists of exercises. English textbooks also offer mainly exercises, interspersed with some points of explanation and worked examples.

Why is it different in France? There is clearly an understanding in France that these cognitive activities help pupils to understand the notion being introduced by the teacher. In contrast to the 'old' *cours magistral* (lecture type teaching), teachers and inspectors claim that the activity approach is a 'softer' way to teach mathematics. In terms of French educational traditions, it seems to fit in with Piaget's notions of constructivism and their associated teaching approaches. From previous research (Pepin, 1999) we know that French teachers focused on developing mathematical thinking which included exploring, developing and understanding

concepts, and mathematical reasoning. These approaches, it is claimed, reflect the ideal of rationality (in encyclopaedism) embodied in the notion of *formation d'esprit*.

In England, and this seems like stating the obvious, textbooks appear sparse. This is to say that, in terms of layout, there are fewer questions and/or text on every page than in French and German textbooks. The structure is such that chapters are relatively brief, and within each chapter there is an initial introduction to new ideas and techniques. This is then followed by a worked example and an exercise of questions similar to the worked example. Questions that differ significantly from the worked example are usually marked as more demanding. The use of language, both general and technical, is kept to a minimum and sentence structure is generally simple.

2. Pupil access to textbooks

In England, textbooks have traditionally been provided by the school, and they were issued to pupils for one year. Now, it seems that these practices have changed, because teachers said that they could no longer afford to buy them from their allocated budgets. Indeed, the purchase of textbooks, teachers said, was heavily influenced by cost, with decisions sometimes being made entirely on this basis even when teachers judged that cheaper textbooks were not as good as more expensive alternatives. However, even when cost was taken into account, many pupils at Key Stage[1] 4 and almost all pupils at Key Stage 3 had not been issued with a textbook to use in school and at home. Some teachers/schools had found alternatives: pupils bought their own revision guides in Key Stage 4 and these were used as textbooks; pupils had access to a book in some lessons and a cheaper one was issued to keep at home; worksheets accompanying particular schemes were issued for homework and the books kept in school. Thus, the majority of pupils in Key Stage 3 and a significant number in Key Stage 4 only worked from textbooks during lessons under teacher guidance. 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 that they had to rely entirely on teacher guided input in lessons, or materials and resources outside school which often had few links with what was actually being taught and how it was being taught in school. In addition, and because pupils had limited access to textbooks, teachers did not show pupils how to use those books.

In France, the situation was quite different. Every pupil had a textbook provided by the school (or sometimes privately bought) to be used in school and at home during the school year. Traditionally, each year, one year-group of textbooks was purchased and renewed. As there are four years in the *collège*, every four years a new textbook was chosen by teachers of the school. Teachers mentioned that this has also changed in the light of financial constraints, but as a general rule it was still the case. They also said that this gave them a 'good rhythm' for revising their lesson plans, since in any year, new lessons needed to be developed for only a small fraction of their classes. The important point here is that every pupil had a mathematics textbook provided by the school and most teachers asked pupils to bring those books to every lesson. Moreover, at the beginning of the school year teachers introduced pupils to those 'new' books and showed them how to use them. Lesson observations show that teachers explained the structure of the textbooks (*activités- l'essentiel- exercices)*. For example, they referred to the *pages bleues* (revision chapters of the previous years) or the mini-dictionary at the back of the book and how these could be used by pupils to help them in their work. Thus, not only did pupils have a relatively recent textbook for their own use, but teachers also helped them to use that book.

In Germany, yet another picture was painted. Pupils had to buy their own textbooks which were selected by schools/teachers from a 'schoolbook catalogue' provided by the ministry. Only in case of 'hardship' (i.e. if parents did not have the financial means to buy the textbooks) would the school provide the textbooks. This was particularly evident in the *Hauptschule*, where some pupils 'borrowed' the textbooks from the school. Because teachers knew that textbooks meant a considerable financial burden for parents, textbooks were not often changed. As a general rule, schools had to keep using a particular textbook for at least five years. At the end of the school year, a 'book market' (*Schulbuchbasar*) was usually organised, so that textbooks could be purchased second hand. Teachers also helped to organise exchanges and purchases of second hand books between pupils outside this market. Interestingly, and this could be explained with the parental involvement in terms of finances when buying textbooks, teacher were very aware of parents' opinions on the quality of and of the financial costs involved with textbooks. For example, teachers remarked that parents liked/disliked certain textbooks and the 'five-year-rule' was generally strictly adhered to because pupils could pass textbooks on to their younger brothers or sisters in the school. The important point here is that every pupil had a mathematics textbook, either bought or borrowed, to be brought to every lesson and used at home. One teacher even mentioned that pupils should make the book 'their own' by writing their own notes in it.

3. Use of textbooks

Across the three countries, to a greater or lesser extent, textbooks were used for three kinds of activities: for teaching in order to lay down rules and conditions; for explaining the logical processes and going through worked examples; and for the provision of exercises to practice. Teachers in all three countries emphasised the use of textbooks for exercises. There were, however, differences in the extent teachers used them with respect to the two other categories. French teachers, for example, used the books for explanations, but 'insisted' on

[1] In England, compulsory schooling is divided into four key stages. The teachers in this study taught pupils in Key Stage 3 (age 11-14) and Key Stage 4 (14-16).

providing the rules and essence of the lesson (*cours*) without and in a different way than the book. German teachers deliberately used different worked examples from those in the textbooks, in order to initiate class discussion about the problems that might be encountered. English teachers mostly introduced and explained a concept or skill to students, gave examples on the board and then expected pupils to practice on their own or with someone nearby. The exercises were usually given from the textbooks, while they saw their duty to attend to individual pupils or attend to other teaching related duties.

3.1 Teachers' use of textbooks in lessons

Whilst all teachers emphasised the importance of textbooks in their lessons and for their teaching, there was considerable variation in the classroom use of textbooks. The ten mathematics teachers teaching in English schools and interviewed for this research all used textbooks regularly. Almost all of that use in lesson time was for pupils to practice exercises selected by the teacher, following on from teacher explanation of a particular skill or technique. All the teachers in this research were either already heavy users of textbooks or were becoming increasingly so. They reported this increase as being due to lack of time to prepare other materials and resources.

"I use textbooks in most lessons and our whole scheme of work is written around the textbook." (JBF)

"… whatever topic it is I would deliver it in the most interesting way I can think of and the most investigative way I can think of and then I need them to practise, so I need exercises; I don't need a textbook that tells me how to do it, because I know how to do it." (JBLH)

"We are hard pressed for time and we're much more hard pressed than we were fifteen or so years ago, very much more so, the teaching load is horrendous, in terms of the amount of free time you have and also the assessments you are asked to give and within the school the number of meetings you are asked to attend, everything just takes so much more time." (MSH)

"And because it's set out (in text books), it makes life that little bit easier." (RHJM)

Most teachers interviewed were experienced mathematics teachers and what they said they wanted from the textbook was exercises for pupils to work through. They said they were less concerned with explanations in textbooks or with suggested teaching approaches or activities, although they looked through these for new ideas or approaches which they might or might not choose to use. They saw their role as being in charge of what to teach [within school and National Curriculum constraints], in what order, how to teach it, and the extent and nature of the practice needed. Thus the coherence and accuracy of the mathematics in the textbooks; the ordering of the topics in the textbooks; and the view of mathematics represented in the textbooks were seen as largely irrelevant.

"I use it for the pupils to practise the skills that I've previously introduced, so I expect to teach the topic and whatever method may be necessary and to do all explanations and then I use the exercises in the textbooks for the pupils to complete; … they don't use it to teach themselves. We teach them and the pupils then practise the skills." (JBF)

"Even though I've been doing the job for years, … one of the things we like about textbooks, is that it gives us new ideas. Or may be ideas that we've not used for ten years and forgot." (ICF)

"I would regard that as my duty to [decide on] my introduction to a topic. … I don't regard that as the duty of the textbook, that's for me, not for the textbook." (JBF)

Most French and German teachers said that they used textbooks *every* lesson, and they claimed that textbooks were one of their main resources, compared with worksheets and information technology, for example. In terms of pedagogic style with respect to the use of textbooks, one German *Gymnasium* teacher (RGG) asserted the following:

"…ich gebrauche Schulbücher selten in der Erarbeitungsphase, wesentlich in der Festigungsphase und zum űben. … Erarbeitungsphase läuft meistens anhand von Beispielen, die ich also selber vortrage, aber dann beziehen sie sich durchaus auf das Schulbuch auch, also daß man die Übungsphase direkt anschließen kann. …, daß das abgestimmt, und auch die Begrifflichkeit dem Schulbuch entspricht, manchmal nehme ich auch die Beispiele aus diesem Schulbuch oder aus anderen Schülbüchern, um dann die Übungsphasen aus diesem Schulbuch dann wirklich auch gleich anschließen zu können." (RGG) [… I seldom use textbooks during the acquisition phase, [but] mainly in the consolidation phase and to practice. … the acquisition phase is mainly made of examples which I present, but which relate to the textbook, in order that one can connect directly when it comes to the exercises phase … that it is co-ordinated, and that the language relates to the textbook, sometimes I take the examples from the book, or out of other textbooks, so that the exercise phase can directly follow…"]

Another *Gymnasium teacher* supported this:

„…ich sag mal Hauptschwerpunkte ist in der Festigung und in der Übungsphase setze ich diese Lehrbücher ein. In der Erarbeitung …zum Teil, weil ich denke die Schüler erwarten einfach, daß man nicht nur so an das Buch geklammert ist sondern daß man sich ganz locker einfach über Mathematik einfach nur unterhält, und ich versuche die Schüler dort abzuholen, wo sie gerade stehen und deswegen führe ich am Anfang häufig ein Gespräch mit den Schülern aus dem sie ihre eigenen Erfahrungen darlegen können, und ich versuche dann daraus das mathematische Problem zu entwickeln." (MGG) […I'd say that the emphasis is in the consolidation phase and I use textbooks in [that] … phase. During the acquisition phase … partly, because I think that pupils expect that one does not stick rigidly to the book, but that one talks about mathematics in an unstructured way, and I try to collect the pupil where s/he they actually stand, and that is why at the start [of the lesson] I often have a concersation with the pupils where they present to me their experiences, and I try to develop a mathematical problem from this]

This indicates that in particular *Gymnasium* teachers had a clear perception of the different phases of a lesson: (1)*Erarbeitungsphase* (acquisition phase); (2)*Festigungsphase* (consolidation phase) and (3)*Űbungsphase* (exercise phase). The two *Gymnasium* teachers used this vocabulary in the same way, although they were not teaching in the same school, whereas the *Hauptschul* teacher used a slightly different form to explain her use of textbooks: she mentioned only the exercise phase.

"… in jeder Unterrichtsstunde. Hauptsächlich für Übungen;

Einführungen mache ich man dann oft mit eigenen Materialen und an der Tafel, und es wird stets von mir gebraucht eben bei Hausaufgaben." (KHG) [… in every lesson, mainly for exercises; introductions I do with my own materials and at the board, and I always use [the textbooks] for homework.]

This is likely to be due to the different teacher education systems for the different school forms in Germany: *Gymnasium* Grammar school)- *Realschule* (Technical school)- *Hauptschule* (secondary Moderns school). What was striking was that the *Hauptschul* teacher not only used a simpler way to describe her lessons in terms of phases, but she also did not elaborate in the same way about the role of the textbooks in this scenario. The German *Gymnasium* teachers' talk also reflected a desire for the lesson to be coherent in its structure and content. This was less apparent with the *Hauptschul* teachers. In more general terms, it can be said, and observations supported that, that there were different classroom cultures in the *Gymnasium* and in the *Hauptschule*. The fact that different textbooks were used in the different school types also supports this. *Gymnasium* teachers explained their 'style' with the ways they wished pupils to work: they wanted pupils to be led to the notion with a 'problem-orientated' lesson (RGG). They wanted to engage pupils in mathematical thinking about the problem at hand, and then deduce the more general notion from this 'problem'. They claimed that the 'real understanding' only came out of the 'lesson conversation' (RGG) which was coherent and problem-orientated, and which connected, finally, to exercises in the book.

This stood in slight contrast to the *Hauptschul* teachers' explanation for using books. They believed that their pupils in this school form needed the teachers' explanations (and not the book) in order to understand, partly because they could not 'read properly', partly because they said that they did not know how to concentrate without the help of the teacher. They clearly saw themselves as the only channel for their pupils to understand mathematics, which resonates with English teachers' perceptions, particularly for low attaining pupils. Interestingly, German *Hauptschul* also mentioned the book as an essential feature of their lessons in the sense of providing a signal that they were in a mathematics lesson and also providing material security:

"…ich hab so das Gefühl, für sie ist es auch so ein Halt, da wird am Anfang des Unterrichts das Buch ausgepackt, und das Heft dazu gelegt und das Mäppchen, so und jetzt haben sie eben Mathematik, und dann haben sie das Buch irgendwo als, ja, Gerüst auch, und Halt und Hausaufgaben vor allen Dingen kann ich in dem Buch dann aufgeben, das ist ist mir sehr wichtig." (KHG) [I have the feeling [that] for them it is a kind of security; at the beginning of the lesson the textbook is taken out, and the book is put next to it and the pencil case, and now they have a mathematics lesson, and they have the textbook as frame and also as a support, and I can give homework from the book, that is important for me.]

It is clear here that even the physical presence of the textbook was part of the classroom culture, it belonged to it in the same way as the other equipment and had to be brought to all lessons. Moreover, in more pedagogical terms, it seemed to give the teacher an important role because pupils were perceived not to be able to read the mathematics for themselves, but rather the teacher needed to explain and help them with the exercises in the book.

French teachers also heavily used the textbooks. Their lesson appeared to be divided into three parts: *activité* (cognitive activity or introductory exercise); *cours* (written statement containing the essential mathematical outcomes of the lesson); *exercices* (practice exercises). The activities were meant to introduce the notion. The textbook was used by different teachers for different parts, but they all wanted to do the *cours* by themselves, without the book. Most French teachers asserted that they used textbooks

"…tout le temps … pour les activités et pour les exercices, très souvent. Bon de temps en temps parfois il y a des activités que je fais moi-même ou des exercices que je leur donne en complément, … , mais sinon je l'utilise très très souvent. … aussi, je montre aux élèves qu'il y a le cours là-dedans, qu'ils peuvent retrouver, comparer à ce que nous on a écrit, …" (MUF) [… all the time … for the activities and for exercises, very often. Well, from time to time, sometimes there are activities that I invent myself, or exercises that I give them to complement… but otherwise I use them very very often … also, I show the pupils that there is a *cours* in there that they can find and which they can compare with what we have written …]

"… toujours par activités, une activité, le retenons, exercice d'application, toujours le même principe chez moi. En sixième, en troisième, c'est pareil, exactement pareil." (REF) [… always with an activity, an activity, the to-be-remembered, application exercise, always the same principle with me. In year 7, in year 10, it is the same, exactly the same.]

It may not be surprising that French teachers described their lesson consistently in this way, since they formed part of the directives from the inspectors and in-service providers. To summarise, all French teachers mentioned the three phases and, to a larger or lesser extent, described their lessons in terms of these three phases.

In the same way as the German and English teachers, French teachers also valued the exercises in textbooks. Like their European colleagues, they wanted to have a good spread of exercises in textbooks.

" J'utilise les livres essentiellement pour les exercices. … [when asked what he values about textbooks]…les exercices, oui, et puis au niveau de la leçon, la progression." (CRF) […I use the books mainly for the exercises… [asked what he values about textbooks] … the exercises, yes, and then in my teaching, the progression …]

"…, et pour les activités et pour les exercices." (MUF) […[he uses the textbook] for the activities and for the exercises …]

"…ce qui nous a surtout intéressé, c'est les exercices, parce que là c'est bien fait…" (REF) […what has interested us in particular are the exercises, because they are well done…]

3.2 Differentiation in relation to the use of textbooks

In Germany and England, different textbooks were published for different achievement groups. In Germany, differences were made between mathematics textbooks for the three school forms of the tri-partite system: the *Gymnasium* (grammar school); the *Realschule* (technical school); and the *Hauptschule* (secondary modern). In England, where pupils were usually 'setted' for each subject, three 'levels' of textbooks usually existed for different achievement groups which differed in content as

well as in text complexity. Only in France it was expected that all pupils followed the same textbook in any particular year. This particularity of France can be viewed in the light of egalitarian views, but also in terms of historical developments which are, in turn, influenced by prevailing cultural and philosophical traditions. Historically, the Haby reforms of 1975 established an essentially common core of lower secondary education, the *collège unique*, and in 1977 a common curriculum was introduced. Since then, the subsequent education ministers have fought hard to prevent *les filières* (streaming). They argue that every child has the right to the entire curriculum which is reflected in a common textbook for all pupils of an age group.

In England, pupil access to textbooks was often determined by Key Stage, and by perceived ability of the pupils. There seemed to be an implicit assumption that textbooks were needed more at Key Stage 4, although an added difficulty for some teachers was that of finding an appropriate textbook for 'low ability' pupils. 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 and often the lack of an appropriate textbook anyway, it seems that 'low ability' 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.

"Interviewer: So there would never be an occasion then when a pupil would have used a textbook in school and will take it home and do something from that at home

JW: No.

Interviewer: Not even in Year 11 ?

JW: Very rarely.

Interviewer: And that's a financial decision, is it ?

JW: Largely, largely it is a financial decision." (JWH)

"…out of 6 classes in Year 11 [age 16] the top three or four may have books issued but it tends to go with ability, the lower ability won't have books issued to them and that is purely because on the whole they can't be reliable enough to look after them and bring them in, and then you end up with the situation when you want to do some work from the book and it is not there, so that's where it comes down to." (JWH)

All teachers in England 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 needs of low ability pupils were heavily influenced by concerns about context, layout and language demands. 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 need 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 in Key Stage 3, that their use was restricted in those lessons to exercises, and that teachers mediated the language used in the exercises, pupils 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.

"[for top sets] I'm still looking for practice exercises, but with a bit more challenge to them, so whatever I do, can the textbook exercises take them on a bit further, so that's what I am looking for, lots of practice all the time, with top-set." (JBLH)

"Intermediate students do not need intriguing exercises otherwise they can't do them ! You know, they don't need to be taxed, they've got to be pretty straight forward." (LSL)

"…but children in the lower sets do not necessarily have a textbook and certainly the Year 11 I have which is a set 9, we do not have a textbook for them, there is not a suitable textbook that we have in the Department for them, which doesn't frighten them because there is just too much in these books, they need to be spoon-fed, they need being given short, concise examples they can follow and then having ten of the same really to do." (MMLH)

"…sometimes they don't listen to the instructions and I think sometimes they don't read them and they don't understand them when they read them, or they read the words without sort of knowing what it is actually asking them to do and so they still do it wrong, Honestly, I always tend to do an introduction myself from the board rather than saying "Read this and get on with it". I think they are used to being told things as opposed to reading and learning for themselves." (AKJM)

An extract from fieldnotes taken during teacher observation includes:

"… after teacher explanation, girls put up their hands at a nearby table. I have not seen them reading the textbook. JW tells them the questions are just like the ones she's shown them already and the girls express surprise. JW tells them how to do the first question. The girls complete it and put up their hands again. One calls out 'miss, I can't do this one [question 2]'. The pupils sit and chat while they wait for JW to come back to them. There is an explanation in the textbook but I have not seen anyone referring to it." (Obs JWH)

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 short recipe-like teaching of algorithms followed by exercises. On the other hand, with the higher 'ability' pupils in the *Hauptschule* teachers' style resembled that of the *Gymnasium* with its emphasis on the whole class development of ideas.

"…das kommt jetzt wieder von Klasse auf Klasse an. Also, im A Kurs benutze ich mehr meine eigenen noch mit, und während im Grundkurs, die brauchen mehr ihr Buch,….was sie dann auch zu Hause nachschlagen können … das ist so wie ein Gerüst. Während der A Kurs oft auch dann so, eher schneller auch was von Folien abschreibt. Ich muß ja auch immer daran

denken, wie schnell können sie etwas übernehmen, von der Tafel oder den Folien …Schüler, die A Kurs Schüler sind ja auch meistens die besseren in Deutsch und die sind dann schneller und fitter … , und ich muß sagen, im B Kurs benutze ich mehr das Buch als im A Kurs; im B Kurs vielleicht 60% …" (KHG) [it depends from class to class. In the A-course [for better pupils] I also use my own [materials], whereas in the basic course, they need the textbook more … that they can look it up at home … it is like a support frame. Whereas the A-course can easier copy something from the board. I always have to bear in mind how fast they can copy something, from the board or from the OHP … pupils who are in the A-course are usually better in German and they are faster and fitter… and I have to say that in the B-course, I use the textbook more often than in the A-course, in the B-course maybe 60 per cent …]

This suggests that the textbook was meant to give low achieving pupils a frame and support for learning, whereas higher achieving pupils were expected to cope with a system rather more similar to the *Gymnasium* where the approach was more conversational for the teaching phase.

Interestingly, the German *Gymnasium* teachers did not make this distinction amongst their pupils and the use of textbooks with different pupils, possibly because they felt that those who could not cope with the intellectual level of the grammar school could go to one of the other school forms. In some ways, differentiation was not high on the agenda. However, the differentiation these teachers wished to make were with respect to different levels of exercises, 'mixed exercises', so that pupils could find 'their own rhythm'. They also believed that textbooks exemplified to pupils 'how to work systematically':

"…und sie müssen eben auch lernen, systematisch zu arbeiten und sich auch etwas einzuteilen, und hier ist in den Büchern eigentlich ja das so vorgemacht…" (MGG) [… and they have to learn to work systematically and to organise themselves, and here in the textbook they are shown how to do it …]

This role and use of the textbook was not mentioned by the *Hauptschul* teachers, although systematic work was also part of their concern with their pupils. It appears that, although they valued systematic work, they did not expect their pupils to learn it from the textbooks but rather from teachers' explanations and presentations.

In terms of differentiation French teachers talked about differentiated exercises.

"Ce qui m'intéresse moi c'est avoir beaucoup d'exercices, mais de niveaux très variables parce que les classes sont de plus en plus hétérogènes et, bon j'arrive assez bien à gérer je trouve l'hétérogénéité des classes dans la mesure où je propose des exercices distincts selon le niveau de l'élève; c'est vraiment un peu à la carte, quoi, et au bout d'un moment ils acceptent assez facilement les élèves de ne pas faire tous les exercices, d'en faire quelques-uns, ceux qui veulent aller un peu plus loin, bon ils vont un peu plus loin, c'est un peu dans cet esprit là." (FEF) [What interests me is to have lots of exercises, but at different levels because the classes are more and more heterogeneous, and … I think of heterogeneity of classes in terms of where I propose distinct exercises according to the level of the pupil; that's really a bit a-la-carte, well, and after a while they accept quite easily not to do all the exercises, to do a few, those who want to go further, well, they go further, it's a bit in this kind of spirit.]

"Il sépare exercices de soutien, plus ou moins exercices faciles, et exercices d'approfondissement." (CRF) [They distinguish between support exercises, more or less difficult exercises, and deepening exercises.]

They expected textbooks to provide them with different kinds of exercises, so that they as teachers could pick and choose for different levels of attainment amongst pupils. It has to be emphasised that in France, the whole year used the same textbook, and it was the teachers' task to differentiate in lessons. Interestingly, teachers did not provide handouts for different cognitive levels of pupil achievement. Instead, they did the same lessons with all pupils, and simply chose different exercises. This practice could be explained in the light of the 'entitlement' idea, i.e. that every pupil is entitled to the same and complete curriculum in mathematics, which in turn is based on egalitarian views.

Conclusions

Textbooks occupy an important position in English, French and German classrooms and education. One could argue that textbooks would ideally be resources for teachers to use in designing their lessons and for pupils to enhance their learning, to name but a few of their functions. However, it is difficult to construct an ideal role for these texts.

The review of the literature on the analysis of mathematics textbooks and their use in classrooms raises important questions about textbooks as representations of the curriculum and about their role as a link between curriculum and pedagogy. In terms of methodology, there seem to be few reliable methods to encompass the various facets of textbooks and their use by teachers and pupils. Each method appears to favour a specific perspective on the whole picture.

Drawing on the findings of the study, it can be said that all teachers felt that they were in charge of their teaching and pupil learning. This included the selection of textbooks according to their criteria and their use in the classrooms.

When trying to 'paint a picture' and develop an understanding of the three countries, **English** textbooks appeared simple, both in terms of complexity and coherence. Questions were mostly straightforward applications of the worked examples provided. They were the routine-type where a 'taught' method was applied in relatively impoverished and non-real contexts and they only rarely required deeper levels of thinking from pupils. Pupil access to textbooks was limited, with many having no access beyond exercises set by teachers in class. Consequently, it is speculated that pupils could not have a sense of 'ownership' of the textbooks, nor of the textbook as a source and support of their independent learning. This, in turn, resulted in a complete reliance on the teacher as the only source of mathematics. Mathematics teachers in England relied increasingly on textbooks. They explained this in terms of shortage of time (for lesson preparation), and they particularly perceived novices and non-specialists to be completely reliant on textbooks. Teachers asked different things of textbooks for perceived 'ability' levels. This appeared to have serious consequences in that teachers seemed to limit the range of learning opportunities given to pupils because of

these perceived attainment levels. For example, it was a common perception that 'intermediate level' pupils could not tackle challenging problems, and thus were given routine questions to answer. Similarly, pupils outside 'top sets' were rarely given any opportunities to read and interpret mathematics from textbooks because of perceived difficulties with the language demand. In terms of educational traditions, it is difficult to 'see clearly' in England, because in recent years cultural traditions, such as the English liberal-humanistic and individualistic traditions (Pepin 1999a), have been overridden by a more technocratic approach. With justifications such as economic performance, parental expectations and the idea of raising standards, teachers are pushed to 'produce results', never mind the mathematical thinking and processes. Although traditionally regarded as 'poor' practice 'to teach by the book' (Doyle, 1992), teachers now feel forced to rely increasingly on textbooks because of their perceived lack of time. Their original concern for a more individualistic and child-centred approaches to teaching and learning is overridden by concerns for examination results and departmental or school league tables. Thus, at present the educational culture in England is that of change, perceived by politicians as change for the better- but without consideration that effective change involves change in the culture of the working group, with shared meanings by all concerned.

In **France**, textbooks were clearly structured into three parts: activity- *cours* – exercises. The activities were meant to attempt to stimulate pupil curiosity and questioning. There were graduated exercises with many demanding questions requiring insights and understanding from pupils. All pupils had textbooks and the same textbook was used by all pupils in the same year group. Schools provided textbooks and pupils kept them for one academic year. Teachers relied on textbooks mainly in terms of exercises, but also for (cognitive) activities. Beside choosing suitable exercises for pupils, teachers felt that there was one part of the lesson that was 'theirs'- the *cours*- and they prepared for that. Textbooks in France were mainly written by inspectors and tended to be in line with current thinking on perceived 'good practice'. However, teachers mediated the texts to the extent where some pupils experienced the pattern of '*cours* followed by exercises', whereas others were given the more problem-solving approach of cognitive activity-*cours*- exercises, depending on teachers' perceptions of learning. Nevertheless, it seemed to be teachers' aims to select stimulating exercises for pupils, in order to give them the opportunity to engage in the process of doing mathematics (as opposed to result-driven closed learning). In terms of educational traditions, the traditional encyclopaedic traditions are still recognisable, for example in teachers' concern for 'entitlement' of all pupils to the curriculum, an egalitarian view. Whilst it is vital to give every pupil access to the entire curriculum, it is not clear whether and how learning will take place. Every child brings a different set of assumptions and experiences to which the teacher has to attend, and French teachers talked about the 'classroom reality', the perceived heterogeneity of groups, which suggested to them a need to apply more individualistic approaches. This, however, has not been part of their education and traditional perceptions of teaching, neither did books consider these aspects. It is, again, left to the 'skill' of the individual teacher to 'bridge the gap' between 'theories of equality' and a heterogeneous audience to be brought up to examination standard.

In **Germany**, there are three textbooks geared towards the perceived achievement level of pupils in the three different school forms. However, all textbooks are clearly structured into mainly two parts: introductory exercise/s and the main notion, followed by; an extensive range of exercises. The level of complexity and coherence is relatively high in German mathematics textbooks, in particular with respect to mathematical logic and structure, but they often appear relatively 'dry' in their presentation, in particular in *Gymnasium* textbooks. Pupils in Germany were expected to buy their own textbooks, or borrow them from the school. In any case, all pupils had to bring their books to every mathematics lesson. This was part of the set-up and routine to have the textbook, book and pencil-case on the table. Teachers used textbooks mainly in terms of exercises in school and for homework. The introduction and explanation of the mathematical notions were expected to be provided by the teacher, in the most 'stimulating' way, but at the same time adhering to perceptions of mathematics as a logical construct to develop mathematical thinking. However, no support was given by books on how to tackle this coherence and logic of mathematics, or to bring it into line with pupil experiences, in particular for pupils of the *Hauptschule*. The teacher was left as the mediator in his/her attempt to make mathematical constructs coherent for learners. In terms of educational traditions, the traditional ideals of Humboldt's humanism are still detectable and upheld in the pedagogic approaches of German *Gymnasium* teachers and influence to a large extent the pedagogic culture of perceived 'good' mathematics teaching. The *Hauptschul* teachers find themselves in a difficult situation: how to teach the highly structured (but watered-down grammar school) mathematics to a low achieving and demotivated audience of children, where about one third have difficulties reading German, and have had life experiences (for example, as refugees) that teachers feel they cannot attend to in class.

To conclude, the findings of the research demonstrate that classroom cultures are shaped by at least two factors: teachers' pedagogic principles in their immediate school and classroom context; and a system's educational and cultural traditions as they develop over time. It is argued that mathematics classroom cultures need to be understood in terms of a wider cultural and systemic context, in order for shared understandings, principles and meanings to be established, whether for promotion of classroom reform or simply for developing a better understanding of this vital component of the mathematics education process.

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